Parallel and its Problems

Parallel

- These lectures will be about using PyCSP
- Before that though they’ll be about CSP
- But before that they’ll be about parallel in general
- But before that …

Doing it Faster in Parallel

- Lets read an 8 page book
- It takes 1 person 3 minutes to read 1 page
- It takes 1 minute rip a page out and hand it to another person
- What is the quickest time in which we read the whole book?
- How many people does it take?

Doing it Faster in Parallel

	1	2	3	4	5	6	7	8	9	10
Person 1	Send	Send	Send	Send	Send	Send	Send	Read		
Person 2	Receive	Read			Receive	Read				
Person 3		Receive	Read			Receive	Read			
Person 4			Receive	Read			Receive	Read		
Person 5				Receive	Read					

Doing it Faster in Parallel

- Lets write an 8 page book
- It takes 1 person 3 minutes to write 1 page
- It takes 1 minute copy a page into the finished book
- What is the most amount of people we can use, beyond which adding further people will not speed up the writing?

Doing it Faster in Parallel

- Moore’s Law is not really true any more.

- If we want faster systems we need to use parallel processing.

- But we need to think a little bit about how we do so.

Concurrency

- Concurrency means that two or more tasks are being undertaken and can each progress without depending on any other task.

- Not specific to computing.

- Doesn’t mean tasks are run at *literally* the same time however.

- For example, a single core PC running multiple programmes at once, a student undertaking multiple courses.

Parallelism

- Parallelism is when multiple tasks are split over more than one processor to be undertaken at *literally* the same time.

- Not specific to computing.

- For example, a multicore PC running multiple programmes at once, a car production line.

CSP

- Communicating Sequential Processes
- A formal language for concurrent and parallel programming
- Message passing
- Defines processes, channels (and several other things)

Processes

- A Process is a collection of sequential code that runs within a parallel system
- It might take some inputs, and might have some outputs.
- Each process can run independently of each other process
- Interesting processes will interact with other processes

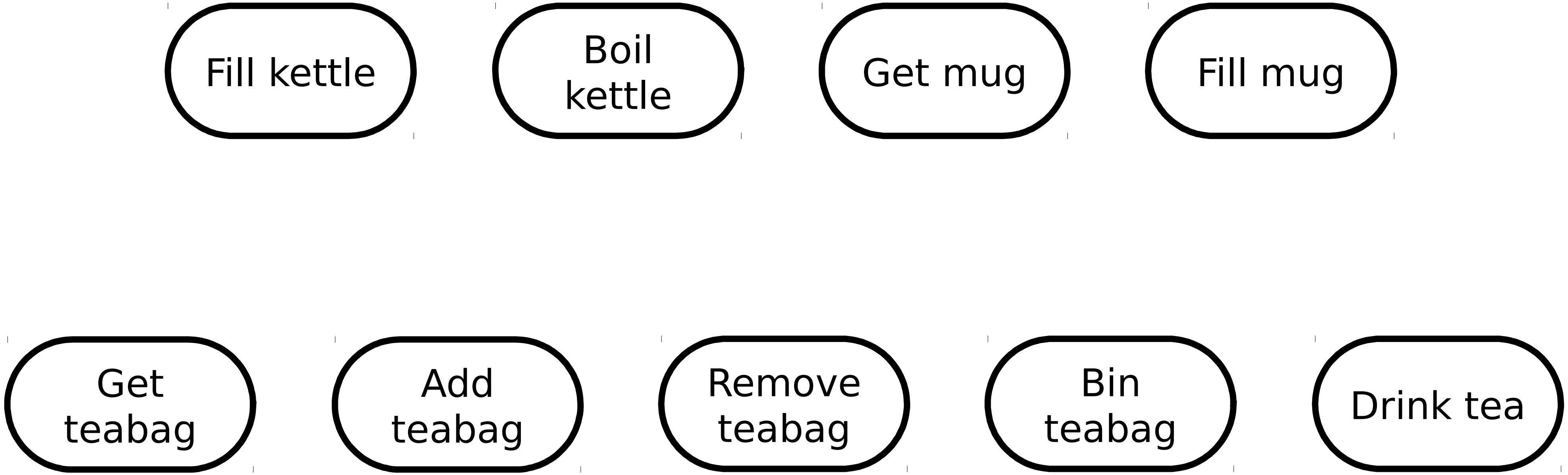
Channels

- Channels are used to communicate between processes
- Channels are one way, with an input and output end
- Multiple processes can connect to the same end (in PyCSP anyway)
- Communication is Synchronous, both processes need to be ready to read/write

