Introduction to Parallel Computing Concepts

Lorie M. Liebrock
New Mexico Tech - Chair of Computer Science
liebrock@cs.nmt.edu

Before we start...

- Research
  - Meet the Scientist (complete one of the MS forms and return it to your teacher)
- Citations
  - Zotero (http://www.zotero.org/)
- Electives
  - Parallel - Tom Robey
- Agile Project Planning (Dana Roberson)

New Awards

- Parallel Programming ($200)
  - The group with the most effective use of parallel programming for simulation; this may include evaluation of the analysis of parallel performance and scalability.
- Visualization ($200)
  - The group with the most effective and aesthetically appealing use of visualization to communicate complex simulation results.

Sponsored by Lorie M. Liebrock from NMT.

Need for Speed

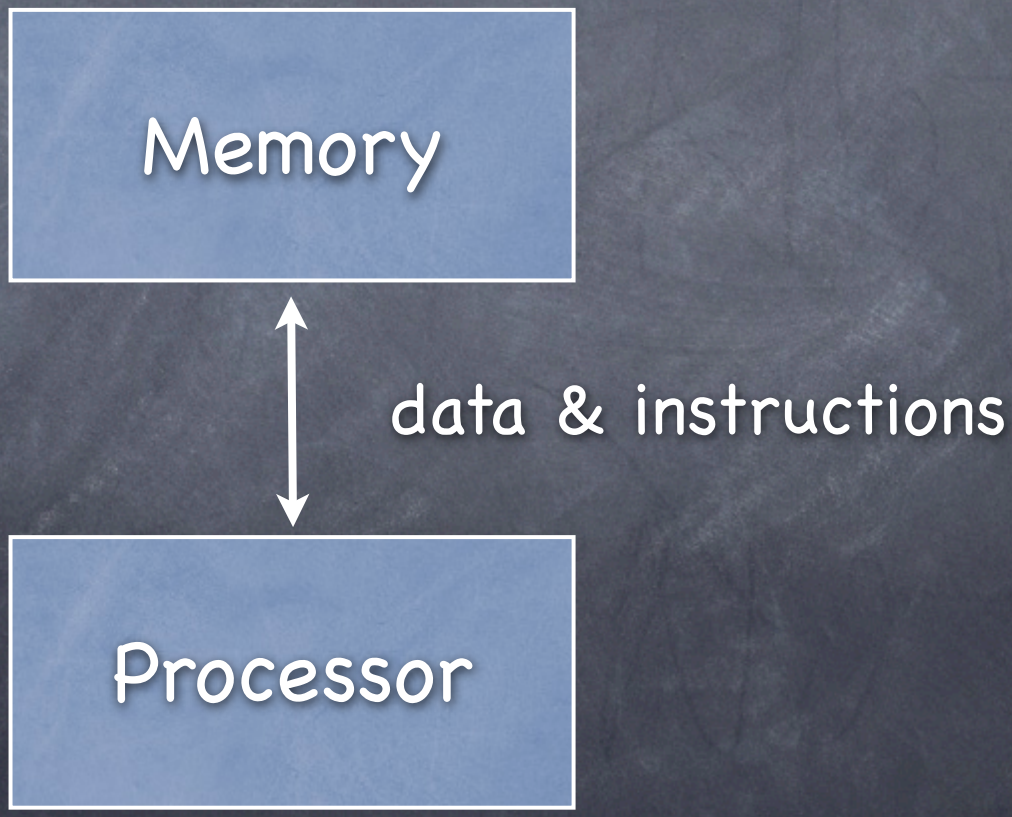
- Continual demand for greater computational speed from a computer system than is currently possible.
- Why?
  - larger problems
  - finer resolution
  - longer time frames
- Computations must be completed within a "reasonable" time period.
- Grand Challenges

How do we get more speed?

- Use multiple computers to solve the problem...
  - n computers can perform n computations n times faster than 1 computer
  - n computers will have n times as much memory
  - if one computer fails, there are still n-1 working

