# CS 5110/6110 Program 4: Echo Chamber (40 points)

**Homophily**: the tendency to form strong social connections with people who share one’s defining characteristics, as age, gender, ethnicity, socioeconomic status, personal beliefs, etc.:*political homophily on social media.*

**Echo Chamber Effect: a** voter is surrounded by associates that share similar beliefs, reinforcing its validity regardless of its merit.

# Part 1

**Ranked Choice.** As municipalities in Cache County face upcoming all-mail in elections, some are exploring ranked-choice voting as a way to cut costs. Ranked-choice voting allows voters to rank candidates in an order of preference in lieu of selecting a single candidate, and municipal leaders say it will help curb the financial impact of costly elections (as no primary election needs to be held). Voters rank all candidates in order of their preference. When tallying the votes, the first-choice candidates of all voters go up against each other and the candidate with the least first choice votes is eliminated. Break ties by eliminating the candidate with the most last choice votes.

The ballots that ranked the eliminated candidate first are redistributed to the candidate they ranked second, and the process is repeated, eliminating candidates and re-tallying ballots until only the winner is left.

Input:

1. The starter code allows the user to select number of voters and number of candidates. It uses a seed so everyone will have the same input (so results should be comparable)
2. The starter code generates the preference of each voter for each candidate by generating a random number between 1 and 10. The higher the number, the higher the preference.
3. For example, the voters (Alice-Greg) have the following preference score for each of the candidates. The format of the list is [candidate, score, ranking]. So Alice gave a score to candidate 1 of 2.5 (which was her 5th choice) and a score of 5.5 to candidate 2 which was her 4th choice.

The complete order of candidates for Alice is [4, 5, 3, 2, 1] which means candidate 4 is her first choice.

Alice [1, 2.5, 5][2, 5.5, 4][3, 6.0, 3][4, 9.0, 1][5, 8.9, 2] ORDER [4, 5, 3, 2, 1]

Bart [1, 6.6, 2][2, 1.8, 5][3, 2.6, 4][4, 5.7, 3][5, 8.9, 1] ORDER [5, 1, 4, 3, 2]

Cindy [1, 4.0, 4][2, 6.7, 3][3, 1.6, 5][4, 8.5, 1][5, 7.2, 2] ORDER [4, 5, 2, 1, 3]

Darin [1, 3.0, 3][2, 5.1, 1][3, 2.3, 5][4, 4.8, 2][5, 2.9, 4] ORDER [2, 4, 1, 5, 3]

Elmer [1, 3.0, 4][2, 9.5, 1][3, 4.3, 3][4, 7.7, 2][5, 3.0, 5] ORDER [2, 4, 3, 1, 5]

Finn [1, 5.5, 4][2, 6.0, 3][3, 6.2, 2][4, 1.6, 5][5, 8.3, 1] ORDER [5, 3, 2, 1, 4]

Greg [1, 6.6, 1][2, 6.5, 2][3, 5.2, 3][4, 4.4, 4][5, 4.4, 5] ORDER [1, 2, 3, 4, 5]

**Social Welfare of Winner**

Models of voters in multiagent systems literature are divided between those utilizing ordinal preferences (where only the ordering of outcomes matter) and cardinal preferences (where outcomes are associated with utility values). We will look at both.

We assume the utility a voter is the distance between her first choice and the selected choice. In this case lower is better.



For the previous data set, if candidate 4 was selected as the winner, the cardinal utility for Alice would be 0 and the ordinal utility for Alice would be 0 (because 4 was her firs choice) However, for Bart the cardinal utility of 4 winning would be 8.9-5.7 = 3.2 For Bart, the ordinal utility is |1-3| = 2. The utility for the system is the sum of the utilities for the voters.

The social welfare is the sum of all the utilities for each voter.

Output:

Output the preference matrix (as above).

Using Ranked Choice voting (described above), list the order in which candidates are eliminated. Output the winner using ranked choice voting.

Output the social welfare for the system given the winner using both cardinal and ordinal utility.

# Part 2

Social network model. Voters are embedded in a social network. Each voter observes the ballots of her neighbors in the network, from which she infers the likely outcome of the election. Each voter may then revise her first choice vote strategically, to maximize her expected utility. The voter knows his complete ranking of the candidates. Winners are determined by plurality (after a series of rounds).

Real world social networks exhibit a property called homophily; sometimes called “The Echo Chamber Effect”, which is the tendency for friends to have similar ideologies.

It is believed that in practice, strategization increases with voter knowledge, yet can improve the social welfare for the population. Strategization may lead to the elimination of less popular candidates, as voters revise their votes to candidates less preferred by them but more likely to win.

A major concern in voting systems is manipulation via strategic voting. This happens when voters benefit from casting a ballot that does not reflect their true preferences; while this may be beneficial for the voter, it misinforms the community on the true preferences of its constituents.

For voters to manipulate successfully, they must have some knowledge regarding the outcome of the election. Each voter assumes her friends are representative of the wider population and will vote strategically to maximize her own expected utility. People with a large number of contacts are more influential than people with few contacts.

Let V = {1, 2, . . . n} represent our set of voters. They are embedded in a social network, represented as a simple, directed graph G = (V, E). We adopt the convention that a directed edge (i, j) ∈ E denotes that voter i observes voter j and as such, j’s actions may influence i. An edge may represent communication between friends, a leader’s influence on followers, or patronage of media and news platforms. Let N (i) denote the set of voters observed by i; i.e. N (i) is the out-neighbors of i.

The voting process proceeds in rounds (where only the first choice is submitted). The first round represents the truth. In each successive round, the voter formulates this ballot as a response based on her observations of her friends – i.e. the previous ballots of her out-neighbors. When no voters wish to deviate from their current ballot, the system has converged to an equilibrium. If it reaches this state, we say the system is stable. At that point, the plurality winner is declared to be the winner.

How should the voter use the knowledge about other voters:

1. Everyone else seems to like my last choice. There is no reason to change my vote.
2. The other voters are split. Several like my second choice and several like my third choice. Changing my vote to my second choice would give them a better chance of winning. My first choice seems to have no chance.
3. Other ideas?

Input: Use the same data for part 1, but use the connection matrix generated by the starter code.

Alice 0 0 1 0 0 0 0

Bart 0 0 0 1 0 0 0

Cindy 0 0 0 0 1 0 0

Darin 0 0 1 0 1 0 0

Elmer 0 0 0 0 0 0 1

Finn 0 0 0 0 1 0 1

Greg 0 1 1 0 0 1 0

Input:

1. Use the same data you generated for part 1, so the results can be compared.
2. Use the connection matrix. This graph representation is directional: **a** may know **b**, but **b** doesn’t necessarily know **a**.

Output:

1. Show the connection matrix.
2. Using the social network model, show how many voters change their mind at each round. You can have voters change their mind any reasonable way. Be sure you explain how voters in your system changed their minds.
3. Output the winner.
4. List the social welfare of your solution using both ordinal and cardinal method. Social welfare should be based on actual preference, not reported preference.

# Summary

Compare the solutions to part 1 and part 2. Try various numbers of candidates and voters.

Submit a video showing your solution and explaining your results.

**Extra (Required for 6110, bonus 4 points for 5110)**

Compare the solution obtained by Borda with these two methods (ranked-choice and social networks). You may find it interesting to compare results for between 10 and 50 voters. How often do all three methods give the same result? On average, what method yields the best utility?

Would you get better more interesting results if connections were more in clusters than determined randomly? Why? When we determine things randomly, we can’t capture common situations like clusters of friend groups or some candidates being more appealing than others.