Drawing the procedure

- Parallel programs are difficult to reason about
- We **NEED** to draw diagrams of what we’re going to do
- Diagrams should show all the different processes and how they are connected

Drawing the procedure



Fill kettle

Boil kettle

Get mug

Fill mug

Get teabag

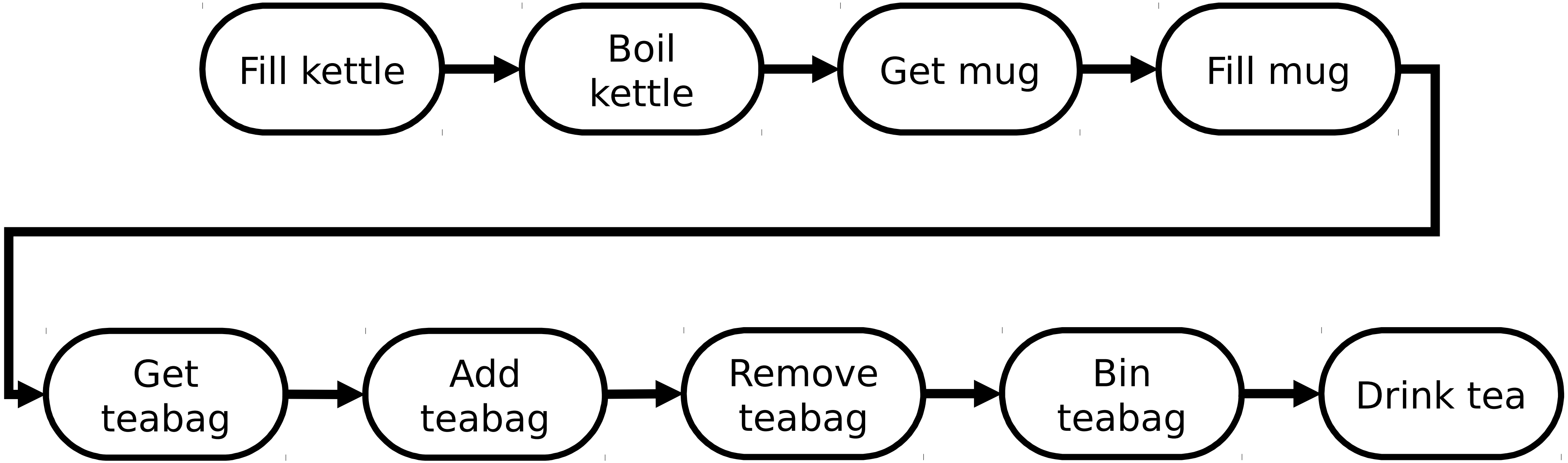
Add teabag

