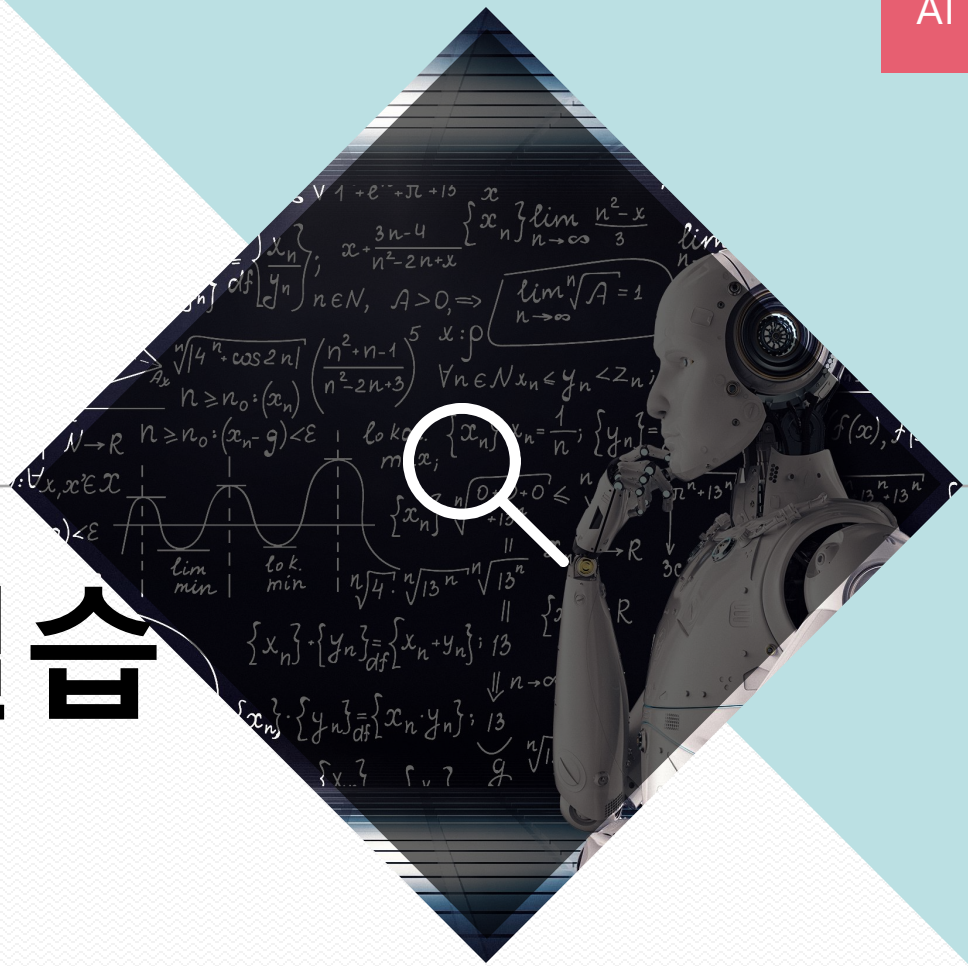
AI TRAINING SERIES



Smart Factory실습

Multi-threading

Agenda

- *How to use tool?*
- *Parallelism*

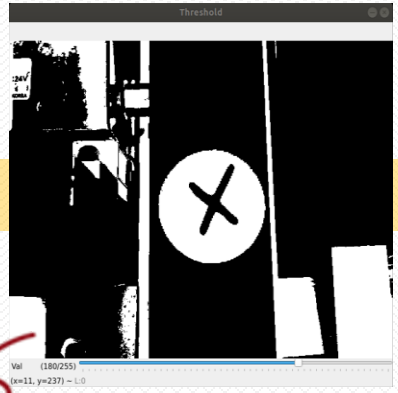
How to use tool?

Motion Detect

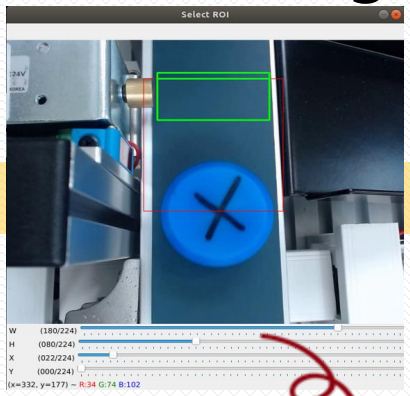
Region of Interesting

Camera Input

Binarization



ROI Setting

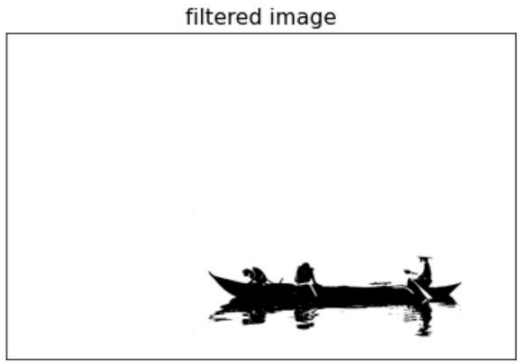


Motion Detect

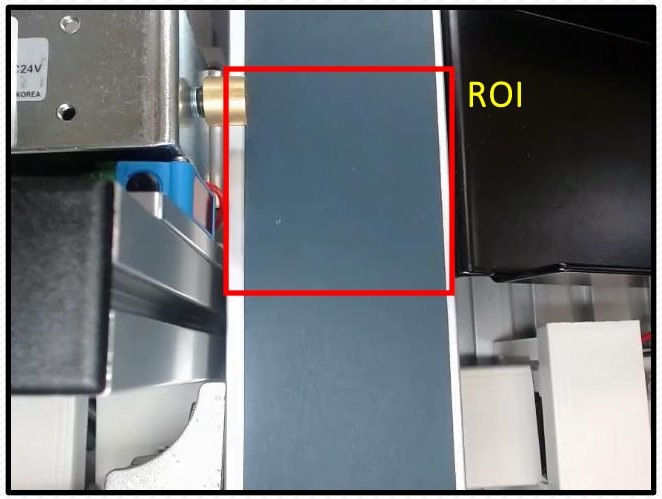
To drastically reduce the amount of information you have to work with

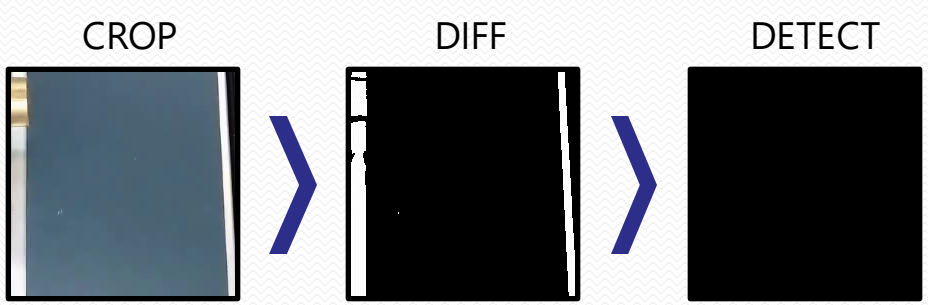
Video Stream with 640x480 resolution

224x224 image



Detailed Flow



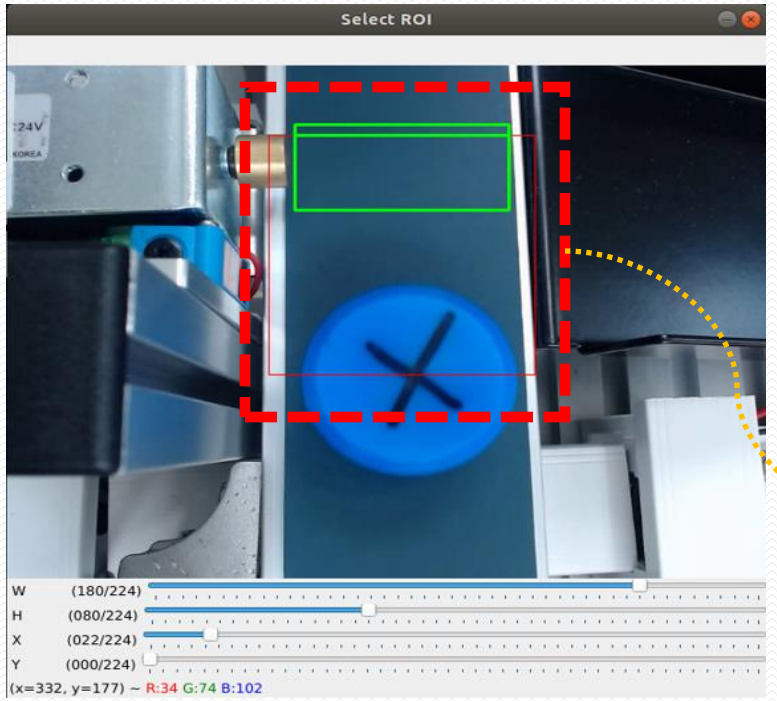


- *Crop the frame per selected ROI*
- *Calculate the frame difference*
  - Apply custom threshold with brightness value
- *Choose the best frames to pass*

