KNL

- KNL is a many-core processor
- It is a high-performance processor
- Can be optimized by standard techniques … but also some special

KNL - Levels of Parallelism

1. Manage domain parallelism (via MPI)
2. Increase Thread Parallelism (OpenMP/Thread Building Blocks)
3. Exploit Data Parallelism (Vectorization)
4. Improve Data Locality (Data Layout and still capture)
Code Modernization

- Term used for activities that update an existing code to be more efficient on modern architectures

- How much do I need to modify?

Code Modernization

- **Code refactoring**: restructuring existing computer code without changing its external behavior.

  - Improves nonfunctional attributes. (code readability, reduces complexity)

Evolutionary Optimization

- **Thread optimization**
- **Check compiler report**
- **Data parallelism**

Start
Find hotspots
Arithmetic optimization

Evolutionary Optimization (OpenMP)

- **#pragma omp parallel for**
- **Check compiler report**
- **Arithmetic optimization**
- **#pragma omp simd**

Start
Find hotspots
Arithmetic optimization
Roofline

- Roofline is an estimate of the highest possible performance
- Is the application communication or calculation limited?
- Is the application calculation or memory limited? (CPU-bound, memory-bound)

Roofline

- Fine-grained granularity:
  - a large number of small tasks
  - amount of work associated is low
  - good for SM
  - good load balancing
- Coarse-grained granularity:
  - small number of large tasks
  - good for MPI
  - potentially bad load balancing

Roofline

\[ s = \frac{f_n}{f_a} \quad \text{[seconds]} \]

idealized “roofline”

Revolutionary Optimization

1. Find hotspots
2. Examine algorithms
3. Design new algorithms
4. Implement new algorithms
Evolutionary + Revolutionary

- Design new algorithms
- Revolutionary
- Examine algorithms
- Find hotspots
- Evolutionary
- Thread optimization
- Arithmetic optimization
- Check compiler report
- Data parallelism
- Implement new algorithms

Reading

- Intel Xeon Phi Processor High Performance Programming Knights Landing Edition
- James Jeffers, James Reinders, and Avinash Sodani
- ISBN: 9780128091944
- Morgan Kaufmann
- Chapter 7