

# Algorithmic Techniques

**Course Goals:** To master commonly used algorithm techniques and computational thinking skills for scalable, many-core/many-thread programming

- Many-core hardware limitations and constraints
- Desirable and undesirable computation patterns
- Practical algorithm techniques to convert undesirable computation patterns into desirable ones

**Syllabus:**

- Week 1
  - Lecture 1 – Introduction – Logistics, scalability
  - Lecture 2 – Overview, tentative schedule
- Week 2:
  - Lecture 3 – Parallelism Scalability Transformations
  - Lecture 4 – Thread Coarsening and Register Tiling
  - MP1: matrix multiplication – thread coarsening and register tiling
- Week 3:
  - Lecture 5 – Memory Tiling
  - Lecture 6 – Memory Tiling
  - MP1: matrix multiplication– thread coarsening and register tiling
- Week 4
  - Lecture 7 – Register Tiling
  - Lecture 8 – Register Tiling
  - MP2: 7-Point Stencil – Z-coarsening and register tiling
- Week 5:
  - Lecture 9 - Data Layout Considerations
  - Lecture 10 – Input Binning
  - MP3: 7-point stencil – 2D memory tiling
- Week 6:
  - Lecture 11 – Input Binning
  - Lecture 12 – Non-uniform Data (Sparse methods)
  - MP4: Lattice Boltzmann Method: Data Layout
- Week 7:
  - Lecture 13 – Non-Uniform Data (Sparse Methods)
  - Lecture 14 – Non-Uniform Data (Variable Binning)
  - MP5: Sparse matrix-vector multiplication (CSR/ELL)
- Week 8:
  - Lecture 15 – Non-Uniform Data (Variable Binning)
  - Lecture 16 – Dynamic Data
  - MP6: Sparse matrix-vector multiplications (JDS)
- Week 9:
  - Lecture 17 - Dynamic Data
  - Lecture 18 – Map-Reduce
  - MP7: BFS – hierarchical (private) queues and kernels
- Week 10:
  - Lecture 19 – Final Project Kick-off Workshop

- Lecture 20 – Final Project Kick-off Workshop
- Week 11:
  - Lecture 21 – Exploratory Topics (Unstructured Mesh?)
  - Lecture 22 – Exploratory Topics (Tree-coded Data?)
- Week 12
  - Lecture 23 – Final Project Algorithm Presentations
  - Lecture 24 – Final Project Algorithm Presentations
- Week 13:
  - Lecture 25 - Final Project Algorithm Presentation
  - Lecture 26 – Final Project Algorithm Presentation
- Week 14:
  - Lecture 27 – Final Project Algorithm Presentation
  - Lecture 28 – Final Project
- Week 15:
  - Lecture 29 – Course Summary
  - Final Project Symposium (6 hours, 15 minutes per student)