Select ROI to Detect Motion

Python Tool (iotdemo-motion-detector)

iotdemo-motion-detector -l ./resource/factory/conveyor.mp4



Pre-Implemented Tool

Python Main (factory.py)

Detect the Frame (each Thread)

- *detected = det.detect(frame)*

if detected is None:
continue

Enqueue (each Thread)

- *q.put(('VIDEO: Cam1 detected', detected))*
- *q.put(('VIDEO: Cam2 detected', detected))*

```
[default]
inverted = False
flipped = False
top_margin = 10
threshold = 127
top_ratio = 0.6
mid_ratio = 0.4
skip_time = 0.099
roi_top_left = (12, 0)
roi_bottom_right = (212, 90)
crop_top_left = (0, 10)
crop_bottom_right = (224, 234)
```

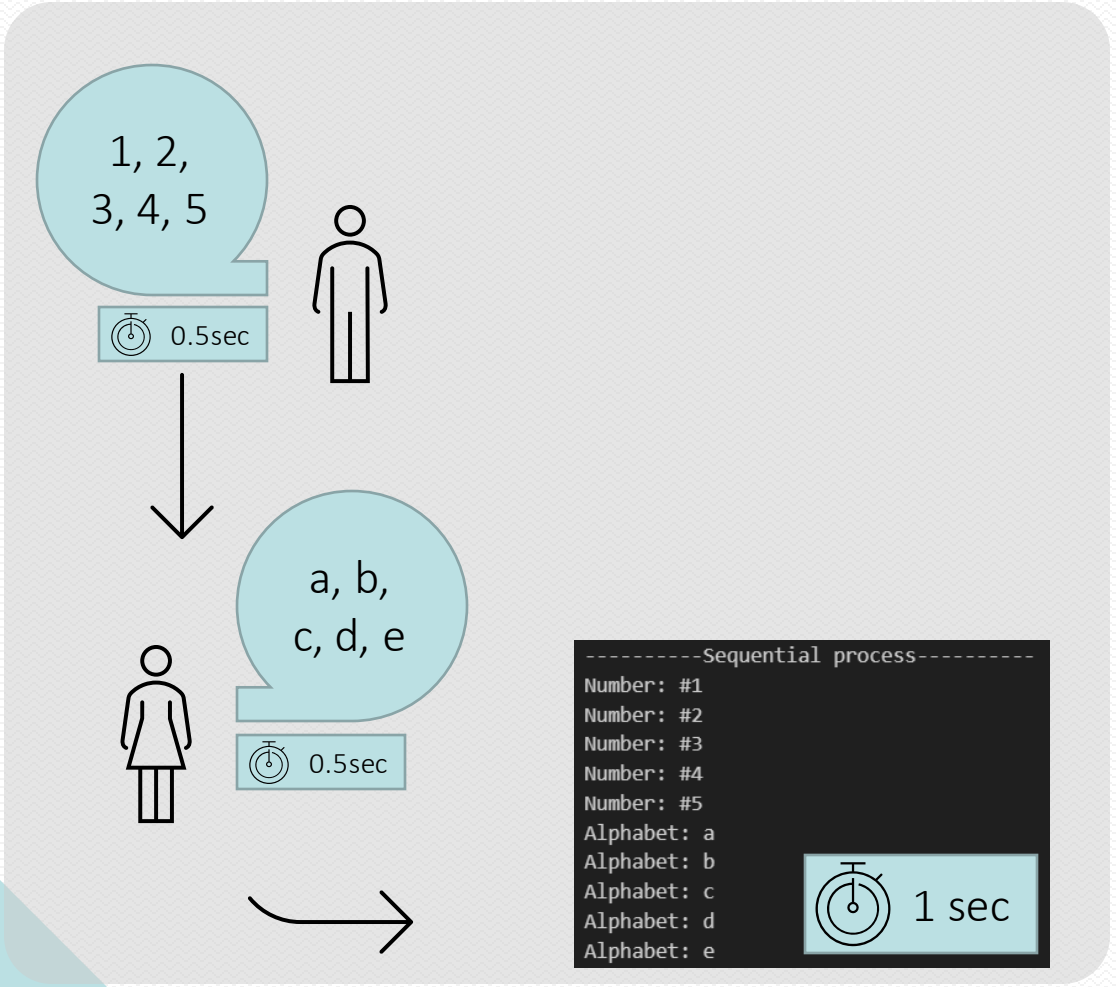
motion.cfg

Cropped Image

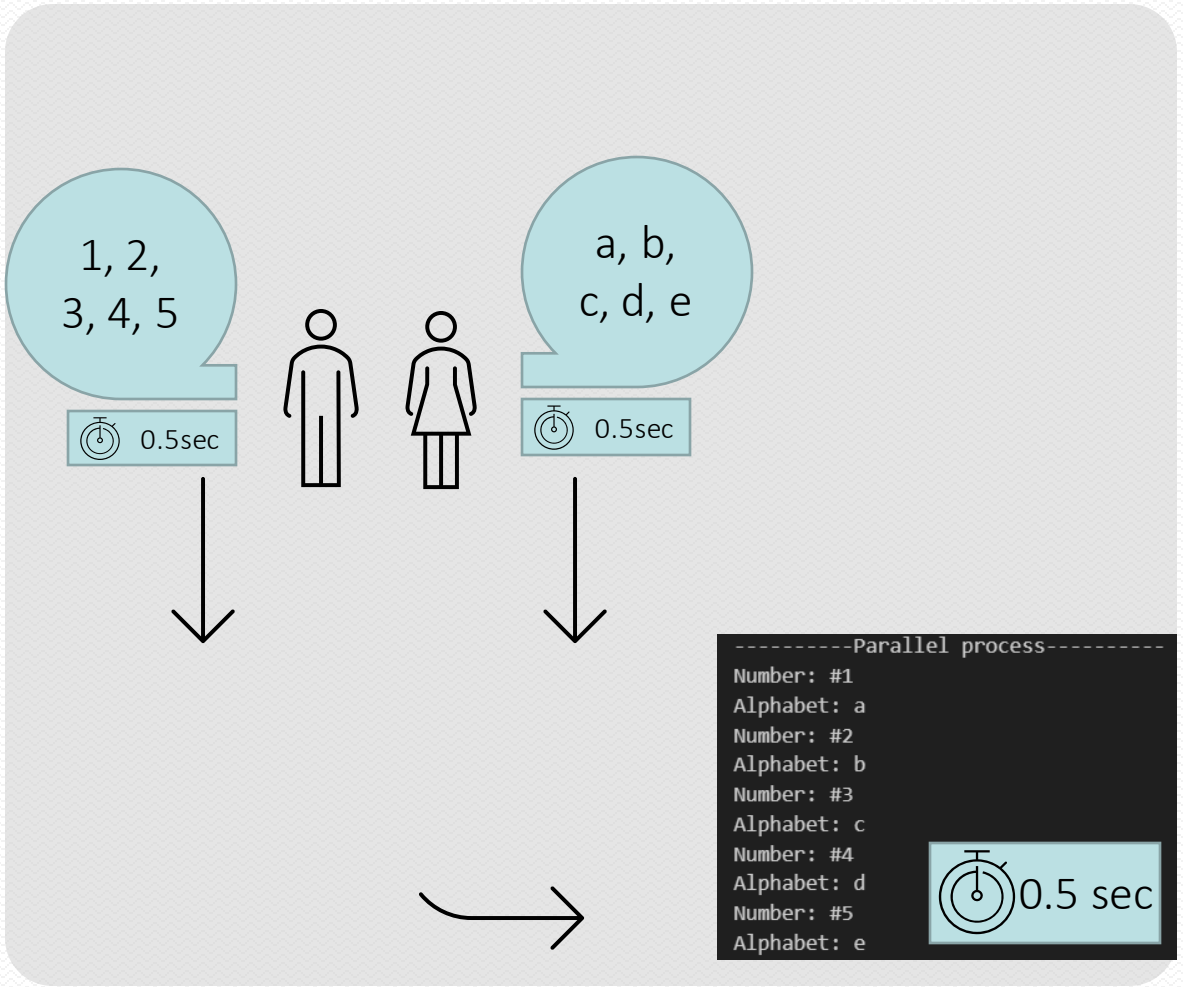
Parallelism

Parallelism

- Sequential vs Parallel



<Sequential>



<Parallel>

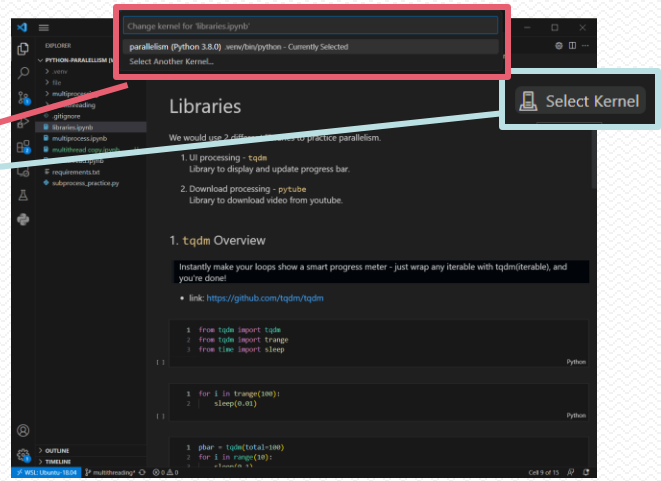
