Pip Packaging and Educational Use of ns-3

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Current state of ns-3 distribution

- ns-3 is typically distributed as a source tarball
  - Requires additional tools (e.g. compiler, cmake, ninja, tar, etc)
  - Requires some setup (e.g. setting up PATH environment variables)
  - You need to be aware that there is a sequence of steps to build the software
    - Not the case for many students, since introductory classes switched from C to Python

- Some package managers package ns-3 as a C++ library
  - Debian, Spack, Homebrew
  - Limited reach and does not ship with everything needed to develop
Python bindings and pip packaging

- Cppyy-based python bindings can be used to provide Python APIs from the C++ ones
  - We just need to package a pre-built ns-3 package with it...

- Pip packaging comes to the rescue
  - One build, many Linux distributions (up to a certain GLibc version)
  - Windows and Mac still in the works due to Cppyy limitations
  - ‘pip install ns3’ and you are good to go
  - And visualizer works too!
Pip installation: Ubuntu 22.04 on WSL

```bash
gabriel@DESKTOP-2SF52OH:~$ pip install ns3
defaulting to user installation because normal site-packages is not writeable
Collecting ns3
  Downloading ns3-3.38.post272-cp310-cp310-manylinux_2_38-x86_64.whl (68.0 MB)
    68.0/68.0 MB 4.4 MB/s eta 0:00:00
Collecting cpypppy==2.4.2
  Downloading cpypppy-2.4.2.tar.gz (26 kB)
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Installing backend dependencies ... done
  Preparing metadata (pyproject.toml) ... done
  Collecting CpyCppy==1.12.12
    Downloading CpyCppy-1.12.12.tar.gz (206 kB)
      Installing build dependencies ... done
      Getting requirements to build wheel ...
      Preparing metadata (pyproject.toml) ... done
    Downloading cpyppy-cling-6.27.11-py2.py3-none-manylinux2014_x86_64.whl (32.4 MB)
    Collecting cpyppy-backend==1.14.10
      Using cached cpyppy-backend-1.14.10-py2.py3-none-linux_x86_64.whl
    Building wheels for collected packages: cpyppy, CpyCppy
      Building wheel for cpyppy: filename=cpyppy-2.4.2-py3-none-any.whl size=19351488 sha256=f17f5e67d8d510e8a564b0e6e6e62ab95582555de6d8bf57f321272df282c3ae40d
        Stored in directory: /home/gabriel/.cache/pip/wheels/1f/73/e4/38da8578450b1a5b6348a5ac98935de2e2991717394ac2f6f
      Building wheel for CpyCppy (pyproject.toml) ... done
        Created wheel for CpyCppy: filename=CpyCppy-1.12.12-cp310-cp310-manylinux_x86_64_whl size=4173446 sha256=27c363e8c68d2504a47f13de567510f8c5edb3818864f3baa4a0f
        Stored in directory: /home/gabriel/.cache/pip/wheels/fd/7a/7b/c93ded3f77ee7f7601b932691be3c0ad543b44bedd223c91a
    Successfully built cpyppy, CpyCppy
    Installing collected packages:
      cpyppy, cpyppy-cling, cpyppy-backend, CpyCppy, ns3
    WARNING: The scripts cling-config, cpyppy-generator, geneFex and rootclig are installed in
      /home/gabriel/.local/bin' which is not on PATH.
    Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-agerc
      script-location.
    Successfully installed CpyCppy-1.12.12 cpyppy-2.4.2 cpyppy-backend-1.14.10 cpyppy-cling-6.27.1 ns
```
Pip installation: Jupyter notebooks

- We could already use the Python bindings via Jupyter but it required a workaround and a local build

```python
import sys

# You must run jupyter from the ns-3-dev directory,
# or adjust these paths to the absolute directory path of ns-3-dev
sys.path.append("./ns-3-dev/build/bindings/python")
sys.path.append("./ns-3-dev/build/lib")

from ns import ns
```

```
!pip install ns3
from ns import ns

Collecting ns3
    Downloading ns3-3.38.post272-cp310-cp310-manylinux_2_28_x86_64.whl (68.0 MB)
    68.0/68.0 MB 7.5 MB/s eta 0:0:0:0
Collecting cppy==2.4.2 (from ns3)
    Downloading cppy-2.4.2.tar.gz (28 kB)
    Installing build dependencies ... done
    Installing requirements to build wheel ... done
    Installing backend dependencies ... done
    Preparing metadata (pyproject.toml) ... done
```
Educational use of ns-3

- ns-3 plus Jupyter allow for rich computer network demonstrations

- Examples are hosted on GitHub, but it cannot render animations
  - https://github.com/Gabrielcarvfer/ns3_for_education

- Notebooks can be viewed locally or via a visualizer
  - e.g. Google Colab
    - https://colab.research.google.com/github/
Demonstration