Common Workflow Language reference implementation

Release 3.1.20240404144622.dev5+g81b5f84

Peter Amstutz and Common Workflow Language Project contribu

May 03, 2024

CONTENTS:

PyPI:

Conda:

Debian:

Quay.io (Docker):

This is the reference implementation of the Common Workflow Language open standards. It is intended to be feature complete and provide comprehensive validation of CWL files as well as provide other tools related to working with CWL.

`cwltool` is written and tested for Python `3.x {x = 6, 8, 9, 10, 11}`

The reference implementation consists of two packages. The `cwltool` package is the primary Python module containing the reference implementation in the `cwltool` module and console executable by the same name.

The `cwlref-runner` package is optional and provides an additional entry point under the alias `cwl-runner`, which is the implementation-agnostic name for the default CWL interpreter installed on a host.

`cwltool` is provided by the CWL project, a member project of Software Freedom Conservancy and our many contributors.

Table of Contents

CHAPTER

ONE

INSTALL

1.1 `cwltool` packages

Your operating system may offer cwltool directly. For Debian, Ubuntu, and similar Linux distribution try

```
sudo apt-get install cwltool
```

If you encounter an error, first try to update package information by using

```
sudo apt-get update
```

If you are running macOS X or other UNIXes and you want to use packages prepared by the conda-forge project, then please follow the install instructions for conda-forge (if you haven't already) and then

```
conda install -c conda-forge cwltool
```

All of the above methods of installing `cwltool` use packages that might contain bugs already fixed in newer versions or be missing desired features. If the packaged version of `cwltool` available to you is too old, then we recommend installing using `pip` and `venv`

```
python3 -m venv env      # Create a virtual environment named 'env' in the current␣
↪directory
source env/bin/activate  # Activate environment before installing `cwltool`
```

Then install the latest `cwlref-runner` package from PyPi (which will install the latest `cwltool` package as well)

```
pip install cwlref-runner
```

If installing alongside another CWL implementation (like `toil-cwl-runner` or `arvados-cwl-runner`) then instead run

```
pip install cwltool
```

1.2 MS Windows users

1. Install Windows Subsystem for Linux 2 and Docker Desktop.
2. Install Debian from the Microsoft Store.
3. Set Debian as your default WSL 2 distro: `wsl --set-default debian`.
4. Return to the Docker Desktop, choose `Settings` → `Resources` → `WSL Integration` and under "Enable integration with additional distros" select "Debian",
5. Reboot if you have not yet already.
6. Launch Debian and follow the Linux instructions above (`apt-get install cwltool` or use the `venv` method)

Network problems from within WSL2? Try these instructions followed by `wsl --shutdown`.

1.3 `cwltool` development version

Or you can skip the direct `pip` commands above and install the latest development version of `cwltool`:

```
git clone https://github.com/common-workflow-language/cwltool.git # clone (copy) the␣
↪cwltool git repository
cd cwltool           # Change to source directory that git clone just downloaded
pip install .[deps]  # Installs ``cwltool`` from source
cwltool --version    # Check if the installation works correctly
```

Remember, if co-installing multiple CWL implementations, then you need to maintain which implementation `cwl-runner` points to via a symbolic file system link or another facility.

1.4 Recommended Software

We strongly suggested to have the following installed:

- One of the following software container engines
  - Podman
  - Docker
  - Singularity/Apptainer: See *Using Singularity*
  - udocker: See *Using uDocker*
- node.js for evaluating CWL Expressions quickly (required for *udocker* users, optional but recommended for the other container engines).

Without these, some examples in the CWL tutorials at http://www.commonwl.org/user_guide/ may not work.

CHAPTER

TWO

RUN ON THE COMMAND LINE

Simple command:

```
cwl-runner my_workflow.cwl my_inputs.yaml
```

Or if you have multiple CWL implementations installed and you want to override the default cwl-runner then use:

```
cwltool my_workflow.cwl my_inputs.yml
```

You can set cwltool options in the environment with `CWLTOOL_OPTIONS`, these will be inserted at the beginning of the command line:

```
export CWLTOOL_OPTIONS="--debug"
```

2.1 Use with boot2docker on macOS

boot2docker runs Docker inside a virtual machine, and it only mounts `Users` on it. The default behavior of CWL is to create temporary directories under e.g. `/Var` which is not accessible to Docker containers.

To run CWL successfully with boot2docker you need to set the `--tmpdir-prefix` and `--tmp-outdir-prefix` to somewhere under `/Users`:

```
$ cwl-runner --tmp-outdir-prefix=/Users/username/project --tmpdir-prefix=/Users/username/
↪project wc-tool.cwl wc-job.json
```

2.2 Using uDocker

Some shared computing environments don't support Docker software containers for technical or policy reasons. As a workaround, the CWL reference runner supports using the udocker program on Linux using `--udocker`.

udocker installation: https://indigo-dc.github.io/udocker/installation_manual.html

Run *cwltool* just as you usually would, but with `--udocker` prior to the workflow path:

```
cwltool --udocker https://github.com/common-workflow-language/common-workflow-language/
↪raw/main/v1.0/v1.0/test-cwl-out2.cwl https://github.com/common-workflow-language/
↪common-workflow-language/raw/main/v1.0/v1.0/empty.json
```

As was mentioned in the *Recommended Software* section,

2.3 Using Singularity

`cwltool` can also use Singularity version 2.6.1 or later as a Docker container runtime. `cwltool` with Singularity will run software containers specified in `DockerRequirement` and therefore works with Docker images only, native Singularity images are not supported. To use Singularity as the Docker container runtime, provide `--singularity` command line option to `cwltool`. With Singularity, `cwltool` can pass all CWL v1.0 conformance tests, except those involving Docker container ENTRYPOINTs.

Example

```
cwltool --singularity https://github.com/common-workflow-language/common-workflow-
↪language/raw/main/v1.0/v1.0/cat3-tool-mediumcut.cwl https://github.com/common-workflow-
↪language/common-workflow-language/raw/main/v1.0/v1.0/cat-job.json
```

2.4 Running a tool or workflow from remote or local locations

`cwltool` can run tool and workflow descriptions on both local and remote systems via its support for HTTP[S] URLs.

Input job files and Workflow steps (via the *run* directive) can reference CWL documents using absolute or relative local filesystem paths. If a relative path is referenced and that document isn't found in the current directory, then the following locations will be searched: http://www.commonwl.org/v1.0/CommandLineTool.html#Discovering_CWL_documents_on_a_local_filesystem

You can also use cwldep to manage dependencies on external tools and workflows.

2.5 Overriding workflow requirements at load time

Sometimes a workflow needs additional requirements to run in a particular environment or with a particular dataset. To avoid the need to modify the underlying workflow, cwltool supports requirement "overrides".

The format of the "overrides" object is a mapping of item identifier (workflow, workflow step, or command line tool) to the process requirements that should be applied.

```
cwltool:overrides:
  echo.cwl:
    requirements:
      EnvVarRequirement:
        envDef:
          MESSAGE: override_value
```

Overrides can be specified either on the command line, or as part of the job input document. Workflow steps are identified using the name of the workflow file followed by the step name as a document fragment identifier "#id". Override identifiers are relative to the top-level workflow document.

```
cwltool --overrides overrides.yml my-tool.cwl my-job.yml
```

```
input_parameter1: value1
input_parameter2: value2
cwltool:overrides:
  workflow.cwl#step1:
    requirements:
```

(continues on next page)

(continued from previous page)

```
    EnvVarRequirement:
      envDef:
        MESSAGE: override_value
```

```
cwltool my-tool.cwl my-job-with-overrides.yml
```

2.6 Combining parts of a workflow into a single document

Use `--pack` to combine a workflow made up of multiple files into a single compound document. This operation takes all the CWL files referenced by a workflow and builds a new CWL document with all Process objects (CommandLineTool and Workflow) in a list in the `$graph` field. Cross references (such as `run:` and `source:` fields) are updated to internal references within the new packed document. The top-level workflow is named `#main`.

```
cwltool --pack my-wf.cwl > my-packed-wf.cwl
```

2.7 Running only part of a workflow

You can run a partial workflow with the `--target` (`-t`) option. This takes the name of an output parameter, workflow step, or input parameter in the top-level workflow. You may provide multiple targets.

```
cwltool --target step3 my-wf.cwl
```

If a target is an output parameter, it will only run only the steps that contribute to that output. If a target is a workflow step, it will run the workflow starting from that step. If a target is an input parameter, it will only run the steps connected to that input.

Use `--print-targets` to get a listing of the targets of a workflow. To see which steps will run, use `--print-subgraph` with `--target` to get a printout of the workflow subgraph for the selected targets.

```
cwltool --print-targets my-wf.cwl

cwltool --target step3 --print-subgraph my-wf.cwl > my-wf-starting-from-step3.cwl
```

2.8 Visualizing a CWL document

The `--print-dot` option will print a file suitable for Graphviz `dot` program. Here is a bash onliner to generate a Scalable Vector Graphic (SVG) file:

```
cwltool --print-dot my-wf.cwl | dot -Tsvg > my-wf.svg
```

2.9 Modeling a CWL document as RDF

CWL documents can be expressed as RDF triple graphs.

```
cwltool --print-rdf --rdf-serializer=turtle mywf.cwl
```

2.10 Environment Variables in cwltool

This reference implementation supports several ways of setting environment variables for tools, in addition to the standard `EnvVarRequirement`. The sequence of steps applied to create the environment is:

0. If the `--preserve-entire-environment` flag is present, then begin with the current environment, else begin with an empty environment.
1. Add any variables specified by `--preserve-environment` option(s).
2. Set `TMPDIR` and `HOME` per the CWL v1.0+ CommandLineTool specification.
3. Apply any `EnvVarRequirement` from the `CommandLineTool` description.
4. Apply any manipulations required by any `cwltool:MPIRequirement` extensions.
5. Substitute any secrets required by `Secrets` extension.
6. Modify the environment in response to `SoftwareRequirement` (see below).

2.10.1 Leveraging SoftwareRequirements (Beta)

CWL tools may be decorated with `SoftwareRequirement` hints that cwltool may in turn use to resolve to packages in various package managers or dependency management systems such as Environment Modules.

Utilizing `SoftwareRequirement` hints using cwltool requires an optional dependency, for this reason be sure to use specify the `deps` modifier when installing cwltool. For instance:

```
$ pip install 'cwltool[deps]'
```

Installing cwltool in this fashion enables several new command line options. The most general of these options is `--beta-dependency-resolvers-configuration`. This option allows one to specify a dependency resolver's configuration file. This file may be specified as either XML or YAML and very simply describes various plugins to enable to "resolve" `SoftwareRequirement` dependencies.

Using these hints will allow cwltool to modify the environment in which your tool runs, for example by loading one or more Environment Modules. The environment is constructed as above, then the environment may modified by the selected tool resolver. This currently means that you cannot override any environment variables set by the selected tool resolver. Note that the environment given to the configured dependency resolver has the variable *_CWLTOOL* set to *1* to allow introspection.

To discuss some of these plugins and how to configure them, first consider the following `hint` definition for an example CWL tool.

```
SoftwareRequirement:
  packages:
  - package: seqtk
    version:
    - r93
```

Now imagine deploying cwltool on a cluster with Software Modules installed and that a `seqtk` module is available at version `r93`. This means cluster users likely won't have the binary `seqtk` on their `PATH` by default, but after sourcing this module with the command `modulecmd sh load seqtk/r93` `seqtk` is available on the `PATH`. A simple dependency resolvers configuration file, called `dependency-resolvers-conf.yml` for instance, that would enable cwltool to source the correct module environment before executing the above tool would simply be:

```
- type: modules
```

The outer list indicates that one plugin is being enabled, the plugin parameters are defined as a dictionary for this one list item. There is only one required parameter for the plugin above, this is `type` and defines the plugin type. This parameter is required for all plugins. The available plugins and the parameters available for each are documented (incompletely) here. Unfortunately, this documentation is in the context of Galaxy tool `requirement` s instead of CWL `SoftwareRequirement` s, but the concepts map fairly directly.

cwltool is distributed with an example of such seqtk tool and sample corresponding job. It could executed from the cwltool root using a dependency resolvers configuration file such as the above one using the command:

```
cwltool --beta-dependency-resolvers-configuration /path/to/dependency-resolvers-conf.yml␣
↪\
    tests/seqtk_seq.cwl \
    tests/seqtk_seq_job.json
```

This example demonstrates both that cwltool can leverage existing software installations and also handle workflows with dependencies on different versions of the same software and libraries. However the above example does require an existing module setup so it is impossible to test this example "out of the box" with cwltool. For a more isolated test that demonstrates all the same concepts - the resolver plugin type `galaxy_packages` can be used.

"Galaxy packages" are a lighter-weight alternative to Environment Modules that are really just defined by a way to lay out directories into packages and versions to find little scripts that are sourced to modify the environment. They have been used for years in Galaxy community to adapt Galaxy tools to cluster environments but require neither knowledge of Galaxy nor any special tools to setup. These should work just fine for CWL tools.

The cwltool source code repository's test directory is setup with a very simple directory that defines a set of "Galaxy packages" (but really just defines one package named `random-lines`). The directory layout is simply:

```
tests/test_deps_env/
  random-lines/
    1.0/
      env.sh
```

If the `galaxy_packages` plugin is enabled and pointed at the `tests/test_deps_env` directory in cwltool's root and a `SoftwareRequirement` such as the following is encountered.

```
hints:
  SoftwareRequirement:
    packages:
    - package: 'random-lines'
      version:
      - '1.0'
```

Then cwltool will simply find that `env.sh` file and source it before executing the corresponding tool. That `env.sh` script is only responsible for modifying the job's `PATH` to add the required binaries.

This is a full example that works since resolving "Galaxy packages" has no external requirements. Try it out by executing the following command from cwltool's root directory:

```
cwltool --beta-dependency-resolvers-configuration tests/test_deps_env_resolvers_conf.yml␣
↪\
    tests/random_lines.cwl \
    tests/random_lines_job.json
```

The resolvers configuration file in the above example was simply:

```
- type: galaxy_packages
  base_path: ./tests/test_deps_env
```

It is possible that the `SoftwareRequirement` s in a given CWL tool will not match the module names for a given cluster. Such requirements can be re-mapped to specific deployed packages or versions using another file specified using the resolver plugin parameter *mapping_files*. We will demonstrate this using *galaxy_packages,* but the concepts apply equally well to Environment Modules or Conda packages (described below), for instance.

So consider the resolvers configuration file. (*tests/test_deps_env_resolvers_conf_rewrite.yml*):

```
- type: galaxy_packages
  base_path: ./tests/test_deps_env
  mapping_files: ./tests/test_deps_mapping.yml
```

And the corresponding mapping configuration file (*tests/test_deps_mapping.yml*):

```
- from:
    name: randomLines
    version: 1.0.0-rc1
  to:
    name: random-lines
    version: '1.0'
```

This is saying if cwltool encounters a requirement of `randomLines` at version `1.0.0-rc1` in a tool, to rewrite to our specific plugin as `random-lines` at version `1.0`. cwltool has such a test tool called `random_lines_mapping.cwl` that contains such a source `SoftwareRequirement`. To try out this example with mapping, execute the following command from the cwltool root directory:

```
cwltool --beta-dependency-resolvers-configuration tests/test_deps_env_resolvers_conf_
↪rewrite.yml \
    tests/random_lines_mapping.cwl \
    tests/random_lines_job.json
```

The previous examples demonstrated leveraging existing infrastructure to provide requirements for CWL tools. If instead a real package manager is used cwltool has the opportunity to install requirements as needed. While initial support for Homebrew/Linuxbrew plugins is available, the most developed such plugin is for the Conda package manager. Conda has the nice properties of allowing multiple versions of a package to be installed simultaneously, not requiring evaluated permissions to install Conda itself or packages using Conda, and being cross-platform. For these reasons, cwltool may run as a normal user, install its own Conda environment and manage multiple versions of Conda packages on Linux and Mac OS X.

The Conda plugin can be endlessly configured, but a sensible set of defaults that has proven a powerful stack for dependency management within the Galaxy tool development ecosystem can be enabled by simply passing cwltool the `--beta-conda-dependencies` flag.

With this, we can use the seqtk example above without Docker or any externally managed services - cwltool should install everything it needs and create an environment for the tool. Try it out with the following command:

```
cwltool --beta-conda-dependencies tests/seqtk_seq.cwl tests/seqtk_seq_job.json
```

The CWL specification allows URIs to be attached to `SoftwareRequirement` s that allow disambiguation of package names. If the mapping files described above allow deployers to adapt tools to their infrastructure, this mechanism allows tools to adapt their requirements to multiple package managers. To demonstrate this within the context of the seqtk, we can simply break the package name we use and then specify a specific Conda package as follows:

```
hints:
  SoftwareRequirement:
    packages:
    - package: seqtk_seq
      version:
      - '1.2'
      specs:
      - https://anaconda.org/bioconda/seqtk
      - https://packages.debian.org/sid/seqtk
```

The example can be executed using the command:

```
cwltool --beta-conda-dependencies tests/seqtk_seq_wrong_name.cwl tests/seqtk_seq_job.json
```

The plugin framework for managing the resolution of these software requirements as maintained as part of galaxy-tool-util - a small, portable subset of the Galaxy project. More information on configuration and implementation can be found at the following links:

- Dependency Resolvers in Galaxy
- Conda for [Galaxy] Tool Dependencies
- Mapping Files - Implementation
- Specifications - Implementation
- Initial cwltool Integration Pull Request

2.11 Use with GA4GH Tool Registry API

Cwltool can launch tools directly from GA4GH Tool Registry API endpoints.

By default, cwltool searches https://dockstore.org/ . Use `--add-tool-registry` to add other registries to the search path.

For example

```
cwltool quay.io/collaboratory/dockstore-tool-bamstats:develop test.json
```

and (defaults to latest when a version is not specified)

```
cwltool quay.io/collaboratory/dockstore-tool-bamstats test.json
```

For this example, grab the test.json (and input file) from https://github.com/CancerCollaboratory/dockstore-tool-bamstats

```
wget https://dockstore.org/api/api/ga4gh/v2/tools/quay.io%2Fbriandoconnor%2Fdockstore-
↪tool-bamstats/versions/develop/PLAIN-CWL/descriptor/test.json
```

(continues on next page)

(continued from previous page)

```
wget https://github.com/CancerCollaboratory/dockstore-tool-bamstats/raw/develop/rna.
↪SRR948778.bam
```

2.12 Running MPI-based tools that need to be launched

Cwltool supports an extension to the CWL spec `http://commonwl.org/cwltool#MPIRequirement`. When the tool definition has this in its `requirements/hints` section, and cwltool has been run with `--enable-ext`, then the tool's command line will be extended with the commands needed to launch it with `mpirun` or similar. You can specify the number of processes to start as either a literal integer or an expression (that will result in an integer). For example:

```
#!/usr/bin/env cwl-runner
cwlVersion: v1.1
class: CommandLineTool
$namespaces:
  cwltool: "http://commonwl.org/cwltool#"
requirements:
  cwltool:MPIRequirement:
    processes: $(inputs.nproc)
inputs:
  nproc:
    type: int
```

Interaction with containers: the MPIRequirement currently prepends its commands to the front of the command line that is constructed. If you wish to run a containerized application in parallel, for simple use cases, this does work with Singularity, depending upon the platform setup. However, this combination should be considered "alpha" – please do report any issues you have! This does not work with Docker at the moment. (More precisely, you get *n* copies of the same single process image run at the same time that cannot communicate with each other.)

The host-specific parameters are configured in a simple YAML file (specified with the `--mpi-config-file` flag). The allowed keys are given in the following table; all are optional.

Key	Type	Default	Description
runner	str	"mpiru	The primary command to use.
nproc_flag	str	"-n"	Flag to set number of processes to start.
default_npro	int	1	Default number of processes.
extra_flags	List[str]	[]	A list of any other flags to be added to the runner's command line before the `baseCommand`.
env_pass	List[str]	[]	A list of environment variables that should be passed from the host environment through to the tool (e.g., giving the node list as set by your scheduler).
env_pass_	List[str]	[]	A list of python regular expressions that will be matched against the host's environment. Those that match will be passed through.
env_set	Mapping[str,sti	{}	A dictionary whose keys are the environment variables set and the values being the values.

2.13 Enabling Fast Parser (experimental)

For very large workflows, *cwltool* can spend a lot of time in initialization, before the first step runs. There is an experimental flag `--fast-parser` which can dramatically reduce the initialization overhead, however as of this writing it has several limitations:

- Error reporting in general is worse than the standard parser, you will want to use it with workflows that you know are already correct.
- It does not check for dangling links (these will become runtime errors instead of loading errors)
- Several other cases fail, as documented in https://github.com/common-workflow-language/cwltool/pull/1720

CHAPTER

THREE

DEVELOPMENT

3.1 Running tests locally

- Running basic tests (`/tests`):

To run the basic tests after installing *cwltool* execute the following:

```
pip install -rtest-requirements.txt
pytest   ## N.B. This requires node.js or docker to be available
```

To run various tests in all supported Python environments, we use tox. To run the test suite in all supported Python environments first clone the complete code repository (see the `git clone` instructions above) and then run the following in the terminal: `pip install "tox<4"; tox -p`

List of all environment can be seen using: `tox --listenvs` and running a specific test env using: `tox -e <env name>` and additionally run a specific test using this format: `tox -e py310-unit -- -v tests/test_examples.py::test_scandeps`

- Running the entire suite of CWL conformance tests:

The GitHub repository for the CWL specifications contains a script that tests a CWL implementation against a wide array of valid CWL files using the cwltest program

Instructions for running these tests can be found in the Common Workflow Language Specification repository at https://github.com/common-workflow-language/common-workflow-language/blob/main/CONFORMANCE_TESTS.md .

3.2 Import as a module

Add

```
import cwltool
```

to your script.

The easiest way to use cwltool to run a tool or workflow from Python is to use a Factory

```
import cwltool.factory
fac = cwltool.factory.Factory()

echo = fac.make("echo.cwl")
result = echo(inp="foo")

# result["out"] == "foo"
```

3.3 CWL Tool Control Flow

Technical outline of how cwltool works internally, for maintainers.

1. Use CWL `load_tool()` to load document.
    1. Fetches the document from file or URL
    2. Applies preprocessing (syntax/identifier expansion and normalization)
    3. Validates the document based on cwlVersion
    4. If necessary, updates the document to the latest spec
    5. Constructs a Process object using `make_tool()` callback. This yields a CommandLineTool, Workflow, or ExpressionTool. For workflows, this recursively constructs each workflow step.
    6. To construct custom types for CommandLineTool, Workflow, or ExpressionTool, provide a custom `make_tool()`
2. Iterate on the `job()` method of the Process object to get back runnable jobs.
    1. `job()` is a generator method (uses the Python iterator protocol)
    2. Each time the `job()` method is invoked in an iteration, it returns one of: a runnable item (an object with a `run()` method), `None` (indicating there is currently no work ready to run) or end of iteration (indicating the process is complete.)
    3. Invoke the runnable item by calling `run()`. This runs the tool and gets output.
    4. An output callback reports the output of a process.
    5. `job()` may be iterated over multiple times. It will yield all the work that is currently ready to run and then yield None.
3. `Workflow` objects create a corresponding `WorkflowJob` and `WorkflowJobStep` objects to hold the workflow state for the duration of the job invocation.
    1. The WorkflowJob iterates over each WorkflowJobStep and determines if the inputs the step are ready.
    2. When a step is ready, it constructs an input object for that step and iterates on the `job()` method of the workflow job step.
    3. Each runnable item is yielded back up to top-level run loop
    4. When a step job completes and receives an output callback, the job outputs are assigned to the output of the workflow step.
    5. When all steps are complete, the intermediate files are moved to a final workflow output, intermediate directories are deleted, and the workflow's output callback is called.
4. `CommandLineTool` job() objects yield a single runnable object.
    1. The CommandLineTool `job()` method calls `make_job_runner()` to create a `CommandLineJob` object
    2. The job method configures the CommandLineJob object by setting public attributes
    3. The job method iterates over file and directories inputs to the CommandLineTool and creates a "path map".
    4. Files are mapped from their "resolved" location to a "target" path where they will appear at tool invocation (for example, a location inside a Docker container.) The target paths are used on the command line.
    5. Files are staged to targets paths using either Docker volume binds (when using containers) or symlinks (if not). This staging step enables files to be logically rearranged or renamed independent of their source layout.

6. The `run()` method of CommandLineJob executes the command line tool or Docker container, waits for it to complete, collects output, and makes the output callback.

3.4 Extension points

The following functions can be passed to main() to override or augment the listed behaviors.

executor

```
executor(tool, job_order_object, runtimeContext, logger)
  (Process, Dict[Text, Any], RuntimeContext) -> Tuple[Dict[Text, Any], Text]
```

An implementation of the top-level workflow execution loop should synchronously run a process object to completion and return the output object.

versionfunc

```
()
  () -> Text
```

Return version string.

logger_handler

```
logger_handler
  logging.Handler
```

Handler object for logging.

The following functions can be set in LoadingContext to override or augment the listed behaviors.

fetcher_constructor

```
fetcher_constructor(cache, session)
  (Dict[unicode, unicode], requests.sessions.Session) -> Fetcher
```

Construct a Fetcher object with the supplied cache and HTTP session.

resolver

```
resolver(document_loader, document)
  (Loader, Union[Text, dict[Text, Any]]) -> Text
```

Resolve a relative document identifier to an absolute one that can be fetched.

The following functions can be set in RuntimeContext to override or augment the listed behaviors.

construct_tool_object

```
construct_tool_object(toolpath_object, loadingContext)
  (MutableMapping[Text, Any], LoadingContext) -> Process
```

Hook to construct a Process object (eg CommandLineTool) object from a document.

select_resources

```
selectResources(request)
  (Dict[str, int], RuntimeContext) -> Dict[Text, int]
```

Take a resource request and turn it into a concrete resource assignment.

make_fs_access

```
make_fs_access(basedir)
  (Text) -> StdFsAccess
```

Return a file system access object.

