Finding market clearing prices Algorithm approach
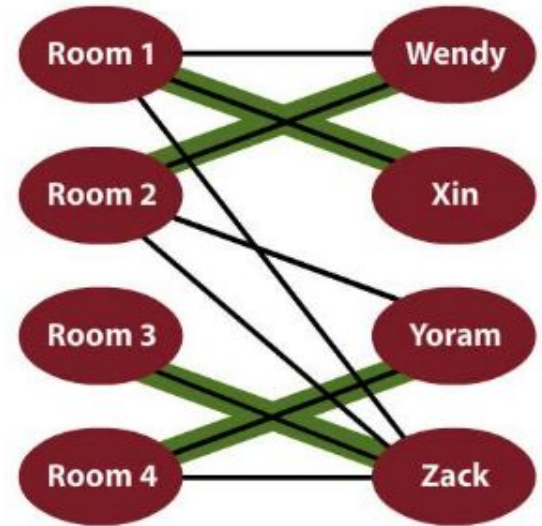
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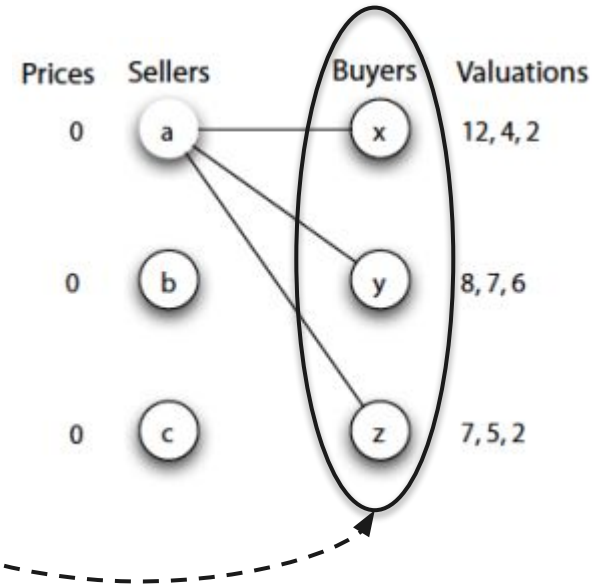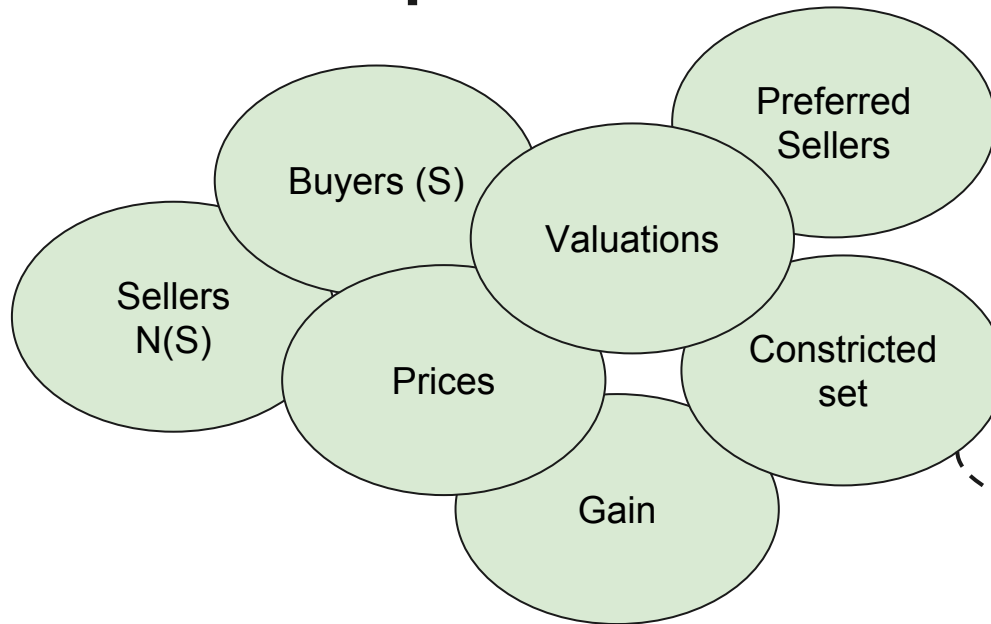
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The problem:

- Bipartite matching problem
- Buyers with different preferences have to match with 1 seller
- Which are the market clearing prices?
- Which buyers will be matched with which sellers?
- Ideal scenario: Perfect Matching

Basic concepts:

Preferred Sellers

Buyers (S)

Valuations

Sellers N(S)

Prices

Constricted set

Gain

Prices	Sellers	Buyers	Valuations
0	a	x	12, 4, 2
0	b	y	8, 7, 6
0	c	z	7, 5, 2

The basic algorithm:

Repeat until convergence or max iterations is reached:

1. Initialize prices, preferences, matching with zeros
2. For each buyer → rank_sellers (create preferences)
3. Find restricted set **S**:
   a. If there is a restricted set increase price for sellers in **N(S)**
   b. Else find perfect matching and finish

Preferences

	S_1	S_2	S_3
B_1	[[1.	0.	0.]
B_2	[0.	1.	1.]
B_3	[1.	1.	0.]]