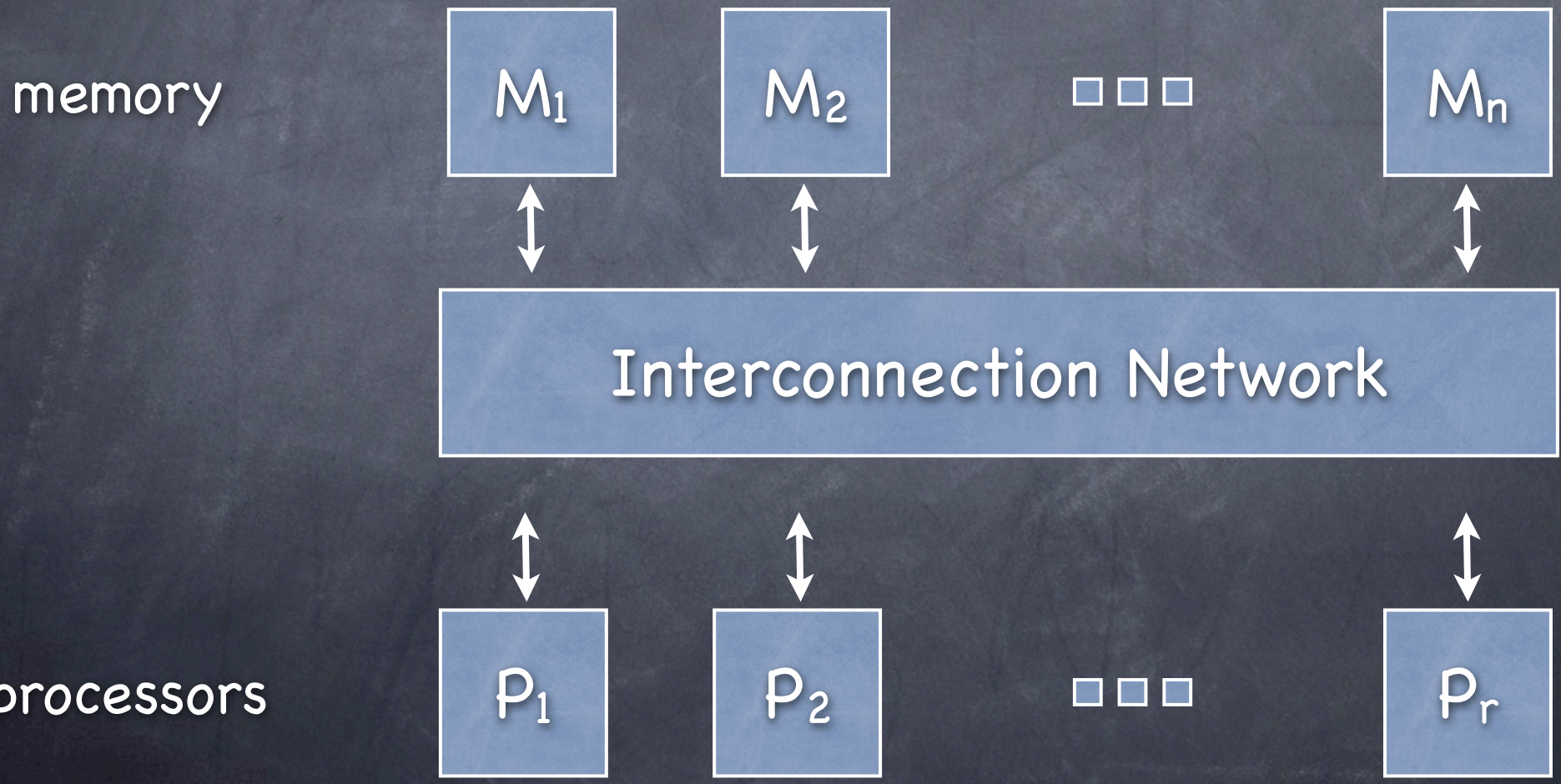
Conventional Computers

- One processor executing a program stored in memory.



Types of Parallel Computers

- Shared Memory



Exercises

- During each exercise
  - You can not talk!
  - You are to follow the instructions to the best of your understanding (don't automatically copy what someone else does).
  - Finish as fast as you can
- Between exercises
  - Ask questions; get clarifications; ...

Shared Exercise 1

- Each group has one shared memory location
- Every group member has a pen
- For each of your numbers
  - read the shared value
  - add your number
  - cross off the old value and write your sum as the new shared value
- Ready, set, go...

