



UCD Michael Smurfit  
Graduate Business School

## Group Assignment – Group 30

Assignment Topic	BINGO		
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Module Title	Programming for Analytics- 2022/23 Autumn		
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Lecturers	Dr. Miguel Nicolau and Ms. Bing Chen		
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Grade/Mark			

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**Declaration of Authorship**

I declare that all material in this assessment is my own work except where there is clear acknowledgement and appropriate reference to the work of others.

Name : Abhishek Sabharwal, Akhilesh Kapoor, Anushka Jain, Ayushi Gautam

Date : 29<sup>th</sup> November 2022

## Individual Contribution

Member Name	Contribution (%)	Responsibilities
Abhishek Sabharwal	25	<ul style="list-style-type: none"><li>• Logic formulation</li><li>• Code development</li><li>• Module compilations</li><li>• Testing and debugging</li></ul>
Akhilesh Kapoor	25	<ul style="list-style-type: none"><li>• Code development</li><li>• Error handling</li><li>• Game extensions</li><li>• Testing and debugging</li></ul>
Anushka Jain	25	<ul style="list-style-type: none"><li>• Code development</li><li>• Error handling</li><li>• Game extensions</li><li>• Testing and debugging</li></ul>
Ayushi Gautam	25	<ul style="list-style-type: none"><li>• Code development</li><li>• UML diagram</li><li>• Report</li><li>• Testing and debugging</li></ul>

# User Manual

## Libraries Included:

1. Numpy
2. Matplotlib
3. FPDF
4. Scipy
5. Warnings
6. Copy
7. Random
8. Pandas
9. Math

To include the above libraries, please execute the following on your Terminal/PowerShell before running the program:

1. pip install numpy
2. pip install matplotlib
3. pip install fpdf
4. pip install scipy
5. pip install pandas

## Assumptions:

1. The grid size is restricted to a square shape to enable diagonal bingos with minimum grid size 3.
2. The grid size ( $n$ ) can only be odd, to place the default free cell in the centre of the ticket.
3. The number of free cells are restricted to ' $n - 2$ ' to make sure the game does not end soon.
4. The free cells are placed in such a way that no two free cells are in the same row, column or diagonal.
5. The default setting is provided for grid sizes 3, 5, 7, and 9. The range is set for a lower default range to 1 and the upper default range to  $(n^2) * 3$ .
6. The range can only have positive whole numbers.
7. All the numbers crossed are replaced with zero.
8. The column range is set to the total number range divided by grid size.  
e.g. A 7\*7 grid with a number range from 1-77 will have a number range in column 1 from 1-11, column 2 from 12-22 and so on.

## Default Settings:

The default settings of user input have been set as below:

Grid size	Lower limit	Upper limit	Number of free cells
3	1	27	1
5	1	75	1
7	1	147	1
9	1	243	1

## User Input Terminologies

The game begins with a few user inputs which can be selected as default also. They are:

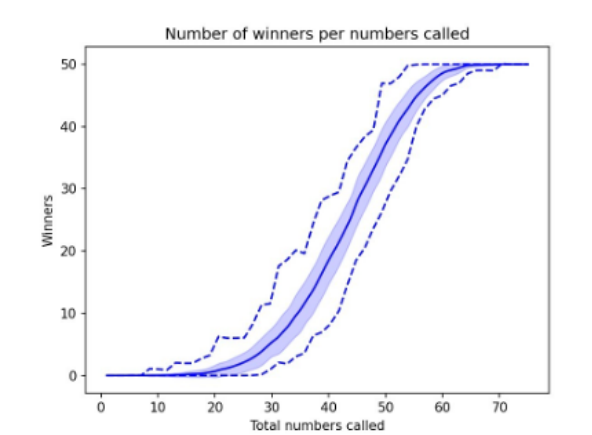
1. Number of players – It specifies the number of tickets that will be generated for all simulations.
2. Number of simulations – It specifies the total number of rounds for which the game will be played.
3. Grid size – The bingo card will be created as  $n * n$  matrix depending upon user input  $n$ . As mentioned in the assumptions, the grid size would be a square matrix where  $n$  is an odd number greater than 3 and preferably less than 25. A display message is prompted if invalid input is entered. For the default option, the user would have 4 choices with grid sizes 3, 5, 7, and 9.
4. Free cell – For the default settings option in the menu, one free cell would be placed in the centre whereas for customizing the input option, the user is given a choice to input the number of free cells. In this case, a display message is prompted if the user enters free cells greater than  $n-2$  where  $n$  is the grid size. We have devised a logic of free cell placement in such a way that no two free cells are placed in the same row, column or diagonal.
5. Range – We are allowing the user to enter the lower and upper limits of the range that will be displayed in cards for the customized option in the menu.

