Week 2 Practice Problems

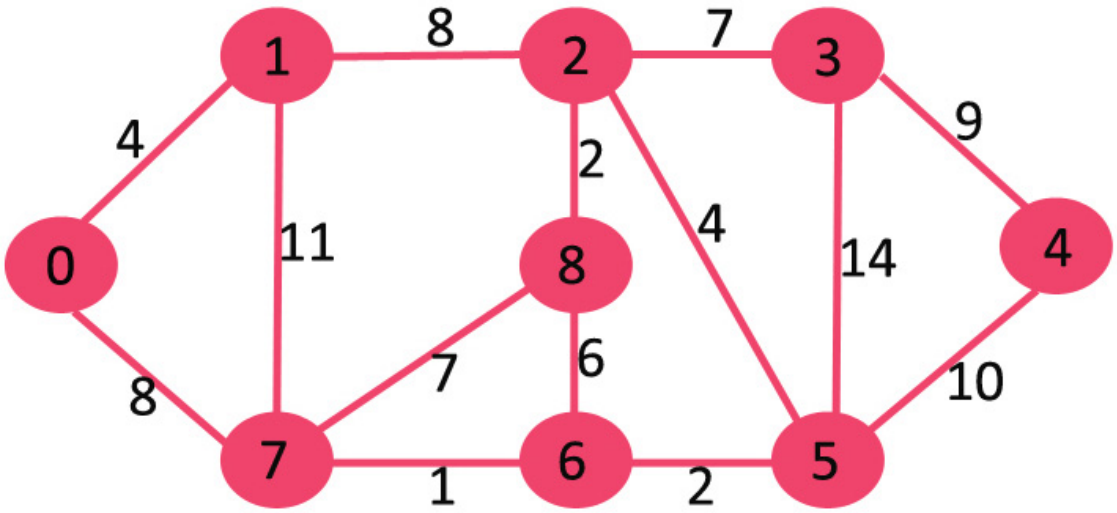
Practice Problems based on Week 2 content

(1) Multiperiod Planning Problems Concepts

- In the ShoeCo example, you are asked to evaluate the solution and identify any problem(s) with it. Do you believe there's anything wrong with the solution? If so, what? How might you suggest fixing that issue (don't worry about following linear programming rules to answer this)?

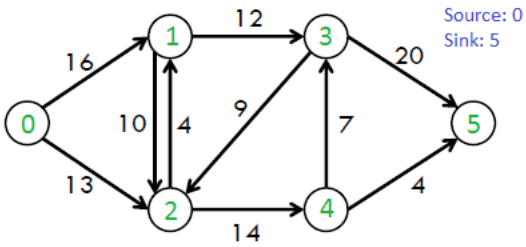
(2) Min-Cost Network Flow Concepts and Definitions

- In Lecture 3, we define the concept of "bipartite graphs." Is the second graph given on that slide bipartite?
- Find a matching for the following graph:



Is it a perfect matching?

- Build an incidence matrix for the following graph:



- Is a balanced MCNF always feasible?
- Find a better lower bound on the "Building a Stadium" longest path example given in Lecture 6.

(3) Modeling practice

Blending Problem

The company Steelco has received an order for 500 tons of steel to be used in shipbuilding. The steel must have the following characteristics:

Chemical Element	Minimum Grade (%)	Maximum Grade (%)
Carbon (C)	2	3
Copper (Cu)	0.4	0.6
Manganese (Mn)	1.2	1.65

The company has seven different raw materials in stock that may be used for the production of this steel. The following table lists the grades, available amounts and prices for all materials:

Raw material	C%	Cu%	Mn%	Availability (tons)	Cost ($/ton)
Iron alloy 1	2.5		1.3	400	200
Iron alloy 2	3		0.8	300	250
Iron alloy 3		0.3		600	150
Copper 1		90		500	200
Copper 2		96	4	200	240
Aluminum 1		0.4	1.2	300	200
Aluminum 2		0.6		250	165

(a) Determine the composition of the steel that minimizes the production cost.