In addition, when providing custom subclasses of Process objects, you can override the following methods:

CommandLineTool.make_job_runner

```
make_job_runner(RuntimeContext)
  (RuntimeContext) -> Type[JobBase]
```

Create and return a job runner object (this implements concrete execution of a command line tool).

Workflow.make_workflow_step

```
make_workflow_step(toolpath_object, pos, loadingContext, parentworkflowProv)
  (Dict[Text, Any], int, LoadingContext, Optional[ProvenanceProfile]) ->␣
↪WorkflowStep
```

Create and return a workflow step object.

3.4.1 cwltool Command Line Options

cwltool

Reference executor for Common Workflow Language standards. Not for production use.

```
usage: cwltool [-h] [--basedir BASEDIR] [--outdir OUTDIR] [--log-dir LOG_DIR]
               [--parallel]
               [--preserve-environment ENVVAR | --preserve-entire-environment]
               [--rm-container | --leave-container]
               [--cidfile-dir CIDFILE_DIR] [--cidfile-prefix CIDFILE_PREFIX]
               [--tmpdir-prefix TMPDIR_PREFIX]
               [--tmp-outdir-prefix TMP_OUTDIR_PREFIX | --cachedir CACHEDIR]
               [--rm-tmpdir | --leave-tmpdir]
               [--move-outputs | --leave-outputs | --copy-outputs]
               [--enable-pull | --disable-pull]
               [--rdf-serializer RDF_SERIALIZER] [--eval-timeout EVAL_TIMEOUT]
               [--provenance PROVENANCE] [--enable-user-provenance]
               [--disable-user-provenance] [--enable-host-provenance]
               [--disable-host-provenance] [--orcid ORCID]
               [--full-name CWL_FULL_NAME]
               [--print-rdf | --print-dot | --print-pre | --print-deps | --print-input-
↪deps | --pack | --version | --validate | --print-supported-versions | --print-subgraph␣
↪| --print-targets | --make-template]
               [--strict | --non-strict] [--skip-schemas]
               [--no-doc-cache | --doc-cache]
               [--verbose | --no-warnings | --quiet | --debug]
               [--write-summary WRITE_SUMMARY] [--strict-memory-limit]
               [--strict-cpu-limit] [--timestamps] [--js-console]
```

(continues on next page)

(continued from previous page)

```
               [--disable-js-validation]
               [--js-hint-options-file JS_HINT_OPTIONS_FILE]
               [--user-space-docker-cmd CMD | --udocker | --singularity | --podman | --
↪no-container]
               [--tool-help] [--relative-deps {primary,cwd}] [--enable-dev]
               [--enable-ext] [--enable-color | --disable-color]
               [--default-container DEFAULT_CONTAINER] [--no-match-user]
               [--custom-net CUSTOM_NET]
               [--enable-ga4gh-tool-registry | --disable-ga4gh-tool-registry]
               [--add-ga4gh-tool-registry GA4GH_TOOL_REGISTRIES]
               [--on-error {stop,continue}]
               [--compute-checksum | --no-compute-checksum]
               [--relax-path-checks] [--force-docker-pull] [--no-read-only]
               [--overrides OVERRIDES]
               [--target TARGET | --single-step SINGLE_STEP | --single-process SINGLE_
↪PROCESS]
               [--mpi-config-file MPI_CONFIG_FILE]
               [cwl_document] ...
```

cwl_document

path or URL to a CWL Workflow, CommandLineTool, or ExpressionTool. If the *inputs_object* has a *cwl:tool* field indicating the path or URL to the cwl_document, then the *cwl_document* argument is optional.

inputs_object

path or URL to a YAML or JSON formatted description of the required input values for the given *cwl_document*.

-h, --help

show this help message and exit

--basedir <basedir>

--outdir <outdir>

Output directory. The default is the current directory.

--log-dir <log_dir>

Log your tools stdout/stderr to this location outside of container This will only log stdout/stderr if you specify stdout/stderr in their respective fields or capture it as an output

--parallel

Run jobs in parallel.

--preserve-environment <envvar>

Preserve specific environment variable when running CommandLineTools. May be provided multiple times. By default PATH is preserved when not running in a container.

--preserve-entire-environment

Preserve all environment variables when running CommandLineTools without a software container.

--rm-container

Delete Docker container used by jobs after they exit (default)

--leave-container

Do not delete Docker container used by jobs after they exit

--cidfile-dir <cidfile_dir>

Store the Docker container ID into a file in the specified directory.

--cidfile-prefix <cidfile_prefix>

Specify a prefix to the container ID filename. Final file name will be followed by a timestamp. The default is no prefix.

--tmpdir-prefix <tmpdir_prefix>

Path prefix for temporary directories. If –tmpdir-prefix is not provided, then the prefix for temporary directories is influenced by the value of the TMPDIR, TEMP, or TMP environment variables. Taking those into consideration, the current default is /tmp/.

--tmp-outdir-prefix <tmp_outdir_prefix>

Path prefix for intermediate output directories. Defaults to the value of –tmpdir-prefix.

--cachedir <cachedir>

Directory to cache intermediate workflow outputs to avoid recomputing steps. Can be very helpful in the development and troubleshooting of CWL documents.

--rm-tmpdir

Delete intermediate temporary directories (default)

--leave-tmpdir

Do not delete intermediate temporary directories

--move-outputs

Move output files to the workflow output directory and delete intermediate output directories (default).

--leave-outputs

Leave output files in intermediate output directories.

--copy-outputs

Copy output files to the workflow output directory and don't delete intermediate output directories.

--enable-pull

Try to pull Docker images

--disable-pull

Do not try to pull Docker images

--rdf-serializer <rdf_serializer>

Output RDF serialization format used by –print-rdf (one of turtle (default), n3, nt, xml)

--eval-timeout <eval_timeout>

Time to wait for a Javascript expression to evaluate before giving an error, default 60s.

--provenance <provenance>

Save provenance to specified folder as a Research Object that captures and aggregates workflow execution and data products.

--enable-user-provenance

Record user account info as part of provenance.

--disable-user-provenance

Do not record user account info in provenance.

--enable-host-provenance

Record host info as part of provenance.

--disable-host-provenance

Do not record host info in provenance.

--orcid <orcid>

Record user ORCID identifier as part of provenance, e.g. https://orcid.org/0000-0002-1825-0097 or 0000-0002-1825-0097. Alternatively the environment variable ORCID may be set.

--full-name <cwl_full_name>

Record full name of user as part of provenance, e.g. Josiah Carberry. You may need to use shell quotes to preserve spaces. Alternatively the environment variable CWL_FULL_NAME may be set.

--print-rdf

Print corresponding RDF graph for workflow and exit

--print-dot

Print workflow visualization in graphviz format and exit

--print-pre

Print CWL document after preprocessing.

--print-deps

Print CWL document dependencies.

--print-input-deps

Print input object document dependencies.

--pack

Combine components into single document and print.

--version

Print version and exit

--validate

Validate CWL document only.

--print-supported-versions

Print supported CWL specs.

--print-subgraph

Print workflow subgraph that will execute. Can combined with –target or –single-step

--print-targets

Print targets (output parameters)

--make-template

Generate a template input object

--strict

Strict validation (unrecognized or out of place fields are error)

--non-strict

Lenient validation (ignore unrecognized fields)

--skip-schemas

Skip loading of schemas

--no-doc-cache

Disable disk cache for documents loaded over HTTP

--doc-cache

Enable disk cache for documents loaded over HTTP

--verbose

Default logging

--no-warnings

Only print errors.

--quiet

Only print warnings and errors.

--debug

Print even more logging

--write-summary <write_summary>, **-w** <write_summary>

Path to write the final output JSON object to. Default is stdout.

--strict-memory-limit

When running with software containers and the Docker engine, pass either the calculated memory allocation from ResourceRequirements or the default of 1 gigabyte to Docker's –memory option.

--strict-cpu-limit

When running with software containers and the Docker engine, pass either the calculated cpu allocation from ResourceRequirements or the default of 1 core to Docker's –cpu option. Requires docker version >= v1.13.

--timestamps

Add timestamps to the errors, warnings, and notifications.

--js-console

Enable javascript console output

--disable-js-validation

Disable javascript validation.

--js-hint-options-file <js_hint_options_file>

File of options to pass to jshint. This includes the added option "includewarnings".

--user-space-docker-cmd <cmd>

(Linux/OS X only) Specify the path to udocker. Implies –udocker

--udocker

(Linux/OS X only) Use the udocker runtime for running containers (equivalent to –user-space-docker-cmd=udocker).

--singularity

Use Singularity or Apptainer runtime for running containers. Requires Singularity v2.6.1+ and Linux with kernel version v3.18+ or with overlayfs support backported.

--podman

Use Podman runtime for running containers.

--no-container

Do not execute jobs in a Docker container, even when *DockerRequirement* is specified under *hints*.

--tool-help

Print command line help for tool

--relative-deps {primary,cwd}

When using –print-deps, print paths relative to primary file or current working directory.

--enable-dev

Enable loading and running unofficial development versions of the CWL standards.

--enable-ext

Enable loading and running 'cwltool:' extensions to the CWL standards.

--enable-color

Enable logging color (default enabled)

--disable-color

Disable colored logging (default false)

--default-container <default_container>

Specify a default software container to use for any CommandLineTool without a DockerRequirement.

--no-match-user

Disable passing the current uid to *docker run –user*

--custom-net <custom_net>

Passed to *docker run* as the '–net' parameter when NetworkAccess is true, which is its default setting.

--enable-ga4gh-tool-registry

Enable tool resolution using GA4GH tool registry API

--disable-ga4gh-tool-registry

Disable tool resolution using GA4GH tool registry API

--add-ga4gh-tool-registry <ga4gh_tool_registries>

Add a GA4GH tool registry endpoint to use for resolution, default ['https://dockstore.org/api']

--on-error {stop,continue}

Desired workflow behavior when a step fails. One of 'stop' (do not submit any more steps) or 'continue' (may submit other steps that are not downstream from the error). Default is 'stop'.

--compute-checksum

Compute checksum of contents while collecting outputs

--no-compute-checksum

Do not compute checksum of contents while collecting outputs

--relax-path-checks

Relax requirements on path names to permit spaces and hash characters.

--force-docker-pull

Pull latest software container image even if it is locally present

--no-read-only

Do not set root directory in the container as read-only

--overrides <overrides>

Read process requirement overrides from file.

--target <target>, **-t** <target>

Only execute steps that contribute to listed targets (can be provided more than once).

--single-step <single_step>

Only executes a single step in a workflow. The input object must match that step's inputs. Can be combined with –print-subgraph.

--single-process <single_process>

Only executes the underlying Process (CommandLineTool, ExpressionTool, or sub-Workflow) for the given step in a workflow. This will not include any step-level processing: 'scatter', 'when'; and there will be no processing of step-level 'default', or 'valueFrom' input modifiers. However, requirements/hints from the step or parent workflow(s) will be inherited as usual.The input object must match that Process's inputs.

--mpi-config-file <mpi_config_file>

Platform specific configuration for MPI (parallel launcher, its flag etc). See README section 'Running MPI-based tools' for details of the format.

3.4.2 Loops

The `cwltool:Loop` requirement enables workflow-level looping of a step. It is valid only under `requirements` of a `WorkflowStep`. Unlike other CWL requirements, Loop requirement is not propagated to inner steps.

The `cwltool:Loop` is not compatible with `scatter` and `when`. Combining a `cwltool:Loop` requirement with a `scatter` or a `when` clause in the same step will produce an error.

The loop condition

The `loopWhen` field controls loop termination. It is an expansion of the CWL v1.2 `when` construct, which controls conditional execution. This is an expression that must be evaluated with `inputs` bound to the step input object and outputs produced in the last step execution, and returns a boolean value. It is an error if this expression returns a value other than `true` or `false`. For example:

```
example:
  run:
    class: ExpressionTool
    inputs:
      i1: int
    outputs:
      o1: int
    expression: >
      ${return {'o1': inputs.i1 + 1};}
  in:
    i1: i1
  out: [o1]
  requirements:
    cwltool:Loop:
      loopWhen: $(inputs.i1 < 10)
      loop:
        i1: o1
      outputMethod: last
```

This loop executes untile the counter `i1` reaches the value of 10, and then terminates. Note that if the `loopWhen` condition evaluates to `false` prior to the first iteration, the loop is skipped. The value assumed by the output fields depends on the specified `outputMethod`, as described below.

The loop field

The `loop` field defines the input parameters of the loop iterations after the first one (inputs of the first iteration are the step input parameters). If no loop rule is specified for a given step `in` field, the initial value is kept constant among all iterations.

The `LoopInput` is basically a reduced version of the `WorkflowStepInput` structure with the possibility to include outputs of the previous step execution in the `valueFrom` expression.

Field	Re-quire	Type	Description
`id`	op-tiona	string	It must reference the `id` of one of the elements in the `in` field of the step.
`loop`	op-tiona	string | string	Specifies one or more of the step output parameters that will provide input to the loop iterations after the first one (inputs of the first iteration are the step input parameters).
`link`	op-tiona	Linkl	The method to use to merge multiple inbound links into a single array. If not specified, the default method is `merge_nested`.
`pick`	op-tiona	Pick-Val-ueMe	The method to use to choose non-null elements among multiple sources.
`valu`	op-tiona	string | Ex-pres-sion	To use `valueFrom`, StepInputExpressionRequirement must be specified in the workflow or workflow step requirements. If `valueFrom` is a constant string value, use this as the value for this input parameter. If `valueFrom` is a parameter reference or expression, it must be evaluated to yield the actual value to be assigned to the input field. The `self` value in the parameter reference or expression must be `null` if there is no `loopSource` field, or the value of the parameter(s) specified in the `loopSource` field. The value of `inputs` in the parameter reference or expression must be the input object to the previous iteration of the workflow step (or the initial inputs for the first iteration).

Loop output modes

The `outputMethod` field specifies the desired method of dealing with loop outputs. It behaves similarly to the `scatterMethod` field. For the sake of simplicity, there can be a single `outputMethod` field for each step instead of specifying a different behaviour for each output element. The `outputMethod` field can take two possible values: `last` or `all`.

The `last` output mode propagates only the last computed element to the subsequent steps when the loop terminates. When a loop with an `outputMethod` equal to `last` is skipped, each output assumes a `null` value.

This is the most recurrent behaviour and it is typical of the optimization processes, when a step must iterate until a desired precision is reached. For example:

```
optimization:
  in:
    a: a
    prev_a:
      default: ${ return inputs.a - (2 * inputs.threshold) }
    threshold: threshold
  run: optimize.cwl
  out: [a]
  requirements:
    cwltool:Loop:
```

(continues on next page)

(continued from previous page)

```
      loopWhen: ${ return (inputs.a - inputs.prev_a) > inputs.threshold)
      loop:
        a: a
        prev_a:
          valueFrom: $(inputs.a)
      outputMethod: last
```

This loop keeps optimizing the initial `a` value until the error value falls below a given (constant) `threshold`. Then, the last values of `a` will be propagated.

The `all` output mode propagates a single array with all output values to the subsequent steps when the loop terminates. When a loop with an `outputMethod` equal to `all` is skipped, each output assumes a `[]` value.

This behaviour is needed when a recurrent simulation produces loop-carried results, but the subsequent steps need to know the total amount of computed values to proceed. For example:

```
simulation:
  in:
    a: a
    day:
      default: 0
    max_day: max_day
  run: simulate.cwl
  out: [a]
  requirements:
    cwltool:Loop:
      loopWhen: ${ return inputs.day < inputs.max_day }
      loop:
        a: a
        day:
          valueFrom: $(inputs.day + 1)
      outputMethod: all
```

In this case, subsequent steps can start processing outputs even before the `simulation` step terminates. When a loop with an `outputMethod` equal to `last` is skipped, each output assumes a `null` value.

Loop-independent iterations

If a `cwltool:Loop` comes with loop-independent iterations, i.e. if each iteration does not depend on the result produced by the previous ones, all iterations can be processed concurrently. For example:

```
example:
  run: inner.cwl
  in:
    i1: i1
  out: [o1]
  requirements:
    cwltool:Loop:
      loopWhen: $(inputs.i1 < 10)
      loop:
        i1:
          valueFrom: $(inputs.i1 + 1)
      outputMethod: all
```

Since each iteration of this loop only depends on the input field `i1`, all its iterations can be processed in parallel if there is enough computing power.

3.4.3 Provenance capture

It is possible to capture the full provenance of a workflow execution to a folder, including intermediate values:

```
cwltool --provenance revsort-run-1/ tests/wf/revsort.cwl tests/wf/revsort-job.json
```

Who executed the workflow?

Optional parameters are available to capture information about *who* executed the workflow *where*:

```
cwltool --orcid https://orcid.org/0000-0002-1825-0097 \
  --full-name "Alice W Land" \
  --enable-user-provenance --enable-host-provenance \
  --provenance revsort-run-1/ \
  tests/wf/revsort.cwl tests/wf/revsort-job.json
```

These parameters are opt-in as they track person-identifiable information. The options `--enable-user-provenance` and `--enable-host-provenance` will pick up account/machine info from where `cwltool` is executed (e.g. UNIX username). This may get the full name of the user wrong, in which case `--full-name` can be supplied.

For consistent tracking it is recommended to apply for an ORCID identifier and provide it as above, since `--enable-user-provenance --enable-host-provenance` are only able to identify the local machine account.

It is possible to set the shell environment variables `ORCID` and `CWL_FULL_NAME` to avoid supplying `--orcid` or `--full-name` for every workflow run, for instance by augmenting the `~/.bashrc` or equivalent:

```
export ORCID=https://orcid.org/0000-0002-1825-0097
export CWL_FULL_NAME="Stian Soiland-Reyes"
```

Care should be taken to preserve spaces when setting *–full-name* or *CWL_FULL_NAME*.

CWLProv folder structure

The CWLProv folder structure under `revsort-run-1` is a Research Object that conforms to the RO BagIt profile and contains PROV traces detailing the execution of the workflow and its steps.

A rough overview of the CWLProv folder structure:

- `bagit.txt` - bag marker for BagIt.
- `bag-info.txt` - minimal bag metadata. `The External-Identifier` key shows which arcp can be used as base URI within the folder bag.
- `manifest-*.txt` - checksums of files under `data/` (algorithms subject to change)
- `tagmanifest-*.txt` - checksums of the remaining files (algorithms subject to change)
- `metadata/manifest.json` - Research Object manifest as JSON-LD. Types and relates files within bag.
- `metadata/provenance/primary.cwlprov*` - PROV trace of main workflow execution in alternative PROV and RDF formats
- `data/` - bag payload, workflow/step input/output data files (content-addressable)

- `data/32/327fc7aedf4f6b69a42a7c8b808dc5a7aff61376` - a data item with checksum `327fc7aedf4f6b69a42a7c8b808dc5a7aff61376` (checksum algorithm is subject to change)
- `workflow/packed.cwl` - The `cwltool --pack` standalone version of the executed workflow
- `workflow/primary-job.json` - Job input for use with `packed.cwl` (references `data/*`)
- `snapshot/` - Direct copies of original files used for execution, but may have broken relative/absolute paths

See the CWLProv paper for more details.

Research Object manifest

The file `metadata/manifest.json` follows the structure defined for Research Object Bundles - but note that `.ro/` is instead called `metadata/` as this conforms to the RO BagIt profile.

Some of the keys of the CWLProv manifest are explained below:

```
"@context": [
    {
        "@base": "arcp://uuid,67f38794-d24a-435f-bd4a-0242a56a581b/metadata/"
    },
    "https://w3id.org/bundle/context"
]
```

This JSON-LD context enables consumers to alternatively consume the JSON file as Linked Data with absolute identifiers. The key for that is the `@base` which means URIs within this JSON file are relative to the `metadata/` folder within this Research Object bag, and the external JSON-LD .

Output from `cwltool` should follow the JSON structure shown beyond; however interested consumer may alternatively parse it as JSON-LD with a RDF triple store like Apache Jena for further querying.

The manifest lists which software version created the Research Object - we will hear more from this UUID later:

```
"createdBy": {
    "uri": "urn:uuid:7c9d9e88-666b-4977-85f4-c02da08a942d",
    "name": "cwltool 1.0.20180416145054"
}
```

Secondly the manifest lists the person who "authored the run" - that is put the workflow and inputs together with cwltool:

```
"authoredBy": {
    "orcid": "https://orcid.org/0000-0002-1825-0097",
    "name": "Stian Soiland-Reyes"
}
```

Note that the author of the workflow run may differ from the author of the workflow definition.

The list of aggregates are the main resources that this Research Object transports:

```
"aggregates": [
    {
        "uri": "urn:hash::sha1:53870991af88a6d678cbeed3255bb65993c52925",
        ...
    },
    { "provenance/primary.cwlprov.xml",
       ...
```

(continues on next page)

(continued from previous page)

```
    },
    {
        "uri": "../workflow/packed.cwl",
        "createdBy": {
            "uri": "urn:uuid:7c9d9e88-666b-4977-85f4-c02da08a942d",
            "name": "cwltool 1.0.20180416145054"
        },
        "conformsTo": "https://w3id.org/cwl/",
        "mediatype": "text/x+yaml; charset=\"UTF-8\"",
        "createdOn": "2018-04-16T18:27:09.513824"
    },
    {
        "uri": "../snapshot/hello-workflow.cwl",
        "conformsTo": "https://w3id.org/cwl/",
        "mediatype": "text/x+yaml; charset=\"UTF-8\"",
        "createdOn": "2018-04-04T13:29:55.717707"
    }
```

Beyond being a listing of file names and identifiers, this also lists formats and light-weight provenance. We note that the CWL file is marked to conform to the https://w3id.org/cwl/ CWL specification.

Some of the files like `packed.cwl` have been created by cwltool as part of the run, while others have been created before the run "outside". Note that `cwltool` is currently unable to extract the original authors and contributors of the original files, this is planned for future versions.

Under `annotations` we see that the main point of this whole research object (`/` aka `arcp://uuid,67f38794-d24a-435f-bd4a-0242a56a581b/`) is to describe something called `urn:uuid:67f38794-d24a-435f-bd4a-0242a56a581b`:

```
"annotations": [
    {
        "about": "urn:uuid:67f38794-d24a-435f-bd4a-0242a56a581b",
        "content": "/",
        "oa:motivatedBy": {
            "@id": "oa:describing"
        }
    },
```

We will later see that this is the UUID for the workflow run. A workflow run is an *activity*, something that happens - it can't be directly saved to a file. However it can be *described* in different ways, in this case as CWLProv provenance:

```
{
 "about": "urn:uuid:67f38794-d24a-435f-bd4a-0242a56a581b",
 "content": [
     "provenance/primary.cwlprov.xml",
     "provenance/primary.cwlprov.nt",
     "provenance/primary.cwlprov.ttl",
     "provenance/primary.cwlprov.provn",
     "provenance/primary.cwlprov.jsonld",
     "provenance/primary.cwlprov.json"
 ],
 "oa:motivatedBy": {
     "@id": "http://www.w3.org/ns/prov#has_provenance"
 }
```

Finally the research object wants to highlight the workflow file:

```
{
    "about": "workflow/packed.cwl",
    "oa:motivatedBy": {
        "@id": "oa:highlighting"
    }
},
```

And links the run ID `67f38794..` to the `primary-job.json` and `packed.cwl`:

```
{
    "about": "urn:uuid:67f38794-d24a-435f-bd4a-0242a56a581b",
    "content": [
        "workflow/packed.cwl",
        "workflow/primary-job.json"
    ],
    "oa:motivatedBy": {
        "@id": "oa:linking"
    }
}
```

Note: `oa:motivatedBy` in CWLProv are subject to change.

PROV profile

The underlying model and information of the PROV files under `metadata/provenance` is the same, but is made available in multiple serialization formats:

- primary.cwlprov.provn – PROV-N Textual Provenance Notation
- primary.cwlprov.xml – PROV-XML
- primary.cwlprov.json – PROV-JSON
- primary.cwlprov.jsonld – PROV-O as JSON-LD (`@context` subject to change)
- primary.cwlprov.ttl – PROV-O as RDF Turtle
- primary.cwlprov.nt – PROV-O as RDF N-Triples

The below extracts use the PROV-N syntax for brevity.

CWLPROV namespaces

Note that the identifiers must be expanded with the defined `prefix`-es when comparing across serializations. These set which vocabularies ("namespaces") are used by the CWLProv statements:

```
prefix data <urn:hash::sha1:>
prefix input <arcp://uuid,0e6cb79e-fe70-4807-888c-3a61b9bf232a/workflow/primary-job.json
↪#>
prefix cwlprov <https://w3id.org/cwl/prov#>
prefix wfprov <http://purl.org/wf4ever/wfprov#>
prefix sha256 <nih:sha-256;>
prefix schema <http://schema.org/>
prefix wfdesc <http://purl.org/wf4ever/wfdesc#>
```

(continues on next page)

(continued from previous page)

```
prefix orcid <https://orcid.org/>
prefix researchobject <arcp://uuid,0e6cb79e-fe70-4807-888c-3a61b9bf232a/>
prefix id <urn:uuid:>
prefix wf <arcp://uuid,0e6cb79e-fe70-4807-888c-3a61b9bf232a/workflow/packed.cwl#>
prefix foaf <http://xmlns.com/foaf/0.1/>
```

Note that the arcp base URI will correspond to the UUID of each main workflow run.

Account who launched cwltool

If `--enable-user-provenance` was used, the local machine account (e.g. Windows or UNIX user name) who started `cwltool` is tracked:

```
agent(id:855c6823-bbe7-48a5-be37-b0f07f20c495, [foaf:accountName="stain", prov:type=
↪'foaf:OnlineAccount', prov:label="stain"])
```

It is assumed that the account was under the control of the named person (in PROV terms "actedOnBehalfOf"):

```
agent(id:433df002-2584-462a-80b0-cf90b97e6e07, [prov:label="Stian Soiland-Reyes",
      prov:type='prov:Person', foaf:account='id:8815e39c-9711-4105-bf52-dbc016c8028f'])
actedOnBehalfOf(id:8815e39c-9711-4105-bf52-dbc016c8028f, id:433df002-2584-462a-80b0-
↪cf90b97e6e07, -)
```

However we do not have an identifier for neither the account or the person, so every `cwltool` run will yield new UUIDs.