## Result:

1. Ticket PDF - A ticket will be generated for each player to play as per the inputs given by the user and will be exported in a PDF format. Below is the sample PDF ticket for a 5 \* 5 grid with user input values.

Ticket Number 1				
[ 15	21	33	59	61]
[ 3	20	35	53	69]
[13	25	0	55	64]
[ 5	30	37	47	74]
[ 1	27	43	51	73]

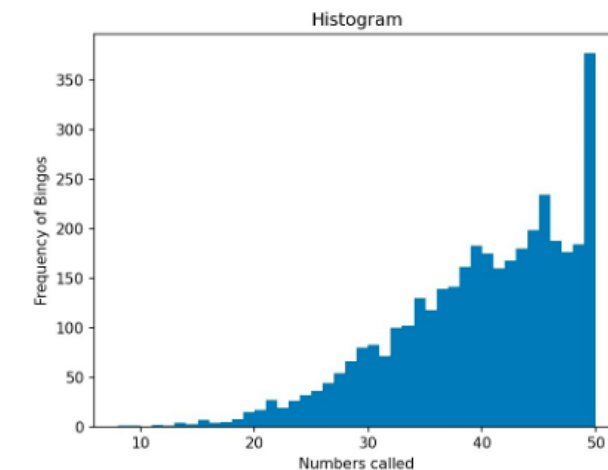
2. Line Plot - The plot shows the average number of bingos depicted in a solid blue line, the minimum and the maximum number of winners observed in dashed lines and the standard deviation in the shaded region across all simulations at each number called.



3. Centrality - The total number of bingos in all simulations at  $n$  numbers called will be represented statistically by the mean, median, 25<sup>th</sup> and 75<sup>th</sup> percentile, skewness, and kurtosis with the result being exported to an excel file.

	A	B	C	D	E	F	G
1	Numbers Called	Mean	Median	Quartile 1	Quartile 3	Skewness	Kurtosis
2	1	0	0	0	0		
3	2	0	0	0	0		
4	3	0	0	0	0		
5	4	1.28	0	0	2	1.462325809	0.701652936
6	5	3.6	3	0	6	0.715217157	-0.468300475
7	6	6.946666667	7	3	10	1.051595578	2.375628861
8	7	11.186666667	11	8	14	1.021787319	2.483075848
9	8	16.973333333	17	12	20	0.688803567	0.90245806
10	9	23.693333333	24	19	29	0.140996964	0.035628378
11	10	31.573333333	32	25	35	0.279057173	0.31319573
12	11	39.733333333	39	33	46	0.036620223	-0.857705115
13	12	47.493333333	46	41	53	0.244125667	-0.53462892
14	13	55.333333333	56	49	61	0.44391984	-0.081004331
15	14	61.826666667	61	55	68	0.521018227	-0.135869243
16	15	69.266666667	69	64	75	0.328100864	-0.643603957
17	16	75.24	75	71	80	-0.023240658	-0.530632479
18	17	81.16	82	76	85	-0.056889303	-0.651568275
19	18	85.933333333	86	83	89	-0.004143521	-0.526202823
20	19	89.613333333	90	87	92	0.065489412	-0.666881695
21	20	93.226666667	93	91	95	0.052950354	-0.477757111
22	21	95.933333333	96	94	98	-0.189836117	-0.875190776
23	22	97.546666667	98	97	99	-0.561981328	-0.28790138
24	23	98.786666667	99	98	100	-0.780271931	0.064030158
25	24	99.506666667	100	99	100	-1.972856173	4.57178404
26	25	99.853333333	100	100	100	-2.649070336	6.602561852
27	26	99.946666667	100	100	100	-3.975718555	13.80633803
28	27	100	100	100	100		
29	28	100	100	100	100		
30							
31							

4. Histogram - This illustrates the number of bingos from all simulations till  $x$  numbers called where  $x$  is specified by the user. Histogram will only be shown if there are bingos when  $x$  numbers have been called.



# UML Activity Diagram

