

# Distributed Algorithms 2020



## LOCAL model port-numbering model + unique identifiers

Nodes have distinct labels from {1, 2, ..., poly(*n*)}

## **CONGEST** model LOCAL model + bandwidth limitation

Messages at most  $O(\log n)$  bits

#### LOCAL · unbounded messages

• everything trivial to solve in O(diameter) rounds: gather full input and solve locally

#### **CONGEST** · bounded messages

- gathering everything is way too expensive
- O(diameter) and O(n) is nontrivial

## Designing efficient algorithms in **CONGEST** model

#### Pipelining





### Pipelining

- Multiple operations in progress *simultaneously*
- Using *different resources*
- In APSP algorithm:
  - multiple waves
  - using different communication links



### Pipelining

- Does not reduce the total number of messages
  - only removes idle periods between messages
- If all communication links are already sending useful data every round, no room for pipelining

## What kind of problems cannot be solved fast in **CONGEST** model?

## **Typical hard problems**

•A: complicated, lots of information

#### • B: bottleneck

 can only send small number of bits per round from A to C

•C: need to know A



#### **Proving hardness**

- Counting argument
- Many possible inputs in A
- Few possible messages across bottleneck B



#### **Proving hardness**

- Counting argument
- Many possible inputs in A
- Few possible messages across bottleneck B
- Contradiction:
  - *different* inputs in A
  - same messages across B
  - same output in C