With `--enable-user-provenance` it is possible to associate the account with a hostname:

```
agent(id:855c6823-bbe7-48a5-be37-b0f07f20c495, [cwlprov:hostname="biggie", prov:type=
↪'foaf:OnlineAccount', prov:location="biggie"])
```

Note that the hostname is often non-global or variable (e.g. on cloud instances or virtual machines), and thus may be unreliable when considering `cwltool` executions on multiple hosts.

If the `--orcid` parameter or `ORCID` shell variable is included, then the person associated with the local machine account is uniquely identified, no matter where the workflow was executed:

```
agent(orcid:0000-0002-1825-0097, [prov:type='prov:Person', prov:label="Stian Soiland-
↪Reyes",
   foaf:account='id:855c6823-bbe7-48a5-be37-b0f07f20c495'])

actedOnBehalfOf(id:855c6823-bbe7-48a5-be37-b0f07f20c495', orcid:0000-0002-1825-0097, -)
```

The running of *cwltool* itself makes it the workflow engine. It is the machine account who launched the cwltool (not necessarily the person behind it):

```
agent(id:7c9d9e88-666b-4977-85f4-c02da08a942d, [prov:type='prov:SoftwareAgent',␣
↪prov:type='wfprov:WorkflowEngine', prov:label="cwltool 1.0.20180416145054"])
wasStartedBy(id:855c6823-bbe7-48a5-be37-b0f07f20c495, -, id:9c3d4d1f-473d-468f-a6f2-
↪1ef4de571a7f, 2018-04-16T18:27:09.428090)
```

Starting a workflow

The main job of the cwltool execution is to run a workflow, here the activity for `workflow/packed.cwl#main`:

```
activity(id:67f38794-d24a-435f-bd4a-0242a56a581b, 2018-04-16T18:27:09.428165, -,␣
↪[prov:type='wfprov:WorkflowRun', prov:label="Run of workflow/packed.cwl#main"])
wasStartedBy(id:67f38794-d24a-435f-bd4a-0242a56a581b, -, id:7c9d9e88-666b-4977-85f4-
↪c02da08a942d, 2018-04-16T18:27:09.428285)
```

Now what is that workflow again? Well a tiny bit of prospective provenance is included:

```
entity(wf:main, [prov:type='prov:Plan', prov:type='wfdesc:Workflow', prov:label=
↪"Prospective provenance"])
entity(wf:main, [prov:label="Prospective provenance", wfdesc:hasSubProcess='wf:main/step0
↪'])
entity(wf:main/step0, [prov:type='wfdesc:Process', prov:type='prov:Plan'])
```

But we can also expand the `wf` identifiers to find that we are talking about `arcp://uuid,0e6cb79e-fe70-4807-888c-3a61b9bf232a/workflow/packed.cwl#` - that is the `main` workflow in the file `workflow/packed.cwl` of the Research Object.

Running workflow steps

A workflow will contain some steps, each execution of these are again nested activities:

```
activity(id:6c7c04ea-dcc8-40d2-92a4-7705f7286756, -, -, [prov:type='wfprov:ProcessRun',␣
↪prov:label="Run of workflow/packed.cwl#main"])
wasStartedBy(id:6c7c04ea-dcc8-40d2-92a4-7705f7286756, -, id:67f38794-d24a-435f-bd4a-
↪0242a56a581b, 2018-04-16T18:27:09.430883)
activity(id:a583b025-9a16-49ce-8515-f3249eb2aacf, -, -, [prov:type='wfprov:ProcessRun',␣
↪prov:label="Run of workflow/packed.cwl#main/step0"])
wasAssociatedWith(id:a583b025-9a16-49ce-8515-f3249eb2aacf, -, wf:main/step0)
```

Again we see the link back to the workflow plan, the workflow execution of `#main/step0` in this case. Note that depending on scattering etc there might be multiple activities for a single step in the workflow definition.

Data inputs (usage)

This activities uses some data at the input `message`:

```
activity(id:a583b025-9a16-49ce-8515-f3249eb2aacf, -, -, [prov:type='wfprov:ProcessRun',␣
↪prov:label="Run of workflow/packed.cwl#main/step0"])
used(id:a583b025-9a16-49ce-8515-f3249eb2aacf,␣
↪data:53870991af88a6d678cbeed3255bb65993c52925, 2018-04-16T18:27:09.433743, [prov:role=
↪'wf:main/step0/message'])
```

Data files within a workflow execution are identified using `urn:hash::sha1:` URIs derived from their sha1 checksum (checksum algorithm and prefix subject to change):

```
entity(data:53870991af88a6d678cbeed3255bb65993c52925, [prov:type='wfprov:Artifact',␣
↪prov:value="Hei7"])
```

Small values (typically those provided on the command line may be present as *prov:value*. The corresponding `data/` file within the Research Object has a content-addressable filename based on the checksum; but it is also possible to look up this independent from the corresponding `metadata/manifest.json` aggregation:

```
"aggregates": [
    {
        "uri": "urn:hash::sha1:53870991af88a6d678cbeed3255bb65993c52925",
        "bundledAs": {
            "uri": "arcp://uuid,0e6cb79e-fe70-4807-888c-3a61b9bf232a/data/53/
↪53870991af88a6d678cbeed3255bb65993c52925",
            "folder": "/data/53/",
            "filename": "53870991af88a6d678cbeed3255bb65993c52925"
        }
    },
```

Data outputs (generation)

Similarly a step typically generates some data, here `response`:

```
activity(id:a583b025-9a16-49ce-8515-f3249eb2aacf, -, -, [prov:type='wfprov:ProcessRun',␣
↪prov:label="Run of workflow/packed.cwl#main/step0"])
wasGeneratedBy(data:53870991af88a6d678cbeed3255bb65993c52925, id:a583b025-9a16-49ce-8515-
↪f3249eb2aacf, 2018-04-16T18:27:09.438236, [prov:role='wf:main/step0/response'])
```

In the hello world example this is interesting because it is the same data output as-is, but typically the outputs will each have different checksums (and thus different identifiers).

The step is ended:

```
wasEndedBy(id:a583b025-9a16-49ce-8515-f3249eb2aacf, -, id:67f38794-d24a-435f-bd4a-
↪0242a56a581b, 2018-04-16T18:27:09.438482)
```

In this case the step output is also a workflow output `response`, so the data is also generated by the workflow activity:

```
activity(id:67f38794-d24a-435f-bd4a-0242a56a581b, 2018-04-16T18:27:09.428165, -,␣
↪[prov:type='wfprov:WorkflowRun', prov:label="Run of workflow/packed.cwl#main"])
wasGeneratedBy(data:53870991af88a6d678cbeed3255bb65993c52925, id:67f38794-d24a-435f-bd4a-
↪0242a56a581b, 2018-04-16T18:27:09.439323, [prov:role='wf:main/response'])
```

Ending the workflow

Finally the overall workflow `#main` also ends:

```
activity(id:67f38794-d24a-435f-bd4a-0242a56a581b, 2018-04-16T18:27:09.428165, -,␣
↪[prov:type='wfprov:WorkflowRun', prov:label="Run of workflow/packed.cwl#main"])
agent(id:7c9d9e88-666b-4977-85f4-c02da08a942d, [prov:type='prov:SoftwareAgent',␣
↪prov:type='wfprov:WorkflowEngine', prov:label="cwltool 1.0.20180416145054"])
wasEndedBy(id:67f38794-d24a-435f-bd4a-0242a56a581b, -, id:7c9d9e88-666b-4977-85f4-
↪c02da08a942d, 2018-04-16T18:27:09.445785)
```

Note that the end of the outer `cwltool` activity is not recorded, as cwltool is still running at the point of writing out this provenance.

Currently the provenance trace do not distinguish executions within nested workflows; it is planned that these will be tracked in separate files under `metadata/provenance/`.

3.4.4 Python version support policy

cwltool will always support Python 3 versions that are officially supported by the Python Software Foundation.

For versions that are no longer supported by the Python Software Foundation (or "upstream" for short), cwltool support also extends to the latest Python versions included in the following major Linux distributions:

- Debian (stable)
- Ubuntu (LTS release standard support)

This means that users may need to install a newer version of Python from their Linux distributor if the default version is too old.

If there is a conflict between a third party package dependency which has dropped support for a Python version that cwltool should support according to this policy, then possible options (such as pinning the dependency, eliminating the dependency, or changing Python version support of cwltool) should be discussed among the cwltool maintainers and downstream users before making the decision to drop support for a Python version before the date outlined in this policy. The reasoning for dropping support for a Python version should be outlined here.

As of 2023-08-14, here are approximate cwltool support periods for Python versions (*EOL* == "End of Life", the end of the support period by that provider):

Python	cwltool end of support
2.7	ended 2020-01 (upstream EOL)
3.5	ended 2020-10 (upstream EOL)
3.6	ended 2023-08-31 (change in cwltool policy)
3.7	ended 2023-07-27 (upstream EOL)
3.8	2024-10-14 (upstream EOL)
3.9	2025-10-01 (upstream EOL)
3.10	2027-04-01 (Ubuntu 22.04 LTS EOL)
3.11	2027-10-01 (upstream EOL)
3.12	2028-10-01 (planned upstream EOL)
3.13	2029-10-01 (planned upstream EOL)

Python version of supported Linux distributions, for reference (as of August 2023)

Python Version	Linux distros where it is a supported version
3.6	Ubuntu 18.04 LTS
3.7	Debian 10
3.8	Ubuntu 20.04 LTS
3.9	Debian 11, Ubuntu 20.04 LTS
3.10	Ubuntu 22.04 LTS
3.11	Debian 12
3.12	Debian 13 (planned)

3.4.5 Process generator

Experimental feature and unofficial extension to the CWL standards.

A process generator is a CWL Process type that executes a concrete CWL process (CommandLineTool, Workflow or ExpressionTool) which produces CWL files as output, then executes the CWL that was generated.

The intention is to have a formalized way to express a pre-processing or bootstrapping step in which a CWL description is generated by another program (such as from a template, or conversion from another workflow language).

The ProcessGenerator is a subtype of CWL process, so it must define its inputs and outputs. The "run" field is similar to the "run" field of a workflow step – it specifies a tool to run that will create new CWL as output.

```
- name: ProcessGenerator
  type: record
  inVocab: true
  extends: cwl:Process
  documentRoot: true
  fields:
    - name: class
      jsonldPredicate:
        "_id": "@type"
        "_type": "@vocab"
      type: string
    - name: run
      type: [string, cwl:Process]
      jsonldPredicate:
        _id: "cwl:run"
        _type: "@id"
        subscope: run
      doc: |
        Specifies the process to run.
```

Process generator example (pytoolgen.cwl)

```
#!/usr/bin/env cwl-runner
cwlVersion: v1.0
$namespaces:
  cwltool: "http://commonwl.org/cwltool#"
class: cwltool:ProcessGenerator
inputs:
  script: string
  dir: Directory
outputs: {}
run:
  class: CommandLineTool
  inputs:
    script: string
    dir: Directory
  outputs:
    runProcess:
      type: File
      outputBinding:
        glob: main.cwl
  requirements:
```

(continues on next page)

(continued from previous page)

```
    InlineJavascriptRequirement: {}
    cwltool:LoadListingRequirement:
      loadListing: shallow_listing
    InitialWorkDirRequirement:
      listing: |
        ${
         var v = inputs.dir.listing;
         v.push({entryname: "inp.py", entry: inputs.script});
         return v;
        }
  arguments: [python, inp.py]
  stdout: main.cwl
```

The process generator has two required inputs: "script" and "dir". It runs the command line tool listed inline in "run" with the input object, which is required to have those parameters. Note: the input object may contain additional parameters which are intended for the generated CWL when it is executed.

The command line tool populates the working directory using InitialWorkDirRequirement. It uses the listing from 'dir' and adds a new file literal called "inp.py" which contains the text from the input parameter "script". Then it runs "python inp.py".

The output of this command line tool is the File parameter "runProcess". In this example, the "inp.py" script, when run, is expected to print the CWL description to standard output, which will be captured in the "runProcess" output parameter.

Next, the ProcessGenerator will load file in the "runProcess" parameter, which in this example is "main.cwl". Finally, it will execute the process with input object that was originally provided to the process generator.

The output of the generated script is used as the output for ProcessGenerator as a whole.

Here's an example (zing.cwl) that uses pytoolgen.cwl.

```
#!/usr/bin/env cwltool
{cwl:tool: pytoolgen.cwl, script: {$include: "#attachment-1"}, dir: {class: Directory,␣
↪location: .}}
--- |
import os
import sys
print("""
cwlVersion: v1.0
class: CommandLineTool
inputs:
  zing: string
outputs: {}
arguments: [echo, $(inputs.zing)]
""")
```

The first line `#!/usr/bin/env cwltool` means that this file can be given the executable bit (+x) and then run directly.

This is a multi-part YAML file. The first section is a CWL input object.

The input object uses "cwl:tool" to indicate that this input object should be used as input to execute "pytoolgen.cwl".

The parameter `script: {$include: "#attachment-1"}` takes the text from the second part of the file (following the YAML division marker `--- |`) and assigns it as a string value to "script".

The "dir" parameter is not doing much in this example, but by capturing the whole directory it allows the Python script to refer to files in the current directory.

In this example the script is trivially printing CWL as a string, but of course could do something much more complex: generate code from a template, select among several possible workflows based on the input, convert from another workflow language, etc.

When this is executed, the following steps happen:

1. pytoolgen.py is loaded and executed with the 1st part of the file as the input object
2. The "script" parameter contains the contents of the second part. The inline command line tool creates a file called "inp.py" with the contents of "script"
3. The inline command line tool runs python on "inp.py" and collects the output, which is CWL description for a trivial "echo" tool.
4. It loads the CWL description and executes it with any additional parameters declared in the input object or command line.

Example runs

Note: requires `cwltool` flags `--enable-ext` and `--enable-dev`

You can set these with the environment parameter CWLTOOL_OPTIONS

```
$ export CWLTOOL_OPTIONS="--enable-dev --enable-ext"

$ ./zing.cwl
INFO /home/peter/work/cwltool/venv3/bin/cwltool 3.1.20211112163758
INFO Resolved './zing.cwl' to 'file:///home/peter/work/cwltool/tests/wf/generator/zing.
↪cwl'
INFO [job d3626216-d7d8-4322-bc21-4d469634cc9a] /tmp/8sez90gb$ python \
    inp.py > /tmp/8sez90gb/main.cwl
INFO [job d3626216-d7d8-4322-bc21-4d469634cc9a] completed success
usage: ./zing.cwl [-h] --zing ZING [job_order]
./zing.cwl: error: the following arguments are required: --zing
```

```
$ ./zing.cwl --zing blurf
INFO /home/peter/work/cwltool/venv3/bin/cwltool 3.1.20211112163758
INFO Resolved './zing.cwl' to 'file:///home/peter/work/cwltool/tests/wf/generator/zing.
↪cwl'
INFO [job a580b69d-2b88-4268-904e-ed105ba7c85e] /tmp/ujff239o$ python \
    inp.py > /tmp/ujff239o/main.cwl
INFO [job a580b69d-2b88-4268-904e-ed105ba7c85e] completed success
INFO [job main.cwl] /tmp/f_7bxncq$ echo \
    blurf
blurf
INFO [job main.cwl] completed success
{
    "runProcess": {
        "location": "file:///home/peter/work/cwltool/tests/wf/generator/main.cwl",
        "basename": "main.cwl",
        "class": "File",
        "checksum": "sha1$8c160b680fb2cededef3228a53425e595b8cdf48",
        "size": 111,
```

(continues on next page)

(continued from previous page)

```
        "path": "/home/peter/work/cwltool/tests/wf/generator/main.cwl"
    }
}
INFO Final process status is success
```

```
$ echo "zing: zoop" > job.yml
$ ./zing.cwl job.yml
INFO /home/peter/work/cwltool/venv3/bin/cwltool 3.1.20211112163758
INFO Resolved './zing.cwl' to 'file:///home/peter/work/cwltool/tests/wf/generator/zing.
↪cwl'
INFO [job 9073a083-dc79-4719-8762-1c024480605c] /tmp/meeo3d19$ python \
    inp.py > /tmp/meeo3d19/main.cwl
INFO [job 9073a083-dc79-4719-8762-1c024480605c] completed success
INFO [job main.cwl] /tmp/2pqdz5nq$ echo \
    zoop
zoop
INFO [job main.cwl] completed success
{
    "runProcess": {
        "location": "file:///home/peter/work/cwltool/tests/wf/generator/main.cwl",
        "basename": "main.cwl",
        "class": "File",
        "checksum": "sha1$8c160b680fb2cededef3228a53425e595b8cdf48",
        "size": 111,
        "path": "/home/peter/work/cwltool/tests/wf/generator/main.cwl"
    }
}
INFO Final process status is success
```

3.4.6 API Reference

This page contains auto-generated API reference documentation[1].

cwltool

Reference implementation of the CWL standards.

Subpackages

cwltool.cwlprov

Stores Research Object including provenance.

[1] Created with sphinx-autoapi

Submodules

cwltool.cwlprov.provenance_constants

Module Contents

cwltool.cwlprov.provenance_constants.__citation__ =
'https://doi.org/10.5281/zenodo.1208477'

cwltool.cwlprov.provenance_constants.CWLPROV_VERSION = 'https://w3id.org/cwl/prov/0.6.0'

cwltool.cwlprov.provenance_constants.METADATA = 'metadata'

cwltool.cwlprov.provenance_constants.DATA = 'data'

cwltool.cwlprov.provenance_constants.WORKFLOW = 'workflow'

cwltool.cwlprov.provenance_constants.SNAPSHOT = 'snapshot'

cwltool.cwlprov.provenance_constants.MAIN

cwltool.cwlprov.provenance_constants.PROVENANCE

cwltool.cwlprov.provenance_constants.LOGS

cwltool.cwlprov.provenance_constants.WFDESC

cwltool.cwlprov.provenance_constants.WFPROV

cwltool.cwlprov.provenance_constants.WF4EVER

cwltool.cwlprov.provenance_constants.RO

cwltool.cwlprov.provenance_constants.ORE

cwltool.cwlprov.provenance_constants.FOAF

cwltool.cwlprov.provenance_constants.SCHEMA

cwltool.cwlprov.provenance_constants.CWLPROV

cwltool.cwlprov.provenance_constants.ORCID

cwltool.cwlprov.provenance_constants.UUID

cwltool.cwlprov.provenance_constants.ENCODING = 'UTF-8'

cwltool.cwlprov.provenance_constants.TEXT_PLAIN

cwltool.cwlprov.provenance_constants.Hasher

cwltool.cwlprov.provenance_constants.SHA1 = 'sha1'

cwltool.cwlprov.provenance_constants.SHA256 = 'sha256'

cwltool.cwlprov.provenance_constants.SHA512 = 'sha512'

cwltool.cwlprov.provenance_constants.USER_UUID

cwltool.cwlprov.provenance_constants.ACCOUNT_UUID

cwltool.cwlprov.provenance_profile

Module Contents

Classes

ProvenanceProfile	Provenance profile.

Functions

copy_job_order(job, job_order_object)	Create copy of job object for provenance.

cwltool.cwlprov.provenance_profile.**copy_job_order**(*job*, *job_order_object*)

Create copy of job object for provenance.

Parameters

- **job** (*Union[cwltool.process.Process, cwltool.utils.JobsType]*)
- **job_order_object** (*cwltool.utils.CWLObjectType*)

Return type
cwltool.utils.CWLObjectType

class cwltool.cwlprov.provenance_profile.**ProvenanceProfile**(*research_object*, *full_name*, *host_provenance*, *user_provenance*, *orcid*, *fsaccess*, *run_uuid=None*)

Provenance profile.

Populated as the workflow runs.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **full_name** (*str*)
- **host_provenance** (*bool*)
- **user_provenance** (*bool*)
- **orcid** (*str*)
- **fsaccess** (cwltool.stdfsaccess.StdFsAccess)
- **run_uuid** (*Optional[uuid.UUID]*)

__str__()

Represent this Provenvance profile as a string.

Return type
str

generate_prov_doc()

Add basic namespaces.

Return type
Tuple[str, prov.model.ProvDocument]

evaluate(*process*, *job*, *job_order_object*, *research_obj*)

Evaluate the nature of job.

Parameters

- **process** (*cwltool.process.Process*)
- **job** (*cwltool.utils.JobsType*)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **research_obj** (*cwltool.cwlprov.ro.ResearchObject*)

Return type
None

record_process_start(*process*, *job*, *process_run_id=None*)

Parameters

- **process** (*cwltool.process.Process*)
- **job** (*cwltool.utils.JobsType*)
- **process_run_id** (*Optional[str]*)

Return type
Optional[str]

start_process(*process_name*, *when*, *process_run_id=None*)

Record the start of each Process.

Parameters

- **process_name** (*str*)
- **when** (*datetime.datetime*)
- **process_run_id** (*Optional[str]*)

Return type
str

record_process_end(*process_name*, *process_run_id*, *outputs*, *when*)

Parameters

- **process_name** (*str*)
- **process_run_id** (*str*)
- **outputs** (*Union[cwltool.utils.CWLObjectType, MutableSequence[cwltool.utils.CWLObjectType], None]*)
- **when** (*datetime.datetime*)

Return type
None

declare_file(*value*)

Parameters
value (*cwltool.utils.CWLObjectType*)

Return type
Tuple[prov.model.ProvEntity, prov.model.ProvEntity, str]

`declare_directory`(*value*)

Register any nested files/directories.

Parameters
value (*cwltool.utils.CWLObjectType*)

Return type
prov.model.ProvEntity

`declare_string`(*value*)

Save as string in UTF-8.

Parameters
value (*str*)

Return type
Tuple[prov.model.ProvEntity, str]

`declare_artefact`(*value*)

Create data artefact entities for all file objects.

Parameters
value (*Any*)

Return type
prov.model.ProvEntity

`used_artefacts`(*job_order*, *process_run_id*, *name=None*)

Add used() for each data artefact.

Parameters

- **job_order** (*Union[cwltool.utils.CWLObjectType, List[cwltool.utils.CWLObjectType]]*)
- **process_run_id** (*str*)
- **name** (*Optional[str]*)

Return type
None

`generate_output_prov`(*final_output*, *process_run_id*, *name*)

Call wasGeneratedBy() for each output,copy the files into the RO.

Parameters

- **final_output** (*Union[cwltool.utils.CWLObjectType, MutableSequence[cwltool.utils.CWLObjectType], None]*)
- **process_run_id** (*Optional[str]*)
- **name** (*Optional[str]*)

Return type
None

`prospective_prov`(*job*)

Create prospective prov recording as wfdesc prov:Plan.

Parameters
job (*cwltool.utils.JobsType*)

Return type
None

activity_has_provenance(*activity*, *prov_ids*)

Add http://www.w3.org/TR/prov-aq/ relations to nested PROV files.

Parameters

- **activity** (*str*)
- **prov_ids** (*Sequence[prov.identifier.Identifier]*)

Return type
None

finalize_prov_profile(*name*)

Transfer the provenance related files to the RO.

Parameters
name (*Optional[str]*)

Return type
List[prov.identifier.QualifiedName]

cwltool.cwlprov.ro

Stores class definition of ResearchObject and WritableBagFile.

Module Contents

Classes

ResearchObject	CWLProv Research Object.

class cwltool.cwlprov.ro.**ResearchObject**(*fsaccess*, *temp_prefix_ro='tmp'*, *orcid=''*, *full_name=''*)

CWLProv Research Object.

Parameters

- **fsaccess** (cwltool.stdfsaccess.StdFsAccess)
- **temp_prefix_ro** (*str*)
- **orcid** (*str*)
- **full_name** (*str*)

self_check()

Raise ValueError if this RO is closed.

Return type
None

__str__()

Represent this RO as a string.

Return type
str

user_provenance(*document*)

Add the user provenance.

Parameters
document (*prov.model.ProvDocument*)

Return type
None

add_tagfile(*path*, *timestamp=None*)

Add tag files to our research object.

Parameters

- **path** (*str*)
- **timestamp** (*Optional[datetime.datetime]*)

Return type
None

add_uri(*uri*, *timestamp=None*)

Parameters

- **uri** (*str*)
- **timestamp** (*Optional[datetime.datetime]*)

Return type
cwltool.cwlprov.Aggregate

add_annotation(*about*, *content*, *motivated_by='oa:describing'*)

Cheap URI relativize for current directory and /.

Parameters

- **about** (*str*)
- **content** (*List[str]*)
- **motivated_by** (*str*)

Return type
str

generate_snapshot(*prov_dep*)

Copy all of the CWL files to the snapshot/ directory.

Parameters
prov_dep (*cwltool.utils.CWLObjectType*)

Return type
None

has_data_file(*sha1hash*)

Confirm the presence of the given file in the RO.

Parameters
sha1hash (*str*)

Return type
bool

add_data_file(*from_fp*, *timestamp=None*, *content_type=None*)

Copy inputs to data/ folder.

Parameters

- **from_fp** (*IO[Any]*)
- **timestamp** (*Optional[datetime.datetime]*)
- **content_type** (*Optional[str]*)

Return type
str

add_to_manifest(*rel_path*, *checksums*)

Add files to the research object manifest.

Parameters

- **rel_path** (*str*)
- **checksums** (*Dict[str, str]*)

Return type
None

cwltool.cwlprov.writablebagfile

Stores class definition of ResearchObject and WritableBagFile.

Module Contents

Classes

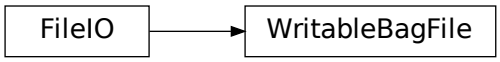
WritableBagFile	Writes files in research object.

