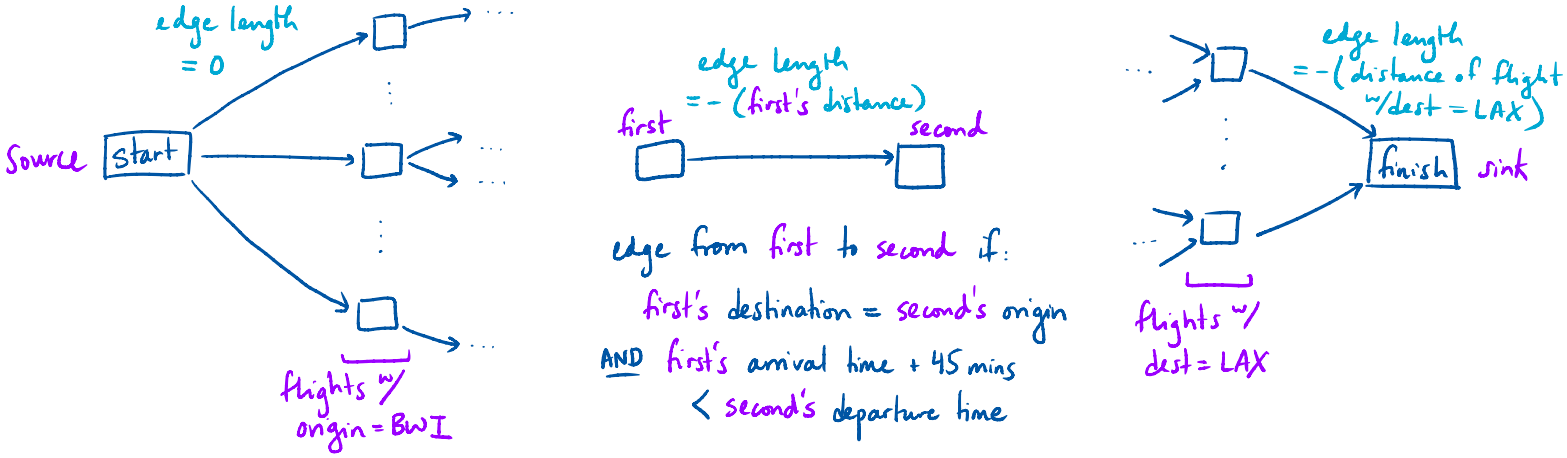
Lesson 4. The Mileage Running Problem

Example 1. Professor May B. Wright needs to fly from Baltimore (BWI) to Los Angeles (LAX) to attend a conference. She thinks this would be the perfect opportunity to accumulate some frequent flyer miles on American Airlines (AA), where she already has Platinum status.

Looking into flights on AA, she sees that every itinerary from BWI to LAX costs roughly the same. She has a full day to spare for travel, so she wants to know: which sequence of AA domestic flights starting at BWI and ending at LAX over the course of one day will allow her to accumulate the most miles?

- Suppose we have a database of every AA domestic flight on a given day.
- In particular, for each flight, we have:
  - the flight number
  - the origin airport
  - the destination airport
  - the departure time at the origin airport
  - the arrival time at the destination airport
  - the distance traveled in miles
- How can we formulate Professor Wright's problem as a shortest path problem?



Node i $\longleftrightarrow$ flight i (except "start" and "finish")

Edge (i,j) $\longleftrightarrow$ flight j can follow flight i in a valid itinerary

SP length $\longleftrightarrow$ negative of maximum total mileage of itinerary from BWI to LAX

SP nodes $\longleftrightarrow$ flights in itinerary w/maximum total mileage.

A Problems

Problem 1 (Reverse engineering)**.** Describe the shortest path problem being solved by the code below. In particular:

- draw the directed graph (nodes and edges),
- specify the edge lengths, and
- specify the source and sink nodes.

```
import networkx as nx
import bellmanford as bf

H = nx.DiGraph()

for i in range(5):
    H.add_node(i)

for i in range(5):
    for j in range(5):
        if j == i + 1:
            H.add_edge(i, j, length=i)
        if j == i + 2:
            H.add_edge(i, j, length=2*i)

length, nodes, negative_cycle = bf.bellman_ford(H, source=0, target=4, weight="length")
```