Shared Exercise 2

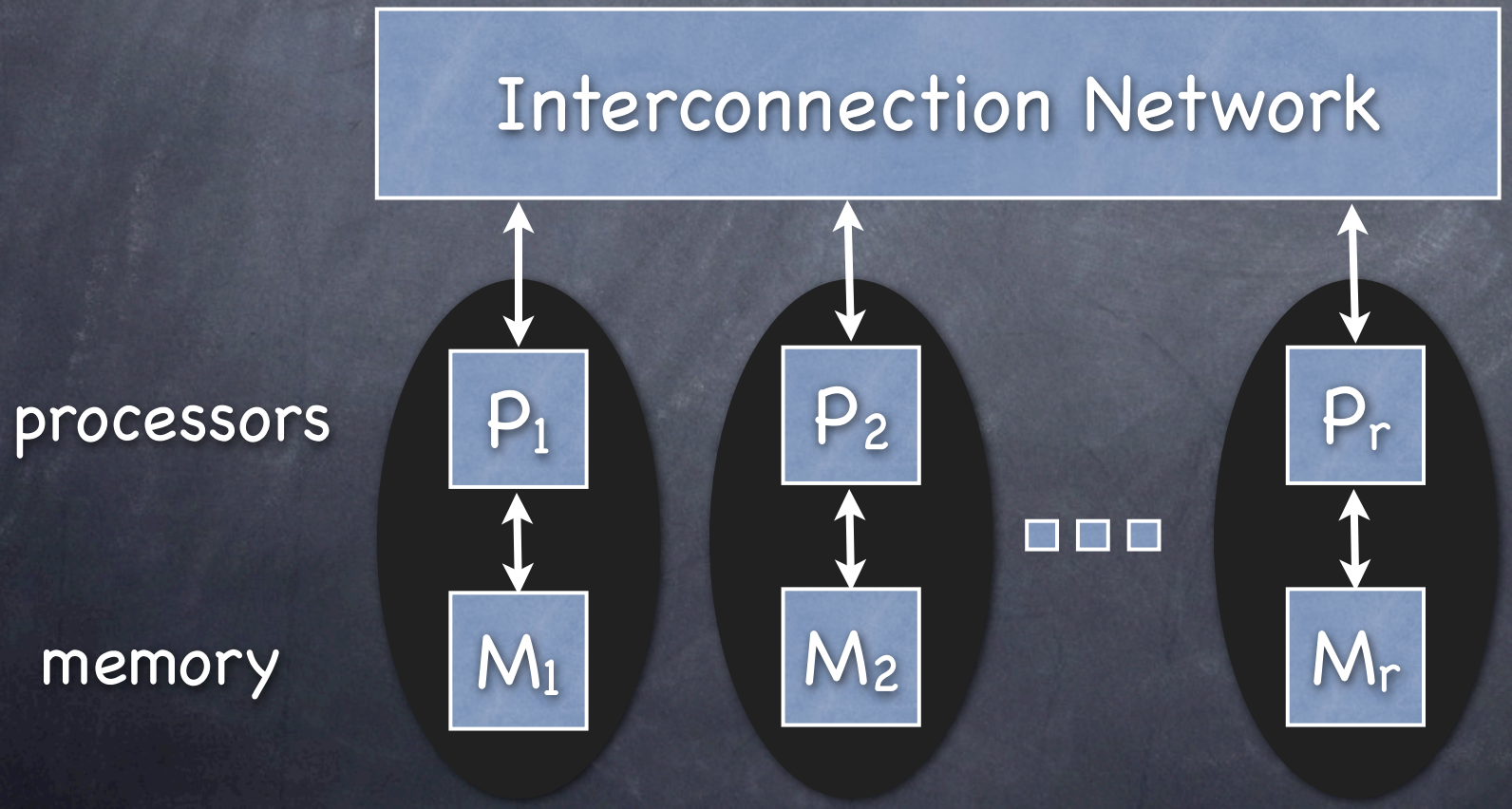
- Each group has one shared memory location
- Each group gets only one pen to write with and only the member with the pen can "access" memory
- Share the pen - put it down for others to use
- For each of your numbers
  - read the shared value
  - add your number
  - cross off the old value and write your sum as the new shared value
- Ready, set, go...

Shared Exercise 3

- Each group has one shared memory location
- Each group gets only one pen to write with and the member with the pen can "access" memory
- Every member of each group is to add all of their numbers in their local memory
- Every member of each group is to add their sum to the shared memory location when they get the pen
- Ready, set, go...