Remove teabag

Bin teabag

Drink tea

Drawing the procedure



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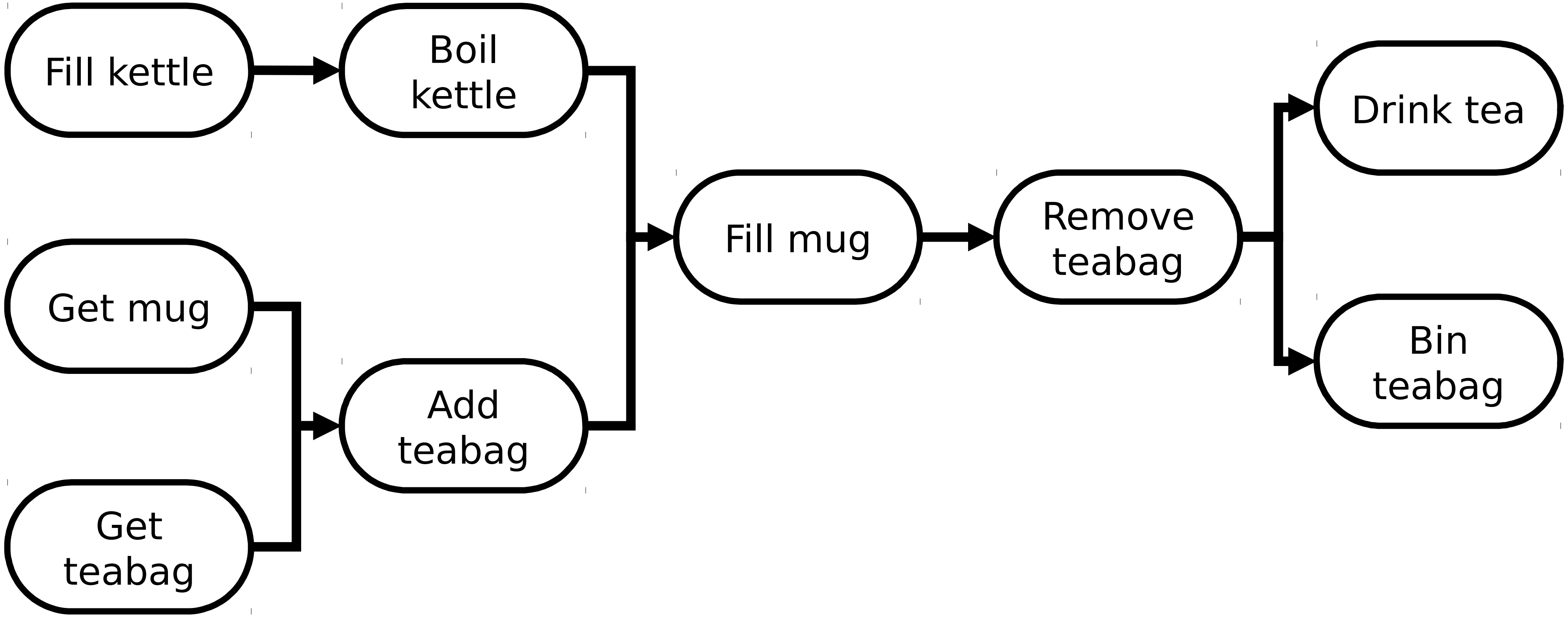

Drawing the procedure

- Lets build a restaurant system to serve dinner for 3

Drawing the procedure

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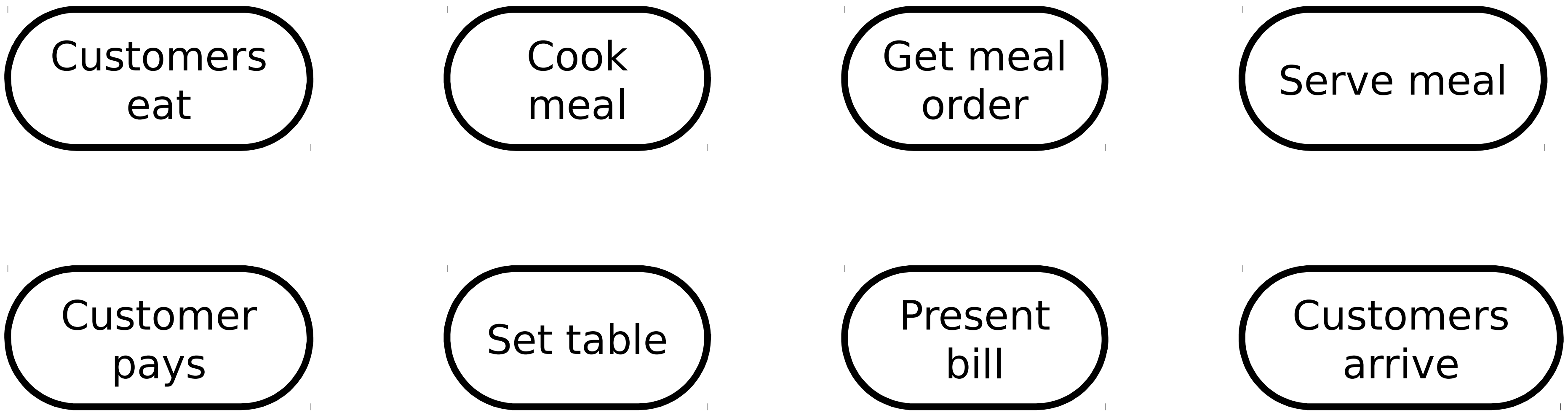


