Introduction to Algorithms

Engineering 1D04, Teaching Session 1

Introductions

Course Webpage:

http://elm.mcmaster.ca/

Introduction to Algorithms

- Problems require solutions.

- The solution to a problem must be stated clearly.

- A clear sequence of steps for solving a specific problem is called an algorithm.

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Introduction to Algorithms

- Task 1
  - Get into groups of 4 and create an algorithm to safely cross a road. Try to be as precise as possible. Some groups will get to share their algorithms.
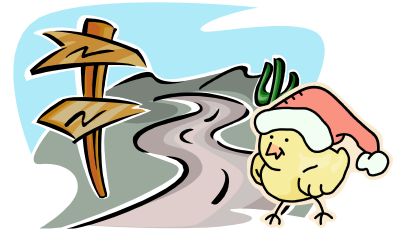
Task 1 Problems

- The order in which tasks are performed is often not obvious.

- The individual steps themselves are often ambiguous.

- Often, the chicken never gets across the road.

- It would be nice to have a more formal way of describing the actions involved in performing a task.

Waking up!!

- Get Out of Bed
- Brush Teeth
- Eat Breakfast
- Brush Teeth Again
- Wash
- Get Dressed
- Put on Shoes
- Run to Catch Bus

Waking in the Morning
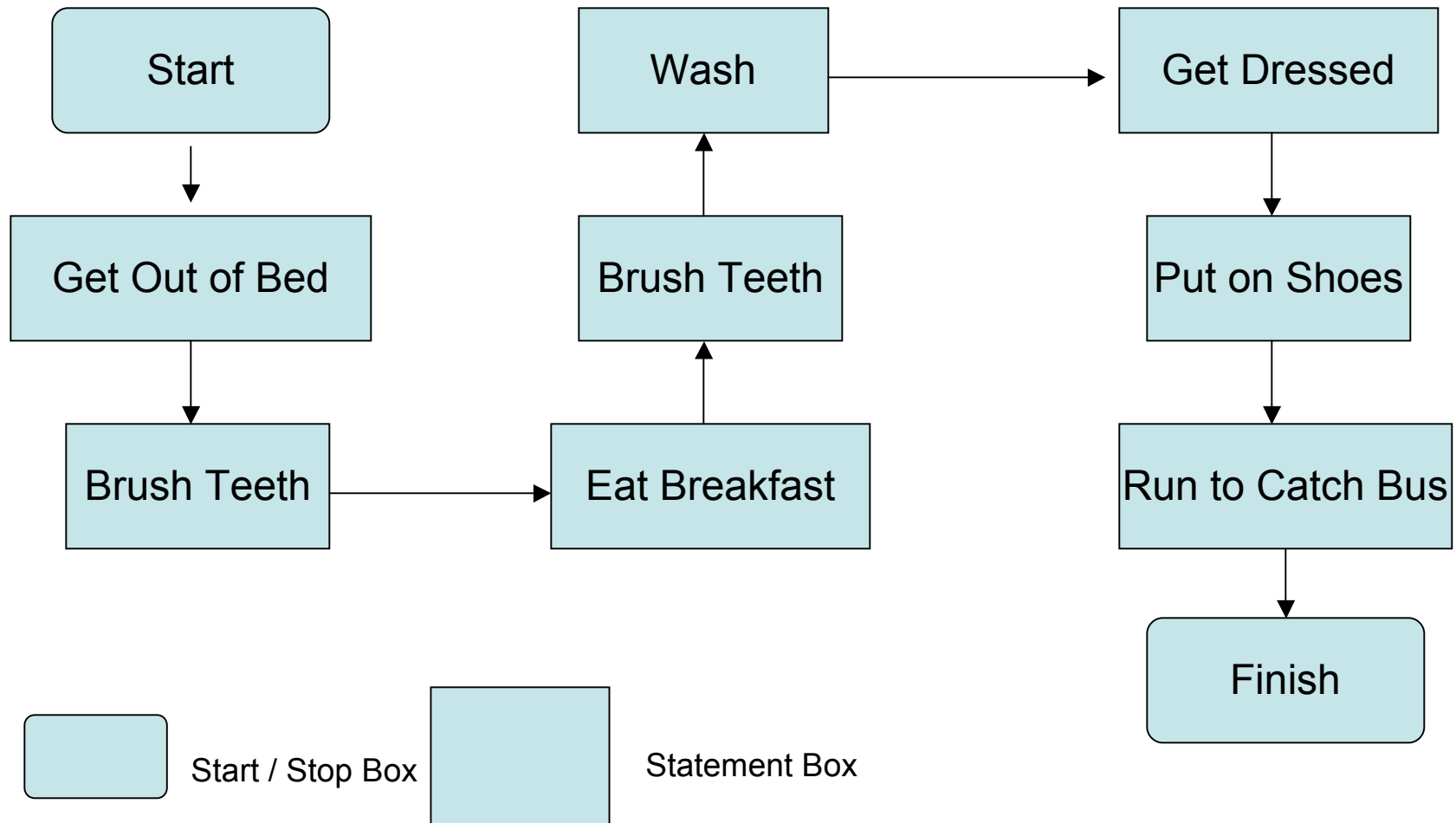
Flowchart Elements