Functions

write_bag_file(research_object, path[, encoding])	Write the bag file into our research object.
open_log_file_for_activity(research_object, uuid_uri)	Begin the per-activity log.
close_ro(research_object[, save_to])	Close the Research Object, optionally saving to specified folder.
packed_workflow(research_object, packed)	Pack CWL description to generate re-runnable CWL object in RO.
create_job(research_object, builder_job[, is_output])	Generate the new job object with RO specific relative paths.

class cwltool.cwlprov.writablebagfile.**WritableBagFile**(*research_object*, *rel_path*)

Bases: io.FileIO



Writes files in research object.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **rel_path** (*str*)

write(*b*)

Write some content to the Bag.

Parameters
b (*Any*)

Return type
int

close()

Flush and close this stream.

Finalize checksums and manifests.

Return type
None

seekable()

Return False, seeking is not supported.

Return type
bool

readable()

Return False, reading is not supported.

Return type
bool

truncate(*size=None*)

Resize the stream, only if we haven't started writing.

Parameters
size (*Optional[int]*)

Return type
int

cwltool.cwlprov.writablebagfile.**write_bag_file**(*research_object*, *path*, *encoding=ENCODING*)

Write the bag file into our research object.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **path** (*str*)
- **encoding** (*Optional[str]*)

Return type
Union[io.TextIOWrapper, *WritableBagFile*]

cwltool.cwlprov.writablebagfile.**open_log_file_for_activity**(*research_object*, *uuid_uri*)

Begin the per-activity log.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **uuid_uri** (*str*)

Return type
Union[io.TextIOWrapper, *WritableBagFile*]

cwltool.cwlprov.writablebagfile.**close_ro**(*research_object*, *save_to=None*)

Close the Research Object, optionally saving to specified folder.

Closing will remove any temporary files used by this research object. After calling this method, this ResearchObject instance can no longer be used, except for no-op calls to .close().

The 'saveTo' folder should not exist - if it does, it will be deleted.

It is safe to call this function multiple times without the 'saveTo' argument, e.g. within a try..finally block to ensure the temporary files of this Research Object are removed.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **save_to** (*Optional[str]*)

Return type
None

cwltool.cwlprov.writablebagfile.**packed_workflow**(*research_object*, *packed*)

Pack CWL description to generate re-runnable CWL object in RO.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **packed** (*str*)

Return type
None

cwltool.cwlprov.writablebagfile.**create_job**(*research_object*, *builder_job*, *is_output=False*)

Generate the new job object with RO specific relative paths.

Parameters

- **research_object** (cwltool.cwlprov.ro.ResearchObject)
- **builder_job** (*cwltool.utils.CWLObjectType*)
- **is_output** (*bool*)

Return type
cwltool.utils.CWLObjectType

Package Contents

Classes

Aggregate	RO Aggregate class.
AuthoredBy	RO AuthoredBy class.

Functions

checksum_copy(src_file[, dst_file, hasher, buffersize])	Compute checksums while copying a file.

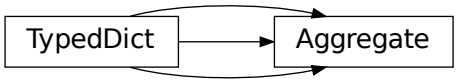
Attributes

Annotation

cwltool.cwlprov.**Annotation**

class cwltool.cwlprov.**Aggregate**

Bases: TypedDict



RO Aggregate class.

uri: str | None

bundledAs: Dict[str, Any] | None

mediatype: str | None

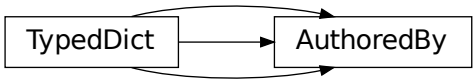
conformsTo: str | List[str] | None

createdOn: str | None

createdBy: Dict[str, str] | None

class cwltool.cwlprov.**AuthoredBy**

Bases: TypedDict



RO AuthoredBy class.

orcid: `str | None`

name: `str | None`

uri: `str | None`

cwltool.cwlprov.**checksum_copy**(*src_file*, *dst_file=None*, *hasher=None*, *buffersize=1024 * 1024*)

Compute checksums while copying a file.

Parameters

- **src_file** (*IO[Any]*)
- **dst_file** (*Optional[IO[Any]]*)
- **hasher** (*Optional[Callable[[], hashlib._Hash]]*)
- **buffersize** (*int*)

Return type

str

Submodules

cwltool.__main__

Default entrypoint for the cwltool module.

cwltool.argparser

Command line argument parsing for cwltool.

Module Contents

Classes

FSAction	Base action for our custom actions.
FSAppendAction	Appending version of the base action for our custom actions.
FileAction	Base action for our custom actions.
DirectoryAction	Base action for our custom actions.
FileAppendAction	Appending version of the base action for our custom actions.
DirectoryAppendAction	Appending version of the base action for our custom actions.
AppendAction	An argparse action that clears the default values if any value is provided.

Functions

arg_parser()	
get_default_args()	Get default values of cwltool's command line options.
add_argument(toolparser, name, inptype, records[, ...])	
generate_parser(toolparser, tool, namemap, records[, ...])	Generate an ArgumentParser for the given CWL Process.

cwltool.argparser.**arg_parser**()

Return type
argparse.ArgumentParser

cwltool.argparser.**get_default_args**()

Get default values of cwltool's command line options.

Return type
Dict[str, Any]

class cwltool.argparser.**FSAction**(*option_strings*, *dest*, *nargs=None*, *urljoin=urllib.parse.urljoin*, *base_uri=''*, ***kwargs*)

Bases: argparse.Action

Base action for our custom actions.

Parameters

- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)
- **urljoin** (*Callable[[str, str], str]*)
- **base_uri** (*str*)
- **kwargs** (*Any*)

objclass: str | None

__call__(*parser*, *namespace*, *values*, *option_string=None*)

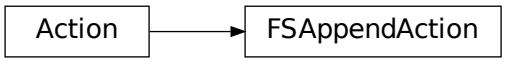
Parameters

- **parser** (*argparse.ArgumentParser*)
- **namespace** (*argparse.Namespace*)
- **values** (*Union[str, Sequence[Any], None]*)
- **option_string** (*Optional[str]*)

Return type
None

class cwltool.argparser.**FSAppendAction**(*option_strings*, *dest*, *nargs=None*, *urljoin=urllib.parse.urljoin*, *base_uri=''*, ***kwargs*)

Bases: argparse.Action



Appending version of the base action for our custom actions.

Parameters

- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)
- **urljoin** (*Callable[[str, str], str]*)
- **base_uri** (*str*)
- **kwargs** (*Any*)

objclass: str | None

__call__(*parser*, *namespace*, *values*, *option_string=None*)

Parameters

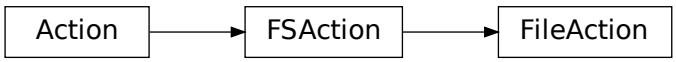
- **parser** (*argparse.ArgumentParser*)

- **namespace** (*argparse.Namespace*)
- **values** (*Union[str, Sequence[Any], None]*)
- **option_string** (*Optional[str]*)

Return type
None

class cwltool.argparser.**FileAction**(*option_strings*, *dest*, *nargs=None*, *urljoin=urllib.parse.urljoin*, *base_uri=''*, ***kwargs*)

Bases: *FSAction*



Base action for our custom actions.

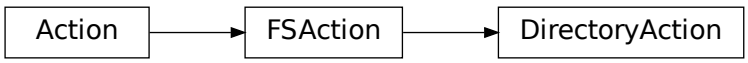
Parameters

- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)
- **urljoin** (*Callable[[str, str], str]*)
- **base_uri** (*str*)
- **kwargs** (*Any*)

objclass: `str | None = 'File'`

class cwltool.argparser.**DirectoryAction**(*option_strings*, *dest*, *nargs=None*, *urljoin=urllib.parse.urljoin*, *base_uri=''*, ***kwargs*)

Bases: *FSAction*



Base action for our custom actions.

Parameters

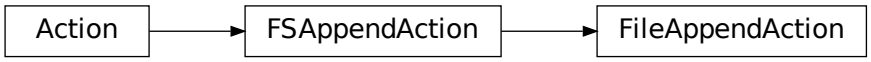
- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)

- **urljoin** (*Callable[[str, str], str]*)
- **base_uri** (*str*)
- **kwargs** (*Any*)

objclass: `str | None = 'Directory'`

class cwltool.argparser.**FileAppendAction**(*option_strings*, *dest*, *nargs=None*, *urljoin=urllib.parse.urljoin*, *base_uri=''*, ***kwargs*)

Bases: *FSAppendAction*



Appending version of the base action for our custom actions.

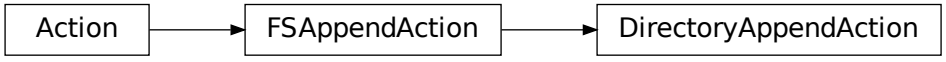
Parameters

- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)
- **urljoin** (*Callable[[str, str], str]*)
- **base_uri** (*str*)
- **kwargs** (*Any*)

objclass: `str | None = 'File'`

class cwltool.argparser.**DirectoryAppendAction**(*option_strings*, *dest*, *nargs=None*, *urljoin=urllib.parse.urljoin*, *base_uri=''*, ***kwargs*)

Bases: *FSAppendAction*



Appending version of the base action for our custom actions.

Parameters

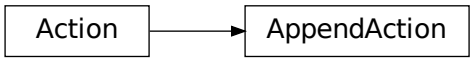
- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)
- **urljoin** (*Callable[[str, str], str]*)

- **base_uri** (*str*)
- **kwargs** (*Any*)

objclass: `str | None = 'Directory'`

class cwltool.argparser.**AppendAction**(*option_strings*, *dest*, *nargs=None*, ***kwargs*)

Bases: argparse.Action



An argparse action that clears the default values if any value is provided.

Parameters

- **option_strings** (*List[str]*)
- **dest** (*str*)
- **nargs** (*Any*)
- **kwargs** (*Any*)

__call__(*parser*, *namespace*, *values*, *option_string=None*)

Parameters

- **parser** (*argparse.ArgumentParser*)
- **namespace** (*argparse.Namespace*)
- **values** (*Union[str, Sequence[Any], None]*)
- **option_string** (*Optional[str]*)

Return type

None

cwltool.argparser.**add_argument**(*toolparser*, *name*, *inptype*, *records*, *description=''*, *default=None*, *input_required=True*, *urljoin=urllib.parse.urljoin*, *base_uri=''*)

Parameters

- **toolparser** (*argparse.ArgumentParser*)
- **name** (*str*)
- **inptype** (*Any*)
- **records** (*List[str]*)
- **description** (*str*)
- **default** (*Any*)
- **input_required** (*bool*)
- **urljoin** (*Callable[[str, str], str]*)

- **base_uri** (*str*)

Return type
None

cwltool.argparser.**generate_parser**(*toolparser*, *tool*, *namemap*, *records*, *input_required=True*, *urljoin=urllib.parse.urljoin*, *base_uri=''*)

Generate an ArgumentParser for the given CWL Process.

Parameters

- **toolparser** (*argparse.ArgumentParser*)
- **tool** (cwltool.process.Process)
- **namemap** (*Dict[str, str]*)
- **records** (*List[str]*)
- **input_required** (*bool*)
- **urljoin** (*Callable[[str, str], str]*)
- **base_uri** (*str*)

Return type
argparse.ArgumentParser

cwltool.builder

Command line builder.

Module Contents

Classes

Builder	Helper class to construct a command line from a CWL CommandLineTool.

Functions

content_limit_respected_read_bytes(f)	Read a file as bytes, respecting the CONTENT_LIMIT.
content_limit_respected_read(f)	Read a file as a string, respecting the CONTENT_LIMIT.
substitute(value, replace)	Perform CWL SecondaryFilesDSL style substitution.

Attributes

INPUT_OBJ_VOCAB

cwltool.builder.**INPUT_OBJ_VOCAB: Dict[str, str]**

cwltool.builder.**content_limit_respected_read_bytes**(*f*)

Read a file as bytes, respecting the CONTENT_LIMIT.

Parameters
f (*IO[bytes]*) – file handle

Returns
the file contents

Raises
WorkflowException – if the file is too large

Return type
bytes

cwltool.builder.**content_limit_respected_read**(*f*)

Read a file as a string, respecting the CONTENT_LIMIT.

Parameters
f (*IO[bytes]*) – file handle

Returns
the file contents

Raises
WorkflowException – if the file is too large

Return type
str

cwltool.builder.**substitute**(*value*, *replace*)

Perform CWL SecondaryFilesDSL style substitution.

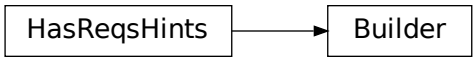
Parameters

- **value** (*str*)
- **replace** (*str*)

Return type
str

class cwltool.builder.**Builder**(*job*, *files*, *bindings*, *schemaDefs*, *names*, *requirements*, *hints*, *resources*, *mutation_manager*, *formatgraph*, *make_fs_access*, *fs_access*, *job_script_provider*, *timeout*, *debug*, *js_console*, *force_docker_pull*, *loadListing*, *outdir*, *tmpdir*, *stagedir*, *cwlVersion*, *container_engine*)

Bases: cwltool.utils.HasReqsHints



Helper class to construct a command line from a CWL CommandLineTool.

Parameters

- **job** (*cwltool.utils.CWLObjectType*)
- **files** (*List[cwltool.utils.CWLObjectType]*)
- **bindings** (*List[cwltool.utils.CWLObjectType]*)
- **schemaDefs** (*MutableMapping[str, cwltool.utils.CWLObjectType]*)
- **names** (*schema_salad.avro.schema.Names*)
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **resources** (*Dict[str, Union[int, float]]*)
- **mutation_manager** (*Optional[cwltool.mutation.MutationManager]*)
- **formatgraph** (*Optional[rdflib.Graph]*)
- **make_fs_access** (*Type[cwltool.stdfsaccess.StdFsAccess]*)
- **fs_access** (*cwltool.stdfsaccess.StdFsAccess*)
- **job_script_provider** (*Optional[cwltool.software_requirements.DependenciesConfiguration]*)
- **timeout** (*float*)
- **debug** (*bool*)
- **js_console** (*bool*)
- **force_docker_pull** (*bool*)
- **loadListing** (*cwltool.utils.LoadListingType*)
- **outdir** (*str*)
- **tmpdir** (*str*)
- **stagedir** (*str*)
- **cwlVersion** (*str*)
- **container_engine** (*str*)

build_job_script(*commands*)

Parameters
commands (*List[str]*)

Return type
Optional[str]

bind_input(*schema*, *datum*, *discover_secondaryFiles*, *lead_pos=None*, *tail_pos=None*)

Bind an input object to the command line.

Raises

- **ValidationException** – in the event of an invalid type union
- ***WorkflowException*** – if a CWL Expression ("position", "required", "pattern", "format") evaluates to the wrong type or if a required secondary file is missing

Parameters

- **schema** (*cwltool.utils.CWLObjectType*)
- **datum** (*Union[cwltool.utils.CWLObjectType, List[cwltool.utils.CWLObjectType]]*)
- **discover_secondaryFiles** (*bool*)
- **lead_pos** (*Optional[Union[int, List[int]]]*)
- **tail_pos** (*Optional[Union[str, List[int]]]*)

Return type

List[MutableMapping[str, Union[str, List[int]]]]

tostr(*value*)

Represent an input parameter as a string.

Raises

WorkflowException – if the item is a File or Directory and the "path" is missing.

Parameters

value (*Union[MutableMapping[str, str], Any]*)

Return type

str

generate_arg(*binding*)

Parameters

binding (*cwltool.utils.CWLObjectType*)

Return type

List[str]

do_eval(*ex*, *context=None*, *recursive=False*, *strip_whitespace=True*)

Parameters

- **ex** (*Optional[cwltool.utils.CWLOutputType]*)
- **context** (*Optional[Any]*)
- **recursive** (*bool*)
- **strip_whitespace** (*bool*)

Return type

Optional[cwltool.utils.CWLOutputType]

cwltool.checker

Static checking of CWL workflow connectivity.

Module Contents

Functions

check_types(srctype, sinktype, linkMerge, valueFrom)	Check if the source and sink types are correct.
merge_flatten_type(src)	Return the merge flattened type of the source type.
can_assign_src_to_sink(src, sink[, strict])	Check for identical type specifications, ignoring extra keys like inputBinding.
missing_subset(fullset, subset)	
static_checker(workflow_inputs, workflow_outputs, ...)	Check if all source and sink types of a workflow are compatible before run time.
check_all_types(src_dict, sinks, sourceField, ...)	Given a list of sinks, check if their types match with the types of their sources.
circular_dependency_checker(step_inputs)	Check if a workflow has circular dependency.
get_dependency_tree(step_inputs)	Get the dependency tree in the form of adjacency list.
processDFS(adjacency, traversal_path, processed, cycles)	Perform depth first search.
get_step_id(field_id)	Extract step id from either input or output fields.
is_conditional_step(param_to_step, parm_id)	
is_all_output_method_loop_step(param_to_step, parm_id)	Check if a step contains a http://commonwl.org/cwltool#Loop requirement with *all* outputMethod.
loop_checker(steps)	Check http://commonwl.org/cwltool#Loop requirement compatibility with other directives.

Attributes

SrcSink

cwltool.checker.**check_types**(*srctype*, *sinktype*, *linkMerge*, *valueFrom*)

Check if the source and sink types are correct.

Raises

WorkflowException – If there is an unrecognized linkMerge type

Parameters

- **srctype** (*cwltool.utils.SinkType*)
- **sinktype** (*cwltool.utils.SinkType*)
- **linkMerge** (*Optional[str]*)
- **valueFrom** (*Optional[str]*)

Return type
Union[Literal[pass], Literal[warning], Literal[exception]]

cwltool.checker.**merge_flatten_type**(*src*)

Return the merge flattened type of the source type.

Parameters
src (*cwltool.utils.SinkType*)

Return type
cwltool.utils.CWLOutputType

cwltool.checker.**can_assign_src_to_sink**(*src*, *sink*, *strict=False*)

Check for identical type specifications, ignoring extra keys like inputBinding.

In non-strict comparison, at least one source type must match one sink type, except for 'null'. In strict comparison, all source types must match at least one sink type.

Parameters

- **src** (*cwltool.utils.SinkType*) – admissible source types
- **sink** (*Optional[cwltool.utils.SinkType]*) – admissible sink types
- **strict** (*bool*)

Return type
bool

cwltool.checker.**missing_subset**(*fullset*, *subset*)

Parameters

- **fullset** (*List[Any]*)
- **subset** (*List[Any]*)

Return type
List[Any]

cwltool.checker.**static_checker**(*workflow_inputs*, *workflow_outputs*, *step_inputs*, *step_outputs*, *param_to_step*)

Check if all source and sink types of a workflow are compatible before run time.

Raises
ValidationException – If any incompatibilities are detected.

Parameters

- **workflow_inputs** (*List[cwltool.utils.CWLObjectType]*)
- **workflow_outputs** (*MutableSequence[cwltool.utils.CWLObjectType]*)
- **step_inputs** (*MutableSequence[cwltool.utils.CWLObjectType]*)
- **step_outputs** (*List[cwltool.utils.CWLObjectType]*)
- **param_to_step** (*Dict[str, cwltool.utils.CWLObjectType]*)

Return type
None

cwltool.checker.**SrcSink**

cwltool.checker.**check_all_types**(*src_dict*, *sinks*, *sourceField*, *param_to_step*)

Given a list of sinks, check if their types match with the types of their sources.

Raises

- ***WorkflowException*** – if there is an unrecognized linkMerge value (from *check_types()*)
- **ValidationException** – if a sourceField is missing

Parameters

- **src_dict** (*Dict[str, cwltool.utils.CWLObjectType]*)
- **sinks** (*MutableSequence[cwltool.utils.CWLObjectType]*)
- **sourceField** (*Union[Literal[source], Literal[outputSource]]*)
- **param_to_step** (*Dict[str, cwltool.utils.CWLObjectType]*)

Return type

Dict[str, List[SrcSink]]

cwltool.checker.**circular_dependency_checker**(*step_inputs*)

Check if a workflow has circular dependency.

Raises

ValidationException – If a circular dependency is detected.

Parameters

step_inputs (*List[cwltool.utils.CWLObjectType]*)

Return type

None

cwltool.checker.**get_dependency_tree**(*step_inputs*)

Get the dependency tree in the form of adjacency list.

Parameters

step_inputs (*List[cwltool.utils.CWLObjectType]*)

Return type

Dict[str, List[str]]

cwltool.checker.**processDFS**(*adjacency*, *traversal_path*, *processed*, *cycles*)

Perform depth first search.

Parameters

- **adjacency** (*Dict[str, List[str]]*)
- **traversal_path** (*List[str]*)
- **processed** (*List[str]*)
- **cycles** (*List[List[str]]*)

Return type

None

cwltool.checker.**get_step_id**(*field_id*)

Extract step id from either input or output fields.

Parameters

field_id (*str*)

Return type
str

cwltool.checker.**is_conditional_step**(*param_to_step*, *parm_id*)

Parameters

- **param_to_step** (*Dict[str, cwltool.utils.CWLObjectType]*)
- **parm_id** (*str*)

Return type
bool

cwltool.checker.**is_all_output_method_loop_step**(*param_to_step*, *parm_id*)

Check if a step contains a http://commonwl.org/cwltool#Loop requirement with *all* outputMethod.

Parameters

- **param_to_step** (*Dict[str, cwltool.utils.CWLObjectType]*)
- **parm_id** (*str*)

Return type
bool

cwltool.checker.**loop_checker**(*steps*)

Check http://commonwl.org/cwltool#Loop requirement compatibility with other directives.

Raises
ValidationException – If there is an incompatible combination between cwltool:loop and 'scatter' or 'when'.

Parameters
steps (*Iterator[MutableMapping[str, Any]]*)

Return type
None

cwltool.command_line_tool

Implementation of CommandLineTool.

Module Contents

Classes

PathCheckingMode	What characters are allowed in path names.
ExpressionJob	Job for *ExpressionTool*.
ExpressionTool	Abstract CWL Process.
AbstractOperation	Abstract CWL Process.
CallbackJob	Callback Job class, used by *CommandLineTool.job()*.
CommandLineTool	Abstract CWL Process.

Functions

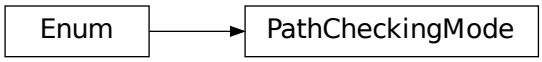
remove_path(f)	
revmap_file(builder, outdir, f)	Remap a file from internal path to external path.
check_adjust(accept_re, builder, file_o)	Map files to assigned path inside a container.
check_valid_locations(fs_access, ob)	

Attributes

OutputPortsType

class cwltool.command_line_tool.**PathCheckingMode**(**args*, ***kwds*)

Bases: enum.Enum



What characters are allowed in path names.

We have the strict (default) mode and the relaxed mode.

STRICT

Accepts names that contain one or more of the following:

\w	unicode word characters this includes most characters that can be part of a word in any language, as well as numbers and the underscore
.	a literal period
+	a literal plus sign
,	a literal comma
-	a literal minus sign
:	a literal colon
@	a literal at-symbol
]	a literal end-square-bracket
^	a literal caret symbol
\u2600-\u26FF	matches a single character in the range between (index 9728) and (index 9983)
\U0001f600-\U0001f64f	matches a single character in the range between (index 128512) and (index 128591)

Note: the following characters are intentionally not included:

1. reserved words in POSIX: !, {, }
2. POSIX metacharacters listed in the CWL standard as okay to reject: |, &, ;, <, >, (,), $, `, ", ', <space>, <tab>, <newline>.

   (In accordance with https://www.commonwl.org/v1.0/CommandLineTool.html#File under "path")
3. POSIX path separator: \

   (also listed at https://www.commonwl.org/v1.0/CommandLineTool.html#File under "path")
4. Additional POSIX metacharacters: *, ?, [, #, ~, =, %.

TODO: switch to https://pypi.org/project/regex/ and use \p{Extended_Pictographic} instead of the manual emoji ranges

RELAXED

Accept anything.

class cwltool.command_line_tool.**ExpressionJob**(*builder*, *script*, *output_callback*, *requirements*, *hints*, *outdir=None*, *tmpdir=None*)

Job for *ExpressionTool*.

Parameters

- **builder** (cwltool.builder.Builder)
- **script** (*str*)
- **output_callback** (*Optional[cwltool.utils.OutputCallbackType]*)
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **outdir** (*Optional[str]*)
- **tmpdir** (*Optional[str]*)

run(*runtimeContext*, *tmpdir_lock=None*)

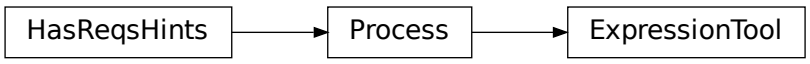
Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **tmpdir_lock** (*Optional[threading.Lock]*)

Return type
None

class cwltool.command_line_tool.**ExpressionTool**(*toolpath_object*, *loadingContext*)

Bases: *cwltool.process.Process*



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (cwltool.context.LoadingContext)

job(*job_order*, *output_callbacks*, *runtimeContext*)

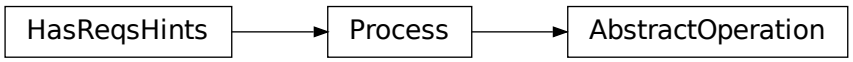
Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
Generator[*ExpressionJob*, None, None]

class cwltool.command_line_tool.**AbstractOperation**(*toolpath_object*, *loadingContext*)

Bases: *cwltool.process.Process*



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (cwltool.context.LoadingContext)

job(*job_order*, *output_callbacks*, *runtimeContext*)

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

cwltool.command_line_tool.**remove_path**(*f*)

Parameters
f (*cwltool.utils.CWLObjectType*)

Return type
None

cwltool.command_line_tool.**revmap_file**(*builder*, *outdir*, *f*)

Remap a file from internal path to external path.

For Docker, this maps from the path inside tho container to the path outside the container. Recognizes files in the pathmapper or remaps internal output directories to the external directory.

Parameters

- **builder** (cwltool.builder.Builder)
- **outdir** (*str*)
- **f** (*cwltool.utils.CWLObjectType*)

Return type
Optional[cwltool.utils.CWLObjectType]

class cwltool.command_line_tool.**CallbackJob**(*job*, *output_callback*, *cachebuilder*, *jobcache*)

Callback Job class, used by *CommandLineTool.job()*.