Customers eat

Cook meal

Get meal order

Serve meal

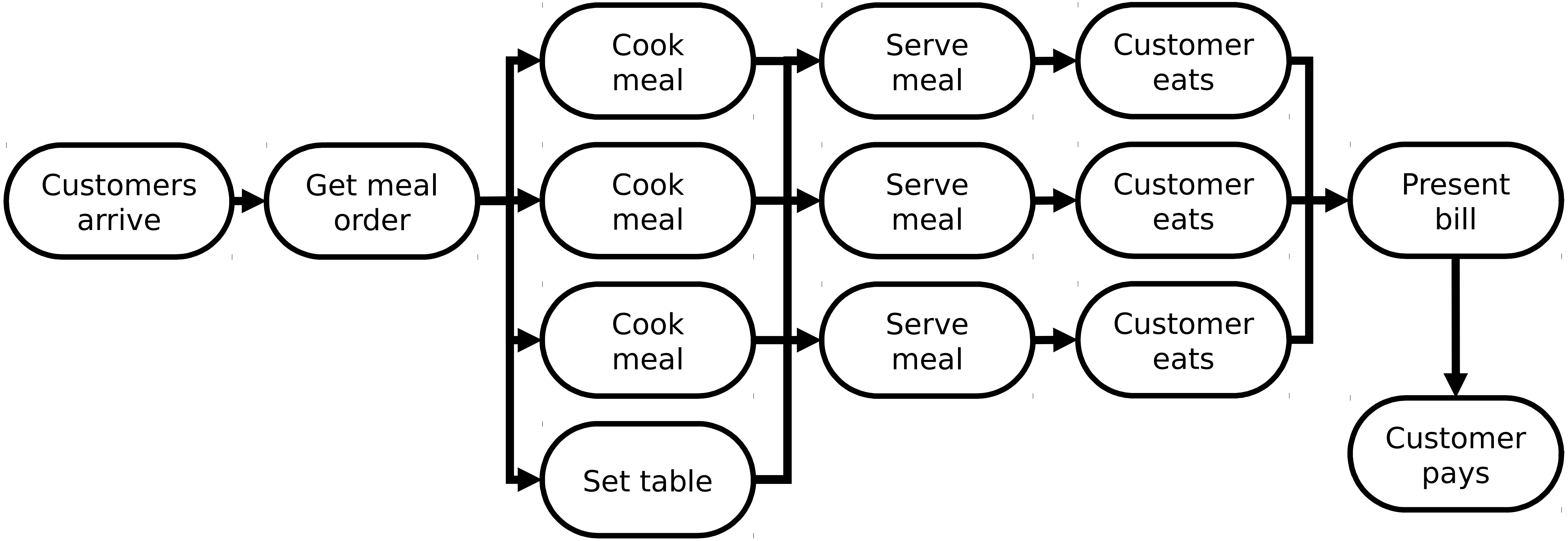
Customer pays

Set table

Present bill

Customers arrive

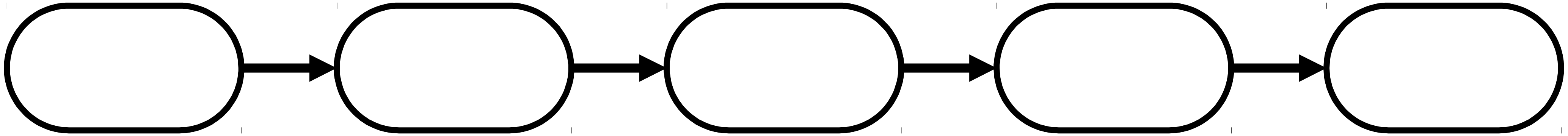
Drawing the procedure



Task Parallel

- Task Parallel is a model of parallelism
- Different tasks are distributed across different processors
- These systems will typically have a pipeline structure
- For example, a production line

