Increasing Awareness of Energy Consumption in Jupyter Notebooks

presented by Marcel

Why?

- Data science and Machine Learning are very power-hungry disciplines
- Jupyter Notebooks are a popular data science tool
- Hides energy consumption
  - Not necessarily local: Server-client architecture
  - Often offered as a service (e.g., Google Colab)

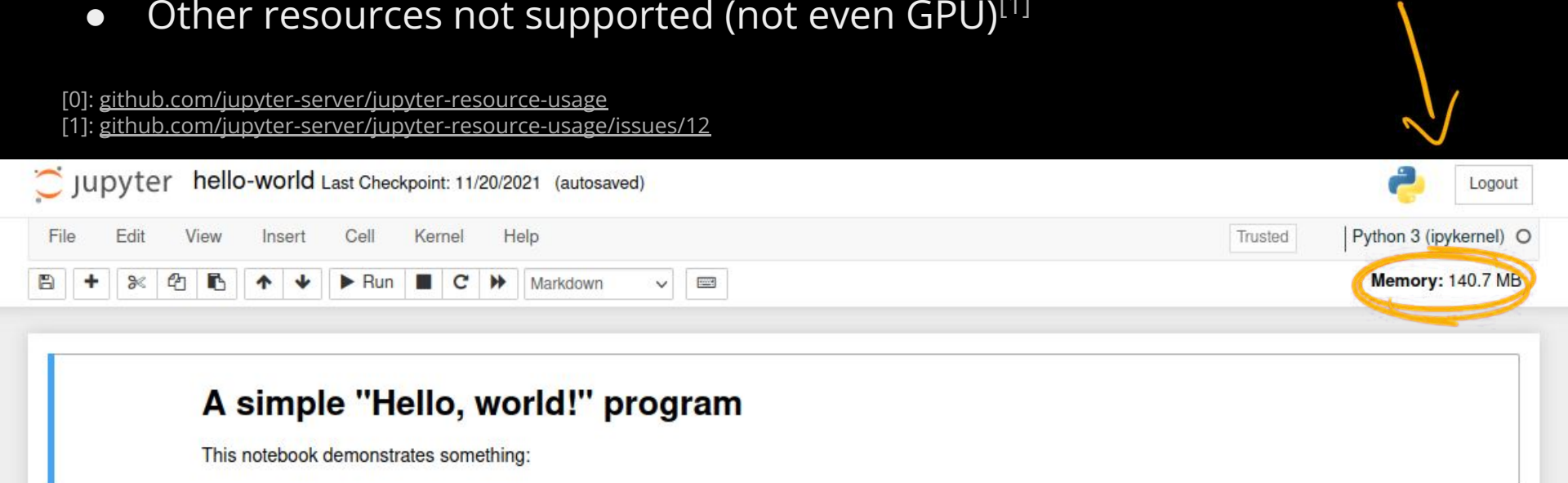
[0]

[0]: en.wikipedia.org/wiki/Project_Jupyter#/media/File:Jupyter_logo.svg

Existing works

- jupyter-resource-usage[0]
- Uses `psutil` to measure RAM and CPU usage
- Other resources not supported (not even GPU)[1]

[0]: github.com/jupyter-server/jupyter-resource-usage
[1]: github.com/jupyter-server/jupyter-resource-usage/issues/12



How to track energy usage

- Intel CPUs offer a Running Average Power Limit (RAPL)
- Each trackable power metric has several files in `/sys/bus/event_source/devices/power/events`
  - `…/event`
  - `…/event.scale`
  - `…/event.unit`
- `perf_event_open` syscall returns a file descriptor
- Reading from that file returns cumulative ticks since tracking started