Practice Preparation

- Virtual environment setup

  $ cd Class02/python-parallelism
  $ python3 -m venv .venv
  $ source .venv/bin/activate
  (.venv)$ pip install --upgrade pip
  Open **libraries.ipynb**
  Click 'Select Kernel'
  Selecte 'Install/Enable suggested extensions'
  (.venv)$ pip install -r ./requirements.txt
  (.venv)$ ipython kernel install --user --name=parallelism

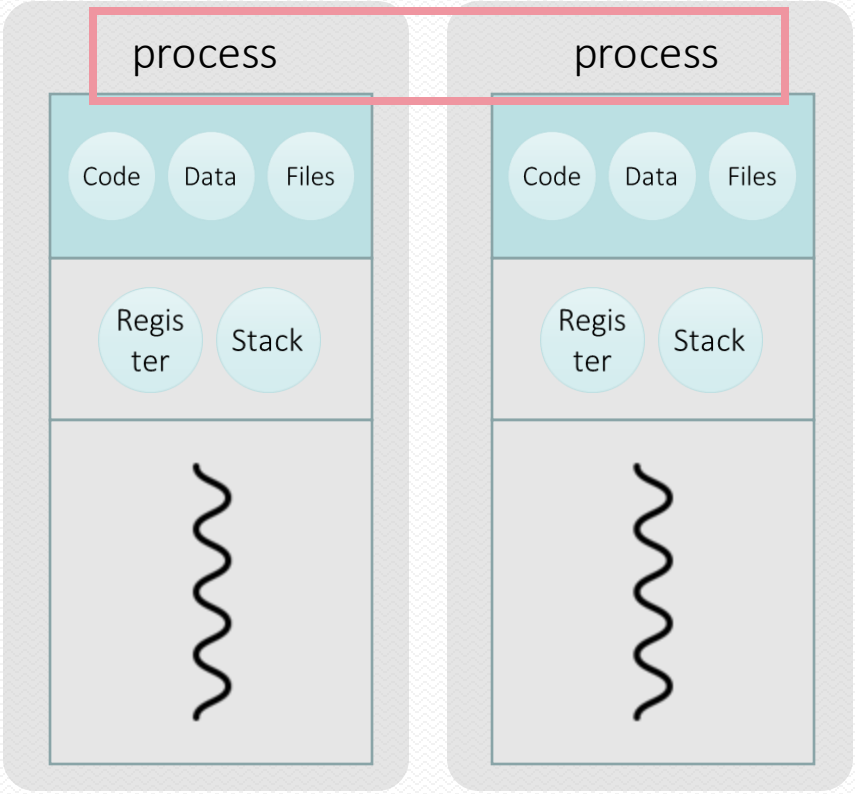
  # Verification
  (.venv)$ jupyter-kernelspec list

- Select IPython kernel from VSCode UI
  - Click `Select Kernel`
  - Choose `parallelism`



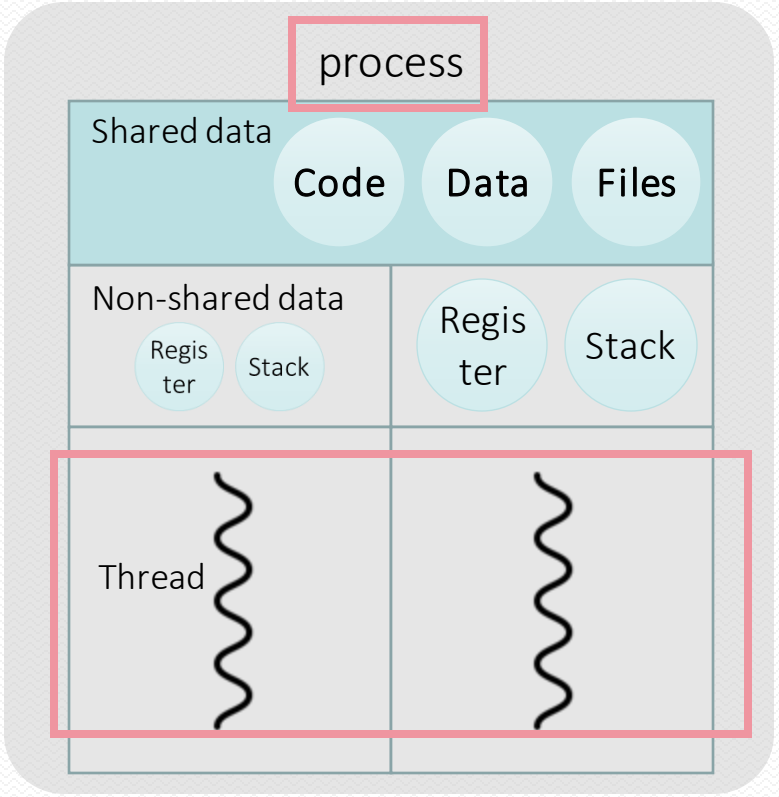
Multi-processing vs Multi-threading

Use **multiple processes**
to execute multiple tasks



<Multi-processing>

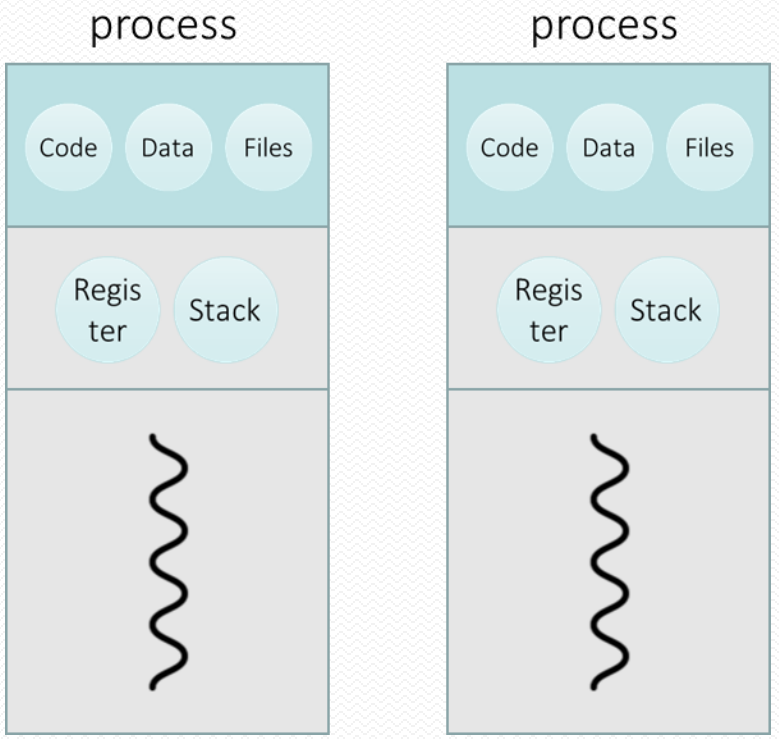
Use **single process**,
but run **multiple threads** inside



