Quantum Computing (QUC) Pre-Study

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Reference Texts

Below are two reference texts for the foundational part of this course:

- The review paper [ZX-calculus for the Working Quantum Computer Scientist](#) by John van de Wetering, freely available online.
- The book [Picturing Quantum Processes](#) by Bob Coecke and Aleks Kissinger, which can be acquired from Cambridge University Press.

Python

This module uses Python 3.8+, which you should have installed and configured on your machine. You can download the installer for your architecture from www.python.org/downloads: any version from 3.8.3 is good. For your reference, notebooks for the latest iteration have been tested using Python 3.9.7.

After you're done, make sure that you have the correct version of Python by running the following in a command prompt:

```
python --version
```

Check that you get something like `Python 3.8.X` or `Python 3.9.X` as a response. Also make sure that `pip` (the package installer for Python) is working correctly, by running the following in a command prompt:

```
pip --version
```

Check that you get something like `pip 21.X.Y from ... (python 3.Z)`, where `X` and `Y` depend on your specific version (I have `pip 21.3` right now), `Z` is either 8 or 9, and `...` is going to be the local folder where `pip` resides. The important part here is `(python 3.Z)` at the end, confirming that `pip` will install the Packages for the correct version of Python (`Z` must be 8 or 9). For good measure, also upgrade `pip`:

```
pip install --upgrade pip
```

If you need a refresher on Python 3, you are encouraged to go through the official [Python Tutorial](#). If you are on a unix-like system, you may need to use `python3` and `pip3` instead of `python` and `pip` (see [PEP394](#)).

Requirements

This module requires the following Python libraries and the material has been tested with these specific versions:

```
ipython>=7.30.1
notebook>=6.4.6
qiskit[visualization]>=0.34.0
matplotlib>=3.5.1
seaborn>=0.11.2
scipy>=1.7.3
```

A `requirements.txt` file is made available for your convenience, so that the libraries can be installed by running the following command in this folder:

```
pip install -r requirements.txt
```

Again, on a Unix-like system you may need to use `pip3` to target your Python 3 distribution. You can use `pip show` to verify the installed module versions, e.g.

```
C:\WINDOWS\system32>pip show ipython
Name: ipython
Version: 7.30.1
```

Jupyter Notebooks

This module is partially taught on Jupyter notebooks. Once installed (the `notebook` library above), you can run Jupyter notebooks by opening a command prompt into a folder containing notebooks (possibly organised in sub-folders) and running:

```
jupyter notebook
```

This will launch a local server and open your default browser at a page showing you the Jupyter notebooks in the folder, as well as any sub-folders containing notebooks.

The documentation for Jupyter notebooks is available at jupyter-notebook.readthedocs.io and a rather thorough introduction as available at the Notebook Examples section. You are encouraged to go through this section and familiarize yourselves with the workings of Jupyter notebooks.

Qiskit

This module uses IBM's Qiskit as a platform for quantum software development (the `qiskit` library above). The `matplotlib` and `seaborn` libraries are necessary for some of Qiskit's visualizations and might need to be installed separately.

Once installed, launch your python interpreter (`python`, or `python3`) and execute the following commands:

```
>>> import qiskit
>>> qiskit.__qiskit_version__
```

You should get the following (or newer versions):

```
>>> import qiskit
>>> qiskit.__qiskit_version__
{'qiskit-terra': '0.18.3', 'qiskit-aer': '0.9.1',
 'qiskit-ignis': '0.6.0', 'qiskit-ibmq-provider': '0.17.0',
 'qiskit-aqua': '0.9.5', 'qiskit': '0.31.0',
 'qiskit-nature': None, 'qiskit-finance': None,
 'qiskit-optimization': None, 'qiskit-machine-learning': None}
```

For your reference, however, the Qiskit documentation is available at qiskit.org/documentation.

IBM Quantum Lab

As part of this module, we will run some code on quantum computers made available online by IBM. Sign up to the IBM Quantum Lab and follow these steps to configure Qiskit for programmatic access to the quantum systems..