How to track energy usage

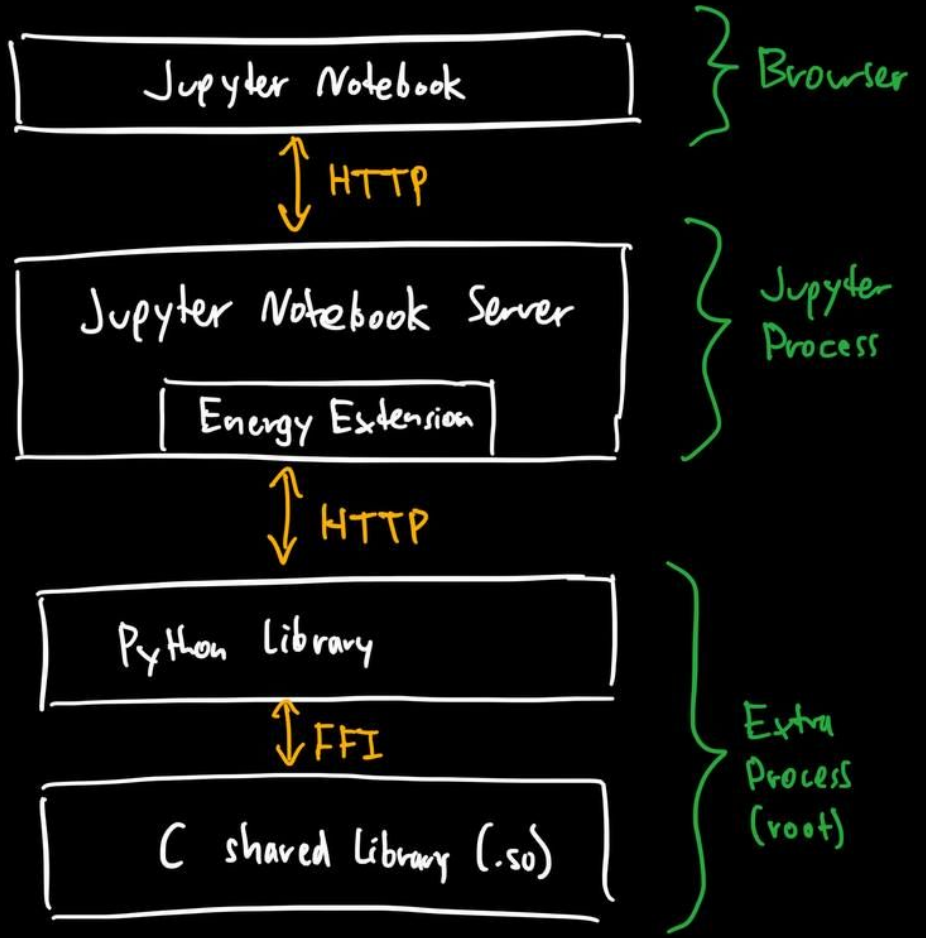
```c
#include <linux/perf_event.h>

struct perf_event_attr attr;
memset(&attr, 0, sizeof(attr));
attr.type   = type;   // from /sys/bus/event_source/devices/power/type
attr.size   = sizeof(attr);
attr.config = config; // from /sys/bus/event_source/devices/power/events/<event>

long fd = syscall(
  __NR_perf_event_open, // perf_event_open syscall
  &attr,
  -1, // restricting to a pid is not supported
  0,  // not running on a particular cpu
  -1, // group_fd is not supported
  0   // no flags
);
```

How to track energy usage

```
long int ticks_before;
read(fd, &ticks_before, sizeof(long int));

sleep(10);

long int ticks_after;
read(fd, &ticks_after, sizeof(long int));

close(fd);

// scale from /sys/bus/event_source/devices/power/events/<event>.scale
double used_energy = (double)(ticks_after - ticks_before) * scale;

// unit from /sys/bus/event_source/devices/power/events/<event>.unit
printf("In 10 seconds, you used %0.3f %s.\n", used_energy, unit);
// In 10 seconds, you used 3.458 Joules.
```