(b) Now you must also produce at least 50 tons of oil. Oil is made up of the same raw materials and has the same min and max chemical grade requirements. Modify your model to include the required production of oil.

Production Planning Problem

The company Sailco manufactures sailboats. During the next 4 months the company must meet the following demands for their sailboats:

Month	1	2	3	4
Demand	40	60	70	25

At the beginning of Month 1, Sailco has 10 boats in inventory. Each month it must determinehow many boats to produce. During any month, Sailco can produce up to 40 boats with regular labor and an unlimited number of boats with overtime labor. Boats produced with regular labor cost \$400 each to produce, while boats produced with overtime labor cost \$450 each. It costs \$20 to hold a boat in inventory from one month to the next. Build the LP model that determines the production and inventory schedule that minimizes the cost ofmeeting the next 4 months demands. Solve the model in Julia.

- Now modify your model to allow backlogging. It costs \$30 to backlog a sailboat every month. Build the LP model that incorporates backlogging and solve it in Julia.

Shipping Plushies

Suppose you are an optimization expert working for popular plushie manufacturer, Assemble-an-Animal. You have been tasked with figuring out how to distribute plushies. You have a total of 160 orders, which you are shipping from the manufacturing site to four different warehouses in Milwaukee, Paris, Sydney, and New Delhi. The plushies will then be shipped to three different distribution centers in Amsterdam, London, and Beijing. Each warehouse can hold a maximum number of orders (shown in table below). The plushies can either be flown to the distribution centers or taken by train. Because of travel distance restrictions, your deliveries must abide by the following rules: * Milwaukee can only deliver to Amsterdam and London and only by air. * Paris can deliver to Amsterdam and London by air or rail and Beijing by air. * Sydney can only deliver to Beijing, and only by air. * New Delhi can deliver to Beijing by rail, Amsterdam by rail or air, and London by air.

Costs of rail and air transport per order are in the table below.

The contract you have with the airline company requires that any single shipment contains no more than 45 orders. The only restriction on rail transport is that no more than 60 orders can fit on a single shipment.

In addition, to maintain good favor with your contracted airline, you must send at least 15 orders by air to Beijing. 5 orders by air to Amsterdam, and 10 orders by air to London.

Warehouse Distribution Center	Amsterdam air (rail)	London air (rail)	Beijing air (rail)	Warehouse capacity
Milwaukee	\$12k (-)	\$11k (-)	- (-)	45
Paris	\$12k (\$10k)	\$14k (\$12k)	\$20k (-)	50
Sydney	- (-)	- (-)	\$18k (-)	70
New Delhi	\$9k (\$7k)	\$8k (-)	- (\$5k)	30

- What type of network flow problem is this?
- Draw the network. How (if at all) do you need to modify the network to fit the structure of the problem you named above?

- Build and solve a MCNF problem to determine how you should transport your 160 orders to minimize the total transportation cost. You can use the code snippet below to initilize your problem:

[1]:
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num_orders = 160 # total orders
w = [:M, :P, :S, :N] # warehouses
dc = [:A, :L, :B] # distribution centers
modes = [:air, :rail] # possible modes of transportation

max_w_cap = Dict(zip(w,[45,50,70,30])) # capacity of each warehouse

nodes = [] # fill in nodes
arcs = []; # fill in arcs. you might want to use tuples -- e.g., arc from node1␣
 ↪to node2: (:node1,:node2)
```

Project Planning

Suppose you are making a plan for completing your final project in CS 524 this summer. You've come up with a list of tasks, their predecessor relationships, and the duration (in days) of each task you must complete before handing in your project. You've constructed the following table containing the relevant information:

Activity	Description	Predecessor	Duration
A	Build model	n/a	2
B	Write report intro	n/a	6
C	Collect data	n/a	4
D	Run/debug model	A	3
E	Incorporate data in model	C	5
F	Perform sensitivity analysis	A	4
G	Finish report	B, D, E	2

- Draw the network of this project planning problem
- Build and solve a linear programming model that will allow you to determine when you need to start your project to ensure you'll be done by the due date (in terms of days before project is due – e.g., must start at least 5 days before due date).

[ ]:
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