Parameters

- **job** (CommandLineTool)
- **output_callback** (*Optional[cwltool.utils.OutputCallbackType]*)
- **cachebuilder** (cwltool.builder.Builder)
- **jobcache** (*str*)

run(*runtimeContext*, *tmpdir_lock=None*)

Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **tmpdir_lock** (*Optional[threading.Lock]*)

Return type
None

cwltool.command_line_tool.**check_adjust**(*accept_re*, *builder*, *file_o*)

Map files to assigned path inside a container.

We need to also explicitly walk over input, as implicit reassignment doesn't reach everything in builder.bindings

Parameters

- **accept_re** (*Pattern[str]*)
- **builder** (cwltool.builder.Builder)
- **file_o** (*cwltool.utils.CWLObjectType*)

Return type
cwltool.utils.CWLObjectType

cwltool.command_line_tool.**check_valid_locations**(*fs_access*, *ob*)

Parameters

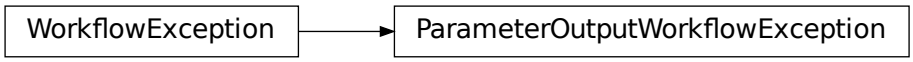
- **fs_access** (cwltool.stdfsaccess.StdFsAccess)
- **ob** (*cwltool.utils.CWLObjectType*)

Return type
None

cwltool.command_line_tool.**OutputPortsType**

exception cwltool.command_line_tool.**ParameterOutputWorkflowException**(*msg*, *port*, ***kwargs*)

Bases: *cwltool.errors.WorkflowException*



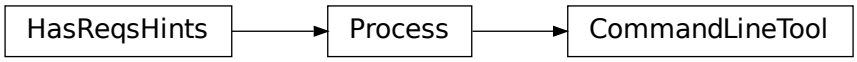
Common base class for all non-exit exceptions.

Parameters

- **msg** (*str*)
- **port** (*cwltool.utils.CWLObjectType*)
- **kwargs** (*Any*)

class cwltool.command_line_tool.**CommandLineTool**(*toolpath_object*, *loadingContext*)

Bases: *cwltool.process.Process*



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (cwltool.context.LoadingContext)

make_job_runner(*runtimeContext*)

Parameters
runtimeContext (cwltool.context.RuntimeContext)

Return type
Type[*cwltool.job.JobBase*]

static make_path_mapper(*reffiles*, *stagedir*, *runtimeContext*, *separateDirs*)

Parameters

- **reffiles** (*List[cwltool.utils.CWLObjectType]*)
- **stagedir** (*str*)
- **runtimeContext** (cwltool.context.RuntimeContext)
- **separateDirs** (*bool*)

Return type
cwltool.pathmapper.PathMapper

updatePathmap(*outdir*, *pathmap*, *fn*)

Update a PathMapper with a CWL File or Directory object.

Parameters

- **outdir** (*str*)
- **pathmap** (cwltool.pathmapper.PathMapper)
- **fn** (*cwltool.utils.CWLObjectType*)

Return type
None

job(*job_order*, *output_callbacks*, *runtimeContext*)

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
Generator[Union[*cwltool.job.JobBase*, *CallbackJob*], None, None]

collect_output_ports(*ports*, *builder*, *outdir*, *rcode*, *compute_checksum=True*, *jobname=''*, *readers=None*)

Parameters

- **ports** (*Union[ruamel.yaml.comments.CommentedSeq, Set[cwltool.utils.CWLObjectType]]*)
- **builder** (cwltool.builder.Builder)
- **outdir** (*str*)
- **rcode** (*int*)
- **compute_checksum** (*bool*)
- **jobname** (*str*)
- **readers** (*Optional[MutableMapping[str, cwltool.utils.CWLObjectType]]*)

Return type
OutputPortsType

collect_output(*schema*, *builder*, *outdir*, *fs_access*, *compute_checksum=True*)

Parameters

- **schema** (*cwltool.utils.CWLObjectType*)
- **builder** (cwltool.builder.Builder)
- **outdir** (*str*)
- **fs_access** (cwltool.stdfsaccess.StdFsAccess)
- **compute_checksum** (*bool*)

Return type
Optional[cwltool.utils.CWLOutputType]

cwltool.context

Shared context objects that replace use of kwargs.

Module Contents

Classes

ContextBase	Shared kwargs based initializer for *RuntimeContext* and *LoadingContext*.
LoadingContext	Shared kwargs based initializer for *RuntimeContext* and *LoadingContext*.
RuntimeContext	Shared kwargs based initializer for *RuntimeContext* and *LoadingContext*.

Functions

make_tool_notimpl(toolpath_object, loadingContext)	Fake implementation of the make tool function.
log_handler(outdir, base_path_logs, stdout_path, ...)	Move logs from log location to final output.
set_log_dir(outdir, log_dir, subdir_name)	Set the log directory.
getdefault(val, default)	Return the `val` using the `default` as backup in case the val is `None`.

Attributes

default_make_tool

class cwltool.context.**ContextBase**(*kwargs=None*)

Shared kwargs based initializer for *RuntimeContext* and *LoadingContext*.

Parameters
kwargs (*Optional[Dict[str, Any]]*)

cwltool.context.**make_tool_notimpl**(*toolpath_object*, *loadingContext*)

Fake implementation of the make tool function.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (LoadingContext)

Return type
cwltool.process.Process

cwltool.context.**default_make_tool**

cwltool.context.**log_handler**(*outdir*, *base_path_logs*, *stdout_path*, *stderr_path*)

Move logs from log location to final output.

Parameters

- **outdir** (*str*)
- **base_path_logs** (*str*)
- **stdout_path** (*Optional[str]*)
- **stderr_path** (*Optional[str]*)

Return type
None

cwltool.context.**set_log_dir**(*outdir*, *log_dir*, *subdir_name*)

Set the log directory.

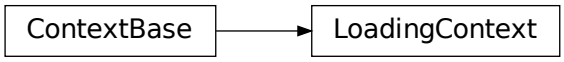
Parameters

- **outdir** (*str*)
- **log_dir** (*str*)
- **subdir_name** (*str*)

Return type
str

class cwltool.context.**LoadingContext**(*kwargs=None*)

Bases: *ContextBase*



Shared kwargs based initializer for *RuntimeContext* and *LoadingContext*.

Parameters
kwargs (*Optional[Dict[str, Any]]*)

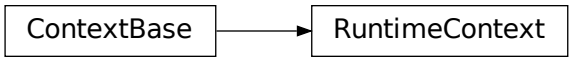
copy()

Return a copy of this *LoadingContext*.

Return type
LoadingContext

class cwltool.context.**RuntimeContext**(*kwargs=None*)

Bases: *ContextBase*



Shared kwargs based initializer for *RuntimeContext* and *LoadingContext*.

Parameters
kwargs (*Optional[Dict[str, Any]]*)

outdir: str | None

tmpdir: str = ''

tmpdir_prefix: str

tmp_outdir_prefix: str = ''

stagedir: str = ''

get_outdir()

Return *outdir* or create one with *tmp_outdir_prefix*.

Return type
str

get_tmpdir()

Return *tmpdir* or create one with *tmpdir_prefix*.

Return type
str

get_stagedir()

Return *stagedir* or create one with *tmpdir_prefix*.

Return type
str

create_tmpdir()

Create a temporary directory that respects *tmpdir_prefix*.

Return type
str

create_outdir()

Create a temporary directory that respects *tmp_outdir_prefix*.

Return type
str

copy()

Return a copy of this *RuntimeContext*.

Return type
RuntimeContext

cwltool.context.**getdefault**(*val*, *default*)

Return the `val` using the `default` as backup in case the val is `None`.

Parameters

- **val** (*Any*)
- **default** (*Any*)

Return type
Any

cwltool.cuda

Support utilities for CUDA.

Module Contents

Functions

cuda_version_and_device_count()	Determine the CUDA version and number of attached CUDA GPUs.
cuda_check(cuda_req, requestCount)	

cwltool.cuda.**cuda_version_and_device_count**()

Determine the CUDA version and number of attached CUDA GPUs.

Return type
Tuple[str, int]

cwltool.cuda.**cuda_check**(*cuda_req*, *requestCount*)

Parameters

- **cuda_req** (*cwltool.utils.CWLObjectType*)
- **requestCount** (*int*)

Return type
int

cwltool.cwlrdf

Module Contents

Functions

gather(tool, ctx)	
printrdf(wflow, ctx, style)	Serialize the CWL document into a string, ready for printing.
lastpart(uri)	
dot_with_parameters(g, stdout)	
dot_without_parameters(g, stdout)	
printdot(wf, ctx, stdout)	

cwltool.cwlrdf.**gather**(*tool*, *ctx*)

Parameters

- **tool** (cwltool.process.Process)
- **ctx** (*schema_salad.utils.ContextType*)

Return type
rdflib.Graph

cwltool.cwlrdf.**printrdf**(*wflow*, *ctx*, *style*)

Serialize the CWL document into a string, ready for printing.

Parameters

- **wflow** (cwltool.process.Process)
- **ctx** (*schema_salad.utils.ContextType*)
- **style** (*str*)

Return type
str

cwltool.cwlrdf.**lastpart**(*uri*)

Parameters
uri (*Any*)

Return type
str

cwltool.cwlrdf.**dot_with_parameters**(*g*, *stdout*)

Parameters

- **g** (*rdflib.Graph*)
- **stdout** (*Union[TextIO, codecs.StreamWriter]*)

Return type
None

cwltool.cwlrdf.**dot_without_parameters**(*g*, *stdout*)

Parameters

- **g** (*rdflib.Graph*)
- **stdout** (*Union[TextIO, codecs.StreamWriter]*)

Return type
None

cwltool.cwlrdf.**printdot**(*wf*, *ctx*, *stdout*)

Parameters

- **wf** (cwltool.process.Process)
- **ctx** (*schema_salad.utils.ContextType*)
- **stdout** (*IO[str]*)

Return type
None

cwltool.cwlviewer

Visualize a CWL workflow.

Module Contents

Classes

CWLViewer	Produce similar images with the https://github.com/common-workflow-language/cwlviewer.

class cwltool.cwlviewer.**CWLViewer**(*rdf_description*)

Produce similar images with the https://github.com/common-workflow-language/cwlviewer.

Parameters
rdf_description (*str*)

get_dot_graph()

Get the dot graph object.

Return type
pydot.Graph

dot()

Get the graph as graphviz.

Return type
str

cwltool.docker

Enables Docker software containers via the {u,}docker or podman runtimes.

Module Contents

Classes

DockerCommandLineJob	Runs a *CommandLineJob* in a software container using the Docker engine.
PodmanCommandLineJob	Runs a *CommandLineJob* in a software container using the podman engine.

class cwltool.docker.**DockerCommandLineJob**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: *cwltool.job.ContainerCommandLineJob*

Runs a *CommandLineJob* in a software container using the Docker engine.

Parameters

- **builder** (cwltool.builder.Builder)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper])
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

get_image(*docker_requirement*, *pull_image*, *force_pull*, *tmp_outdir_prefix*)

Retrieve the relevant Docker container image.

Returns

True upon success

Parameters

- **docker_requirement** (*Dict[str, str]*)
- **pull_image** (*bool*)
- **force_pull** (*bool*)
- **tmp_outdir_prefix** (*str*)

Return type
bool

`get_from_requirements`(*r*, *pull_image*, *force_pull*, *tmp_outdir_prefix*)

Parameters

- **r** (*cwltool.utils.CWLObjectType*)
- **pull_image** (*bool*)
- **force_pull** (*bool*)
- **tmp_outdir_prefix** (*str*)

Return type
Optional[str]

`static append_volume`(*runtime*, *source*, *target*, *writable=False*, *skip_mkdirs=False*)

Add binding arguments to the runtime list.

Parameters

- **runtime** (*List[str]*)
- **source** (*str*)
- **target** (*str*)
- **writable** (*bool*)
- **skip_mkdirs** (*bool*)

Return type
None

`add_file_or_directory_volume`(*runtime*, *volume*, *host_outdir_tgt*)

Append volume a file/dir mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)

Return type
None

`add_writable_file_volume`(*runtime*, *volume*, *host_outdir_tgt*, *tmpdir_prefix*)

Append a writable file mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)
- **tmpdir_prefix** (*str*)

Return type
None

add_writable_directory_volume(*runtime*, *volume*, *host_outdir_tgt*, *tmpdir_prefix*)

Append a writable directory mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)
- **tmpdir_prefix** (*str*)

Return type
None

create_runtime(*env*, *runtimeContext*)

Return the list of commands to run the selected container engine.

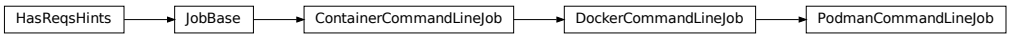
Parameters

- **env** (*MutableMapping[str, str]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
Tuple[List[str], Optional[str]]

class cwltool.docker.**PodmanCommandLineJob**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: *DockerCommandLineJob*



Runs a *CommandLineJob* in a software container using the podman engine.

Parameters

- **builder** (cwltool.builder.Builder)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper])
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

cwltool.docker_id

Helper functions for docker.

Module Contents

Functions

docker_vm_id()	Return the User ID and Group ID of the default docker user inside the VM.
check_output_and_strip(cmd)	Pass a command list to subprocess.check_output().
docker_machine_name()	Get the machine name of the active docker-machine machine.
cmd_output_matches(check_cmd, expected_status)	Run a command and compares output to expected.
boot2docker_running()	Check if boot2docker CLI reports that boot2docker vm is running.
docker_machine_running()	Ask docker-machine for the active machine and checks if its VM is running.
cmd_output_to_int(cmd)	Run the provided command and returns the integer value of the result.
boot2docker_id()	Get the UID and GID of the docker user inside a running boot2docker vm.
docker_machine_id()	Ask docker-machine for active machine and gets the UID of the docker user.

cwltool.docker_id.**docker_vm_id**()

Return the User ID and Group ID of the default docker user inside the VM.

When a host is using boot2docker or docker-machine to run docker with boot2docker.iso (As on Mac OS X), the UID that mounts the shared filesystem inside the VirtualBox VM is likely different than the user's UID on the host. :return: A tuple containing numeric User ID and Group ID of the docker account inside the boot2docker VM

Return type
Tuple[Optional[int], Optional[int]]

cwltool.docker_id.**check_output_and_strip**(*cmd*)

Pass a command list to subprocess.check_output().

Returning None if an expected exception is raised :param cmd: The command to execute :return: Stripped string output of the command, or None if error

Parameters
cmd (*List[str]*)

Return type
Optional[str]

cwltool.docker_id.**docker_machine_name**()

Get the machine name of the active docker-machine machine.

Returns
Name of the active machine or None if error

Return type
Optional[str]

cwltool.docker_id.**cmd_output_matches**(*check_cmd*, *expected_status*)

Run a command and compares output to expected.

Parameters

- **check_cmd** (*List[str]*) – Command list to execute
- **expected_status** (*str*) – Expected output, e.g. "Running" or "poweroff"

Returns
Boolean value, indicating whether or not command result matched

Return type
bool

cwltool.docker_id.**boot2docker_running**()

Check if boot2docker CLI reports that boot2docker vm is running.

Returns
`True` if vm is running, `False` otherwise

Return type
bool

cwltool.docker_id.**docker_machine_running**()

Ask docker-machine for the active machine and checks if its VM is running.

Returns
`True` if vm is running, `False` otherwise

Return type
bool

cwltool.docker_id.**cmd_output_to_int**(*cmd*)

Run the provided command and returns the integer value of the result.

Parameters
cmd (*List[str]*) – The command to run

Returns
Integer value of result, or None if an error occurred

Return type
Optional[int]

cwltool.docker_id.**boot2docker_id**()

Get the UID and GID of the docker user inside a running boot2docker vm.

Returns
Tuple (UID, GID), or (None, None) if error (e.g. boot2docker not present or stopped)

Return type
Tuple[Optional[int], Optional[int]]

cwltool.docker_id.**docker_machine_id**()

Ask docker-machine for active machine and gets the UID of the docker user.

inside the vm :return: tuple (UID, GID), or (None, None) if error (e.g. docker-machine not present or stopped)

Return type
Tuple[Optional[int], Optional[int]]

cwltool.env_to_stdout

Python script that acts like (GNU coreutils) env -0.

When run as a script, it prints the the environment as *(VARNAME=value0)**.

Ideally we would just use *env -0*, because python (thanks to PEPs 538 and 540) will set zero to two environment variables to better handle Unicode-locale interactions, however BSD family implementations of *env* do not all support the *-0* flag so we supply this script that produces equivalent output.

Module Contents

Functions

deserialize_env(data)	Deserialize the output of *env -0* to dictionary.
main()	Print the null-separated environment to stdout.

cwltool.env_to_stdout.**deserialize_env**(*data*)

Deserialize the output of *env -0* to dictionary.

Parameters
data (*str*)

Return type
Dict[str, str]

cwltool.env_to_stdout.**main**()

Print the null-separated environment to stdout.

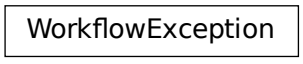
Return type
None

cwltool.errors

Module Contents

exception cwltool.errors.**WorkflowException**

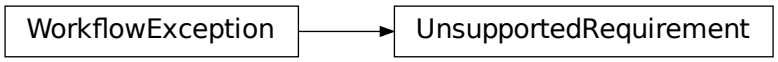
Bases: Exception



Common base class for all non-exit exceptions.

exception cwltool.errors.**UnsupportedRequirement**

Bases: *WorkflowException*



Common base class for all non-exit exceptions.

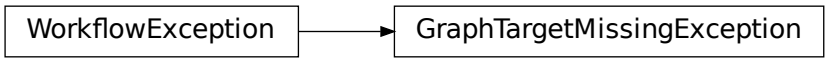
exception cwltool.errors.**ArgumentException**

Bases: Exception

Mismatched command line arguments provided.

exception cwltool.errors.**GraphTargetMissingException**

Bases: *WorkflowException*



When a `$graph` is encountered and there is no target and no `main/#main`.

cwltool.executors

Single and multi-threaded executors.

Module Contents

Classes

JobExecutor	Abstract base job executor.
SingleJobExecutor	Default single-threaded CWL reference executor.
MultithreadedJobExecutor	Experimental multi-threaded CWL executor.
NoopJobExecutor	Do nothing executor, for testing purposes only.

Attributes

TMPDIR_LOCK

cwltool.executors.**TMPDIR_LOCK**

class cwltool.executors.**JobExecutor**

Abstract base job executor.

__call__(*process*, *job_order_object*, *runtime_context*, *logger=_logger*)

Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **runtime_context** (cwltool.context.RuntimeContext)
- **logger** (*logging.Logger*)

Return type
Tuple[Optional[cwltool.utils.CWLObjectType], str]

output_callback(*out*, *process_status*)

Collect the final status and outputs.

Parameters

- **out** (*Optional[cwltool.utils.CWLObjectType]*)
- **process_status** (*str*)

Return type
None

abstract run_jobs(*process*, *job_order_object*, *logger*, *runtime_context*)

Execute the jobs for the given Process.

Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **logger** (*logging.Logger*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
None

execute(*process*, *job_order_object*, *runtime_context*, *logger=_logger*)

Execute the process.

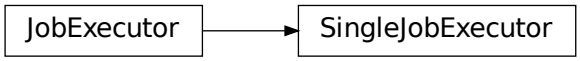
Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **runtime_context** (cwltool.context.RuntimeContext)
- **logger** (*logging.Logger*)

Return type
Tuple[Union[Optional[cwltool.utils.CWLObjectType]], str]

class cwltool.executors.**SingleJobExecutor**

Bases: *JobExecutor*



Default single-threaded CWL reference executor.

run_jobs(*process*, *job_order_object*, *logger*, *runtime_context*)

Execute the jobs for the given Process.

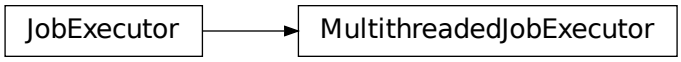
Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **logger** (*logging.Logger*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
None

class cwltool.executors.**MultithreadedJobExecutor**

Bases: *JobExecutor*



Experimental multi-threaded CWL executor.

Does simple resource accounting, will not start a job unless it has cores / ram available, but does not make any attempt to optimize usage.

select_resources(*request*, *runtime_context*)

Naïve check for available cpu cores and memory.

Parameters

- **request** (*Dict[str, Union[int, float]]*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
Dict[str, Union[int, float]]

run_job(*job*, *runtime_context*)

Execute a single Job in a separate thread.

Parameters

- **job** (*Optional[cwltool.utils.JobsType]*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
None

wait_for_next_completion(*runtime_context*)

Wait for jobs to finish.

Parameters
runtime_context (cwltool.context.RuntimeContext)

Return type
None

run_jobs(*process*, *job_order_object*, *logger*, *runtime_context*)

Execute the jobs for the given Process.

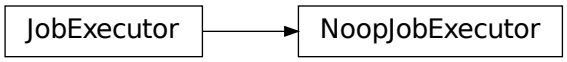
Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **logger** (*logging.Logger*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
None

class cwltool.executors.**NoopJobExecutor**

Bases: *JobExecutor*



Do nothing executor, for testing purposes only.

run_jobs(*process*, *job_order_object*, *logger*, *runtime_context*)

Execute the jobs for the given Process.

Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **logger** (*logging.Logger*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
None

execute(*process*, *job_order_object*, *runtime_context*, *logger=None*)

Execute the process.

Parameters

- **process** (cwltool.process.Process)
- **job_order_object** (*cwltool.utils.CWLObjectType*)
- **runtime_context** (cwltool.context.RuntimeContext)
- **logger** (*Optional[logging.Logger]*)

Return type
Tuple[Optional[cwltool.utils.CWLObjectType], str]

cwltool.factory

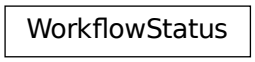
Module Contents

Classes

Callable	Result of :*Factory.make()*.
Factory	Easy way to load a CWL document for execution.

exception cwltool.factory.**WorkflowStatus**(*out*, *status*)

Bases: Exception



Common base class for all non-exit exceptions.

Parameters

- **out** (*Optional[cwltool.utils.CWLObjectType]*)
- **status** (*str*)

class cwltool.factory.**Callable**(*t*, *factory*)

Result of :*Factory.make()*.

Parameters

- **t** (cwltool.process.Process)
- **factory** (Factory)

__call__(***kwargs*)

Parameters
kwargs (*Any*)

Return type
Union[str, Optional[cwltool.utils.CWLObjectType]]

class cwltool.factory.**Factory**(*executor=None*, *loading_context=None*, *runtime_context=None*)

Easy way to load a CWL document for execution.

Parameters

- **executor** (*Optional[cwltool.executors.JobExecutor]*)
- **loading_context** (*Optional[cwltool.context.LoadingContext]*)
- **runtime_context** (*Optional[cwltool.context.RuntimeContext]*)

loading_context: *cwltool.context.LoadingContext*

runtime_context: *cwltool.context.RuntimeContext*

make(*cwl*)

Instantiate a CWL object from a CWl document.

Parameters
cwl (*Union[str, Dict[str, Any]]*)

Return type
Callable

cwltool.flatten

Module Contents

Functions

flatten(thing[, ltypes])	

cwltool.flatten.**flatten**(*thing*, *ltypes=(list, tuple)*)

Parameters

- **thing** (*Any*)
- **ltypes** (*Any*)

Return type
List[Any]

cwltool.job

Module Contents

Classes

JobBase	Base class for get_requirement().
CommandLineJob	Base class for get_requirement().
ContainerCommandLineJob	Commandline job using containers.

Functions

relink_initialworkdir(pathmapper, host_outdir, ...[, ...])	
neverquote(string[, pos, endpos])	

Attributes

CollectOutputsType
needs_shell_quoting_re
FORCE_SHELLED_POPEN
SHELL_COMMAND_TEMPLATE
CONTROL_CODE_RE

cwltool.job.**CollectOutputsType**

cwltool.job.**needs_shell_quoting_re**

cwltool.job.**FORCE_SHELLED_POPEN**

cwltool.job.**SHELL_COMMAND_TEMPLATE = Multiline-String**

```
"""#!/bin/bash
python3 "run_job.py" "job.json"
"""
```

cwltool.job.**relink_initialworkdir**(*pathmapper*, *host_outdir*, *container_outdir*, *inplace_update=False*)

Parameters

- **pathmapper** (cwltool.pathmapper.PathMapper)
- **host_outdir** (*str*)
- **container_outdir** (*str*)
- **inplace_update** (*bool*)

Return type
None

cwltool.job.**neverquote**(*string*, *pos=0*, *endpos=0*)

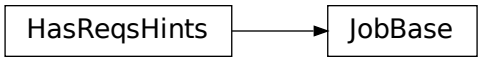
Parameters

- **string** (*str*)
- **pos** (*int*)
- **endpos** (*int*)

Return type
Optional[Match[str]]

class cwltool.job.**JobBase**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: cwltool.utils.HasReqsHints



Base class for get_requirement().

Parameters

- **builder** (cwltool.builder.Builder)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper])
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

__repr__()

Represent this Job object.

Return type
str

abstract run(*runtimeContext*, *tmpdir_lock=None*)

Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **tmpdir_lock** (*Optional[threading.Lock]*)

Return type
None

prepare_environment(*runtimeContext*, *envVarReq*)

Set up environment variables.

Here we prepare the environment for the job, based on any preserved variables and *EnvVarRequirement*. Later, changes due to *MPIRequirement*, *Secrets*, or *SoftwareRequirement* are applied (in that order).

Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **envVarReq** (*Mapping[str, str]*)

Return type
None

process_monitor(*sproc*)

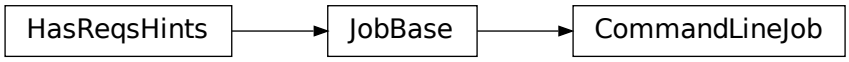
Watch a process, logging its max memory usage.