How this integrates with Jupyter Notebooks

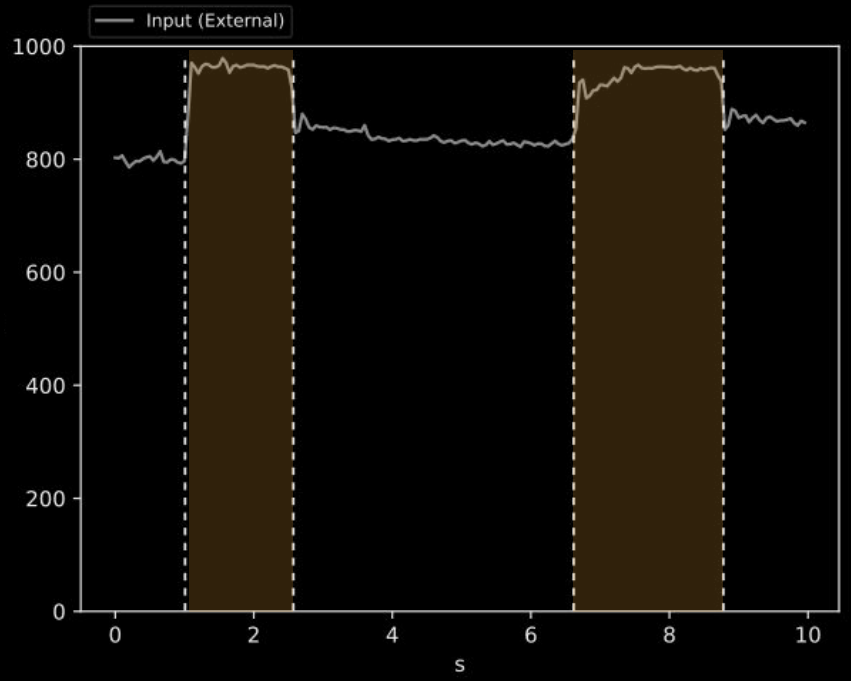
- Temporary!
- Start root process automatically on startup
- Allow hardware event listening for non-roots via `/proc/sys/kernel/perf_event_paranoid`



Demo!

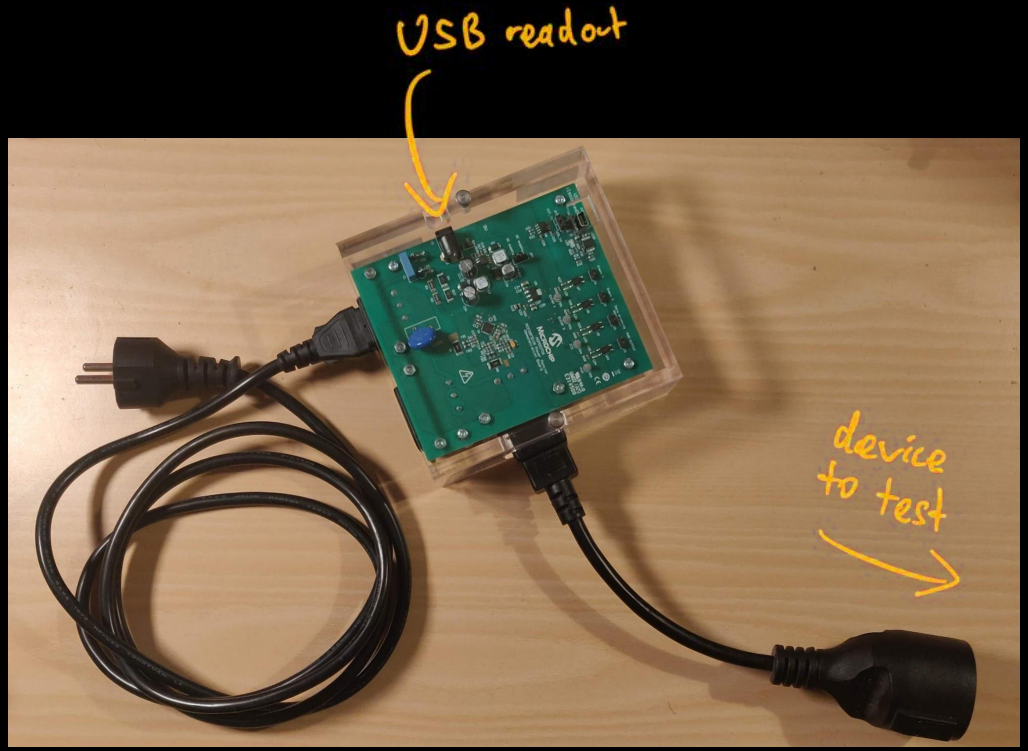
Next steps

- Comparisons:
  You could toast a toast!
- Graph over time
  - Including: When was the Notebook executing code vs idle energy usage?
- Support more sources
  - CPU, GPU, Memory, ...
  - Jetson Counter
- Measure and assess accuracy



Next steps: Measure

- Assess if recorded energy consumption is accurate
- Measure-ception: Measure the overhead of measuring energy
- Measure cool comparison values



github.com/MarcelGarus/jupyter-energy

mgar.us/energy-slides