Getting started with gem5

In this section, we will get familiar the tutorial's codespace environment and run our first gem5 simulation.

Let’s hit the ground running

This example will show

1. How someone obtains gem5.
2. How you build it.
3. Running a very basic "Hello World" simulation.

- Getting and compiling gem5 is often the hardest part.
- There's a lot of complicated things happening behind the scenes. We will explain them later.

Typical Downloading

```
> git clone https://github.com/gem5/gem5
> cd gem5
```

> There are two main branches in the gem5 repository:
> **stable**: The default branch for gem5. Updated at stable releases. Currently v24.0.
> **develop**: The branch in which new features, improvements, etc. are added regularly for the next release.

In this tutorial we're going to use codespaces with a repo which includes some example materials. Though all the gem5 code is v24.0

Using codespaces

- We will be using the "bootcamp environment"
  - Note: That's also where the source for these slides are

> **Step 1:** Go to the classroom https://classroom.github.com/...

You need to be in the github organization (via the classroom) to get free codespaces.

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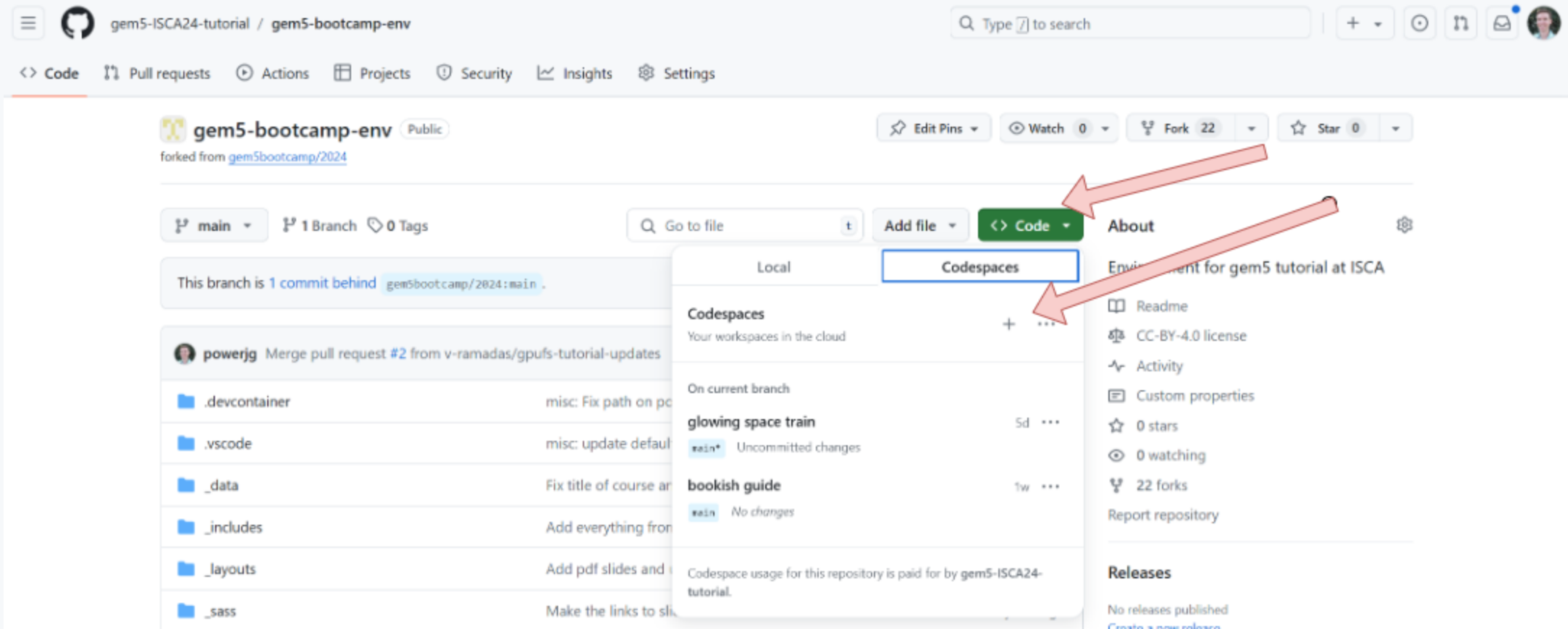
AFTER joining the classroom, you can go to the repository and click on the green "Code" button. Again, note that this is the repo where the slides are.

https://github.com/gem5bootcamp-2024/



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Step 3: Wait for the environment to load.