Start / Stop Box

Statement Box

Waking up!!

- Unfortunately, we are not all that organized. We can't all have such a structured morning experience.

Waking up!!

- Unfortunately, we are not all that organized. We can't all have such a structured morning experience.

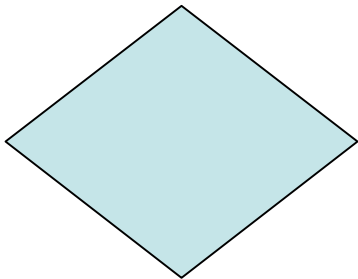- What if we're short on time? Does this change our decision making process?

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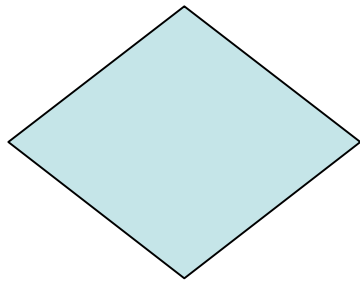
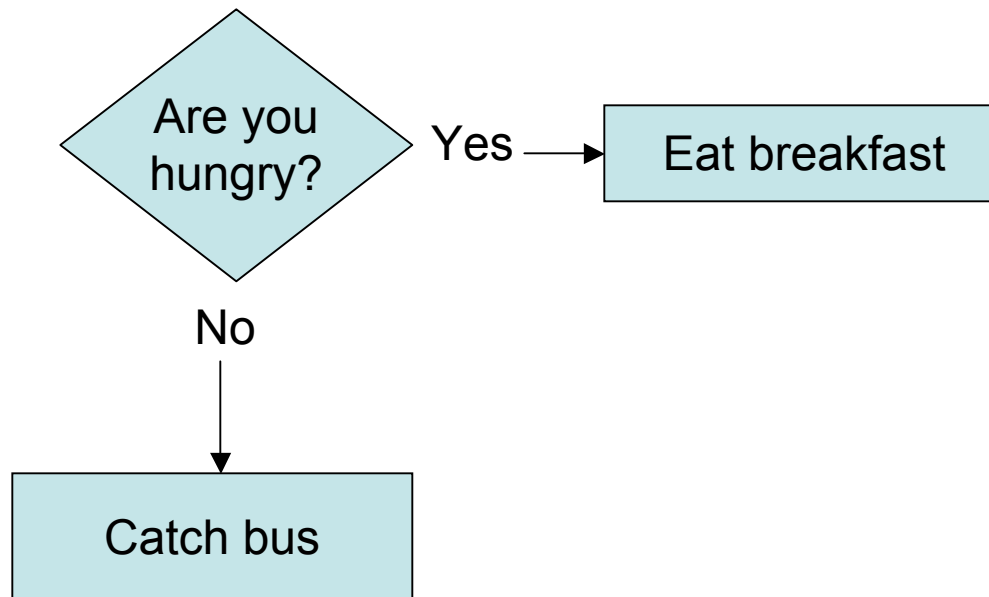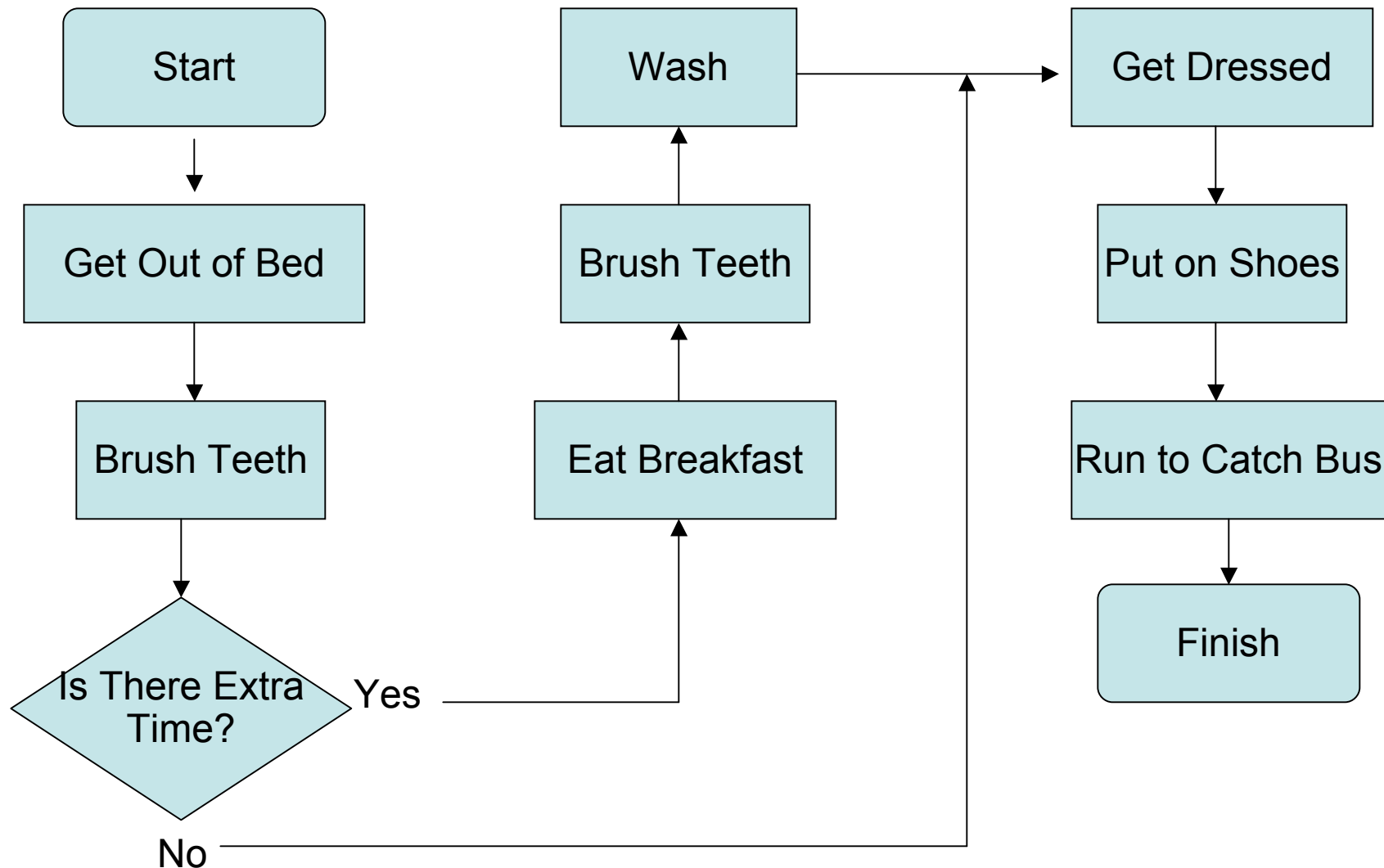# Flowchart Elements