<Multi-threading>

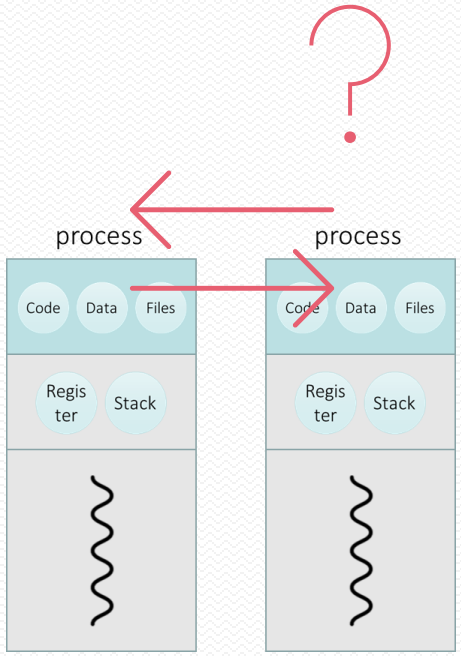
Multi-processing: Concept

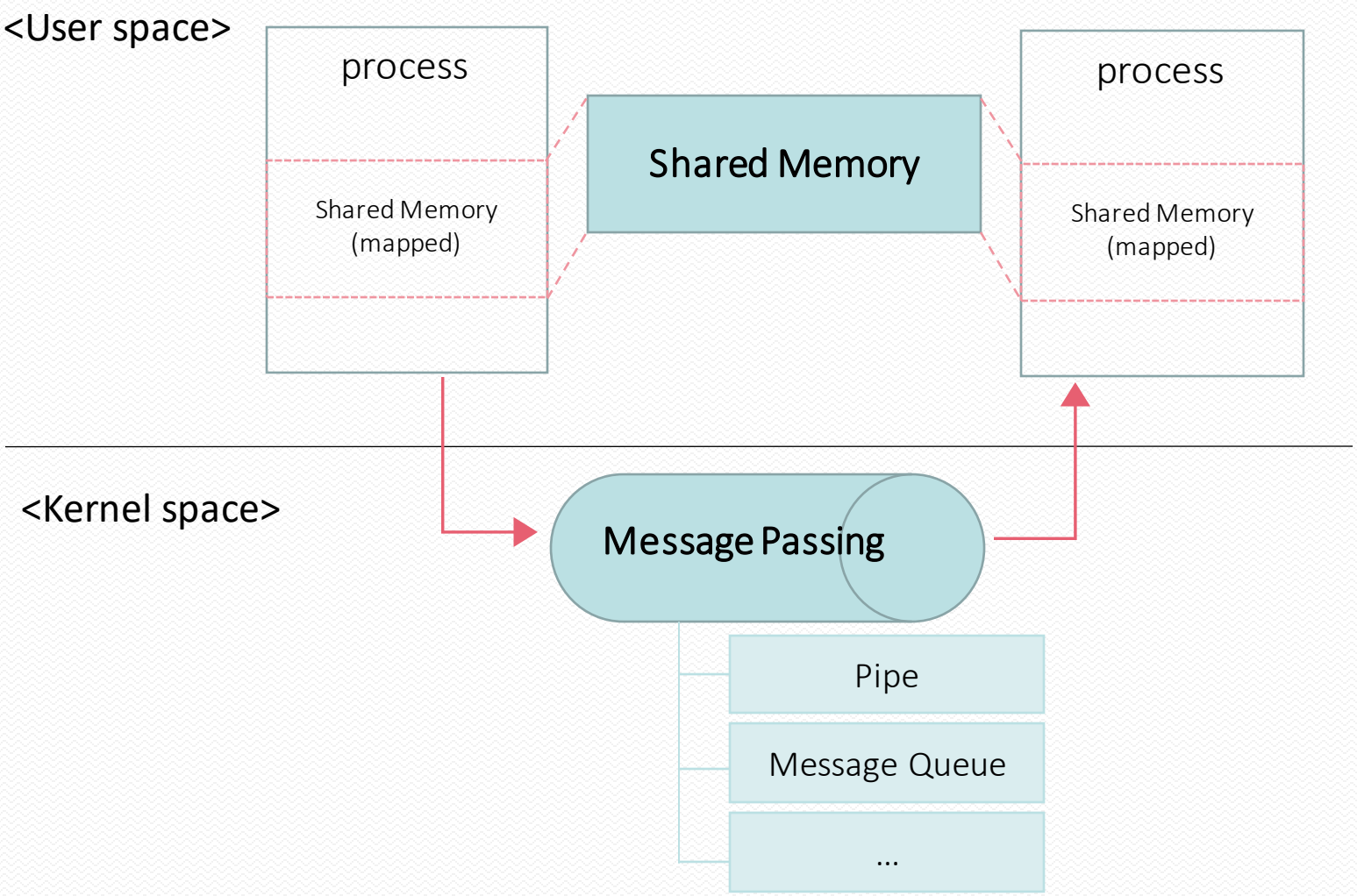
- Each process has code, data, stack and heap areas
- Every processes includes at least 1 thread(main thread)
- Processes are being separated in terms of memory usages