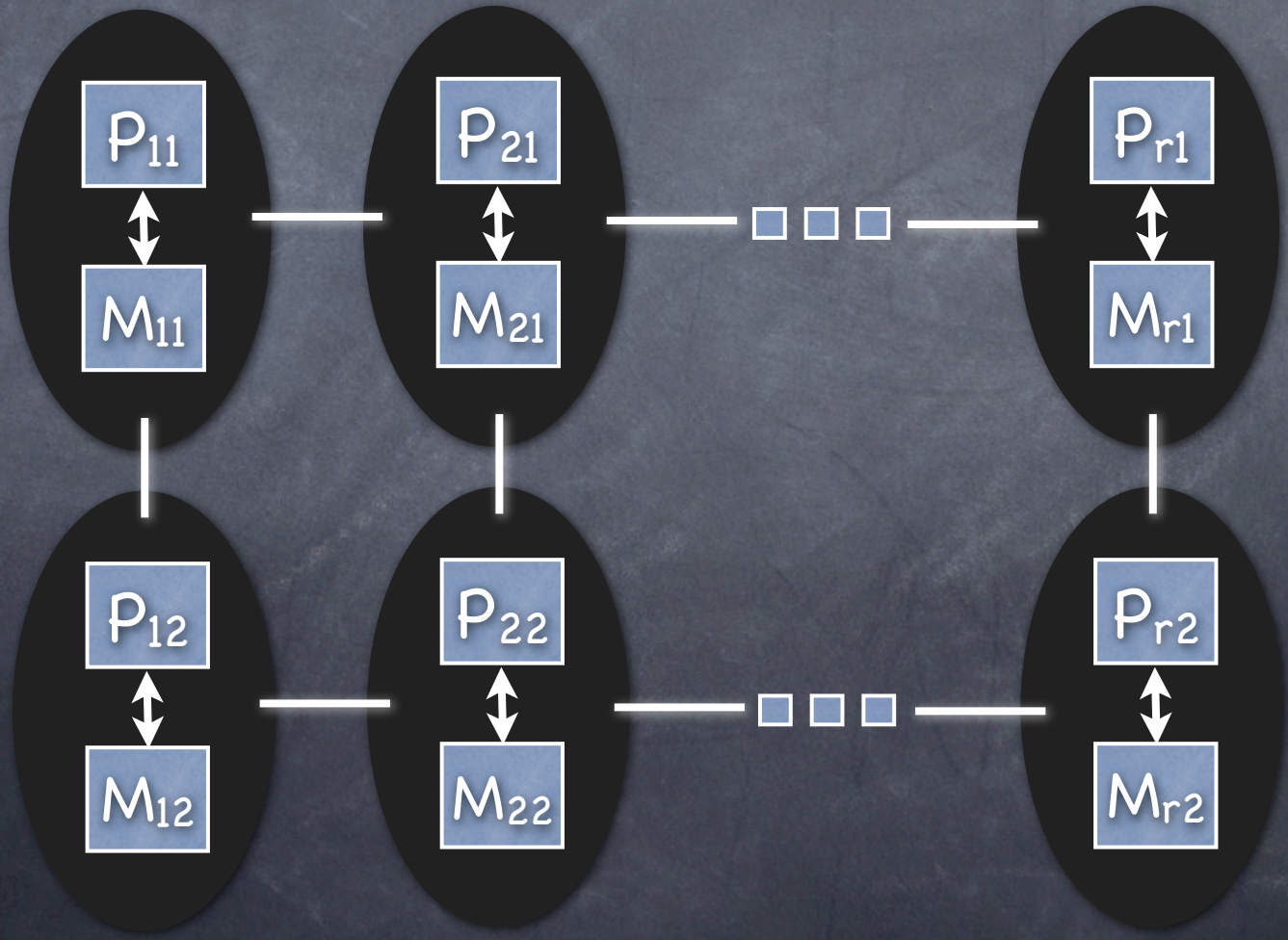
Types of Parallel Computers

- Message-Passing Multiprocessor
  - connected across an interconnection



Types of Parallel Computers

- Message-Passing Multiprocessor
  - 2D array of processors



Distributed Exercise 1

- One person, the lead, in each should will be handed the "message" (0).
- Repeat until all numbers are added:
  - The person with the "message" adds a number to the subtotal, crosses off the old value, and passes that message to another "random" team member
  - When all of your numbers have been added to the message, make a tick mark in the lower right corner and pass the message on. In future round, just pass the message to a "random" team member.
  - When the lead gets the message with enough tick marks, you are done.
- Ready, set, go...

