

Population	Age(Months)	Birthrate	Survival Rate
10	0-3	0	.6
10	3-6	.3	.9
10	6-9	.8	.9
10	9-12	.7	.8
0	12-15	.4	.6
0	15-18	0	0

1. What is the Population Matrix? $P_0 = [10 \ 10 \ 10 \ 10 \ 0 \ 0]$

2. What is the Leslie Matrix?

$$L = \begin{bmatrix} 0 & .6 & 0 & 0 & 0 & 0 \\ .3 & 0 & .9 & 0 & 0 & 0 \\ .8 & 0 & 0 & .9 & 0 & 0 \\ .7 & 0 & 0 & 0 & .8 & 0 \\ 0 & 0 & 0 & 0 & 0 & .6 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

3. How long is each cycle?

3 months

4. Find the number of babies, survivors and the total population after 3 months, 15 months and 30 months. Make sure to show all matrices involved in calculations and answers.

$$P_1 = P_0 L = [18 \ 6 \ 9 \ 9 \ 8 \ 0]$$

Babies: 18
Survivors: 32
Total: 50

$$P_3 = P_0 L^3 = [18.6 \ 10.3 \ 8.7 \ 9.0 \ 7.0 \ 2.3]$$

Babies: 18.6
Survivors: 37.3
Total: 55.9

$$P_{10} = P_0 L^{10} = [21.2 \ 12.4 \ 10.7 \ 9.3 \ 7.4 \ 4.3]$$

Babies: 21.2
Survivors: 44.1
Total: 65.3

Name Key

WU Day 72

12/16/16

1. Arrow's Impossibility Theorem states that any voting system can give undesirable outcomes. Explain what this means. *No voting system is perfect. All voting systems have flaws.*

2. There are 18 delegates to a political party's convention at which four people, A, B, C, and D, have been nominated as the party's candidate for governor. The delegates' preference schedule is shown below.

	Number of Delegates						
	8	9	4				
3 First choice	A	B	C	$\begin{array}{r} 24 \\ 18 \\ 4 \end{array}$	$\begin{array}{r} 16 \\ 27 \\ 8 \end{array}$	$\begin{array}{r} 9 \\ 12 \end{array}$	$\begin{array}{r} 9 \\ 4 \end{array}$
2 Second choice	B	A	B				
1 Third choice	C	D	A				
0 Fourth choice	D	C	D				

A. What nominee would be elected if the party uses a Borda count?

B

B. What Candidate would win using the Hare Voting System?

B

A = 8 A = 8
B = 9 B = 13
~~*C = 4*~~

C. Which Candidate will win using Sequential Pairwise Voting

Agenda B-C-D-A

(B)

BC: 8/4 vs 9/4 (B)
~~*CD: 9/4 vs 4/4 (C)*~~
~~*BD: 5/4 vs 9/4 (B)*~~
~~*BA: 9/8 vs 4/8 (B)*~~

3. After their star pitcher moved to another town, the eight remaining members of the company baseball team needed to select a new pitcher. They used approval voting on the four prospects, and the results are listed below. An "X" indicates an approval vote.

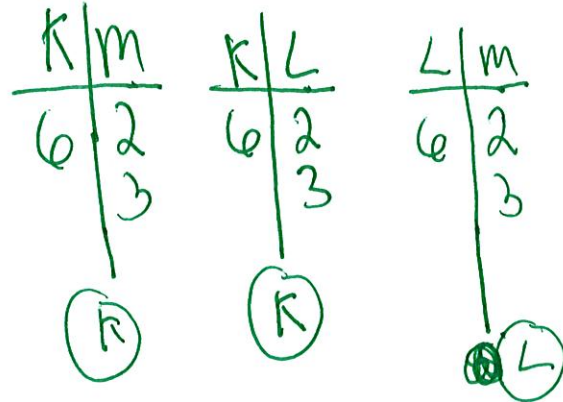
Alan	X	X			X	
Bob	X		X	X	X	X
Chuck		X		X		X
David		X	X		X	X

Which pitcher is chosen if just one is to be selected?

Bob

4. An 11-member committee must choose one of the four applicants, K, L, M, and N, for membership on the committee. The committee members have preferences among the applicants as given below.

	Number of Members		
	6	2	3
First choice	K	M	M
Second choice	L	L	N
Third choice	N	K	L
Fourth choice	M	N	K



- A. Is there a Condorcet Winner? If so, who?

Yes, K ~~is~~ wins against all opponents.

5. Eight board members vote by approval voting on four candidates, A, B, C, and D, for new positions on their board as indicated in the following table. An "X" indicates an approval vote.

	Voters							
	1	2	3	4	5	6	7	8
A	X	X	X	X		X	X	X
B		X	X		X	X		X
C		X		X	X		X	X
D	X		X	X	X	X	X	

- A. Which candidate will be chosen for the board if just one of them is to be elected?

A

- B. Which candidate(s) is (are) elected if 80% approval is necessary and at most two are elected?

A

1. Explain why majority rule is not a good way to choose among four alternatives.

Its possible that none of the four will get a majority. The more people, the less the likely to get majority.

2. In order to choose which type of music to listen to in a student center music lounge, a Condorcet vote is held by the 15 students present. Below are the preference schedules for the students. Is there a Condorcet winner and if so, which music type?

	Number of Students		
	6	5	4
First choice	classical	rock	rock
Second choice	jazz	jazz	classical
Third choice	rock	classical	jazz

R	C
5	6
4	
9	6
(R)	

R	J
5	6
4	
9	6
(R)	

Rock is Condorcet

3. A poll by 15 sports announcers chooses the best basketball team from among three schools: University of Nevada at Las Vegas (LV), University of North Carolina (NC), and Indiana University (IU).