Start / Stop Box

Statement Box

Decision Box

Decision Box

Decision Box

Are you hungry? — Yes → Eat breakfast

No ↓

Catch bus

Waking in the Morning with Decision

Waking in the Morning with Decision

- Get Out of Bed

- Brush Teeth

- If There is Extra Time
  - Eat Breakfast
  - Brush Teeth (Again)
  - Wash

- Get Dressed
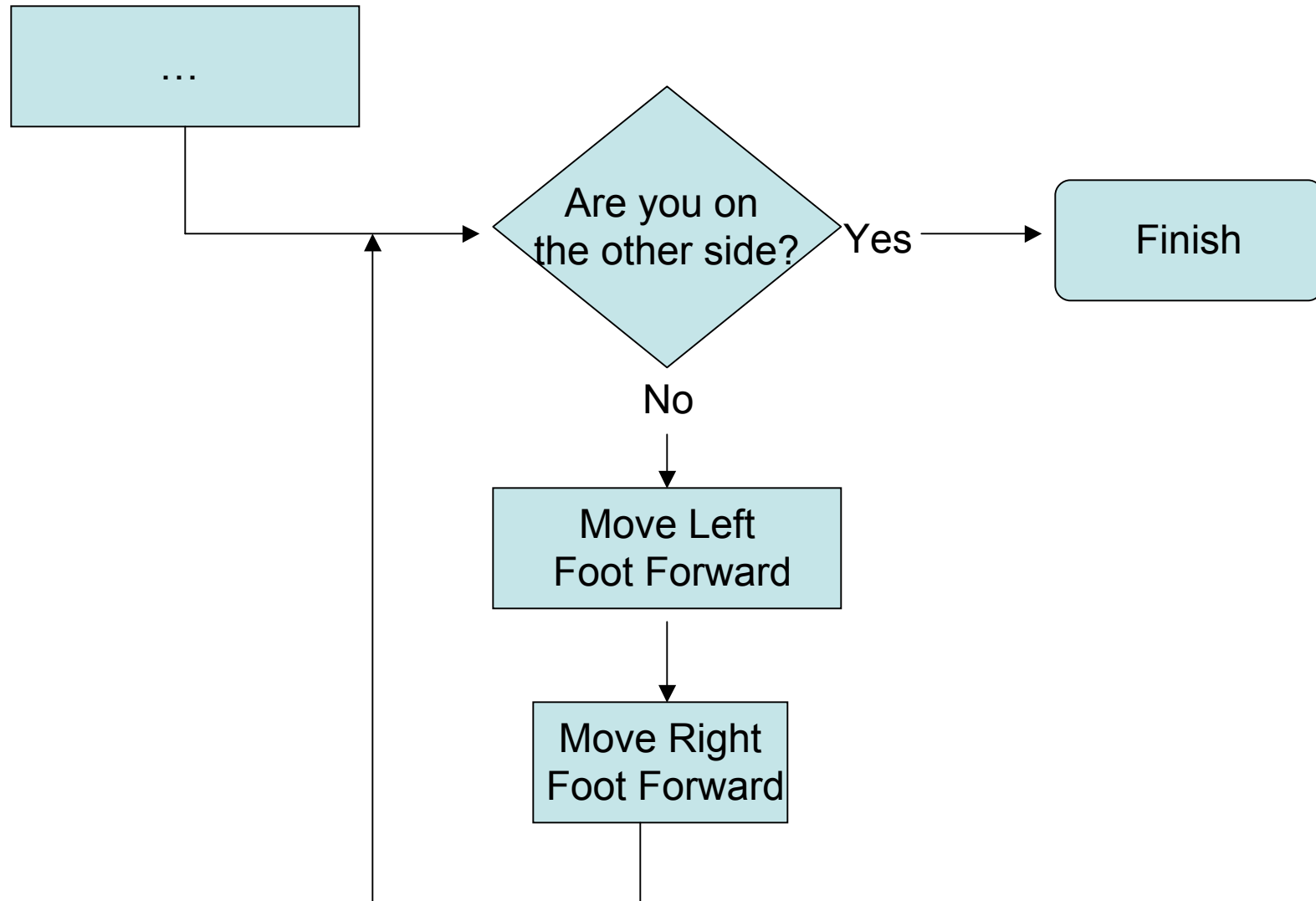
- Put on Shoes

- Run to Catch Bus

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Crossing the Road

- Some tasks need to be repeated until a condition is satisfied.

- Walking can be described as move left foot forward, move right foot forward, left foot, right foot … .

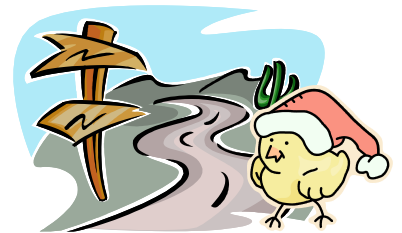- This can be visualized by a loop in the flowchart.
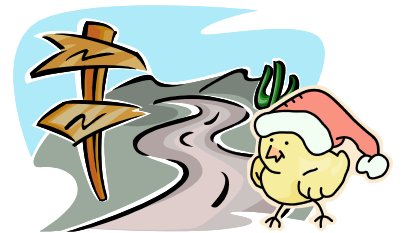
Crossing the Road

Crossing the Road

- …
- While you're not on the other side
  - Move Left Foot Forward
  - Move Right Foot Forward

Introduction to Algorithms

- Task 2
  - Return to your groups. Make a flowchart for safely crossing a road and derive a natural language description from it. Be as detailed as possible. Compare it to your previous natural language description.

Algorithms

- What are the most important characteristics of an algorithm?

Algorithms

