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Enabling Portable High Performance Cancer Image Analysis

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High Performance Cancer Image Analysis

Research & Clinical Demands

Higher computation power are needed to facilitate:

- advanced analysis methods and algorithms;
- analysis over larger amount of clinical data.

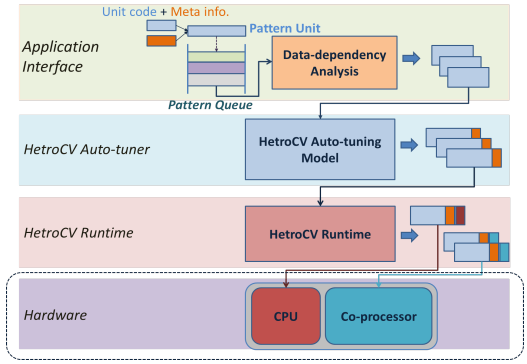
Solutions

- **Cloud**: low accessibility; relative high cost
- **Accelerators**: high accessibility; high production/cost ratio ✓

New Challenges

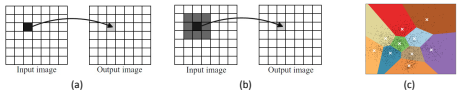
- **Heterogeneity**: task scheduling and load balancing between Host-Processor and Accelerators on heterogeneous compute nodes
- **Portability**: achieve portable optimized performance over platforms with different configuration and system loads

HetroCV: Performance Auto-tuning Framework and Runtime [1]



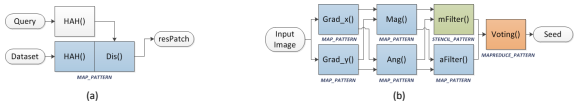
• Pattern-based Image-analysis Workflow

- **Pattern-based Image Analysis**
  - Recent works in computer vision and image processing field have adopted the idea to consider image analysis applications as streams of computation units.
  - Pattern-based model provide a high-level, abstracted, platform-independent description of the computation, communication and data access patterns of the element computation units within analysis workflows.
  - Patterns selected: *map* [a]; *stencil* [b]; *map-reduce* [c].



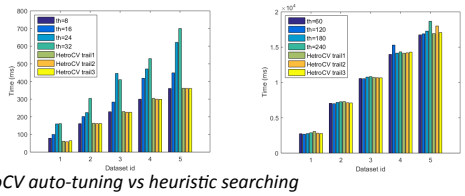
• Testing Applications

- ***Content-based image retrieval (CBIR)*** [a]
  - Cell retrieval procedure, uses color histogram as image feature
- ***Histopathology cell detection (CD)*** [b]
  - Cell detection procedure detects the center of all the cells in the image according to the gray-level information

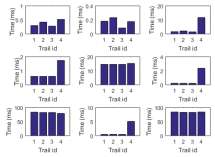


• HetroCV Auto-tuner

- **Learning-based Auto-tuning**
  - Given an algorithm, auto-tuners work through the parameter space to search for the optimal parameter.
  - However, high-dimension parameter often make exhaustively searching impractical for real-time applications.
  - We built 3 classifiers for computation units of 3 selected patterns using support-vector machine.
- *HetroCV auto-tuning vs naïve OpenMP tuning*



- *HetroCV auto-tuning vs heuristic searching*



• HetroCV Runtime

- **Performance model and performance prediction:**
  - Model the computing time on processor(P)/co-processor(C) T as combination of data movement time Tm and computation time Tc.
  - Data movement time T m equals a latency ts for the first unit of data, plus the transfer time dN ∗ tw for the following dN units of data.
- *Maximum-throughput mapping strategy*:
  - A computation unit CUi will be given a queue label qLi ∈ {P,C} and be mapped to processor queue (qLi = P) or coprocessor queue (qLi = C) whichever gives a smaller overall expected complete time.

Paramater Type	ep0	ep1
CPU computation time	1.89	1.77e-8
MIC computation time	5.69	-2.63e-8
CPU-MIC data transfer time	8.54e-12	6.57e-10

Reference:

[1] D.Wang, D.J.Foran, X. Qi and M. Parashar, "HetroCV: Auto-tuning Framework and Runtime for Image Processing and Computer Vision Applications on Heterogeneous Platform. "

Acknowledgements

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