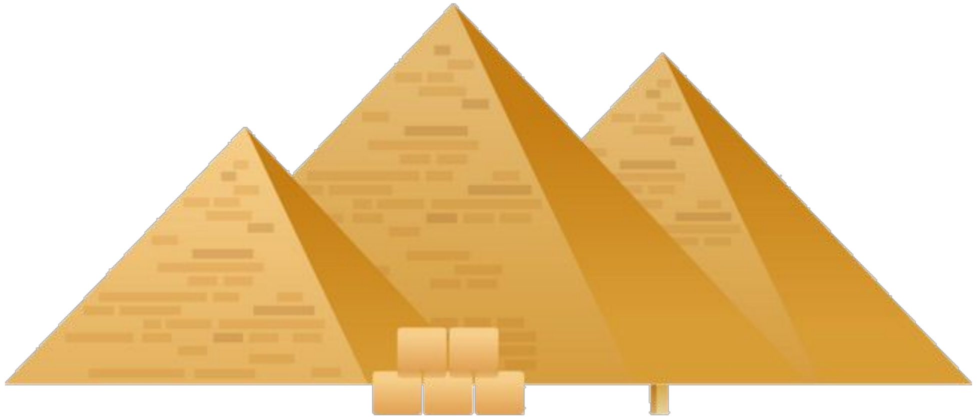


Resolving problems in Python dependencies

September 22nd, DevNation 2021

Fridolin Pokorny <fridolin@redhat.com>

$ whoami && whoweare

- Fridolin "*fridex*" Pokorny
  - Twitter: @fridex
  - Thoth team member since 2019
  - I like Python & road cycling

- Thoth
  - Started as a research project AICoE team, Office of the CTO
  - One of the main offerings: cloud based Python resolver
  - https://thoth-station.ninja

ThothStation

Agenda

- Dependency Monkey

- Cloud based Python resolver with “prescriptions”

Dependency Monkey

Dependency Monkey

- A service capable of evaluating different combinations of Python packages that can be resolved considering dependency graph

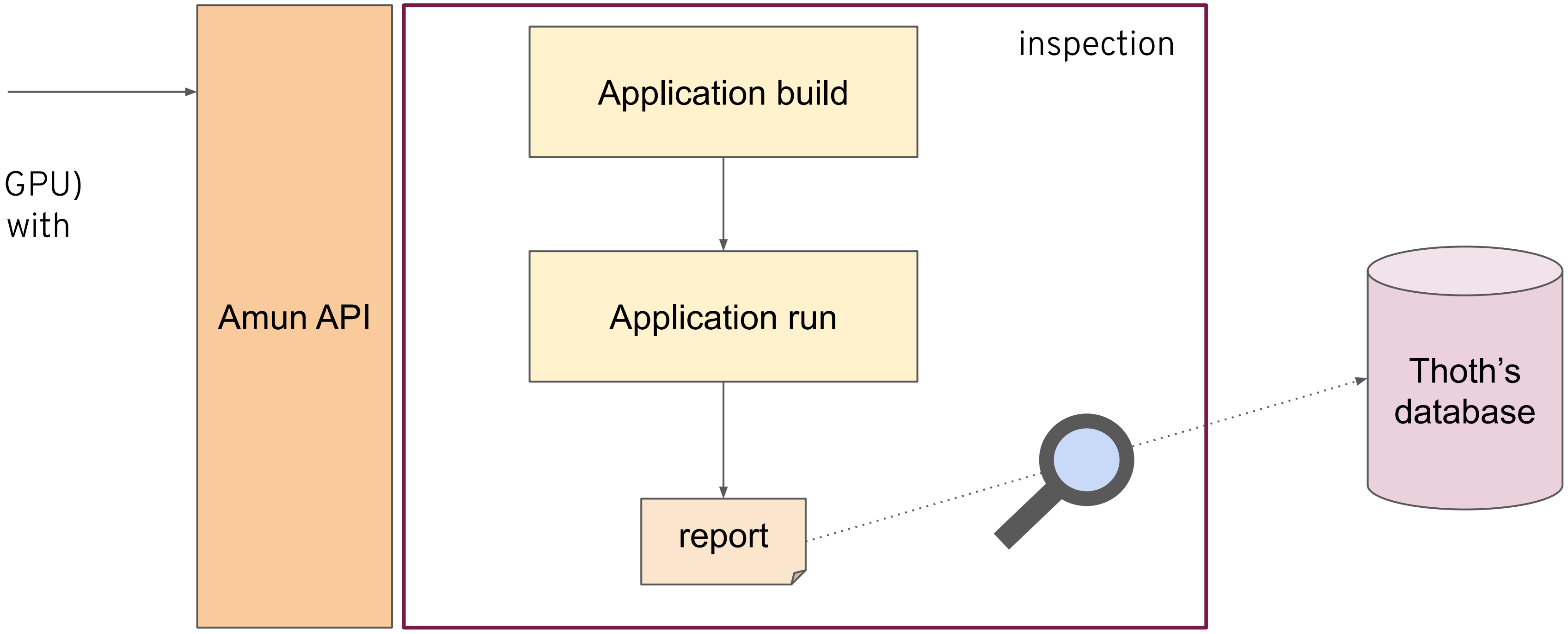
- developers.redhat.com article
  - [Resolve Python dependencies with Thoth Dependency Monkey]

