Recitation 1

Introduction

1.1 Administrivia and Anncouncements

- Welcome to 15-210!
- The course website is http://www.cs.cmu.edu/~15210/. It contains the syllabus, schedule, library documentation, staff contact information, and other useful resources.
- We will be using Piazza (https://piazza.com/) as a hub for course announcements and general questions pertaining to the course. Please check it frequently to make sure you don't miss anything.
- The first (zeroeth?) homework assignment, *SuperLab*, has been released! It's due **Friday at 5pm**, but don't worry – it's short, and only worth 50 points.
- Homeworks will be distributed through Autolab (https://autolab.cs.cmu.edu/). Most homework assignments will be released on Fridays and will be due one week later. You will submit coding tasks on Autolab, and written tasks on Gradescope (https://gradescope.com/).

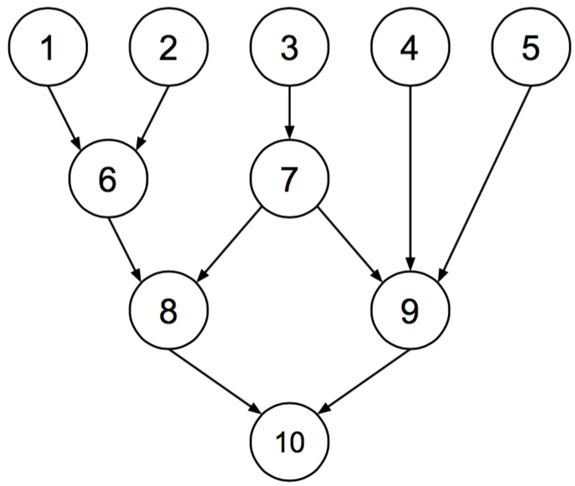
1.2 Let's Make a Burger

Here's a super pedantic recipe for making a burger (ingredients: patty, lettuce, sliced onion, sliced cheese, burger bun).

1. Prepare patty.
2. Prepare cheese.
3. Prepare bun.
4. Prepare onion.
5. Prepare lettuce.
6. After completing 1 and 2, grill the patty with the cheese placed on top.
7. After completing 3, toast the bun, then lay the two pieces toasted-side up.
8. After completing 6 and 7, place the grilled patty (now covered in melted cheese) on top of the bottom half of the toasted bun.
9. After completing 4, 5, and 7, place the lettuce and onion on top of the top half of the toasted bun.
10. After completing 8 and 9, serve the burger.

Photograph: Nicholas Chen

Task 1.1. *Diagram the dependencies in the given recipe by creating a vertex for each step and drawing a directed edge from x to y if the recipe specifies that x must finish before y begins.*



Task 1.2. *Assuming each step takes unit time, what is the minimum amount of time required to complete the recipe when there are (a) 1 chef, (b) 2 chefs, (c) 5 chefs, and (d) an infinite number of chefs? For each part, justify your answer by specifying a* ***schedule*** *which indicates, for each step in the recipe, which chef executes that step, and at what time.*

We can write a schedule as a sequence of sets of steps, where the elements of each set are executed concurrently, and the sets are executed sequentially, left-to-right. If we have p chefs, then each set can have at most p elements. We'll just assign chefs arbitrarily to the elements of these sets.

With 1 chef, we can complete the recipe in 10 units of time:

$$\{1\}, \{2\}, \{3\}, \{4\}, \{5\}, \{6\}, \{7\}, \{8\}, \{9\}, \{10\}.$$

With 2 chefs, we require 6 units of time. There are many optimal schedules in this case (try finding them all!). Below is one of them.

$$\{1, 2\}, \{3, 4\}, \{5, 6\}, \{7\}, \{8, 9\}, \{10\}.$$

With 5 chefs, we can do it in 4 units of time like so:

$$\{1, 2, 3, 4, 5\}, \{6, 7\}, \{8, 9\}, \{10\}.$$

With an infinite number of chefs, we can't do better than 4 units of time, because there is a chain of dependencies of length 4 (for example: 1,6,8,10).

1.2.1 Work and Span

Task 1.3. *Give a reasonable definition of work and span which are applicable in this context. Using your definition, state the work and span of making a burger.*

We can define the *work* as the total number of steps which need to be completed. We can define the *span* as the number of steps in the longest chain of dependencies. The work and span of making a burger, then, are 10 and 4.

Remark 1.4. *An important result in parallel computing is the* ***greedy scheduling principle****. In the context of recipes, this principle states that, for a recipe with work W and span S, p chefs are able to complete the recipe in at most $\frac{W}{p} + S$ time. We will see a proof of the greedy scheduling principle soon in lecture.*