Building gem5

```
> scons build/ALL/gem5.opt
```

- This takes a while (10-15 minutes with 16 cores, ~1hr on 1 core).
- If you're using codespaces, we have prebuilt binaries for you.
- We'll talk more about the build system and options later.

```
[     CXX] ALL/python/m5/ext/pystats/serializable_stat.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/abstract_stat.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/group.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/simstat.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/statistic.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/storagetype.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/timeconversion.py.cc -> .o
[     CXX] ALL/python/m5/ext/pystats/jsonloader.py.cc -> .o
[     CXX] ALL/python/m5/stats/gem5stats.py.cc -> .o
[     CXX] src/python/embedded.cc -> ALL/python/embedded.o
[     CXX] src/python/importer.cc -> ALL/python/importer.o
[     CXX] ALL/python/m5ImporterCode.cc -> .o
[     CXX] src/python/pybind11/core.cc -> ALL/python/pybind11/core.o
[     CXX] src/python/pybind11/debug.cc -> ALL/python/pybind11/debug.o
[     CXX] src/python/pybind11/event.cc -> ALL/python/pybind11/event.o
[     CXX] src/python/pybind11/object_file.cc -> ALL/python/pybind11/object_file.o
[CONFIG H] HAVE_HDF5, 1 -> ALL/config/have_hdf5.hh
[     CXX] src/python/pybind11/stats.cc -> ALL/python/pybind11/stats.o
[     CXX] ALL/python/m5/objects/SimObject.py.cc -> .o
[SO Param] m5.objects.SimObject, SimObject -> ALL/python/_m5/param_SimObject.cc
```

Let’s start by writing a simulation configuration

```
from gem5.prebuilt.demo.x86_demo_board import X86DemoBoard
from gem5.resources.resource import obtain_resource
from gem5.simulate.simulator import Simulator
```

This template code is available in the materials/ directory.
Open the `materials/01-basic.py` file and start editing.

Let’s be lazy and use a prebuild board

```
board = X86DemoBoard()
```

The X86DemoBoard has the following properties:

- Single Channel DDR3, 2GB Memory.
- A 4 core 3GHz processor (using gem5’s ‘timing’ model).
- A MESI Two Level Cache Hierarchy, with 32kB data and instruction case and a 1MB L2 Cache.
- Will be run as a Full-System simulation.

Source is available: src/python/gem5/prebuilt/demo/x86_demo_board.py.