- What are the most important characteristics of an algorithm?
  - A step-by-step procedure for solving a problem
  - Finite number of steps
  - Depends only on input

Algorithms

- Need only:
  - sequential actions
  - decisions
  - "while" loops (iteration)
- Anything that is computable can be computed using just these control structures

A More Mathematical Example ☺

- Let's try an algorithm that is more mathematical

- Do these two lines intersect?
  - Line 1: $(x_1, y_1) \rightarrow (x_2, y_2)$
  - Line 2: $(u_1, v_1) \rightarrow (u_2, v_2)$

    (same groups - work it out)

Intersecting Lines

$Y = mX + c$

$Line\,1: m_1 = \dfrac{y_2 - y_1}{x_2 - x_1}$

$Line\,2: m_2 = \dfrac{v_2 - v_1}{u_2 - u_1}$

$Line\,1: y_1 = m_1 x_1 + c_1$

$so \qquad c_1 = y_1 - m_1 x_1$

$Line\,2: v_1 = m_2 u_1 + c_2$

$so \qquad c_2 = v_1 - m_2 u_1$

$Then\ solve$

$s = m_1 r + c_1$

$s = m_2 r + c_2$

(x₁, y₁)

(u₁, v₁)

(r, s)

(u₂, v₂)

(x₂, y₂)

Intersecting Lines

$Y = mX + c$

$Line\,1 : m_1 = \dfrac{y_2 - y_1}{x_2 - x_1}$

$Line\,2 : m_2 = \dfrac{v_2 - v_1}{u_2 - u_1}$

$Line\,1 : y_1 = m_1 x_1 + c_1$

$so \qquad c_1 = y_1 - m_1 x_1$

$Line\,2 : v_1 = m_2 u_1 + c_2$

$so \qquad c_2 = v_1 - m_2 u_1$

$Then\ solve$

$s = m_1 r + c_1$

$s = m_2 r + c_2$

(x_1, y_1)