Parameters
sproc (*subprocess.Popen[str]*)

Return type
None

class cwltool.job.**CommandLineJob**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: *JobBase*



Base class for get_requirement().

Parameters

- **builder** (cwltool.builder.Builder)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper])
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

run(*runtimeContext*, *tmpdir_lock=None*)

Parameters

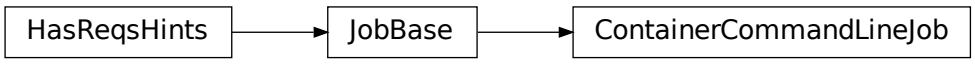
- **runtimeContext** (cwltool.context.RuntimeContext)
- **tmpdir_lock** (*Optional[threading.Lock]*)

Return type
None

cwltool.job.**CONTROL_CODE_RE** = '\\x1b\\[[0-9;]*[a-zA-Z]'

class cwltool.job.**ContainerCommandLineJob**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: *JobBase*



Commandline job using containers.

Parameters

- **builder** (cwltool.builder.Builder)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper])
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

CONTAINER_TMPDIR: str = '/tmp'

abstract get_from_requirements(*r*, *pull_image*, *force_pull*, *tmp_outdir_prefix*)

Parameters

- **r** (*cwltool.utils.CWLObjectType*)
- **pull_image** (*bool*)
- **force_pull** (*bool*)
- **tmp_outdir_prefix** (*str*)

Return type
Optional[str]

abstract create_runtime(*env*, *runtime_context*)

Return the list of commands to run the selected container engine.

Parameters

- **env** (*MutableMapping[str, str]*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
Tuple[List[str], Optional[str]]

abstract static append_volume(*runtime*, *source*, *target*, *writable=False*)

Add binding arguments to the runtime list.

Parameters

- **runtime** (*List[str]*)
- **source** (*str*)
- **target** (*str*)
- **writable** (*bool*)

Return type
None

abstract add_file_or_directory_volume(*runtime*, *volume*, *host_outdir_tgt*)

Append volume a file/dir mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)

- **host_outdir_tgt** (*Optional[str]*)

Return type
None

abstract add_writable_file_volume(*runtime*, *volume*, *host_outdir_tgt*, *tmpdir_prefix*)

Append a writable file mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)
- **tmpdir_prefix** (*str*)

Return type
None

abstract add_writable_directory_volume(*runtime*, *volume*, *host_outdir_tgt*, *tmpdir_prefix*)

Append a writable directory mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)
- **tmpdir_prefix** (*str*)

Return type
None

create_file_and_add_volume(*runtime*, *volume*, *host_outdir_tgt*, *secret_store*, *tmpdir_prefix*)

Create the file and add a mapping.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)
- **secret_store** (*Optional[cwltool.secrets.SecretStore]*)
- **tmpdir_prefix** (*str*)

Return type
str

add_volumes(*pathmapper*, *runtime*, *tmpdir_prefix*, *secret_store=None*, *any_path_okay=False*)

Append volume mappings to the runtime option list.

Parameters

- **pathmapper** (cwltool.pathmapper.PathMapper)
- **runtime** (*List[str]*)
- **tmpdir_prefix** (*str*)
- **secret_store** (*Optional[cwltool.secrets.SecretStore]*)

- **any_path_okay** (*bool*)

Return type
None

run(*runtimeContext*, *tmpdir_lock=None*)

Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **tmpdir_lock** (*Optional[threading.Lock]*)

Return type
None

docker_monitor(*cidfile*, *tmpdir_prefix*, *cleanup_cidfile*, *docker_exe*, *process*)

Record memory usage of the running Docker container.

Parameters

- **cidfile** (*str*)
- **tmpdir_prefix** (*str*)
- **cleanup_cidfile** (*bool*)
- **docker_exe** (*str*)
- **process** (*subprocess.Popen[str]*)

Return type
None

cwltool.load_tool

Loads a CWL document.

Module Contents

Functions

default_loader([fetcher_constructor, enable_dev, ...])	
resolve_tool_uri(argsworkflow[, resolver, ...])	
fetch_document(argsworkflow[, loadingContext])	Retrieve a CWL document.
update_index(document_loader, pr)	
fast_parser(workflowobj, fileuri, uri, loadingContext, ...)	
resolve_and_validate_document(loadingContext, ...[, ...])	Validate a CWL document.
make_tool(uri, loadingContext)	Make a Python CWL object.
load_tool(argsworkflow[, loadingContext])	
resolve_overrides(ov, ov_uri, baseurl)	
load_overrides(ov, base_url)	
recursive_resolve_and_validate_document(...[, ...])	Validate a CWL document, checking that a tool object can be built.

Attributes

docloaderctx
jobloader_id_name
jobloaderctx
overrides_ctx

cwltool.load_tool.**docloaderctx**: **schema_salad.utils.ContextType**

cwltool.load_tool.**jobloader_id_name** = **'__id'**

cwltool.load_tool.**jobloaderctx**: **schema_salad.utils.ContextType**

cwltool.load_tool.**overrides_ctx**: **schema_salad.utils.ContextType**

cwltool.load_tool.**default_loader**(*fetcher_constructor=None*, *enable_dev=False*, *doc_cache=True*)

Parameters

- **fetcher_constructor** (*Optional[schema_salad.utils.FetcherCallableType]*)
- **enable_dev** (*bool*)

- **doc_cache** (*bool*)

Return type
schema_salad.ref_resolver.Loader

cwltool.load_tool.**resolve_tool_uri**(*argsworkflow*, *resolver=None*, *fetcher_constructor=None*, *document_loader=None*)

Parameters

- **argsworkflow** (*str*)
- **resolver** (*Optional[cwltool.utils.ResolverType]*)
- **fetcher_constructor** (*Optional[schema_salad.utils.FetcherCallableType]*)
- **document_loader** (*Optional[schema_salad.ref_resolver.Loader]*)

Return type
Tuple[str, str]

cwltool.load_tool.**fetch_document**(*argsworkflow*, *loadingContext=None*)

Retrieve a CWL document.

Parameters

- **argsworkflow** (*Union[str, cwltool.utils.CWLObjectType]*)
- **loadingContext** (*Optional[cwltool.context.LoadingContext]*)

Return type
Tuple[*cwltool.context.LoadingContext*, ruamel.yaml.comments.CommentedMap, str]

cwltool.load_tool.**update_index**(*document_loader*, *pr*)

Parameters

- **document_loader** (*schema_salad.ref_resolver.Loader*)
- **pr** (*ruamel.yaml.comments.CommentedMap*)

Return type
None

cwltool.load_tool.**fast_parser**(*workflowobj*, *fileuri*, *uri*, *loadingContext*, *fetcher*)

Parameters

- **workflowobj** (*Union[ruamel.yaml.comments.CommentedMap, ruamel.yaml.comments.CommentedSeq, None]*)
- **fileuri** (*Optional[str]*)
- **uri** (*str*)
- **loadingContext** (cwltool.context.LoadingContext)
- **fetcher** (*schema_salad.fetcher.Fetcher*)

Return type
Tuple[Union[ruamel.yaml.comments.CommentedMap, ruamel.yaml.comments.CommentedSeq], ruamel.yaml.comments.CommentedMap]

cwltool.load_tool.**resolve_and_validate_document**(*loadingContext*, *workflowobj*, *uri*, *preprocess_only=False*)

Validate a CWL document.

Parameters

- **loadingContext** (cwltool.context.LoadingContext)
- **workflowobj** (*Union[ruamel.yaml.comments.CommentedMap, ruamel.yaml.comments.CommentedSeq]*)
- **uri** (*str*)
- **preprocess_only** (*bool*)

Return type
Tuple[*cwltool.context.LoadingContext*, str]

cwltool.load_tool.**make_tool**(*uri*, *loadingContext*)

Make a Python CWL object.

Parameters

- **uri** (*Union[str, ruamel.yaml.comments.CommentedMap, ruamel.yaml.comments.CommentedSeq]*)
- **loadingContext** (cwltool.context.LoadingContext)

Return type
cwltool.process.Process

cwltool.load_tool.**load_tool**(*argsworkflow*, *loadingContext=None*)

Parameters

- **argsworkflow** (*Union[str, cwltool.utils.CWLObjectType]*)
- **loadingContext** (*Optional[cwltool.context.LoadingContext]*)

Return type
cwltool.process.Process

cwltool.load_tool.**resolve_overrides**(*ov*, *ov_uri*, *baseurl*)

Parameters

- **ov** (*schema_salad.utils.IdxResultType*)
- **ov_uri** (*str*)
- **baseurl** (*str*)

Return type
List[cwltool.utils.CWLObjectType]

cwltool.load_tool.**load_overrides**(*ov*, *base_url*)

Parameters

- **ov** (*str*)
- **base_url** (*str*)

Return type
List[cwltool.utils.CWLObjectType]

cwltool.load_tool.**recursive_resolve_and_validate_document**(*loadingContext*, *workflowobj*, *uri*, *preprocess_only=False*)

Validate a CWL document, checking that a tool object can be built.

Parameters

- **loadingContext** (cwltool.context.LoadingContext)
- **workflowobj** (*Union[ruamel.yaml.comments.CommentedMap, ruamel.yaml.comments.CommentedSeq]*)
- **uri** (*str*)
- **preprocess_only** (*bool*)

Return type

Tuple[*cwltool.context.LoadingContext*, str, *cwltool.process.Process*]

cwltool.loghandler

Shared logger for cwltool.

Module Contents

Functions

configure_logging(stderr_handler, quiet, ...)	no_warnings,	Configure logging.

Attributes

defaultStreamHandler

cwltool.loghandler.**defaultStreamHandler**

cwltool.loghandler.**configure_logging**(*stderr_handler*, *no_warnings*, *quiet*, *debug*, *enable_color*, *timestamps*, *base_logger=_logger*)

Configure logging.

Parameters

- **stderr_handler** (*logging.Handler*)
- **no_warnings** (*bool*)
- **quiet** (*bool*)
- **debug** (*bool*)
- **enable_color** (*bool*)
- **timestamps** (*bool*)

- **base_logger** (*logging.Logger*)

Return type
None

cwltool.main

Entry point for cwltool.

Module Contents

Classes

ProvLogFormatter	Enforce ISO8601 with both T and Z.

Functions

append_word_to_default_user_agent(word)	Append the specified word to the requests http user agent string if it's not already there.
generate_example_input(inptype, default)	Convert a single input schema into an example.
realize_input_schema(input_types, schema_defs)	Replace references to named typed with the actual types.
generate_input_template(tool)	Generate an example input object for the given CWL process.
load_job_order(args, stdin, fetcher_constructor, ...)	
init_job_order(job_order_object, args, process, ...[, ...])	
make_relative(base, obj)	Relativize the location URI of a File or Directory object.
printdeps(obj, document_loader, stdout, relative_deps, uri)	Print a JSON representation of the dependencies of the CWL document.
prov_deps(obj, document_loader, uri[, basedir])	
find_deps(obj, document_loader, uri[, basedir, nestdirs])	Find the dependencies of the CWL document.
print_pack(loadingContext, uri)	Return a CWL serialization of the CWL document in JSON.
supported_cwl_versions(enable_dev)	
setup_schema(args, custom_schema_callback)	
setup_provenance(args, runtimeContext[, argsl])	
setup_loadingContext(loadingContext, runtimeContext, args)	Prepare a LoadingContext from the given arguments.
make_template(tool, target)	Make a template CWL input object for the give Process.
inherit_reqshints(tool, parent)	Copy down requirements and hints from ancestors of a given process.
choose_target(args, tool, loading_context)	Walk the Workflow, extract the subset matches all the args.targets.
choose_step(args, tool, loading_context)	Walk the given Workflow and extract just args.single_step.
choose_process(args, tool, loadingContext)	Walk the given Workflow and extract just args.single_process.
check_working_directories(runtimeContext)	Make any needed working directories.
print_targets(tool, stdout, loading_context[, prefix])	Recursively find targets for --subgraph and friends.
main([argsl, args, job_order_object, stdin, stdout, ...])	
find_default_container(builder[, default_container, ...])	Find a container.
windows_check()	See if we are running on MS Windows and warn about the lack of support.
run(*args, **kwargs)	Run cwltool.

Attributes

docker_exe
ProvOut

cwltool.main.**docker_exe**: str

cwltool.main.**append_word_to_default_user_agent**(*word*)

Append the specified word to the requests http user agent string if it's not already there.

Parameters
word (*str*)

Return type
None

cwltool.main.**generate_example_input**(*inptype*, *default*)

Convert a single input schema into an example.

Parameters

- **inptype** (*Optional[cwltool.utils.CWLOutputType]*)
- **default** (*Optional[cwltool.utils.CWLOutputType]*)

Return type
Tuple[Any, str]

cwltool.main.**realize_input_schema**(*input_types*, *schema_defs*)

Replace references to named typed with the actual types.

Parameters

- **input_types** (*MutableSequence[Union[str, cwltool.utils.CWLObjectType]]*)
- **schema_defs** (*MutableMapping[str, cwltool.utils.CWLObjectType]*)

Return type
MutableSequence[Union[str, cwltool.utils.CWLObjectType]]

cwltool.main.**generate_input_template**(*tool*)

Generate an example input object for the given CWL process.

Parameters
tool (cwltool.process.Process)

Return type
cwltool.utils.CWLObjectType

cwltool.main.**load_job_order**(*args*, *stdin*, *fetcher_constructor*, *overrides_list*, *tool_file_uri*)

Parameters

- **args** (*argparse.Namespace*)
- **stdin** (*IO[Any]*)
- **fetcher_constructor** (*Optional[schema_salad.utils.FetcherCallableType]*)
- **overrides_list** (*List[cwltool.utils.CWLObjectType]*)

- **tool_file_uri** (*str*)

Return type
Tuple[Optional[cwltool.utils.CWLObjectType], str, schema_salad.ref_resolver.Loader]

cwltool.main.**init_job_order**(*job_order_object*, *args*, *process*, *loader*, *stdout*, *print_input_deps=False*, *relative_deps='primary'*, *make_fs_access=StdFsAccess*, *input_basedir=''*, *secret_store=None*, *input_required=True*, *runtime_context=None*)

Parameters

- **job_order_object** (*Optional[cwltool.utils.CWLObjectType]*)
- **args** (*argparse.Namespace*)
- **process** (cwltool.process.Process)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **stdout** (*IO[str]*)
- **print_input_deps** (*bool*)
- **relative_deps** (*str*)
- **make_fs_access** (Callable[[str], cwltool.stdfsaccess.StdFsAccess])
- **input_basedir** (*str*)
- **secret_store** (*Optional[cwltool.secrets.SecretStore]*)
- **input_required** (*bool*)
- **runtime_context** (*Optional[cwltool.context.RuntimeContext]*)

Return type
cwltool.utils.CWLObjectType

cwltool.main.**make_relative**(*base*, *obj*)

Relativize the location URI of a File or Directory object.

Parameters

- **base** (*str*)
- **obj** (*cwltool.utils.CWLObjectType*)

Return type
None

cwltool.main.**printdeps**(*obj*, *document_loader*, *stdout*, *relative_deps*, *uri*, *basedir=None*, *nestdirs=True*)

Print a JSON representation of the dependencies of the CWL document.

Parameters

- **obj** (*cwltool.utils.CWLObjectType*)
- **document_loader** (*schema_salad.ref_resolver.Loader*)
- **stdout** (*IO[str]*)
- **relative_deps** (*str*)
- **uri** (*str*)
- **basedir** (*Optional[str]*)
- **nestdirs** (*bool*)

Return type
None

cwltool.main.**prov_deps**(*obj*, *document_loader*, *uri*, *basedir=None*)

Parameters

- **obj** (*cwltool.utils.CWLObjectType*)
- **document_loader** (*schema_salad.ref_resolver.Loader*)
- **uri** (*str*)
- **basedir** (*Optional[str]*)

Return type
cwltool.utils.CWLObjectType

cwltool.main.**find_deps**(*obj*, *document_loader*, *uri*, *basedir=None*, *nestdirs=True*)

Find the dependencies of the CWL document.

Parameters

- **obj** (*cwltool.utils.CWLObjectType*)
- **document_loader** (*schema_salad.ref_resolver.Loader*)
- **uri** (*str*)
- **basedir** (*Optional[str]*)
- **nestdirs** (*bool*)

Return type
cwltool.utils.CWLObjectType

cwltool.main.**print_pack**(*loadingContext*, *uri*)

Return a CWL serialization of the CWL document in JSON.

Parameters

- **loadingContext** (cwltool.context.LoadingContext)
- **uri** (*str*)

Return type
str

cwltool.main.**supported_cwl_versions**(*enable_dev*)

Parameters
enable_dev (*bool*)

Return type
List[str]

cwltool.main.**setup_schema**(*args*, *custom_schema_callback*)

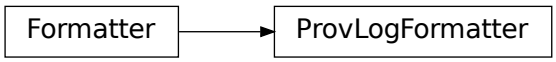
Parameters

- **args** (*argparse.Namespace*)
- **custom_schema_callback** (*Optional[Callable[[], None]]*)

Return type
None

class cwltool.main.**ProvLogFormatter**

Bases: logging.Formatter



Enforce ISO8601 with both T and Z.

formatTime(*record*, *datefmt=None*)

Override the default formatTime to include the timezone.

Parameters

- **record** (*logging.LogRecord*)
- **datefmt** (*Optional[str]*)

Return type
str

cwltool.main.**ProvOut**

cwltool.main.**setup_provenance**(*args*, *runtimeContext*, *argsl=None*)

Parameters

- **args** (*argparse.Namespace*)
- **runtimeContext** (cwltool.context.RuntimeContext)
- **argsl** (*Optional[List[str]]*)

Return type
Tuple[ProvOut, logging.StreamHandler[ProvOut]]

cwltool.main.**setup_loadingContext**(*loadingContext*, *runtimeContext*, *args*)

Prepare a LoadingContext from the given arguments.

Parameters

- **loadingContext** (*Optional[*cwltool.context.LoadingContext*]*)
- **runtimeContext** (cwltool.context.RuntimeContext)
- **args** (*argparse.Namespace*)

Return type
cwltool.context.LoadingContext

cwltool.main.**make_template**(*tool*, *target*)

Make a template CWL input object for the give Process.

Parameters

- **tool** (cwltool.process.Process)
- **target** (*IO[str]*)

Return type
None

cwltool.main.**inherit_reqshints**(*tool*, *parent*)

Copy down requirements and hints from ancestors of a given process.

Parameters

- **tool** (cwltool.process.Process)
- **parent** (cwltool.process.Process)

Return type
None

cwltool.main.**choose_target**(*args*, *tool*, *loading_context*)

Walk the Workflow, extract the subset matches all the args.targets.

Parameters

- **args** (*argparse.Namespace*)
- **tool** (cwltool.process.Process)
- **loading_context** (cwltool.context.LoadingContext)

Return type
Optional[*cwltool.process.Process*]

cwltool.main.**choose_step**(*args*, *tool*, *loading_context*)

Walk the given Workflow and extract just args.single_step.

Parameters

- **args** (*argparse.Namespace*)
- **tool** (cwltool.process.Process)
- **loading_context** (cwltool.context.LoadingContext)

Return type
Optional[*cwltool.process.Process*]

cwltool.main.**choose_process**(*args*, *tool*, *loadingContext*)

Walk the given Workflow and extract just args.single_process.

Parameters

- **args** (*argparse.Namespace*)
- **tool** (cwltool.process.Process)
- **loadingContext** (cwltool.context.LoadingContext)

Return type
Optional[*cwltool.process.Process*]

cwltool.main.**check_working_directories**(*runtimeContext*)

Make any needed working directories.

Parameters
runtimeContext (cwltool.context.RuntimeContext)

Return type
Optional[int]

cwltool.main.**print_targets**(*tool*, *stdout*, *loading_context*, *prefix=''*)

Recursively find targets for –subgraph and friends.

Parameters

- **tool** (cwltool.process.Process)
- **stdout** (*IO[str]*)
- **loading_context** (cwltool.context.LoadingContext)
- **prefix** (*str*)

Return type
None

cwltool.main.**main**(*argsl=None*, *args=None*, *job_order_object=None*, *stdin=sys.stdin*, *stdout=None*, *stderr=sys.stderr*, *versionfunc=versionstring*, *logger_handler=None*, *custom_schema_callback=None*, *executor=None*, *loadingContext=None*, *runtimeContext=None*, *input_required=True*)

Parameters

- **argsl** (*Optional[List[str]]*)
- **args** (*Optional[argparse.Namespace]*)
- **job_order_object** (*Optional[cwltool.utils.CWLObjectType]*)
- **stdin** (*IO[Any]*)
- **stdout** (*Optional[IO[str]]*)
- **stderr** (*IO[Any]*)
- **versionfunc** (*Callable[[], str]*)
- **logger_handler** (*Optional[logging.Handler]*)
- **custom_schema_callback** (*Optional[Callable[[], None]]*)
- **executor** (*Optional[cwltool.executors.JobExecutor]*)
- **loadingContext** (*Optional[cwltool.context.LoadingContext]*)
- **runtimeContext** (*Optional[cwltool.context.RuntimeContext]*)
- **input_required** (*bool*)

Return type
int

cwltool.main.**find_default_container**(*builder*, *default_container=None*, *use_biocontainers=None*, *container_image_cache_path=None*)

Find a container.

Parameters

- **builder** (*cwltool.utils.HasReqsHints*)
- **default_container** (*Optional[str]*)
- **use_biocontainers** (*Optional[bool]*)
- **container_image_cache_path** (*Optional[str]*)

Return type
Optional[str]

cwltool.main.**windows_check**()

See if we are running on MS Windows and warn about the lack of support.

Return type
None

cwltool.main.**run**(**args*, ***kwargs*)

Run cwltool.

Parameters

- **args** (*Any*)
- **kwargs** (*Any*)

Return type
int

cwltool.mpi

Experimental support for MPI.

Module Contents

Classes

MpiConfig

Attributes

MpiConfigT
MPIRequirementName

cwltool.mpi.**MpiConfigT**

cwltool.mpi.**MPIRequirementName** = **'http://commonwl.org/cwltool#MPIRequirement'**

class cwltool.mpi.**MpiConfig**(*runner='mpirun'*, *nproc_flag='-n'*, *default_nproc=1*, *extra_flags=None*, *env_pass=None*, *env_pass_regex=None*, *env_set=None*)

Parameters

- **runner** (*str*)
- **nproc_flag** (*str*)
- **default_nproc** (*Union[int, str]*)
- **extra_flags** (*Optional[List[str]]*)

- **env_pass** (*Optional[List[str]]*)
- **env_pass_regex** (*Optional[List[str]]*)
- **env_set** (*Optional[Mapping[str, str]]*)

classmethod load(*config_file_name*)

Create the MpiConfig object from the contents of a YAML file.

The file must contain exactly one object, whose attributes must be in the list allowed in the class initialiser (all are optional).

Parameters
config_file_name (*str*)

Return type
MpiConfigT

pass_through_env_vars(*env*)

Take the configured list of environment variables and pass them to the executed process.

Parameters
env (*MutableMapping[str, str]*)

Return type
None

set_env_vars(*env*)

Set some variables to the value configured.

Parameters
env (*MutableMapping[str, str]*)

Return type
None

cwltool.mutation

Module Contents

Classes

MutationManager	Lock manager for checking correctness of in-place update of files.

Attributes

MutationState

cwltool.mutation.**MutationState**

class cwltool.mutation.**MutationManager**

Lock manager for checking correctness of in-place update of files.

Used to validate that in-place file updates happen sequentially, and that a file which is registered for in-place update cannot be read or updated by any other steps.

register_reader(*stepname*, *obj*)

Parameters

- **stepname** (*str*)
- **obj** (*cwltool.utils.CWLObjectType*)

Return type
None

release_reader(*stepname*, *obj*)

Parameters

- **stepname** (*str*)
- **obj** (*cwltool.utils.CWLObjectType*)

Return type
None

register_mutation(*stepname*, *obj*)

Parameters

- **stepname** (*str*)
- **obj** (*cwltool.utils.CWLObjectType*)

Return type
None

set_generation(*obj*)

Parameters
obj (*cwltool.utils.CWLObjectType*)

Return type
None

unset_generation(*obj*)

Parameters
obj (*cwltool.utils.CWLObjectType*)

Return type
None

cwltool.pack

Reformat a CWL document and all its references to be a single stream.

Module Contents

Functions

find_run(d, loadref, runs)	
find_ids(d, ids)	
replace_refs(d, rewrite, stem, newstem)	
import_embed(d, seen)	
pack(loadingContext, uri[, rewrite_out, loader])	

Attributes

LoadRefType

cwltool.pack.**LoadRefType**

cwltool.pack.**find_run**(*d*, *loadref*, *runs*)

Parameters

- **d** (*Union[cwltool.utils.CWLObjectType, schema_salad.utils.ResolveType]*)
- **loadref** (*LoadRefType*)
- **runs** (*Set[str]*)

Return type
None

cwltool.pack.**find_ids**(*d*, *ids*)

Parameters

- **d** (*Union[cwltool.utils.CWLObjectType, cwltool.utils.CWLOutputType, MutableSequence[cwltool.utils.CWLObjectType], None]*)
- **ids** (*Set[str]*)

Return type
None

cwltool.pack.**replace_refs**(*d*, *rewrite*, *stem*, *newstem*)

Parameters

- **d** (*Any*)
- **rewrite** (*Dict[str, str]*)
- **stem** (*str*)
- **newstem** (*str*)

Return type
None

cwltool.pack.**import_embed**(*d*, *seen*)

Parameters

- **d** (*Union[MutableSequence[cwltool.utils.CWLObjectType], cwltool.utils.CWLObjectType, cwltool.utils.CWLOutputType]*)
- **seen** (*Set[str]*)

Return type
None

cwltool.pack.**pack**(*loadingContext*, *uri*, *rewrite_out=None*, *loader=None*)

Parameters

- **loadingContext** (cwltool.context.LoadingContext)
- **uri** (*str*)
- **rewrite_out** (*Optional[Dict[str, str]]*)
- **loader** (*Optional[schema_salad.ref_resolver.Loader]*)

Return type
cwltool.utils.CWLObjectType

cwltool.pathmapper

Module Contents

Classes

PathMapper	Mapping of files from relative path provided in the file to a tuple.