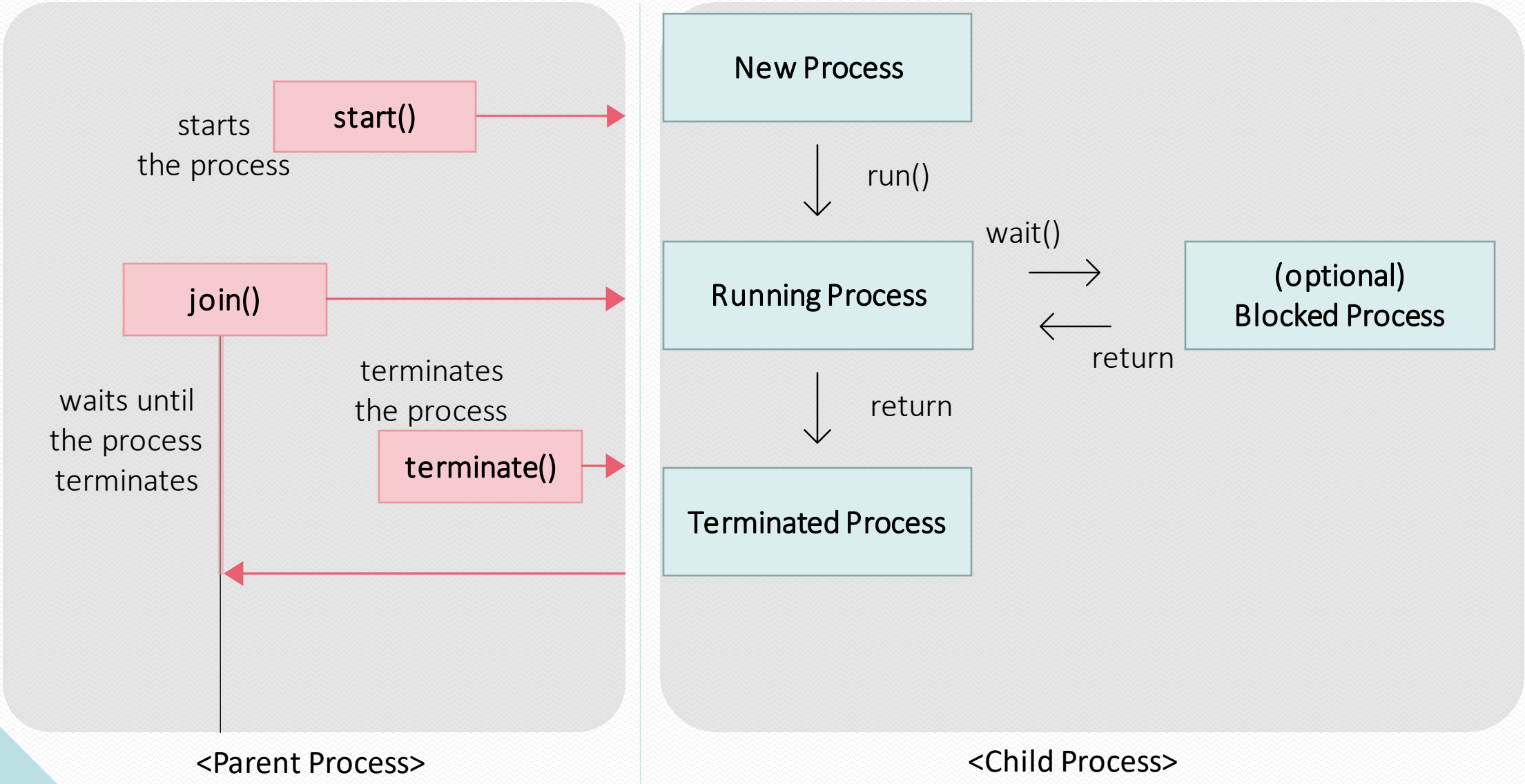
<Multi-processing>

Multi-processing: Inter-process Communication(IPC)



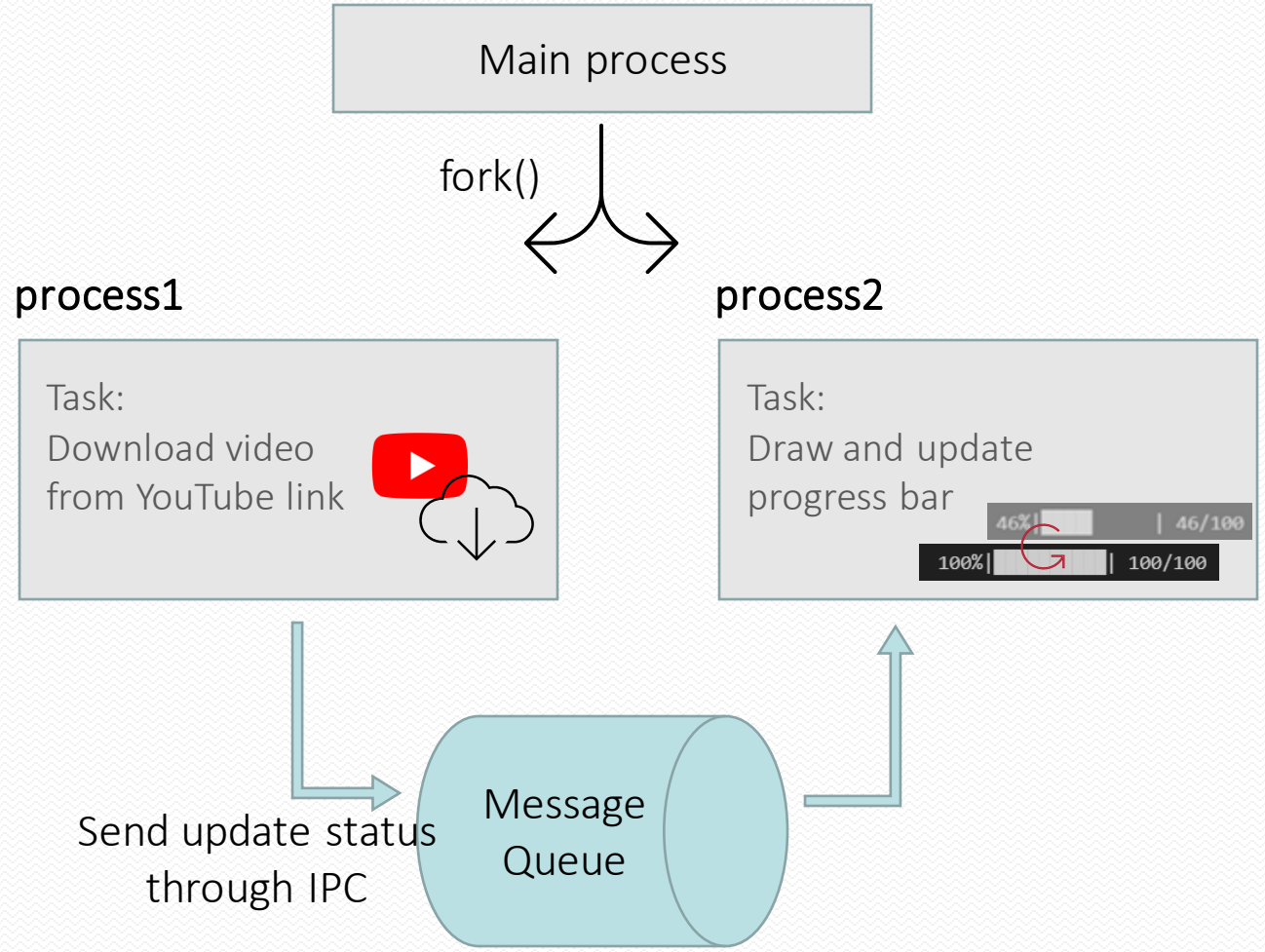


Multi-processing: Lifecycle of Process(multiprocessing.Process class)



Multi-processing: example

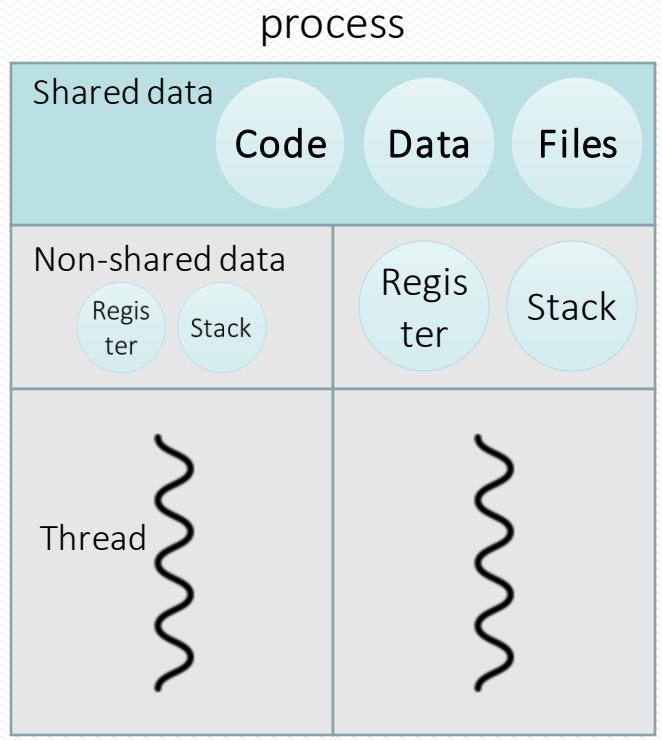
- `pytube`, `tqdm` example



Reference: https://docs.python.org/3/library/multiprocessing.html#multiprocessing-programming