Distributed Exercise 2

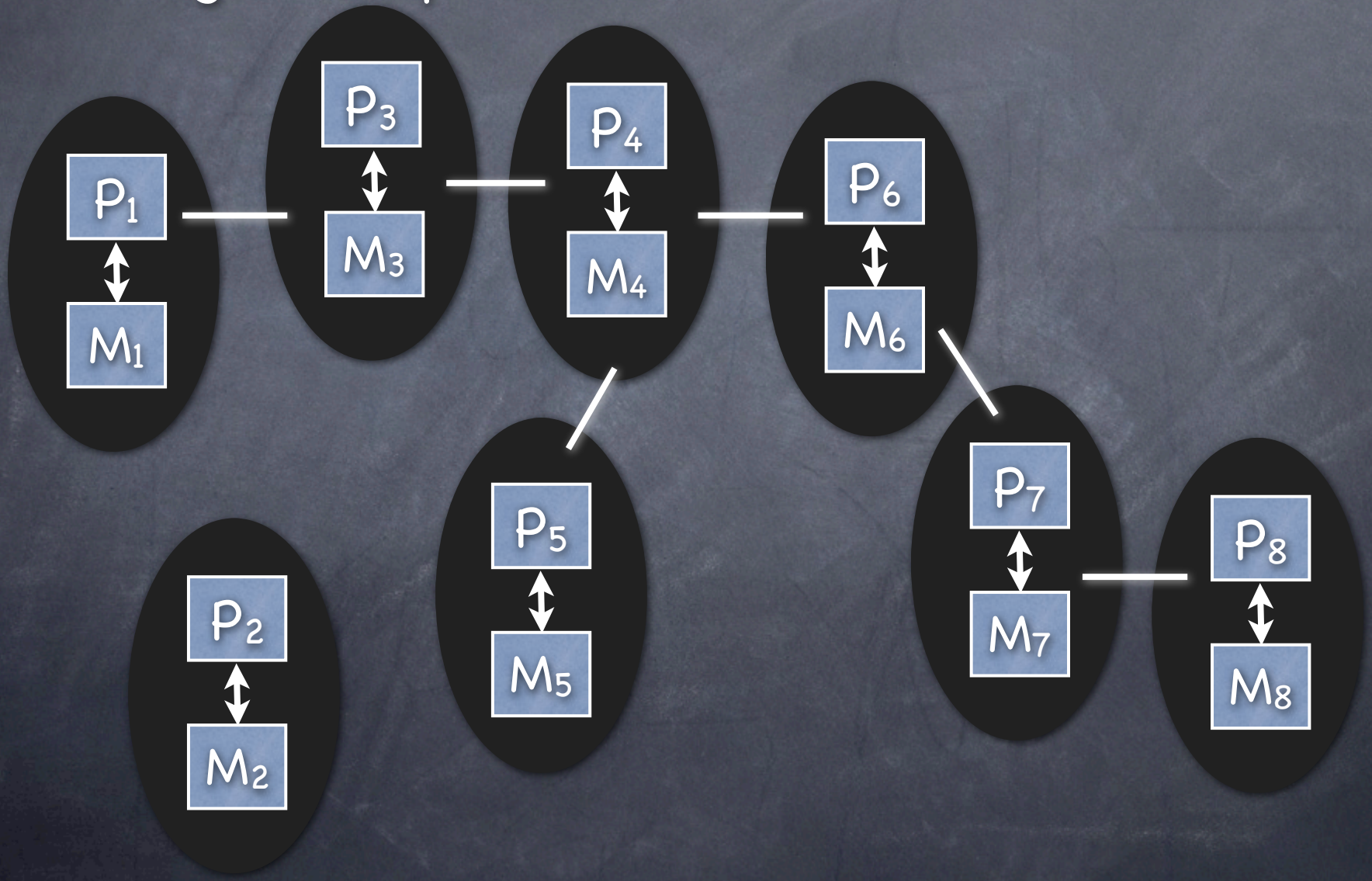
- One person, the lead, in each should will be handed the "message" (0).
- Arrange your group in a ring
- Repeat until all numbers are added:
  - The person with the "message" adds a number to the subtotal, crosses off the old value, and passes that message to the next team member
  - When all of your numbers have been added to the message, make a tick mark in the lower right corner and pass the message on. In future round, just pass the message to a "random" team member.
  - When the lead gets the message with enough tick marks, you are done.
- Ready, set, go...

Distributed Exercise 3

- One person, the lead, in each should will be handed the "message" (0).
- Arrange your group in a ring
- Each group member adds up their numbers
- Repeat until all numbers are added:
  - The person with the "message" adds their to the message.
  - Pass the "message" to the next group member in the ring
  - When the lead gets the message, you are done.
- Ready, set, go...