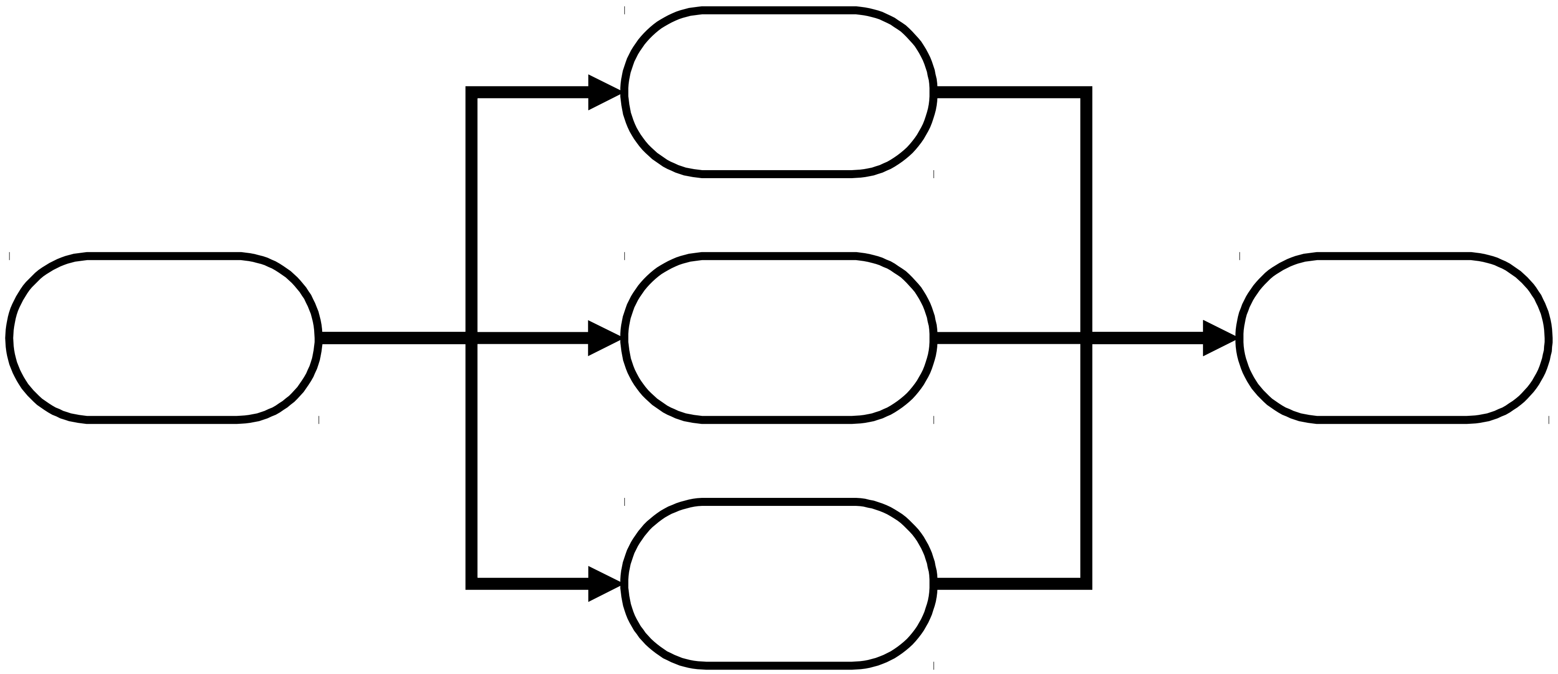
Task Parallel



Data Parallel

- Data Parallel is a model of parallelism
- A large chunk of data is broken up and split across different processors all performing the same task
- These systems will typically have a parallel(?) structure
- For example, map-reduce

Data Parallel



Task and Data Parallel

- Data Parallelism is better suited to *embarrassingly parallel* problems. These are problems with no data dependency.

- Task Parallelism is better suited to systems where the same process needs to be repeated on an ongoing basis.

- Most systems will be a mix of the two, plus some old fashioned sequential code.