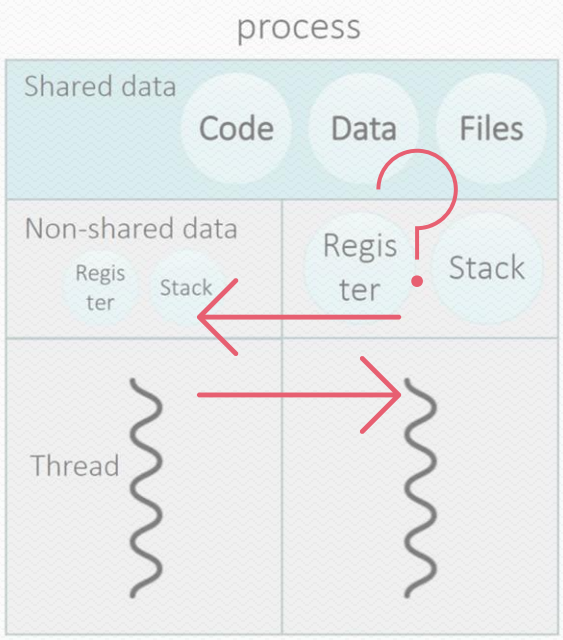
Multi-threading: Concept

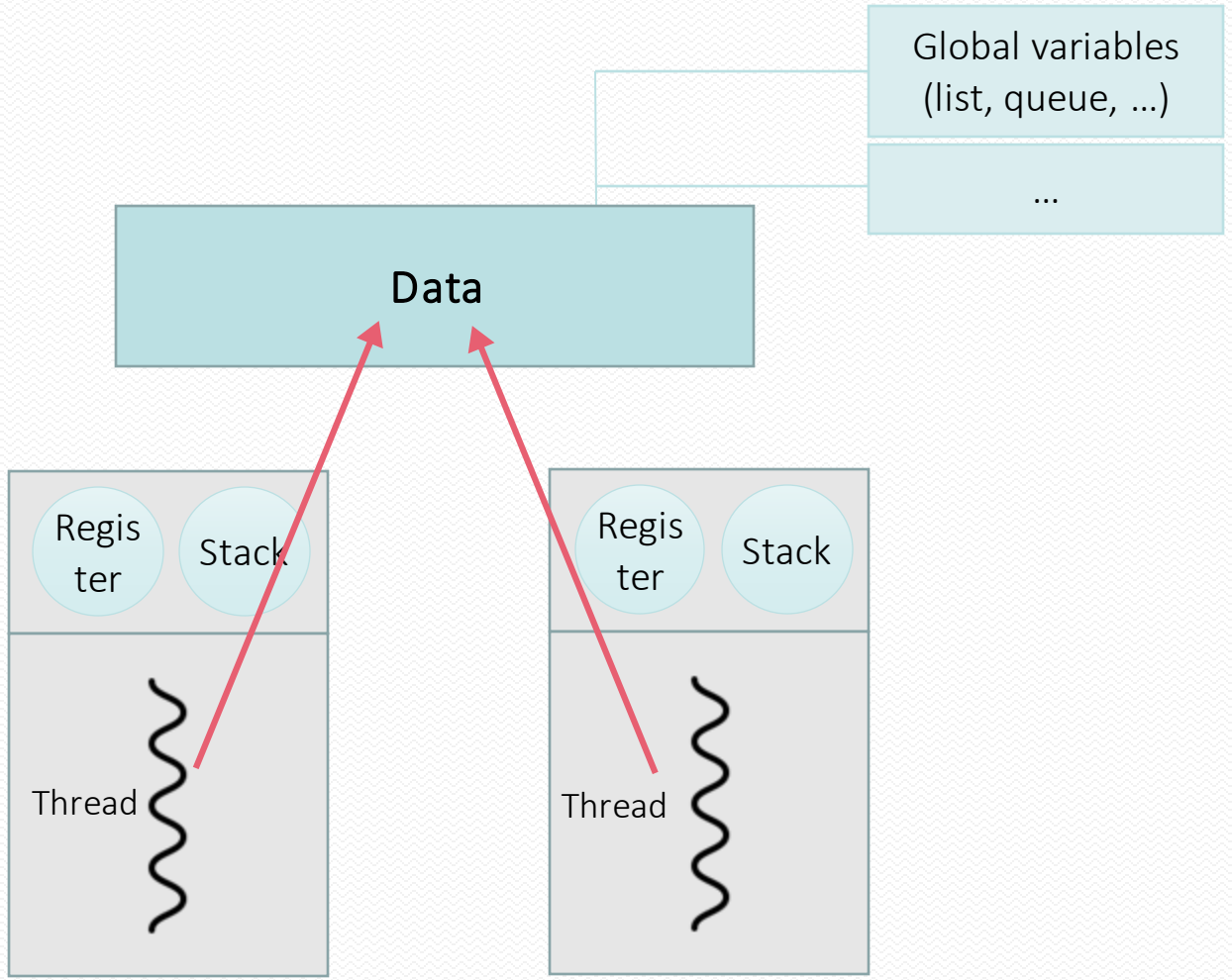
- A light-weight process
- Utilize **single process** to execute multiple tasks
- Process consists of **multiple threads**, where each threads represents each tasks
- Threads in one process share memory area, in terms of code, data segments and heap



<Multi-threading>

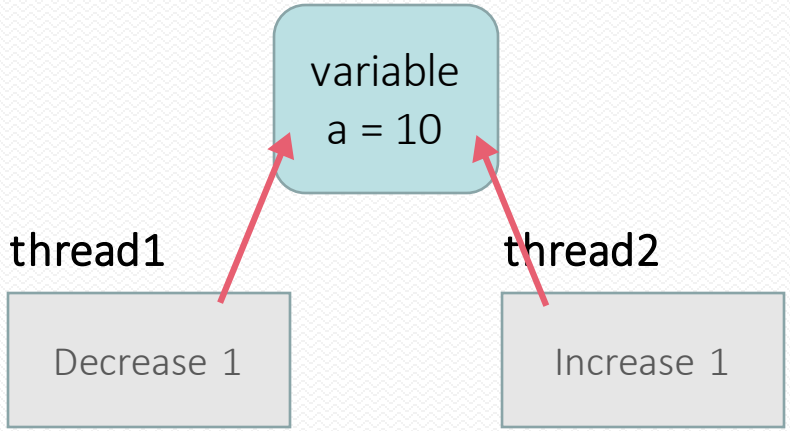
Multi-threading: Communication between threads





GIL(Global Interpreter Lock)

- GIL in python, is a mutex which ensures to run only one thread at once

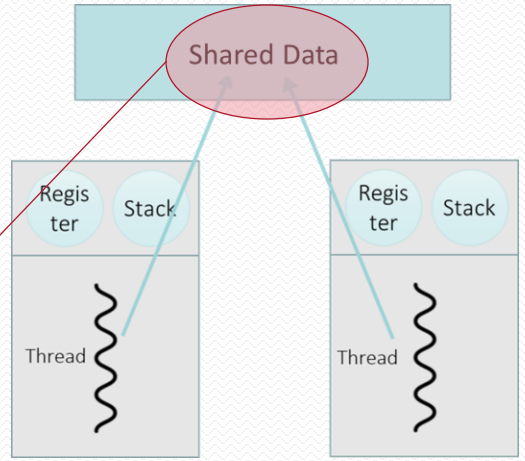


<Race condition>

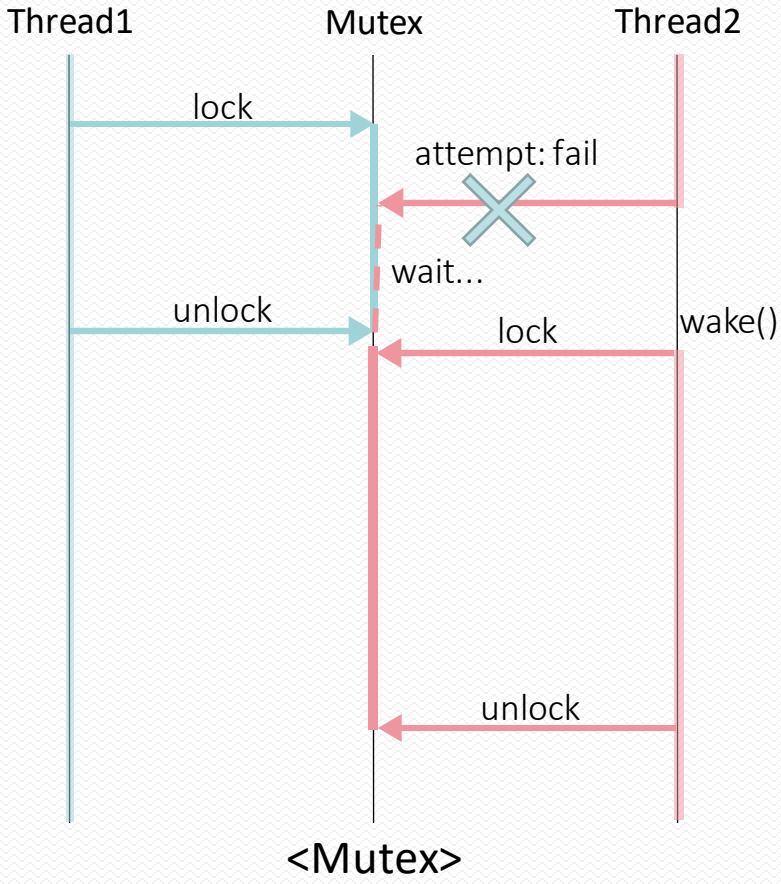
thread1:	thread2:
Read: a	Read: a
Decrease 1	Increase 1
Write: a	Write: a
Result: a?	Result: a?

