Any of the following topics might be covered on the midterm this Friday (November 17).

• C
  - Bitwise operators
  - Unsigned ints
  - `strtol`
  - Long long ints
  - `random` and `srandom`
  - Issues with two-dimensional arrays: using one-dimensional arrays to simulate two-dimensional arrays
  - `qsort` library function
  - Function pointer arguments
  - `memcpy`

• Distributed-memory MIMD programming
  - Speedup, efficiency, scalability
  - Taking timings: Unix `time` utility, C library `clock` function, C library `gettimeofday`, MPI library `MPI_Wtime`.
  - Variability in execution times
  - Processor time vs Wall-clock time.
  - Clock resolution
Problems with distributed memory timing: different clocks, different start and finish times.

- Data-parallel parallelization
- Tree-structured global sum
- Butterfly
- Dot product, matrix-vector multiplication
- Odd-even transposition sort
- Merge-split

- **MPI**
  - Collective communication vs point-to-point communication
    - MPI_BARRIER.
    - MPI_Reduce, MPI_Allreduce
    - MPI_Bcast, MPI_Scatter, MPI_Gather
    - MPI_Allgather
    - MPI_Sendrecv
    - MPI_MINLOC
    - MPI Safety

- **Data distributions**
  - Block distribution
  - Cyclic distribution
  - Block-cyclic distribution
  - Row and column distributions
  - Converting between local and global indexes and subscripts

- **The Floyd-Warshall algorithm and Dijkstra’s algorithm**
  - Graph, digraph
  - Adjacency matrix

- **Shared-memory MIMD programming**
- Shared variables and global variables
- Threads vs processes
- Static vs dynamic creation of threads
- Atomic operation
- Race condition
- Critical section
- Producer-consumer synchronization
- Spinlocks and busy-waiting
- Mutexes
- Semaphores, binary semaphores
- Matrix-vector multiplication

• Pthreads API
  - `-lpthread, pthread.h`
  - `pthread_t`
  - `pthread_create`
  - `pthread_join`
  - `Rank kludge`
  - `pthread_mutex_t`
  - `Mutex functions`

• Semaphore API
  - `sem_t`
  - `Semaphore functions`