- Resolve a valid resolution which is then tested in the cluster
  - The resolved packages are tested and the knowledge is derived
    - Specifically to runtime environment (OS, Python version, ...)
    - Specifically to hardware available in the cluster

Amun API

- A service that can test the application with the resolved stack
  - https://github.com/thoth-station/amun-api

Base image
A list of RPM packages
Python dependencies
Hardware requirements (CPU, GPU)
A script to test the application with



Observed issues

- Dependency Monkey Zoo
  - https://github.com/thoth-station/dependency-monkey-zoo
  - Inspections we run to verify correctness

- AI software stack inspection with Thoth and TensorFlow
  - https://thoth-station.ninja/j/tf_21_urllib3.html
  - Prescription: tf_21_urllib3.yaml

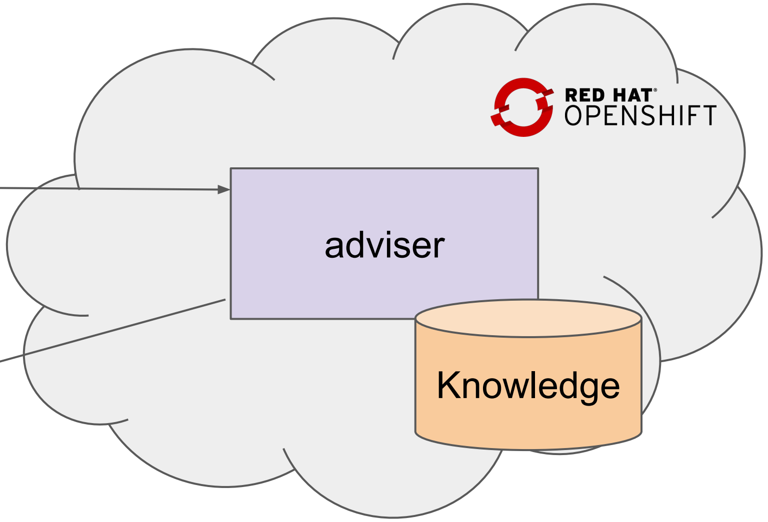
Thoth: The cloud Python resolver

The Python resolver run in cloud

- Recommendation engine for Python applications
- Publicly available to the community
- Stochastic resolver implementing gradient-free reinforcement learning methods
- See documentation for more information:
    - https://thoth-station.ninja/docs/developers/adviser

Python cloud resolver

Requirements
Constraints
Information about software in runtime environment
 - OS, Python version, base image, CUDA, ...
Information about hardware in runtime environment
 - CPU, GPU, ...
Static source-code analysis
Recommendation type



Lockfile + justification

```
$ pip install thamos
$ thamos config
$ thamos advise
```

Why gradient-free reinforcement learning?

