

• Instructor: Prof. Oleksandr Tymbaliuk \rightsquigarrow call "Sasha"

• Discuss Syllabus:

- Lectures MWF $9^{00} - 9^{53}$

- Textbook "Excursions in modern mathematics", 8th Edition, by P. Tannenbaum

- Hwk will be assigned on Blackboard \rightsquigarrow also grades will be posted on Blackboard.

- Recitations are very useful: go to master your skills

- Exam dates: Sept 30, $9^{00} - 9^{53}$ in class

Nov 2, $9^{00} - 9^{53}$ in class

Dec. 14, $20^{20} - 23^{00}$ TBA \leftarrow FINAL

- Grade will be computed in the following way

25% (Hwk) + 20% (Midterm 1) + 20% (Midterm 2) + 35% (Final)

N.B. We reserve up to 5% for participation, but we will not lower your grade for not participating.

• Restrictions:

- No calculators on exams

- No joint work on exams

- No make-up for missed exams

• Mathematical Learning Center (MLC)

This is a very useful facility, located at the basement of Math. Dept.

You will find other Professors and Graduate students ready to answer your q-s (but not to solve your hwk). Open M-F, $10^{00} - 18^{30}$ (check the time!)

This week we will go over Section 1 of Textbook: "Mathematics of Elections".

Many of us face many (mini-)elections, but we hardly ever think of any mathematics behind this procedure.

- Let us start by mentioning the basic elements of all elections:
 - Candidates (people, events, dates, teams etc. - something we choose from)
 - Voters (us, like general public, or members of some society/group/etc)
 - people who make a choice
 - Ballots (means by which voters express their preference on candidates)
 - e.g. paper, text message, call, ...

→ Outcome: Having Voters casting the preference on Candidates via Ballots, at the end they tell the outcome.

It can be the winner-only outcome (1 candidate is chosen) or it might be a partial ranking outcome (several top candidates are chosen).

BUT: there is one step missing above, right before the outcome. And it is:

* Voting Method - The rule by which we produce the outcome from all ballots submitted in election.

We will discuss several different voting methods, but before we proceed, let us look at some examples of Ballots.

Examples of Ballots

Single-choice ballot

CHOOSE 1 candidate
• Andrew
• Bob
✗ Catrin
• Dina

You just check one of them

Preference ballot 1

List in order of preference	
1 st	Catrin
2 nd	Bob
3 ^d	Andrew
4 th	Dina

Here you put
e.g. Catrin as 1st
Bob as 2nd
Andrew as 3^d
Dina as 4th

Preference ballots 2

Rank candidates in order of preference	
Andrew	3
Bob	2
Catrin	1
Dina	4

Here you enter numbers reflecting your preference
This table matches the previous (2)

- The most common voting method is the "Plurality Method".

This method can be used only for the winner-only elections and it just counts how many times each of the candidates was chosen as a top preference on a ballot and then selects a candidate with the maximal number.

Example 1: In an election of the president of a high-school council we have 4 candidates (Aisha, Bob, Chris, Dina) and 40 voters, out of which 15 vote for Aisha, 10 for Chris, 11 for Dina, 4 for Bob. So, we see that Aisha got more votes than any other candidate.

Outcome: Aisha wins.

Example 2: Same problem but with preference ballots (1st kind)

Number of Voters	15	10	11	4
1 st	A	C	D	B
2 nd	B	B	B	C
3 rd	C	D	A	D
4 th	D	A	C	A

This diagram encodes all ballots (there $15+10+11+4=40$ of them),

← i.e. 15 voters voted as in column 1
 10 -"- 2
 11 -"- 3
 4 -"- 4

If we still use the "Plurality Method", then we actually do not care about rows 2,3,4: all we need to know is that 15 people voted for A, 10 - for C, 11 - for D, 4 - for B.

* There are several problems with this method:

1) The winner does not necessarily have $>50\%$ of votes (in the above example A got 15 votes, which is less than $\frac{1}{2} \cdot 40 = 20$)

2) Sometimes voters know that someone they prefer the most does not have any chances to win, and hence are forced to vote for someone else they think has higher chances.

3) There might be another candidate who is more preferable by all voters (compare A vs B)