- Thread-safety
  - Prevents race condition
- Performance issue:
  - Takes more time than actual multi-threaded program

Multi-threading: Problem & Solution

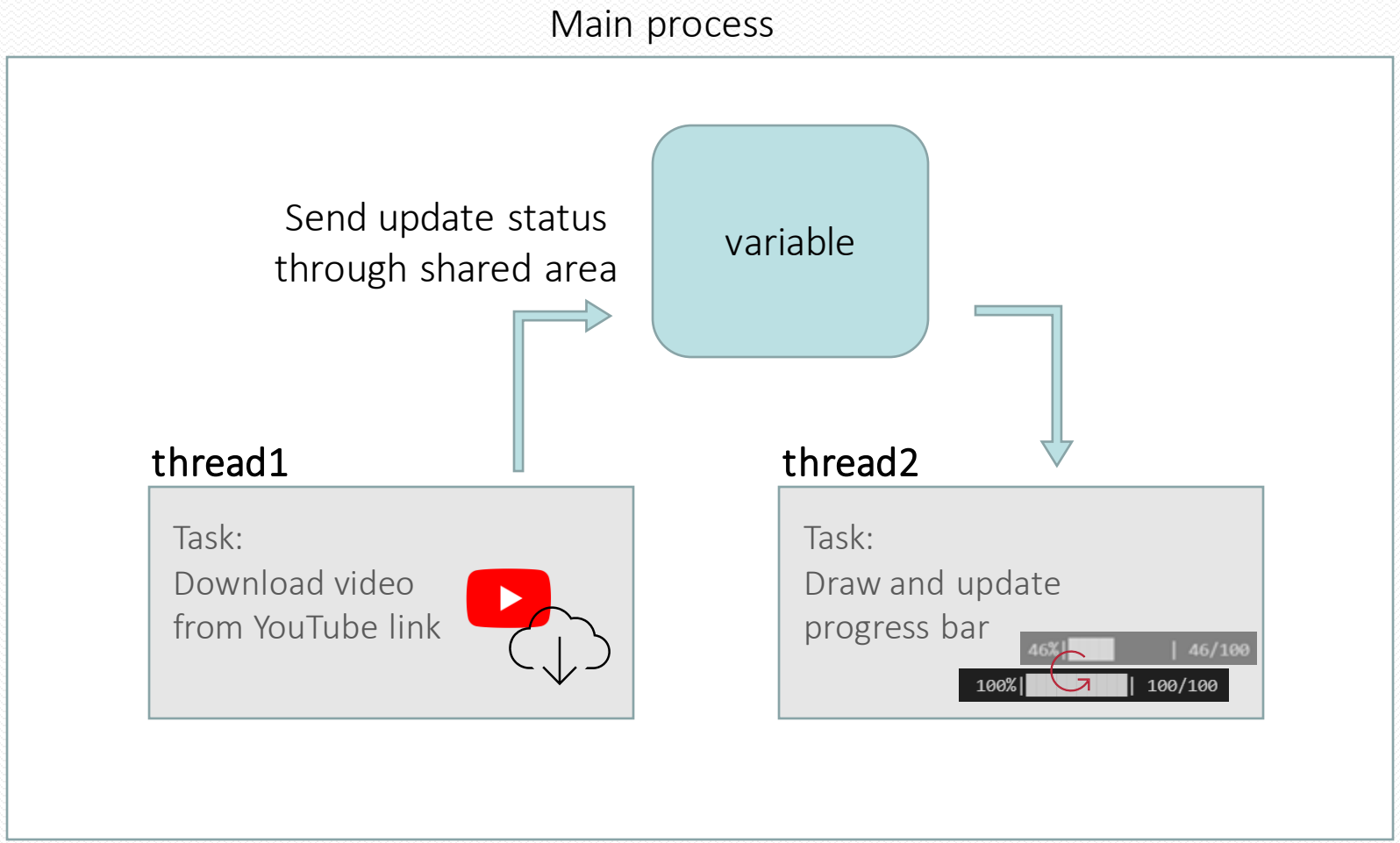


- Synchronization Problem
  - When multiple threads attempt to access to shared area at the same time
- Solution
  - Mutex(Mutual Exclusion)



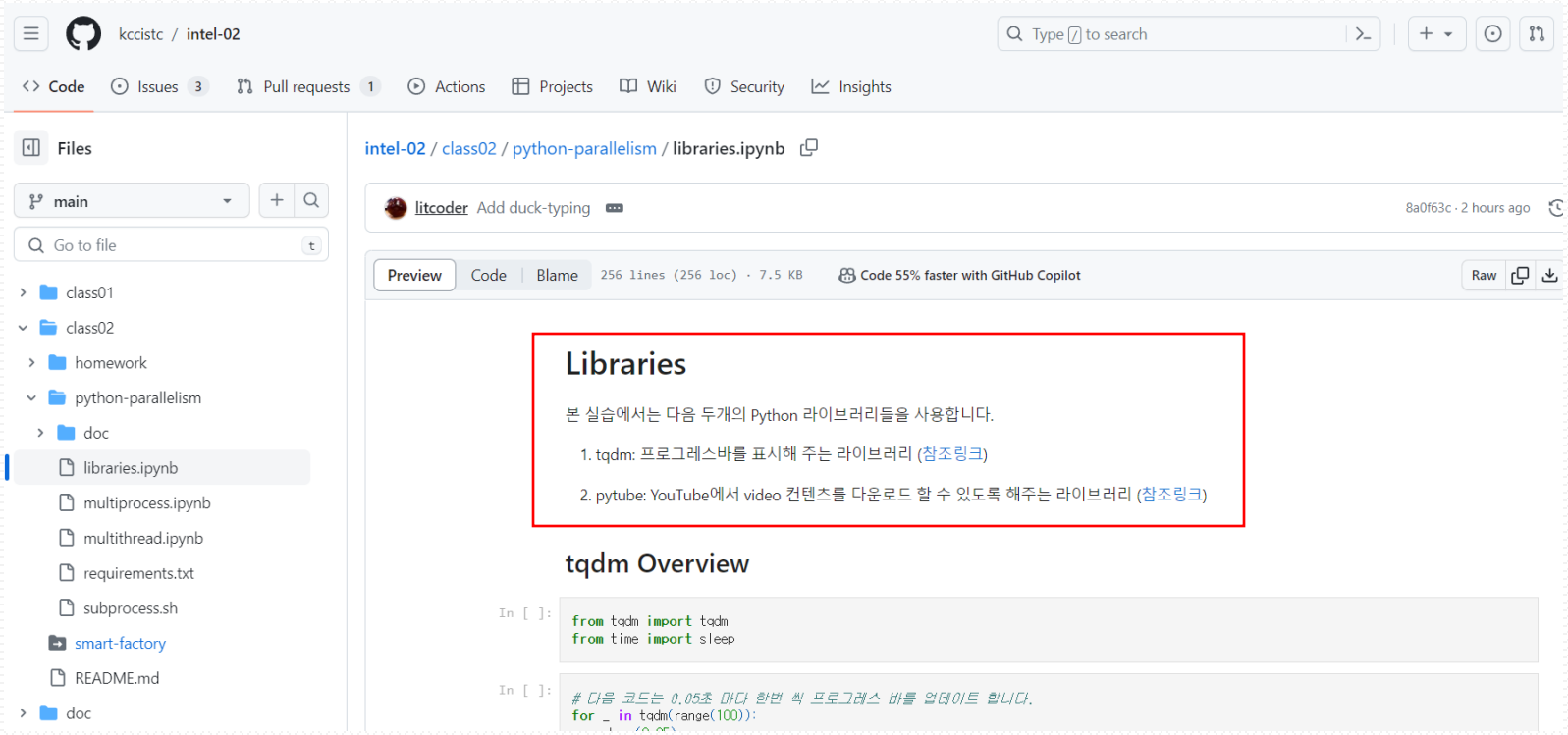
Multi-threading: Example

- `pytube`, `tqdm` example



- .venv/bin/pip install -r python-parallelism/requirements.txt
- .venv/bin/pip freeze|wc -l

https://github.com/kccistc/intel-02/blob/main/class02/python-parallelism/libraries.ipynb