Let't load some software

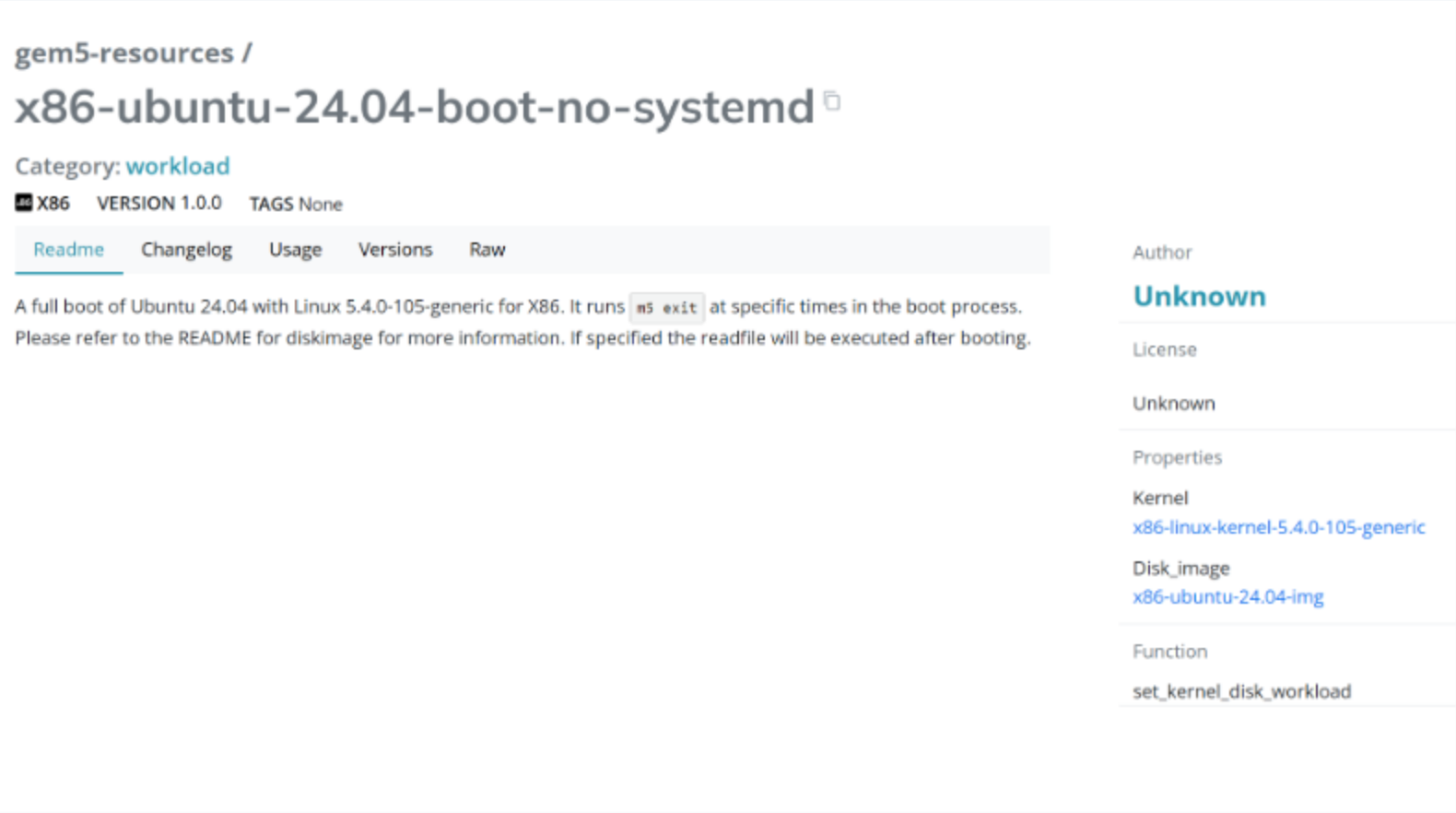
```
board.set_workload(
    obtain_resource("x86-ubuntu-24.04-boot-no-systemd")
)
```

- `obtain_resource` downloads the files needed to run workload
  - Boots Ubuntu without systemd then exits the simulation
  - Downloads disk image, kernel, and sets default parameters

See the gem5 resource page

gem5 resources web portal

Link



Now, let's create a simulator to actually run

```
sim = Simulator(board)
sim.run(20_000_000_000) # 20 billion ticks or 20 ms
```

That's it!

```
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from gem5.simulate.simulator import Simulator
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board.set_workload(
    obtain_resource("x86-ubuntu-24.04-boot-no-systemd")
)
sim = Simulator(board)
sim.run(20_000_000_000) # 20 billion ticks or 20 ms
```

To run it:

```
> gem5 materials/01-basic.py
```

Take aways

- `gem5` is a Python interpreter.
- The *interface* to `gem5` is Python scripts.
- `gem5` contains many Python libraries.
  - All of the models in gem5 (e.g., caches, CPUs, etc.).
  - The standard library (stdlib)
- The output of gem5 is in `m5out/` by default.
  - Details of configuration
  - Other output
  - **Statistics** (the most important part)
- The codespaces environment is configured to make things easy.
  - You'll need to do some work to set up your own environment.