The algorithm - basic methods (1):

- rank_sellers (buyer, valuations, prices, **preference**):
    a. Compute the gain of buyer for each seller
    b. Add the sellers with the best gain to the buyer preferences

The algorithm - basic methods (2):

- find_restricted_set (preference, **prices**):
    a. Initialize **S**, **N(S)** to empty sets
    b. Check the edges recursively:
        i. If an edge can be removed then remove it
    c. From the remaining edges construct **S**
    d. From **S** construct **N(S)**
    e. If len(**S**) > len(**N(S)**)
        i. Increase the price by one for each seller in **N(S)**
   f. Else there is a perfect matching

Experiments with different inputs:

- ➔ Different number of sellers & buyers (2-50)

- ➔ Different valuations with random integers

- ➔ Number of sellers must be equal or greater than number of buyers
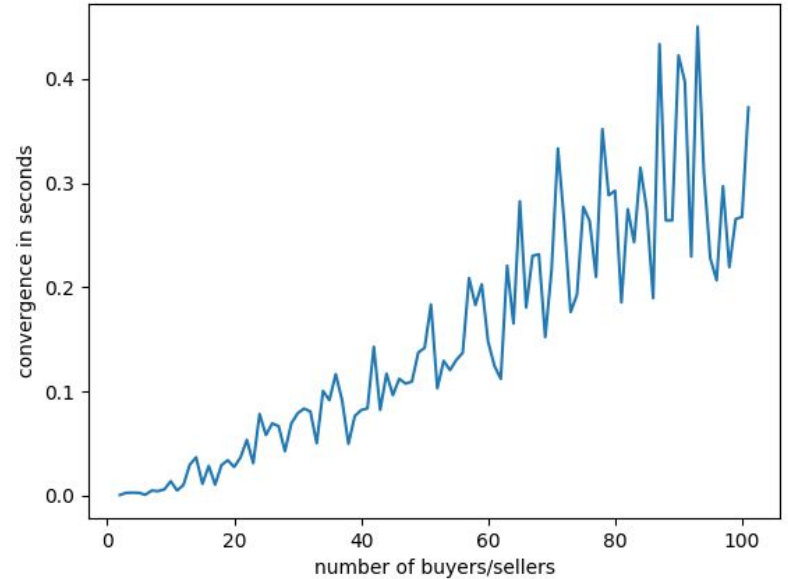
- ➔ Maximum iterations until convergence 100

Algorithm performance:

- Average number of iterations until convergence: **4.5**
- The number of iterations converges between 2-7 iterations even for larger numbers of buyers and sellers.
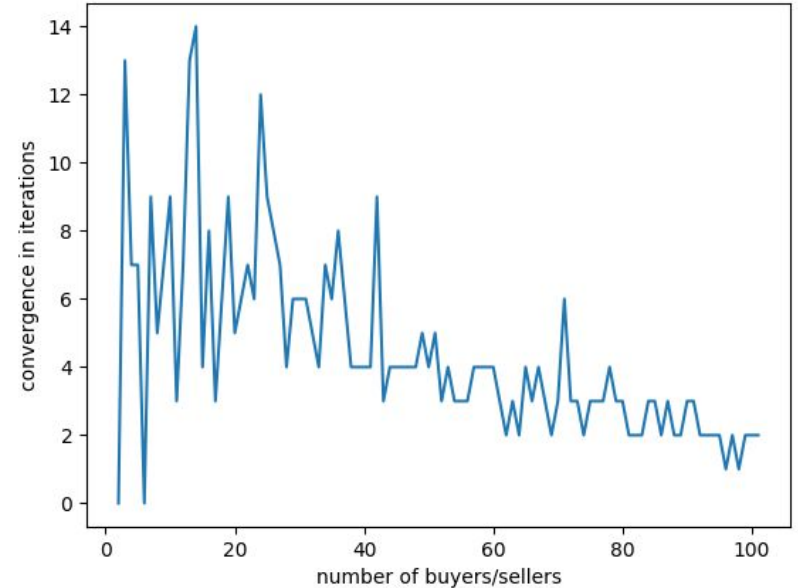
Algorithm performance:

- The time of convergence increases as the number of buyers/sellers increases

Algorithm performance:

# Buyers/Sellers	Avg. Iterations	Avg. Seconds
20	6 iter.	0.06 sec.
30	4 iter.	0.07 sec.
40	4 iter.	0.09 sec.
50	4 iter.	0.15 sec.
100	2 iter.	0.35 sec.