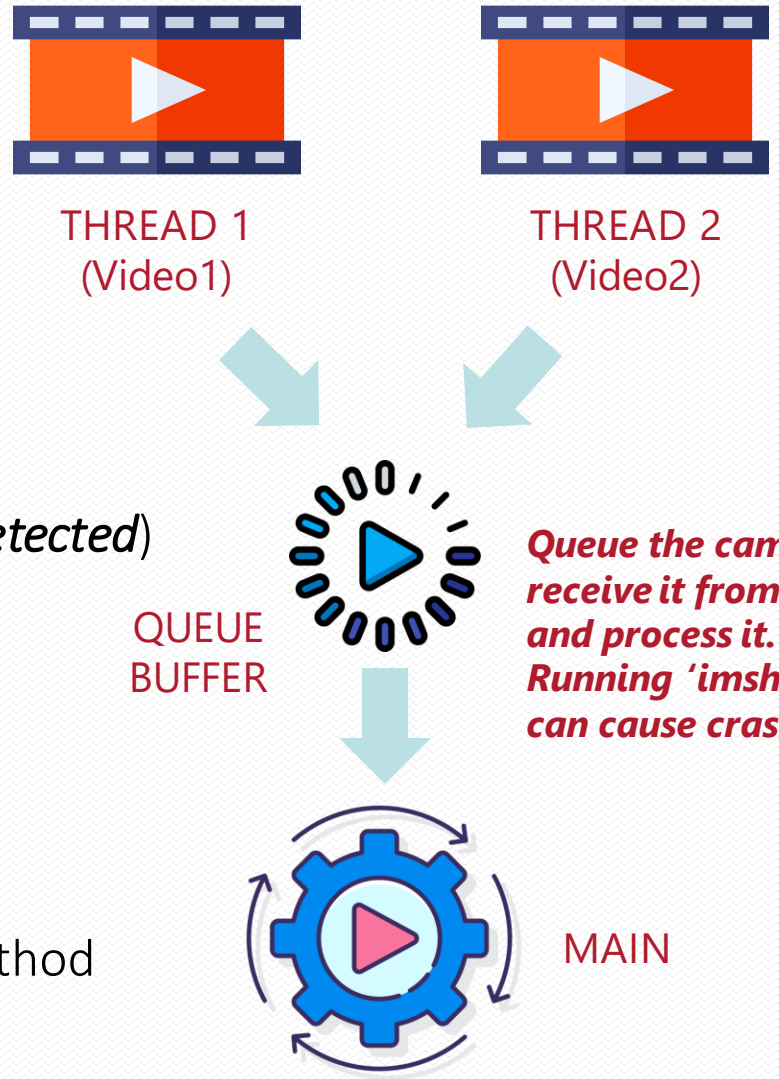


Multi-processing vs Multi-threading

	Reliability	Communication	Execution time	Memory usage
Multi-processing	More reliable: Memory isolation	Slower: IPC mechanism	Slower: Consuming more time to start process	Less effective: Consuming more memory space
Multi-threading	Less reliable: Sharing memory space, need additional protection (i.e. Mutex)	Faster: Using shared memory space	Faster: Consuming less time to start thread	More effective: Consuming less memory space

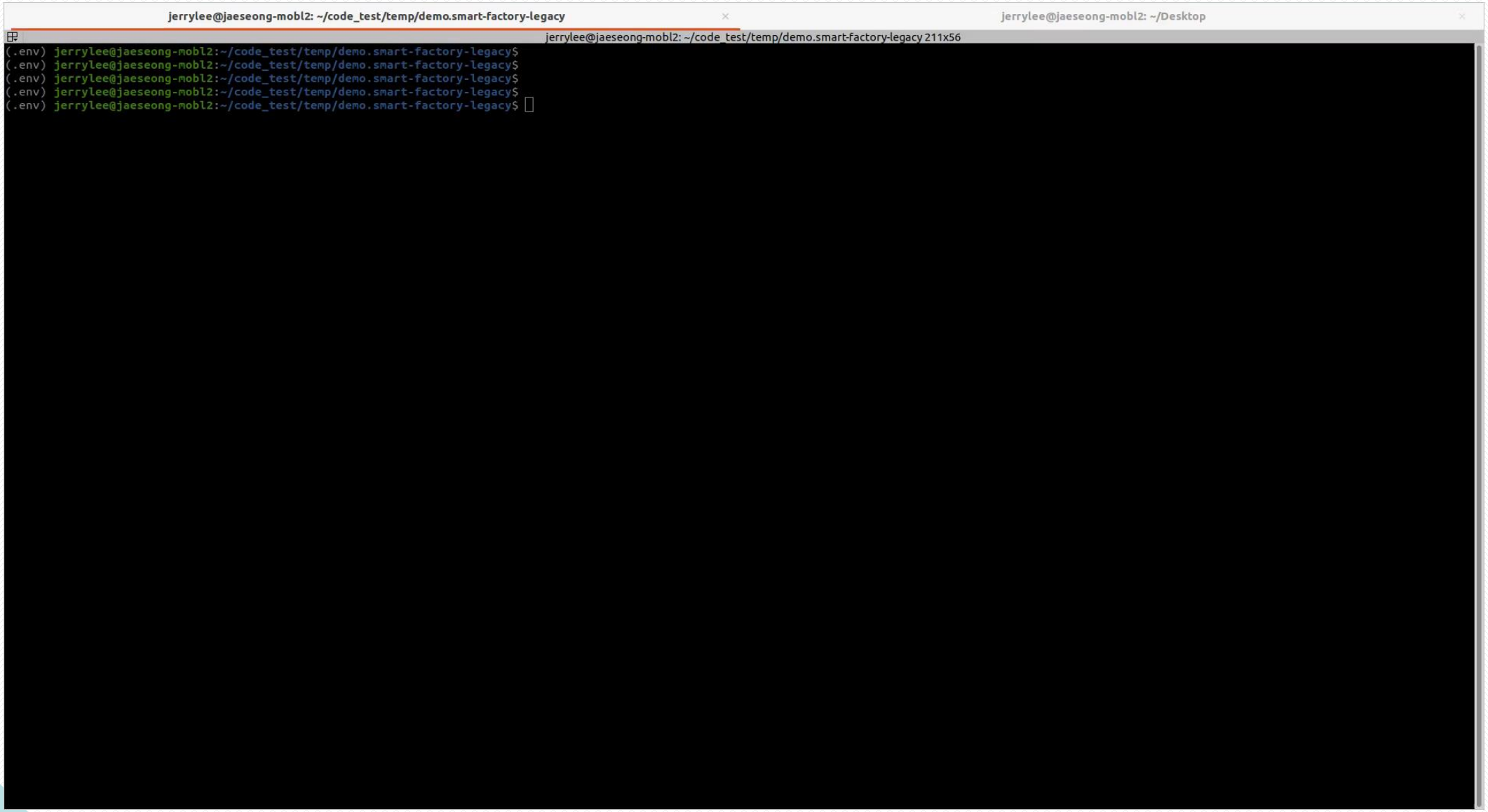
Multi-thread Hands-on (factory.py)

- Implement the two threads, one queue for Smart Factory
- Thread 1/2
  - Video open/close and Call **MotionDetector**
  - In the while loop,
    Enqueue read video frame
    (as a tuple, name: ***'Video:Cam1/2 live',*** data: ***frame***)
    When a motion is detected, Enqueue the frame
    (as a tuple, name: ***'Video:Cam1/2 detected',*** data: ***detected***)
- Main
  - Create the thread1/2 and start that threads
  - In **FactoryController** loop,
    get the event(name, data) from queue
  - If the name has ***'Video:'***,
    the data display with ***'name[6:]'*** using **"imshow"** method



Queue the camera stream, receive it from the main and process it.
Running 'imshow' on each thread can cause crash issues!

Multi-thread Hands-on (cont,)



THANK YOU