Types of Parallel Computation

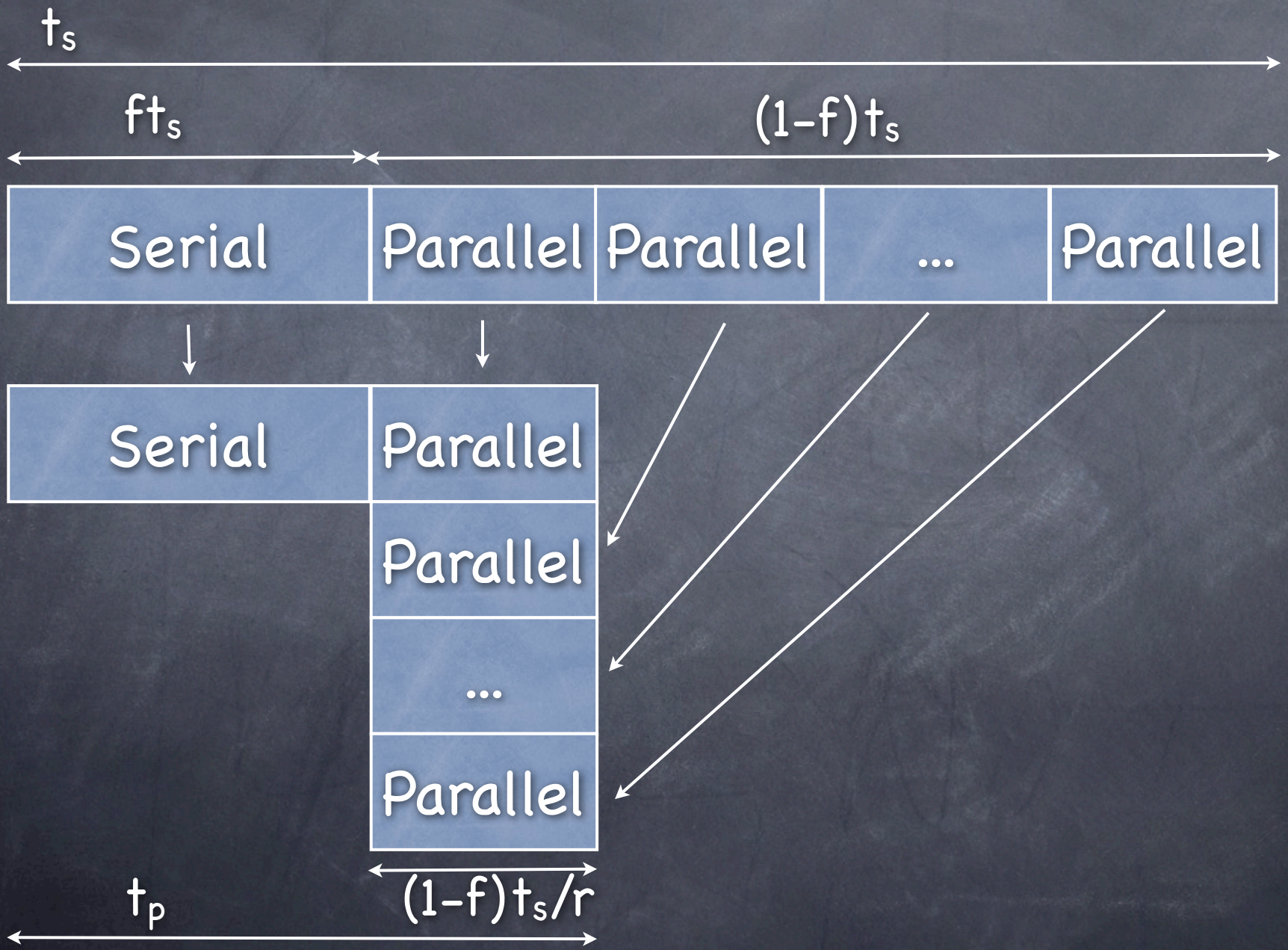
- Agent computations



Agent Exercise

- You will represent your "state" by holding up the correct number of fingers on your right hand
- In your group area, move around very slowly in random directions
- As you see a group member within arms reach, if their number is smaller than yours, change to their number.
- Hold your value when time is called
- Ready, set, go...

Potential Increased Speed



Scalability

- Hardware scalability
- Algorithmic scalability
- Combined scalability

Parallel Processing Summary

- We have looked at:
  - why to do parallel processing
  - shared memory systems
  - distributed memory systems
  - agent based computations
  - performance

Questions

- What Questions do you have?
- Which type of parallel computer would scale better?
- How would you design a more scalable parallel machine?