Attributes

MapperEnt	Mapper entries.

cwltool.pathmapper.**MapperEnt**

Mapper entries.

cwltool.pathmapper.**resolved:** str

The "real" path on the local file system (after resolving relative paths and traversing symlinks

cwltool.pathmapper.**target:** str

The path on the target file system (under stagedir)

cwltool.pathmapper.**type:** str

The object type. One of "File", "Directory", "CreateFile", "WritableFile", or "CreateWritableFile".

cwltool.pathmapper.**staged:** bool

If the File has been staged yet

class cwltool.pathmapper.**PathMapper**(*referenced_files*, *basedir*, *stagedir*, *separateDirs=True*)

Mapping of files from relative path provided in the file to a tuple.

(absolute local path, absolute container path)

The tao of PathMapper:

The initializer takes a list of `class: File` and `class: Directory` objects, a base directory (for resolving relative references) and a staging directory (where the files are mapped to).

The purpose of the setup method is to determine where each File or Directory should be placed on the target file system (relative to stagedir).

If `separatedirs=True`, unrelated files will be isolated in their own directories under stagedir. If `separatedirs=False`, files and directories will all be placed in stagedir (with the possibility for name collisions...)

The path map maps the "location" of the input Files and Directory objects to a tuple (resolved, target, type). The "resolved" field is the "real" path on the local file system (after resolving relative paths and traversing symlinks). The "target" is the path on the target file system (under stagedir). The type is the object type (one of File, Directory, CreateFile, WritableFile, CreateWritableFile).

The latter three (CreateFile, WritableFile, CreateWritableFile) are used by InitialWorkDirRequirement to indicate files that are generated on the fly (CreateFile and CreateWritableFile, in this case "resolved" holds the file contents instead of the path because they file doesn't exist) or copied into the output directory so they can be opened for update ("r+" or "a") (WritableFile and CreateWritableFile).

Parameters

- **referenced_files** (*List[cwltool.utils.CWLObjectType]*)
- **basedir** (*str*)
- **stagedir** (*str*)
- **separateDirs** (*bool*)

visitlisting(*listing*, *stagedir*, *basedir*, *copy=False*, *staged=False*)

Parameters

- **listing** (*List[cwltool.utils.CWLObjectType]*)

- **stagedir** (*str*)
- **basedir** (*str*)
- **copy** (*bool*)
- **staged** (*bool*)

Return type
None

visit(*obj*, *stagedir*, *basedir*, *copy=False*, *staged=False*)

Parameters

- **obj** (*cwltool.utils.CWLObjectType*)
- **stagedir** (*str*)
- **basedir** (*str*)
- **copy** (*bool*)
- **staged** (*bool*)

Return type
None

setup(*referenced_files*, *basedir*)

Parameters

- **referenced_files** (*List[cwltool.utils.CWLObjectType]*)
- **basedir** (*str*)

Return type
None

mapper(*src*)

Parameters
src (*str*)

Return type
MapperEnt

files()

Return a dictionary keys view of locations.

Return type
KeysView[str]

items()

Return a dictionary items view.

Return type
ItemsView[str, MapperEnt]

items_exclude_children()

Return a dictionary items view minus any entries which are children of other entries.

Return type
ItemsView[str, MapperEnt]

reversemap(*target*)

Find the (source, resolved_path) for the given target, if any.

Parameters
target (*str*)

Return type
Optional[Tuple[str, str]]

update(*key*, *resolved*, *target*, *ctype*, *stage*)

Update an existine entry.

Parameters

- **key** (*str*)
- **resolved** (*str*)
- **target** (*str*)
- **ctype** (*str*)
- **stage** (*bool*)

Return type
MapperEnt

__contains__(*key*)

Test for the presence of the given relative path in this mapper.

Parameters
key (*str*)

Return type
bool

__iter__()

Get iterator for the maps.

Return type
Iterator[MapperEnt]

cwltool.process

Classes and methods relevant for all CWL Process types.

Module Contents

Classes

LogAsDebugFilter	Filter instances are used to perform arbitrary filtering of LogRecords.
Process	Abstract CWL Process.

Functions

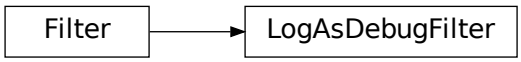
use_standard_schema(version)	
use_custom_schema(version, name, text)	
get_schema(version)	
shortname(inputid)	
stage_files(pathmapper[, stage_func, ignore_writable, ...])	Link or copy files to their targets. Create them as needed.
relocateOutputs(outputObj, destination_path, ...[, ...])	
cleanIntermediate(output_dirs)	
add_sizes(fsaccess, obj)	
fill_in_defaults(inputs, job, fsaccess)	For each missing input in the input object, copy over the default.
avroize_type(field_type[, name_prefix])	Add missing information to a type so that CWL types are valid.
get_overrides(overrides, toolid)	Combine overrides for the target tool ID.
var_spool_cwl_detector(obj[, item, obj_key])	Detect any textual reference to /var/spool/cwl.
eval_resource(builder, resource_req)	
uniquename(stem[, names])	
nestdir(base, deps)	
mergedirs(listing)	
scandeps(base, doc, reffields, urlfields, loadref[, ...])	Search for external files references in a CWL document or input object.
compute_checksums(fs_access, fileobj)	

Attributes

supportedProcessRequirements
cwl_files
salad_files
SCHEMA_CACHE
SCHEMA_FILE
SCHEMA_DIR
SCHEMA_ANY
custom_schemas
FILE_COUNT_WARNING
CWL_IANA

class cwltool.process.**LogAsDebugFilter**(*name*, *parent*)

Bases: logging.Filter



Filter instances are used to perform arbitrary filtering of LogRecords.

Loggers and Handlers can optionally use Filter instances to filter records as desired. The base filter class only allows events which are below a certain point in the logger hierarchy. For example, a filter initialized with "A.B" will allow events logged by loggers "A.B", "A.B.C", "A.B.C.D", "A.B.D" etc. but not "A.BB", "B.A.B" etc. If initialized with the empty string, all events are passed.

Parameters

- **name** (*str*)
- **parent** (*logging.Logger*)

filter(*record*)

Determine if the specified record is to be logged.

Returns True if the record should be logged, or False otherwise. If deemed appropriate, the record may be modified in-place.

Parameters

record (*logging.LogRecord*)

Return type
bool

cwltool.process.**supportedProcessRequirements**

cwltool.process.**cwl_files = ('Workflow.yml', 'CommandLineTool.yml', 'CommonWorkflowLanguage.yml', 'Process.yml',...**

cwltool.process.**salad_files = ('metaschema.yml', 'metaschema_base.yml', 'salad.md', 'field_name.yml', 'import_include.md',...**

cwltool.process.**SCHEMA_CACHE: Dict[str, Tuple[schema_salad.ref_resolver.Loader, schema_salad.avro.schema.Names | schema_salad.avro.schema.SchemaParseException, cwltool.utils.CWLObjectType, schema_salad.ref_resolver.Loader]]**

cwltool.process.**SCHEMA_FILE: cwltool.utils.CWLObjectType | None**

cwltool.process.**SCHEMA_DIR: cwltool.utils.CWLObjectType | None**

cwltool.process.**SCHEMA_ANY: cwltool.utils.CWLObjectType | None**

cwltool.process.**custom_schemas: Dict[str, Tuple[str, str]]**

cwltool.process.**use_standard_schema**(*version*)

Parameters
version (*str*)

Return type
None

cwltool.process.**use_custom_schema**(*version*, *name*, *text*)

Parameters

- **version** (*str*)
- **name** (*str*)
- **text** (*str*)

Return type
None

cwltool.process.**get_schema**(*version*)

Parameters
version (*str*)

Return type
Tuple[schema_salad.ref_resolver.Loader, Union[schema_salad.avro.schema.Names, schema_salad.avro.schema.SchemaParseException], cwltool.utils.CWLObjectType, schema_salad.ref_resolver.Loader]

cwltool.process.**shortname**(*inputid*)

Parameters
inputid (*str*)

Return type
str

cwltool.process.**stage_files**(*pathmapper*, *stage_func=None*, *ignore_writable=False*, *symlink=True*, *secret_store=None*, *fix_conflicts=False*)

Link or copy files to their targets. Create them as needed.

Raises
WorkflowException – if there is a file staging conflict

Parameters

- **pathmapper** (cwltool.pathmapper.PathMapper)
- **stage_func** (*Optional[Callable[[str, str], None]]*)
- **ignore_writable** (*bool*)
- **symlink** (*bool*)
- **secret_store** (*Optional[cwltool.secrets.SecretStore]*)
- **fix_conflicts** (*bool*)

Return type
None

cwltool.process.**relocateOutputs**(*outputObj*, *destination_path*, *source_directories*, *action*, *fs_access*, *compute_checksum=True*, *path_mapper=PathMapper*)

Parameters

- **outputObj** (*cwltool.utils.CWLObjectType*)
- **destination_path** (*str*)
- **source_directories** (*Set[str]*)
- **action** (*str*)
- **fs_access** (cwltool.stdfsaccess.StdFsAccess)
- **compute_checksum** (*bool*)
- **path_mapper** (*Type[cwltool.pathmapper.PathMapper]*)

Return type
cwltool.utils.CWLObjectType

cwltool.process.**cleanIntermediate**(*output_dirs*)

Parameters
output_dirs (*Iterable[str]*)

Return type
None

cwltool.process.**add_sizes**(*fsaccess*, *obj*)

Parameters

- **fsaccess** (cwltool.stdfsaccess.StdFsAccess)
- **obj** (*cwltool.utils.CWLObjectType*)

Return type
None

cwltool.process.**fill_in_defaults**(*inputs*, *job*, *fsaccess*)

For each missing input in the input object, copy over the default.

Raises
WorkflowException – if a required input parameter is missing

Parameters

- **inputs** (*List[cwltool.utils.CWLObjectType]*)
- **job** (*cwltool.utils.CWLObjectType*)
- **fsaccess** (cwltool.stdfsaccess.StdFsAccess)

Return type
None

cwltool.process.**avroize_type**(*field_type*, *name_prefix=''*)

Add missing information to a type so that CWL types are valid.

Parameters

- **field_type** (*Union[cwltool.utils.CWLObjectType, MutableSequence[Any], cwltool.utils.CWLOutputType, None]*)
- **name_prefix** (*str*)

Return type
Union[cwltool.utils.CWLObjectType, MutableSequence[Any], cwltool.utils.CWLOutputType, None]

cwltool.process.**get_overrides**(*overrides*, *toolid*)

Combine overrides for the target tool ID.

Parameters

- **overrides** (*MutableSequence[cwltool.utils.CWLObjectType]*)
- **toolid** (*str*)

Return type
cwltool.utils.CWLObjectType

cwltool.process.**var_spool_cwl_detector**(*obj*, *item=None*, *obj_key=None*)

Detect any textual reference to /var/spool/cwl.

Parameters

- **obj** (*cwltool.utils.CWLOutputType*)
- **item** (*Optional[Any]*)
- **obj_key** (*Optional[Any]*)

Return type
bool

cwltool.process.**eval_resource**(*builder*, *resource_req*)

Parameters

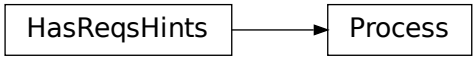
- **builder** (cwltool.builder.Builder)
- **resource_req** (*Union[str, int, float]*)

Return type
Optional[Union[str, int, float]]

cwltool.process.**FILE_COUNT_WARNING = 5000**

class cwltool.process.**Process**(*toolpath_object*, *loadingContext*)

Bases: cwltool.utils.HasReqsHints



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (cwltool.context.LoadingContext)

evalResources(*builder*, *runtimeContext*)

Parameters

- **builder** (cwltool.builder.Builder)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
Dict[str, Union[int, float]]

checkRequirements(*rec*, *supported_process_requirements*)

Check the presence of unsupported requirements.

Parameters

- **rec** (*Union[MutableSequence[cwltool.utils.CWLObjectType], cwltool.utils.CWLObjectType, cwltool.utils.CWLOutputType, None]*)
- **supported_process_requirements** (*Iterable[str]*)

Return type
None

validate_hints(*avsc_names*, *hints*, *strict*)

Process the hints field.

Parameters

- **avsc_names** (*schema_salad.avro.schema.Names*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **strict** (*bool*)

Return type
None

visit(*op*)

Parameters
op (*Callable[[ruamel.yaml.comments.CommentedMap], None]*)

Return type
None

abstract job(*job_order*, *output_callbacks*, *runtimeContext*)

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

__str__()
Return the id of this CWL process.

Return type
str

cwltool.process.**uniquename**(*stem*, *names=None*)

Parameters

- **stem** (*str*)
- **names** (*Optional[Set[str]]*)

Return type
str

cwltool.process.**nestdir**(*base*, *deps*)

Parameters

- **base** (*str*)
- **deps** (*cwltool.utils.CWLObjectType*)

Return type
cwltool.utils.CWLObjectType

cwltool.process.**mergedirs**(*listing*)

Parameters
listing (*MutableSequence[cwltool.utils.CWLObjectType]*)

Return type
MutableSequence[cwltool.utils.CWLObjectType]

cwltool.process.**CWL_IANA = 'https://www.iana.org/assignments/media-types/application/cwl'**

cwltool.process.**scandeps**(*base*, *doc*, *reffields*, *urlfields*, *loadref*, *urljoin=urllib.parse.urljoin*, *nestdirs=True*)
Search for external files references in a CWL document or input object.

Looks for objects with ‘class: File’ or ‘class: Directory’ and adds them to the list of dependencies.

Parameters

- **base** (*str*) – the base URL for relative references.
- **doc** (*Union[cwltool.utils.CWLObjectType, MutableSequence[cwltool.utils.CWLObjectType]]*) – a CWL document or input object
- **urlfields** (*Set[str]*) – added as a File dependency
- **reffields** (*Set[str]*) – field name like a workflow step 'run'; will be added as a dependency and also loaded (using the 'loadref' function) and recursively scanned for dependencies. Those dependencies will be added as secondary files to the primary file.
- **nestdirs** (*bool*) – if true, create intermediate directory objects when a file is located in a subdirectory under the starting directory. This is so that if the dependencies are materialized, they will produce the same relative file system locations.
- **loadref** (*Callable[[str, str], Union[ruamel.yaml.comments.CommentedMap, ruamel.yaml.comments.CommentedSeq, str, None]]*)
- **urljoin** (*Callable[[str, str], str]*)

Returns
A list of File or Directory dependencies

Return type
MutableSequence[cwltool.utils.CWLObjectType]

cwltool.process.**compute_checksums**(*fs_access*, *fileobj*)

Parameters

- **fs_access** (cwltool.stdfsaccess.StdFsAccess)
- **fileobj** (*cwltool.utils.CWLObjectType*)

Return type
None

cwltool.procgenerator

Module Contents

Classes

ProcessGeneratorJob	Result of ProcessGenerator.job().
ProcessGenerator	Abstract CWL Process.

class cwltool.procgenerator.**ProcessGeneratorJob**(*procgenerator*)

Result of ProcessGenerator.job().

Parameters
procgenerator (ProcessGenerator)

receive_output(*jobout*, *processStatus*)

Process the results.

Parameters

- **jobout** (*Optional[cwltool.utils.CWLObjectType]*)

- **processStatus** (*str*)

Return type
None

job(*job_order*, *output_callbacks*, *runtimeContext*)

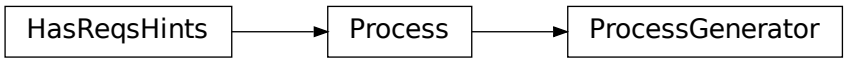
Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

class cwltool.procgenerator.**ProcessGenerator**(*toolpath_object*, *loadingContext*)

Bases: *cwltool.process.Process*



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (cwltool.context.LoadingContext)

job(*job_order*, *output_callbacks*, *runtimeContext*)

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

result(*job_order*, *jobout*, *runtimeContext*)

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **jobout** (*cwltool.utils.CWLObjectType*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
Tuple[*cwltool.process.Process*, cwltool.utils.CWLObjectType]

cwltool.resolver

Resolves references to CWL documents from local or remote places.

Module Contents

Functions

resolve_local(document_loader, uri)	
tool_resolver(document_loader, uri)	
resolve_ga4gh_tool(document_loader, uri)	

Attributes

ga4gh_tool_registries
GA4GH_TRS_FILES
GA4GH_TRS_PRIMARY_DESCRIPTOR

cwltool.resolver.**resolve_local**(*document_loader*, *uri*)

Parameters

- **document_loader** (*Optional[schema_salad.ref_resolver.Loader]*)
- **uri** (*str*)

Return type
Optional[str]

cwltool.resolver.**tool_resolver**(*document_loader*, *uri*)

Parameters

- **document_loader** (*schema_salad.ref_resolver.Loader*)
- **uri** (*str*)

Return type
Optional[str]

cwltool.resolver.**ga4gh_tool_registries** = ['https://dockstore.org/api']

cwltool.resolver.**GA4GH_TRS_FILES** = '{0}/api/ga4gh/v2/tools/{1}/versions/{2}/CWL/files'

cwltool.resolver.**GA4GH_TRS_PRIMARY_DESCRIPTOR** = '{0}/api/ga4gh/v2/tools/{1}/versions/{2}/plain-CWL/descriptor/{3}'

cwltool.resolver.**resolve_ga4gh_tool**(*document_loader*, *uri*)

Parameters

- **document_loader** (*schema_salad.ref_resolver.Loader*)
- **uri** (*str*)

Return type
Optional[str]

cwltool.run_job

Only used when there is a job script or CWLTOOL_FORCE_SHELL_POPEN=1.

Module Contents

Functions

handle_software_environment(cwl_env, script)	Update the provided environment dict by running the script.
main(argv)	Read in the configuration JSON and execute the commands.

cwltool.run_job.**handle_software_environment**(*cwl_env*, *script*)

Update the provided environment dict by running the script.

Parameters

- **cwl_env** (*Dict[str, str]*)
- **script** (*str*)

Return type
Dict[str, str]

cwltool.run_job.**main**(*argv*)

Read in the configuration JSON and execute the commands.

The first argument is the path to the JSON dictionary file containing keys:
"commands": an array of strings that represents the command line to run "cwd": A string specifying which directory to run in "env": a dictionary of strings containing the environment variables to set "stdin_path": a string (or a null) giving the path that should be piped to STDIN "stdout_path": a string (or a null) giving the path that should receive the STDOUT "stderr_path": a string (or a null) giving the path that should receive the STDERR

The second argument is optional, it specifies a shell script to execute prior,
and the environment variables it sets will be combined with the environment variables from the "env" key in the JSON dictionary from the first argument.

Parameters
argv (*List[str]*)

Return type
int

cwltool.secrets

Minimal in memory storage of secrets.

Module Contents

Classes

SecretStore	Minimal implementation of a secret storage.

class cwltool.secrets.**SecretStore**

Minimal implementation of a secret storage.

add(*value*)

Add the given value to the store.

Returns a placeholder value to use until the real value is needed.

Parameters
value (*Optional[cwltool.utils.CWLOutputType]*)

Return type
Optional[cwltool.utils.CWLOutputType]

store(*secrets*, *job*)

Sanitize the job object of any of the given secrets.

Parameters

- **secrets** (*List[str]*)
- **job** (*cwltool.utils.CWLObjectType*)

Return type
None

has_secret(*value*)

Test if the provided document has any of our secrets.

Parameters
value (*cwltool.utils.CWLOutputType*)

Return type
bool

retrieve(*value*)

Replace placeholders with their corresponding secrets.

Parameters
value (*cwltool.utils.CWLOutputType*)

Return type
cwltool.utils.CWLOutputType

cwltool.singularity

Support for executing Docker format containers using Singularity {2,3}.x or Apptainer 1.x.

Module Contents

Classes

SingularityCommandLineJob	Commandline job using containers.

Functions

get_version()	Parse the output of 'singularity --version' to determine the flavor and version.
is_apptainer_1_or_newer()	Check if apptainer singularity distribution is version 1.0 or higher.
is_version_2_6()	Check if this singularity version is exactly version 2.6.
is_version_3_or_newer()	Check if this version is singularity version 3 or newer or equivalent.
is_version_3_1_or_newer()	Check if this version is singularity version 3.1 or newer or equivalent.
is_version_3_4_or_newer()	Detect if Singularity v3.4+ is available.
is_version_3_9_or_newer()	Detect if Singularity v3.9+ is available.

cwltool.singularity.**get_version**()

Parse the output of 'singularity –version' to determine the flavor and version.

Both pieces of information will be cached.

Returns
A tuple containing: - A tuple with major and minor version numbers as integer. - A string with the name of the singularity flavor.

Return type
Tuple[List[int], str]

cwltool.singularity.**is_apptainer_1_or_newer**()

Check if apptainer singularity distribution is version 1.0 or higher.

Apptainer v1.0.0 is compatible with SingularityCE 3.9.5. See: https://github.com/apptainer/apptainer/releases

Return type
bool

cwltool.singularity.**is_version_2_6**()

Check if this singularity version is exactly version 2.6.

Also returns False if the flavor is not singularity or singularity-ce.

Return type
bool

cwltool.singularity.**is_version_3_or_newer**()

Check if this version is singularity version 3 or newer or equivalent.

Return type
bool

cwltool.singularity.**is_version_3_1_or_newer**()

Check if this version is singularity version 3.1 or newer or equivalent.

Return type
bool

cwltool.singularity.**is_version_3_4_or_newer**()

Detect if Singularity v3.4+ is available.

Return type
bool

cwltool.singularity.**is_version_3_9_or_newer**()

Detect if Singularity v3.9+ is available.

Return type
bool

class cwltool.singularity.**SingularityCommandLineJob**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: *cwltool.job.ContainerCommandLineJob*

Commandline job using containers.

Parameters

- **builder** (cwltool.builder.Builder)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper])
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

static get_image(*dockerRequirement*, *pull_image*, *tmp_outdir_prefix*, *force_pull=False*)

Acquire the software container image in the specified dockerRequirement.

Uses Singularity and returns the success as a bool. Updates the provided dockerRequirement with the specific dockerImageId to the full path of the local image, if found. Likewise the dockerRequirement['dockerPull'] is updated to a docker:// URI if needed.

Parameters

- **dockerRequirement** (*Dict[str, str]*)
- **pull_image** (*bool*)
- **tmp_outdir_prefix** (*str*)
- **force_pull** (*bool*)

Return type
bool

get_from_requirements(*r*, *pull_image*, *force_pull*, *tmp_outdir_prefix*)

Return the filename of the Singularity image.

(e.g. hello-world-latest.{img,sif}).

Parameters

- **r** (*cwltool.utils.CWLObjectType*)
- **pull_image** (*bool*)
- **force_pull** (*bool*)
- **tmp_outdir_prefix** (*str*)

Return type
Optional[str]

static append_volume(*runtime*, *source*, *target*, *writable=False*)

Add binding arguments to the runtime list.

Parameters

- **runtime** (*List[str]*)
- **source** (*str*)
- **target** (*str*)
- **writable** (*bool*)

Return type
None

add_file_or_directory_volume(*runtime*, *volume*, *host_outdir_tgt*)

Append volume a file/dir mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)

Return type
None

add_writable_file_volume(*runtime*, *volume*, *host_outdir_tgt*, *tmpdir_prefix*)

Append a writable file mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)

- **host_outdir_tgt** (*Optional[str]*)
- **tmpdir_prefix** (*str*)

Return type
None

add_writable_directory_volume(*runtime*, *volume*, *host_outdir_tgt*, *tmpdir_prefix*)

Append a writable directory mapping to the runtime option list.

Parameters

- **runtime** (*List[str]*)
- **volume** (*cwltool.pathmapper.MapperEnt*)
- **host_outdir_tgt** (*Optional[str]*)
- **tmpdir_prefix** (*str*)

Return type
None

create_runtime(*env*, *runtime_context*)

Return the Singularity runtime list of commands and options.

Parameters

- **env** (*MutableMapping[str, str]*)
- **runtime_context** (cwltool.context.RuntimeContext)

Return type
Tuple[List[str], Optional[str]]

cwltool.singularity_utils

Support for executing Docker format containers using Singularity {2,3}.x or Apptainer 1.x.

Module Contents

Functions

singularity_supports_userns()	Confirm if the version of Singularity install supports the --userns flag.

cwltool.singularity_utils.**singularity_supports_userns**()

Confirm if the version of Singularity install supports the –userns flag.

Return type
bool

cwltool.software_requirements

This module handles resolution of SoftwareRequirement hints.

This is accomplished mainly by adapting cwltool internals to galaxy-tool-util's concept of "dependencies". Despite the name, galaxy-tool-util is a light weight library that can be used to map SoftwareRequirements in all sorts of ways - Homebrew, Conda, custom scripts, environment modules. We'd be happy to find ways to adapt new packages managers and such as well.

Module Contents

Classes

DependenciesConfiguration	Dependency configuration class, for RuntimeContext.job_script_provider.

Functions

get_dependencies(builder)	
get_container_from_software_requirements(...[, ...])	
ensure_galaxy_lib_available()	

Attributes

ToolRequirement	
SOFTWARE_REQUIREMENTS_ENABLED	
COMMAND_WITH_DEPENDENCIES_TEMPLATE	

cwltool.software_requirements.**ToolRequirement**

cwltool.software_requirements.**SOFTWARE_REQUIREMENTS_ENABLED**

cwltool.software_requirements.**COMMAND_WITH_DEPENDENCIES_TEMPLATE**

class cwltool.software_requirements.**DependenciesConfiguration**(*args*)

Dependency configuration class, for RuntimeContext.job_script_provider.