	Number of Announcers			
	5	6	2	2
First choice	LV	NC	IU	NC
Second choice	IU	LV	NC	IU
Third choice	NC	IU	LV	LV

- A. If the individual rankings are as summarized in the table, which team wins if they use a rank method that assigns 2, 1, and 0 point(s) to each first, second, and third choice respectively? Which method is this that is being used?

Borda Count

- B. If the plurality method is used, who is selected?

North Carolina

LV = 5
NC = 8
IU = 2

4. Seventeen board members vote on four candidates, A, B, C, or D, for a new position on their board. Their preference schedules are shown below.

	Number of Members		
	7	6	4
First choice	A	D	C
Second choice	B	A	B
Third choice	C	B	D
Fourth choice	D	C	A

A. Which candidate will be selected if they use the Hare system?

Handwritten calculations for the Hare system:

- Initial counts: A=7, B=6, C=4, D=6
- Diagram showing B and C being eliminated.
- Revised counts: A=7, D=10
- Final result: **D** (circled)

B. Using the Hare system according to the preference schedules shown, what happens if A rejects the offer before the ranking?

Handwritten calculations for the Hare system with A's rejection:

	7	6	4
1st	B	D	C
2nd	C	B	B
3rd	D	C	D

Handwritten counts: B=7, C=4, D=6

Final result: **B** (circled)

5. Consider the following preference table:

	Number of voters			
	4	6	8	4
3 First choice	D	C	A	B
2 Second choice	C	B	D	A
1 Third choice	B	D	C	C
0 Fourth choice	A	A	B	D

Which candidate will be chosen if the Borda count is used?

Handwritten Borda count calculation:

	A	B	C	D
0		4	8	12
0		12	18	6
24		0	8	16
8		12	4	0
32		28	38	34

Final result: **C** (circled)

DISCRETE Chapter - VOTING

Key

Use the following preference schedule to answer questions #1 - 10:

Voters	8	5	6	3	9
1st	A	A	B	C	D
2nd	B	D	C	B	B
3rd	C	C	D	A	A
4th	D	B	A	D	C

1) How many candidates are in this election?

4

2) How many distinct ballots were cast?

5

3) How many people voted in this election?

31

4) Using the plurality method, who is the winner?

A = 8
B = 6
C = 3
D = 7

A

6) Using the method of pairwise comparisons, who is the winner?

A vs B
B

A vs C
A

A vs D
A

B vs C
B

B vs D
B

C vs D
C

B

7) Using the

Borda Count ranking method, which candidate

comes in last place?

E = 51
8 · 3 = 24
5 · 2 = 10
6 · 0 = 0
3 · 1 = 3
9 · 1 = 9

F = 58
8 · 2 = 16
5 · 0 = 0
6 · 3 = 18
3 · 2 = 6
9 · 2 = 18

G = 34
8 · 1 = 8
5 · 1 = 5
6 · 2 = 12
3 · 3 = 9
9 · 0 = 0

D = 43
8 · 0 = 0
5 · 2 = 10
6 · 1 = 6
3 · 0 = 0
9 · 3 = 27

C comes in last place

9) Which of the candidates was the Majority candidate?

None

10) Which of the candidates was the Condorcet candidate?

B

MA 111-Introduction to Contemporary Mathematics
Voting Theory
Worksheet # 1

Derek is running congress. His campaign advisers must decide on a keystone issue for the campaign. The 10 advisers each rank the following issues in order of importance: Environmental and Energy Policy, Immigration Policy, Marriage Policy, and Tax Policy. A preference schedule of how the advisers voted is given below.

	4	2	1	3	
3	1st	E	M	T	I
2	2nd	T	E	M	M
1	3rd	M	I	I	T
0	4th	I	T	E	E

1. Which issue wins using the *Plurality Method*?

E

2. Is there a majority winner? Why or why not?

No; because no voter has over 50% 1st place votes.

3. Which issue wins under the *Borda Count Method*?

E = 16

$$\begin{aligned} 4 \cdot 3 &= 12 \\ 2 \cdot 2 &= 4 \\ 1 \cdot 0 &= 0 \\ 3 \cdot 0 &= 0 \end{aligned}$$

M = 18

$$\begin{aligned} 4 \cdot 1 &= 4 \\ 2 \cdot 3 &= 6 \\ 1 \cdot 2 &= 2 \\ 3 \cdot 2 &= 6 \end{aligned}$$

T = 14

$$\begin{aligned} 4 \cdot 2 &= 8 \\ 2 \cdot 0 &= 0 \\ 1 \cdot 3 &= 3 \\ 3 \cdot 1 &= 3 \end{aligned}$$

I = 12

$$\begin{aligned} 4 \cdot 0 &= 0 \\ 2 \cdot 1 &= 2 \\ 1 \cdot 1 &= 1 \\ 3 \cdot 3 &= 9 \end{aligned}$$

M is Winner

4. Which issue wins using the *Pairwise Comparison Method*?

<u>E</u>	<u>M</u>
4	2
	1
	3

<u>E</u>	<u>T</u>
4	1
	2
	3

<u>E</u>	<u>I</u>
4	1
	2
	3

<u>M</u>	<u>T</u>
2	4
	3
	1

Tie

<u>M</u>	<u>I</u>
4	3
	2
	1

<u>T</u>	<u>I</u>
4	2
	1
	3

Tie

NO one mand E are tied.

5. Is there a *Condorcet Candidate*? Why or why not?

No, there was not a person that won all head to head matchups

6. Suppose Derek's campaign committee decides to make Environmental issues the keystone issue. Do you think that this is the right choice? If so, explain why. If not, explain which issue you would choose and why.

Based off previous questions either ~~E~~ E or M would be an ok choice. We may need to see other voting methods to produce a clear issues winner.