- Wide range (*infinite?*) of possible resolutions depending on requirements used in the application and other inputs to the resolver
- A model is trained on each request to the resolver
- Exploration phase and subsequent exploitation phase comes with the resolved software stack

Resolution pipeline

- The resolution process is using a pipeline made out of units of different type
    - Base pipeline types: boots, pseudonyms, sieves, steps, strides, wraps

- Pipeline units can be implemented directly in Python or declaratively in YAML files

- The resolution pipeline is constructed dynamically based on inputs to the resolution engine

Declarative interface for the resolver to resolve Python packages following prescribed rules

Prescriptions - declarative interface to the cloud based resolver

- Provide a way to declarativelly state how the resolution process should look like
- developers.redhat.com article:
    - Thoth prescriptions for resolving Python dependencies
- A set of YAML files that are automatically consumed by resolver in a deployment

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Prescriptions - Example

- Pillow in version 8.3.0 does not work with NumPy

  https://github.com/python-pillow/Pillow/issues/5571

```
with PIL.Image.open(filepath) as img:
    numpy.array(img, dtype=numpy.float32)
```

```
>       frame_paletted = np.array(im, np.uint8)
E       TypeError: __array__() takes 1 positional argument but 2 were given

/lib/python3.9/site-packages/imageio/plugins/pillow.py:745: TypeError
```

```yaml
units:
 steps:
 - name: Pillow830TypeErrorStep
   type: step
   should_include:
     adviser_pipeline: true
   match:
     package_version:
       name: pillow
       version: ==8.3.0
       index_url: https://pypi.org/simple
     state:
       resolved_dependencies:
       - name: numpy
   run:
     not_acceptable: Pillow in version 8.3.0 does not work with NumPy
     stack_info:
     - type: WARNING
       message: Pillow in version 8.3.0 does not work with NumPy
       link: https://github.com/python-pillow/Pillow/issues/5571
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Prescriptions - Examples

- Use tensorflow-gpu as a “*pseudonym*” to tensorflow if GPU enabled environment is available
    - tf_gpu.yaml
- Use the right tensorflow-gpu for the environment following support matrix
    - tf_cuda.yaml
    - tf_cudnn.yaml
- TensorFlow in version 2.1 can cause runtime errors when running with h5py>=3 caused by overpinning
    - tf_21_h5py.yaml

Prescriptions - Examples

- Prioritize resolving AICoE builds of TensorFlow for AVX2 enabled environments
    - tf_avx2.yaml
- Use *only* CUDA 11.1 builds of torch available on a PyTorch index:
    - gpu_index.yaml
- Prioritize resolving AICoE builds of TensorFlow for AVX2 enabled environments
    - tf_avx2.yaml
- Use *only* CUDA 11.1 builds of torch available on a PyTorch index:
    - gpu_index.yaml

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Prescriptions - Examples

- `tempfile.mktemp` is deprecated due to vulnerability to race conditions
  - tempfile.yaml
- a GPU is available but no CUDA is available
  - gpu_no_cuda.yaml
- GitPython requires Git present in the runtime environment
  - rpm.yaml
  - The resolver can consider also ABI or Python packages already shipped in pre-built container images
- ... more examples can be found at:
  - https://thoth-station.ninja/docs/developers/adviser/prescription.html

References

- Dependency Monkey
  - https://thoth-station.ninja/docs/developers/adviser/dependency_monkey.html
- Prescriptions for Python open-source projects
  - Feel free to contribute to build better Python ecosystem:
    - https://github.com/thoth-station/prescriptions
- Declarative interface for the resolver to state requirements on Python packages in runtime environments
  - https://thoth-station.ninja/docs/developers/adviser/prescription.html

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Thank you

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