Parameters

args (*argparse.Namespace*)

build_job_script(*builder*, *command*)

Parameters

- **builder** (cwltool.builder.Builder)
- **command** (*List[str]*)

Return type
str

cwltool.software_requirements.**get_dependencies**(*builder*)

Parameters
builder (*cwltool.utils.HasReqsHints*)

Return type
galaxy.tool_util.deps.requirements.ToolRequirements

cwltool.software_requirements.**get_container_from_software_requirements**(*use_biocontainers*, *builder*, *container_image_cache_path='.'*)

Parameters

- **use_biocontainers** (*bool*)
- **builder** (*cwltool.utils.HasReqsHints*)
- **container_image_cache_path** (*Optional[str]*)

Return type
Optional[str]

cwltool.software_requirements.**ensure_galaxy_lib_available**()

Return type
None

cwltool.stdfsaccess

Abstracted IO access.

Module Contents

Classes

StdFsAccess	Local filesystem implementation.

Functions

abspath(src, basedir)	

cwltool.stdfsaccess.**abspath**(*src*, *basedir*)

Parameters

- **src** (*str*)
- **basedir** (*str*)

Return type
str

class cwltool.stdfsaccess.**StdFsAccess**(*basedir*)

Local filesystem implementation.

Parameters
basedir (*str*)

glob(*pattern*)

Parameters
pattern (*str*)

Return type
List[str]

open(*fn*, *mode*)

Parameters

- **fn** (*str*)
- **mode** (*str*)

Return type
IO[Any]

exists(*fn*)

Parameters
fn (*str*)

Return type
bool

size(*fn*)

Parameters
fn (*str*)

Return type
int

isfile(*fn*)

Parameters
fn (*str*)

Return type
bool

`isdir`(*fn*)

Parameters
fn (*str*)

Return type
bool

`listdir`(*fn*)

Parameters
fn (*str*)

Return type
List[str]

`join`(*path*, **paths*)

Parameters

- **path** (*str*)
- **paths** (*str*)

Return type
str

`realpath`(*path*)

Parameters
path (*str*)

Return type
str

cwltool.subgraph

Module Contents

Functions

subgraph_visit(current, nodes, visited, direction)	
declare_node(nodes, nodeid, tp)	
find_step(steps, stepid, loading_context)	Find the step (raw dictionary and WorkflowStep) for a given step id.
get_subgraph(roots, tool, loading_context)	Extract the subgraph for the given roots.
get_step(tool, step_id, loading_context)	Extract a single WorkflowStep for the given step_id.
get_process(tool, step_id, loading_context)	Find the underlying Process for a given Workflow step id.

Attributes

Node
UP
DOWN
INPUT
OUTPUT
STEP

cwltool.subgraph.**Node**

cwltool.subgraph.**UP** = 'up'

cwltool.subgraph.**DOWN** = 'down'

cwltool.subgraph.**INPUT** = 'input'

cwltool.subgraph.**OUTPUT** = 'output'

cwltool.subgraph.**STEP** = 'step'

cwltool.subgraph.**subgraph_visit**(*current*, *nodes*, *visited*, *direction*)

Parameters

- **current** (*str*)
- **nodes** (*MutableMapping[str, Node]*)
- **visited** (*Set[str]*)
- **direction** (*str*)

Return type
None

cwltool.subgraph.**declare_node**(*nodes*, *nodeid*, *tp*)

Parameters

- **nodes** (*Dict[str, Node]*)
- **nodeid** (*str*)
- **tp** (*Optional[str]*)

Return type
Node

cwltool.subgraph.**find_step**(*steps*, *stepid*, *loading_context*)

Find the step (raw dictionary and WorkflowStep) for a given step id.

Parameters

- **steps** (*List[cwltool.workflow.WorkflowStep]*)

- **stepid** (*str*)
- **loading_context** (cwltool.context.LoadingContext)

Return type
Tuple[Optional[cwltool.utils.CWLObjectType], Optional[*cwltool.workflow.WorkflowStep*]]

cwltool.subgraph.**get_subgraph**(*roots*, *tool*, *loading_context*)

Extract the subgraph for the given roots.

Parameters

- **roots** (*MutableSequence[str]*)
- **tool** (cwltool.workflow.Workflow)
- **loading_context** (cwltool.context.LoadingContext)

Return type
ruamel.yaml.comments.CommentedMap

cwltool.subgraph.**get_step**(*tool*, *step_id*, *loading_context*)

Extract a single WorkflowStep for the given step_id.

Parameters

- **tool** (cwltool.workflow.Workflow)
- **step_id** (*str*)
- **loading_context** (cwltool.context.LoadingContext)

Return type
ruamel.yaml.comments.CommentedMap

cwltool.subgraph.**get_process**(*tool*, *step_id*, *loading_context*)

Find the underlying Process for a given Workflow step id.

Parameters

- **tool** (cwltool.workflow.Workflow)
- **step_id** (*str*)
- **loading_context** (cwltool.context.LoadingContext)

Return type
Tuple[Any, *cwltool.workflow.WorkflowStep*]

cwltool.task_queue

TaskQueue.

Module Contents

Classes

TaskQueue	A TaskQueue class.

class cwltool.task_queue.**TaskQueue**(*lock*, *thread_count*)

A TaskQueue class.

Uses a first-in, first-out queue of tasks executed on a fixed number of threads.

New tasks enter the queue and are started in the order received, as worker threads become available.

If thread_count == 0 then tasks will be synchronously executed when add() is called (this makes the actual task queue behavior a no-op, but may be a useful configuration knob).

The thread_count is also used as the maximum size of the queue.

The threads are created during TaskQueue initialization. Call join() when you're done with the TaskQueue and want the threads to stop.

Parameters

- **lock** (*threading.Lock*)
- **thread_count** (*int*)

in_flight: *int* = **0**

The number of tasks in the queue.

add(*task*, *unlock=None*, *check_done=None*)

Add your task to the queue.

The optional unlock will be released prior to attempting to add the task to the queue.

If the optional "check_done" threading.Event's flag is set, then we will skip adding this task to the queue.

If the TaskQueue was created with thread_count == 0 then your task will be synchronously executed.

Parameters

- **task** (*Callable[[], None]*)
- **unlock** (*Optional[threading.Condition]*)
- **check_done** (*Optional[threading.Event]*)

Return type
None

drain()

Drain the queue.

Return type
None

join()

Wait for all threads to complete.

Return type
None

cwltool.udocker

Enables Docker software containers via the udocker runtime.

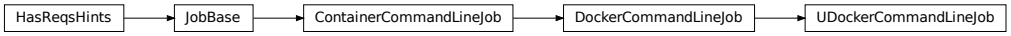
Module Contents

Classes

UDockerCommandLineJob	Runs a CommandLineJob in a software container using the udocker engine.

class cwltool.udocker.**UDockerCommandLineJob**(*builder*, *joborder*, *make_path_mapper*, *requirements*, *hints*, *name*)

Bases: *cwltool.docker.DockerCommandLineJob*



Runs a CommandLineJob in a software container using the udocker engine.

Parameters

- **builder** (*cwltool.builder.Builder*)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **make_path_mapper** (*Callable[[List[cwltool.utils.CWLObjectType], str, cwltool.context.RuntimeContext, bool], cwltool.pathmapper.PathMapper]*)
- **requirements** (*List[cwltool.utils.CWLObjectType]*)
- **hints** (*List[cwltool.utils.CWLObjectType]*)
- **name** (*str*)

static append_volume(*runtime*, *source*, *target*, *writable=False*, *skip_mkdirs=False*)

Add binding arguments to the runtime list.

Parameters

- **runtime** (*List[str]*)
- **source** (*str*)
- **target** (*str*)
- **writable** (*bool*)
- **skip_mkdirs** (*bool*)

Return type

None

cwltool.update

Module Contents

Functions

v1_1to1_2(doc, loader, baseuri)	Public updater for v1.1 to v1.2.
v1_0to1_1(doc, loader, baseuri)	Public updater for v1.0 to v1.1.
v1_1_0dev1to1_1(doc, loader, baseuri)	Public updater for v1.1.0-dev1 to v1.1.
v1_2_0dev1todev2(doc, loader, baseuri)	Public updater for v1.2.0-dev1 to v1.2.0-dev2.
v1_2_0dev2todev3(doc, loader, baseuri)	Public updater for v1.2.0-dev2 to v1.2.0-dev3.
v1_2_0dev3todev4(doc, loader, baseuri)	Public updater for v1.2.0-dev3 to v1.2.0-dev4.
v1_2_0dev4todev5(doc, loader, baseuri)	Public updater for v1.2.0-dev4 to v1.2.0-dev5.
v1_2_0dev5to1_2(doc, loader, baseuri)	Public updater for v1.2.0-dev5 to v1.2.
identity(doc, loader, baseuri)	Do-nothing, CWL document upgrade function.
checkversion(doc, metadata, enable_dev)	Check the validity of the version of the give CWL document.
update(doc, loader, baseuri, enable_dev, metadata[, ...])	Update a CWL document to 'update_to' (if provided) or INTERNAL_VERSION.

Attributes

ORDERED_VERSIONS
UPDATES
DEVUPDATES
ALLUPDATES
INTERNAL_VERSION
ORIGINAL_CWLVERSION

cwltool.update.**v1_1to1_2**(*doc*, *loader*, *baseuri*)

Public updater for v1.1 to v1.2.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type

Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_0to1_1**(*doc*, *loader*, *baseuri*)

Public updater for v1.0 to v1.1.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type
Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_1_0dev1to1_1**(*doc*, *loader*, *baseuri*)
Public updater for v1.1.0-dev1 to v1.1.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type
Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_2_0dev1todev2**(*doc*, *loader*, *baseuri*)
Public updater for v1.2.0-dev1 to v1.2.0-dev2.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type
Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_2_0dev2todev3**(*doc*, *loader*, *baseuri*)
Public updater for v1.2.0-dev2 to v1.2.0-dev3.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type
Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_2_0dev3todev4**(*doc*, *loader*, *baseuri*)
Public updater for v1.2.0-dev3 to v1.2.0-dev4.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type
Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_2_0dev4todev5**(*doc*, *loader*, *baseuri*)

Public updater for v1.2.0-dev4 to v1.2.0-dev5.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type

Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**v1_2_0dev5to1_2**(*doc*, *loader*, *baseuri*)

Public updater for v1.2.0-dev5 to v1.2.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type

Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**ORDERED_VERSIONS = ['v1.0', 'v1.1.0-dev1', 'v1.1', 'v1.2.0-dev1', 'v1.2.0-dev2', 'v1.2.0-dev3', 'v1.2.0-dev4',...**

cwltool.update.**UPDATES: Dict[str, *Callable*[[ruamel.yaml.comments.CommentedMap, schema_salad.ref_resolver.Loader, str], Tuple[ruamel.yaml.comments.CommentedMap, str]] | None]**

cwltool.update.**DEVUPDATES: Dict[str, *Callable*[[ruamel.yaml.comments.CommentedMap, schema_salad.ref_resolver.Loader, str], Tuple[ruamel.yaml.comments.CommentedMap, str]] | None]**

cwltool.update.**ALLUPDATES**

cwltool.update.**INTERNAL_VERSION = 'v1.2'**

cwltool.update.**ORIGINAL_CWLVERSION = 'http://commonwl.org/cwltool#original_cwlVersion'**

cwltool.update.**identity**(*doc*, *loader*, *baseuri*)

Do-nothing, CWL document upgrade function.

Parameters

- **doc** (*ruamel.yaml.comments.CommentedMap*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)

Return type

Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**checkversion**(*doc*, *metadata*, *enable_dev*)

Check the validity of the version of the give CWL document.

Returns the document and the validated version string.

Parameters

- **doc** (*Union[ruamel.yaml.comments.CommentedSeq, ruamel.yaml.comments.CommentedMap]*)
- **metadata** (*ruamel.yaml.comments.CommentedMap*)
- **enable_dev** (*bool*)

Return type
Tuple[ruamel.yaml.comments.CommentedMap, str]

cwltool.update.**update**(*doc*, *loader*, *baseuri*, *enable_dev*, *metadata*, *update_to=None*)

Update a CWL document to 'update_to' (if provided) or INTERNAL_VERSION.

Parameters

- **doc** (*Union[ruamel.yaml.comments.CommentedSeq, ruamel.yaml.comments.CommentedMap]*)
- **loader** (*schema_salad.ref_resolver.Loader*)
- **baseuri** (*str*)
- **enable_dev** (*bool*)
- **metadata** (*ruamel.yaml.comments.CommentedMap*)
- **update_to** (*Optional[str]*)

Return type
ruamel.yaml.comments.CommentedMap

cwltool.utils

Shared functions and other definitions.

cwltool.validate_js

Module Contents

Classes

SuppressLog	Filter instances are used to perform arbitrary filtering of LogRecords.

Functions

is_expression(tool, schema)	Test a field/schema combo to see if it is a CWL Expression.
get_expressions(tool, schema[, source_line])	
jshint_js(js_text[, globals, options, ...])	
print_js_hint_messages(js_hint_messages, source_line)	Log the message from JSHint, using the line number.
validate_js_expressions(tool, schema[, ...])	

Attributes

JSHintJSReturn

cwltool.validate_js.**is_expression**(*tool*, *schema*)

Test a field/schema combo to see if it is a CWL Expression.

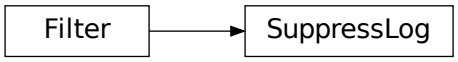
Parameters

- **tool** (*Any*)
- **schema** (*Optional[schema_salad.avro.schema.Schema]*)

Return type
bool

class cwltool.validate_js.**SuppressLog**(*name*)

Bases: logging.Filter



Filter instances are used to perform arbitrary filtering of LogRecords.

Loggers and Handlers can optionally use Filter instances to filter records as desired. The base filter class only allows events which are below a certain point in the logger hierarchy. For example, a filter initialized with "A.B" will allow events logged by loggers "A.B", "A.B.C", "A.B.C.D", "A.B.D" etc. but not "A.BB", "B.A.B" etc. If initialized with the empty string, all events are passed.

Parameters
name (*str*)

filter(*record*)

Never accept a record.

Parameters
record (*logging.LogRecord*)

Return type
bool

cwltool.validate_js.**get_expressions**(*tool*, *schema*, *source_line=None*)

Parameters

- **tool** (*Union[ruamel.yaml.comments.CommentedMap, str, ruamel.yaml.comments.CommentedSeq]*)
- **schema** (*Optional[Union[schema_salad.avro.schema.Schema, schema_salad.avro.schema.ArraySchema]]*)
- **source_line** (*Optional[schema_salad.sourceline.SourceLine]*)

Return type
List[Tuple[str, Optional[schema_salad.sourceline.SourceLine]]]

cwltool.validate_js.**JSHintJSReturn**

cwltool.validate_js.**jshint_js**(*js_text*, *globals=None*, *options=None*, *container_engine='docker'*, *eval_timeout=60*)

Parameters

- **js_text** (*str*)
- **globals** (*Optional[List[str]]*)
- **options** (*Optional[Dict[str, Union[List[str], str, int]]]*)
- **container_engine** (*str*)
- **eval_timeout** (*float*)

Return type
JSHintJSReturn

cwltool.validate_js.**print_js_hint_messages**(*js_hint_messages*, *source_line*)

Log the message from JSHint, using the line number.

Parameters

- **js_hint_messages** (*List[str]*)
- **source_line** (*Optional[schema_salad.sourceline.SourceLine]*)

Return type
None

cwltool.validate_js.**validate_js_expressions**(*tool*, *schema*, *jshint_options=None*, *container_engine='docker'*, *eval_timeout=60*)

Parameters

- **tool** (*ruamel.yaml.comments.CommentedMap*)
- **schema** (*schema_salad.avro.schema.Schema*)
- **jshint_options** (*Optional[Dict[str, Union[List[str], str, int]]]*)

- **container_engine** (*str*)
- **eval_timeout** (*float*)

Return type
None

cwltool.workflow

Module Contents

Classes

Workflow	Abstract CWL Process.
WorkflowStep	Abstract CWL Process.

Functions

default_make_tool(toolpath_object, loadingContext)	Instantiate the given CWL Process.
used_by_step(step, shortinputid)	

cwltool.workflow.**default_make_tool**(*toolpath_object*, *loadingContext*)

Instantiate the given CWL Process.

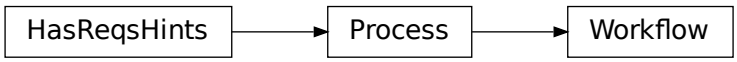
Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **loadingContext** (cwltool.context.LoadingContext)

Return type
cwltool.process.Process

class cwltool.workflow.**Workflow**(*toolpath_object*, *loadingContext*)

Bases: *cwltool.process.Process*



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)

- **loadingContext** (cwltool.context.LoadingContext)

make_workflow_step(*toolpath_object*, *pos*, *loadingContext*, *parentworkflowProv=None*)

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **pos** (*int*)
- **loadingContext** (cwltool.context.LoadingContext)
- **parentworkflowProv** (*Optional[*cwltool.cwlprov.provenance_profile.ProvenanceProfile*]*)

Return type
WorkflowStep

job(*job_order*, *output_callbacks*, *runtimeContext*)

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

visit(*op*)

Parameters
op (Callable*[[ruamel.yaml.comments.CommentedMap], None]*)

Return type
None

cwltool.workflow.**used_by_step**(*step*, *shortinputid*)

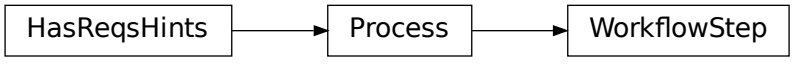
Parameters

- **step** (*cwltool.utils.StepType*)
- **shortinputid** (*str*)

Return type
bool

class cwltool.workflow.**WorkflowStep**(*toolpath_object*, *pos*, *loadingContext*, *parentworkflowProv=None*)

Bases: *cwltool.process.Process*



Abstract CWL Process.

Parameters

- **toolpath_object** (*ruamel.yaml.comments.CommentedMap*)
- **pos** (*int*)
- **loadingContext** (cwltool.context.LoadingContext)
- **parentworkflowProv** (*Optional[*cwltool.cwlprov.provenance_profile.ProvenanceProfile*]*)

checkRequirements(*rec*, *supported_process_requirements*)

Check the presence of unsupported requirements.

Parameters

- **rec** (*Union[MutableSequence[cwltool.utils.CWLObjectType], cwltool.utils.CWLObjectType, cwltool.utils.CWLOutputType, None]*)
- **supported_process_requirements** (*Iterable[str]*)

Return type
None

receive_output(*output_callback*, *jobout*, *processStatus*)

Parameters

- **output_callback** (*cwltool.utils.OutputCallbackType*)
- **jobout** (*cwltool.utils.CWLObjectType*)
- **processStatus** (*str*)

Return type
None

job(*job_order*, *output_callbacks*, *runtimeContext*)

Initialize sub-workflow as a step in the parent profile.

Parameters

- **job_order** (*cwltool.utils.CWLObjectType*)
- **output_callbacks** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

visit(*op*)

Parameters
op (Callable*[[ruamel.yaml.comments.CommentedMap], None]*)

Return type
None

cwltool.workflow_job

Module Contents

Classes

WorkflowJobStep	Generated for each step in Workflow.steps().
ReceiveScatterOutput	Produced by the scatter generators.
WorkflowJob	Generates steps from the Workflow.
WorkflowJobLoopStep	Generated for each step in Workflow.steps() containing a Loop requirement.

Functions

parallel_steps(steps, rc, runtimeContext)	
nested_crossproduct_scatter(process, joborder, ...)	
crossproduct_size(joborder, scatter_keys)	Compute the size of a cross product.
flat_crossproduct_scatter(process, joborder, ...)	
dotproduct_scatter(process, joborder, scatter_keys, ...)	
match_types(sinktype, src, iid, inputobj, linkMerge, ...)	
object_from_state(state, params, frag_only, ...[, ...])	

class cwltool.workflow_job.**WorkflowJobStep**(*step*)

Generated for each step in Workflow.steps().

Parameters

step (cwltool.workflow.WorkflowStep)

job(*joborder*, *output_callback*, *runtimeContext*)

Parameters

- **joborder** (*cwltool.utils.CWLObjectType*)
- **output_callback** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type

cwltool.utils.JobsGeneratorType

class cwltool.workflow_job.**ReceiveScatterOutput**(*output_callback*, *dest*, *total*)

Produced by the scatter generators.

Parameters

- **output_callback** (*cwltool.utils.ScatterOutputCallbackType*)

- **dest** (*cwltool.utils.ScatterDestinationsType*)
- **total** (*int*)

receive_scatter_output(*index*, *jobout*, *processStatus*)

Record the results of a scatter operation.

Parameters

- **index** (*int*)
- **jobout** (*cwltool.utils.CWLObjectType*)
- **processStatus** (*str*)

Return type
None

setTotal(*total*, *steps*)

Set the total number of expected outputs along with the steps.

This is necessary to finish the setup.

Parameters

- **total** (*int*)
- **steps** (*List[Optional[cwltool.utils.JobsGeneratorType]]*)

Return type
None

cwltool.workflow_job.**parallel_steps**(*steps*, *rc*, *runtimeContext*)

Parameters

- **steps** (*List[Optional[cwltool.utils.JobsGeneratorType]]*)
- **rc** (ReceiveScatterOutput)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

cwltool.workflow_job.**nested_crossproduct_scatter**(*process*, *joborder*, *scatter_keys*, *output_callback*, *runtimeContext*)

Parameters

- **process** (WorkflowJobStep)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **scatter_keys** (*MutableSequence[str]*)
- **output_callback** (*cwltool.utils.ScatterOutputCallbackType*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

cwltool.workflow_job.**crossproduct_size**(*joborder*, *scatter_keys*)

Compute the size of a cross product.

Parameters

- **joborder** (*cwltool.utils.CWLObjectType*)
- **scatter_keys** (*MutableSequence[str]*)

Return type
int

cwltool.workflow_job.**flat_crossproduct_scatter**(*process*, *joborder*, *scatter_keys*, *output_callback*, *runtimeContext*)

Parameters

- **process** (WorkflowJobStep)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **scatter_keys** (*MutableSequence[str]*)
- **output_callback** (*cwltool.utils.ScatterOutputCallbackType*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

cwltool.workflow_job.**dotproduct_scatter**(*process*, *joborder*, *scatter_keys*, *output_callback*, *runtimeContext*)

Parameters

- **process** (WorkflowJobStep)
- **joborder** (*cwltool.utils.CWLObjectType*)
- **scatter_keys** (*MutableSequence[str]*)
- **output_callback** (*cwltool.utils.ScatterOutputCallbackType*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

cwltool.workflow_job.**match_types**(*sinktype*, *src*, *iid*, *inputobj*, *linkMerge*, *valueFrom*)

Parameters

- **sinktype** (*Optional[cwltool.utils.SinkType]*)
- **src** (*cwltool.utils.WorkflowStateItem*)
- **iid** (*str*)
- **inputobj** (*cwltool.utils.CWLObjectType*)
- **linkMerge** (*Optional[str]*)
- **valueFrom** (*Optional[str]*)

Return type
bool

cwltool.workflow_job.**object_from_state**(*state*, *params*, *frag_only*, *supportsMultipleInput*, *sourceField*, *incomplete=False*)

Parameters

- **state** (*Dict[str, Optional[cwltool.utils.WorkflowStateItem]]*)

- **params** (*cwltool.utils.ParametersType*)
- **frag_only** (*bool*)
- **supportsMultipleInput** (*bool*)
- **sourceField** (*str*)
- **incomplete** (*bool*)

Return type
Optional[cwltool.utils.CWLObjectType]

class cwltool.workflow_job.**WorkflowJob**(*workflow*, *runtimeContext*)

Generates steps from the Workflow.

Parameters

- **workflow** (cwltool.workflow.Workflow)
- **runtimeContext** (cwltool.context.RuntimeContext)

do_output_callback(*final_output_callback*)

Parameters
final_output_callback (*cwltool.utils.OutputCallbackType*)

Return type
None

receive_output(*step*, *outputparms*, *final_output_callback*, *jobout*, *processStatus*)

Parameters

- **step** (WorkflowJobStep)
- **outputparms** (*List[cwltool.utils.CWLObjectType]*)
- **final_output_callback** (*cwltool.utils.OutputCallbackType*)
- **jobout** (*cwltool.utils.CWLObjectType*)
- **processStatus** (*str*)

Return type
None

try_make_job(*step*, *final_output_callback*, *runtimeContext*)

Parameters

- **step** (WorkflowJobStep)
- **final_output_callback** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

run(*runtimeContext*, *tmpdir_lock=None*)

Log the start of each workflow.

Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **tmpdir_lock** (*Optional[threading.Lock]*)

Return type
None

job(*joborder*, *output_callback*, *runtimeContext*)

Parameters

- **joborder** (*cwltool.utils.CWLObjectType*)
- **output_callback** (*Optional[cwltool.utils.OutputCallbackType]*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

class cwltool.workflow_job.**WorkflowJobLoopStep**(*step*, *container_engine*)

Generated for each step in Workflow.steps() containing a Loop requirement.

Parameters

- **step** (WorkflowJobStep)
- **container_engine** (*str*)

job(*joborder*, *output_callback*, *runtimeContext*)

Generate a WorkflowJobStep job until the *loopWhen* condition evaluates to False.

Parameters

- **joborder** (*cwltool.utils.CWLObjectType*)
- **output_callback** (*cwltool.utils.OutputCallbackType*)
- **runtimeContext** (cwltool.context.RuntimeContext)

Return type
cwltool.utils.JobsGeneratorType

loop_callback(*runtimeContext*, *jobout*, *processStatus*)

Update the joborder object with output values from the last iteration.

Parameters

- **runtimeContext** (cwltool.context.RuntimeContext)
- **jobout** (*cwltool.utils.CWLObjectType*)
- **processStatus** (*str*)

Return type
None

Package Contents

cwltool.**__author__** = 'pamstutz@veritasgenetics.com'

cwltool.**CWL_CONTENT_TYPES** = ['text/plain', 'application/json', 'text/vnd.yaml', 'text/yaml', 'text/x-yaml',...

3.5 Indices and tables

- genindex
- modindex
- search

PYTHON MODULE INDEX

C

INDEX

Symbols

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

R

S