CPU + GPU HETEROGENEOUS COMPUTING (THE LAB)

Ana Lucia Varbanescu, University of Amsterdam, NL
a.l.varbanescu@uva.nl

With significant contributions by:
Jie Shen @ Delft University of Technology
Stijn Heldens @ U Twente
**CPU + GPU**

**CPU**
Low latency, high flexibility.
Excellent for irregular codes with limited parallelism.

**GPU**
High throughput.
Excellent for massively parallel workloads.
Workload

- DAG (directed acyclic graph) of "kernels"
Two main challenges

- How to **program** the workload in a “user-friendly” and “heterogeneity-friendly” way
  - Unified programming models?
  - Low- or high-level?
  - …

- How to **split** the work between the different processors
  - Static
  - Dynamic
  - Hybrid … ?
(1) Heterogeneous Computing PMs

**Generic**
- OpenACC, OpenMP 4.0
- OmpSS, StarPU, ...
- HPL

**Specific**
- HyGraph, Cashmere, GlassWing
- TOTEM
- OpenCL

**High level**
- Focus on: productivity and performance

**Low level**
- Domain and/or application specific. Focus on performance.
- More difficult to use.

**High productivity; not all applications are easy to implement.**

**OpenMP+CUDA**
- The most common atm. Useful for performance, more difficult to use in practice.
Heterogeneous Computing today

Limited applicability. Low overhead => high performance

Qilin, Insieme, SKMD, **Glinda**, ...

Not interesting, given that static & run-time based systems exist.

Only **Glinda**, only for pipeline-like DAGs.

Improved applicability, but remains limited. Low overhead => high performance

Run-time based systems:
- StarPU
- OmpSS
- HyGraph

High Applicability, potentially high overhead

Single kernel

Sporadic attempts and light runtime systems

Multi-kernel (complex) DAG

Static

Dynamic
The lab

- Three application (classes)
  - Single-kernel: matrix multiplication
  - Multi-kernel: image processing pipeline
  - Domain-specific: graph processing

- Given code templates
  - Fill in the blanks
  - Compare & improve
  - Reflect
Where?
- DAS5 (http://www.cs.vu.nl/das5/)
  - Ask me for *temporary* accounts

What?
- Code + basic report

When?
- Deadlines given earlier

What if …
- “I want my own project?” – OK on a case-by-case basis
- “I don’t know programming?” – it will be difficult

My email:
A.L.Varbanescu@uva.nl