(u_1, v_1)

(r, s)

(u_2, v_2)
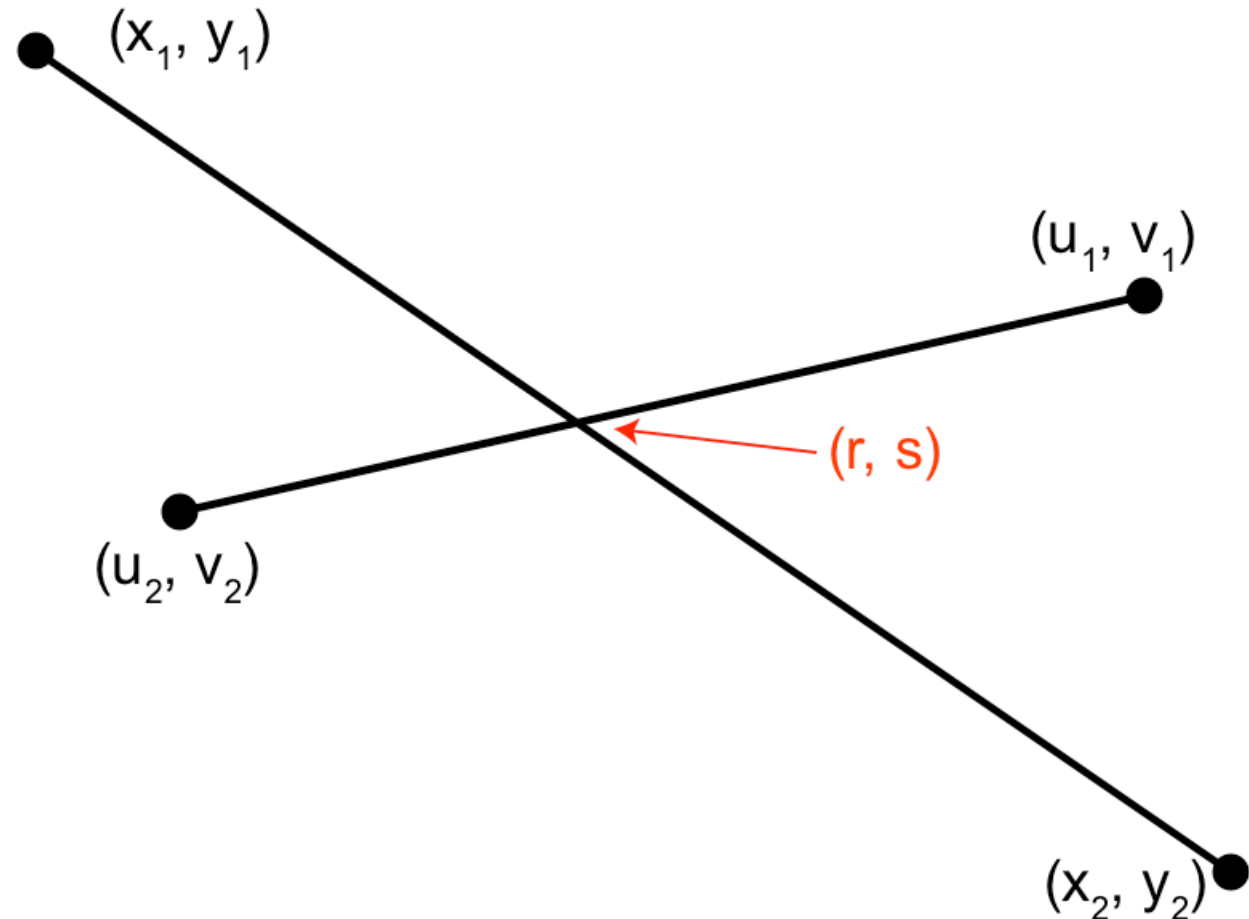
(x_2, y_2)

What problems will you face?

Intersecting Lines

- Work on the problem between now and Lab 2 - you will need to solve this in that lab session.