Dice and Coin Simulations

using random numbers on a spreadsheet

The aims of this session are to enable you to use a spreadsheet to

- simulate throwing dice and tossing coins,
- record your results in a table,
- illustrate your results graphically,
- make comparisons between observed and expected frequencies.

Random Numbers

Random numbers are generated using the function =RAND() as follows:

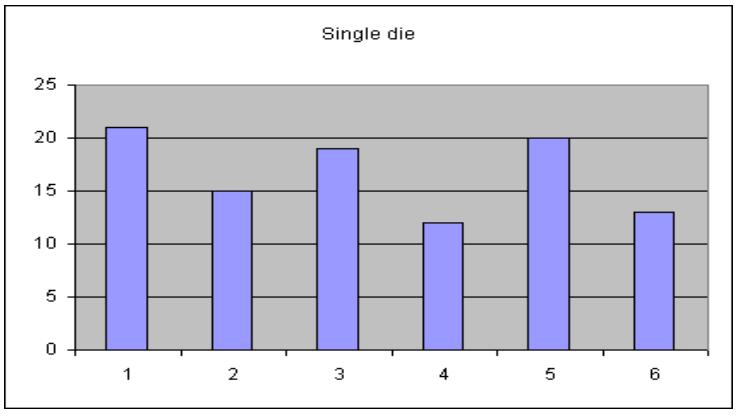
Random number	*Format*	*Example*
Decimal in range 0 to 1	=RAND()	0.2341232786
Decimal in range 0 to 6	=6*RAND()	1.404739672
Integer 0, 1, 2, 3, 4 or 5	=INT(6*RAND())	1
Integer 1, 2, 3, 4, 5 or 6	=INT(6*RAND())+1	2
Integer 0 or 1	=INT(2*RAND())	0

Simulating dice throwing (1): Single die

- Design a spreadsheet to simulate the throwing of a die 100 times.
- Record your results as indicated below.
- Use the function =COUNTIF(Start cell : Finish cell , *x*-cell) to record the frequency of each *x*-value.
- Use the "chart wizard" to produce a bar chart to illustrate the frequency distribution.

	Dice score
1	6
2	5
3	2
4	2
5	6
6	6
7	1
8	6
9	1
10	5
11	5
12	3
13	5
14	3
15	4
16	1
17	3
18	2
19	5
20	3
etc.	etc.

x	*f*
1	21
2	15
3	19
4	12
5	20
6	13
Total	100



Simulating dice throwing (2): Sum of two dice

Make a copy of the first spreadsheet and modify it to do the following:

- Design a spreadsheet to simulate the throwing of two dice 100 times.
- Record your results in two columns.
- Add a column to represent the total of the two scores.
- Use the function =COUNTIF(Start cell : Finish cell , *x*-cell) to record the frequency of each *x*-value, where *x* represents the total score.
- Use the "chart wizard" to produce a bar chart to illustrate the frequency distribution.
- Repeat the simulation many times by pressing F9.
- Which is the most popular total? Is it always the same? Should it be the same "in the long run"?
- Extend the simulation to 1000 pairs of values.
- Are there any differences between the pattern for 100 pairs of throws and 1000 pairs of throws?
- Complete the following table for the possible 36 possible totals when two dice are thrown:

+	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

- Use the table to generate a column of expected frequencies for your simulation.
- Plot both "observed frequencies" and "expected frequencies" on your chart.
- Are your "observed frequencies" similar to the "expected frequencies"?

Simulating dice throwing (3): Absolute difference of two dice

Make a copy of the second spreadsheet and modify it to do the following:

- Change the "total" column to an "absolute difference" column.
- Use the function =COUNTIF(Start cell : Finish cell , *x*-cell) to record the frequency of each *x*-value, where *x* represents the absolute difference between the scores.
- Use the "chart wizard" to produce a bar chart to illustrate the frequency distribution.
- Repeat the simulation many times by pressing F9.
- Which is the most popular difference? Is it always the same? Should it be the same "in the long run"?
- Extend the simulation to 1000 pairs of values.
- Are there any differences between the pattern for 100 pairs of throws and 1000 pairs of throws?

Pascal's Triangle

Design a spreadsheet to produce Pascal's Triangle, filling in automatically the empty boxes:

	0	1	2	3	4	5	6	7	8	9	10	Total
0	**1**											**1**
1	**1**	**1**										**2**
2	**1**	**2**	**1**									**4**
3	**1**	**3**	**3**	**1**								**8**
4	**1**											
5	**1**					**1**						
6	**1**						**1**					
7	**1**							**1**				
8	**1**								**1**			
9	**1**									**1**		
10	**1**										**1**	

Simulating coin tossing (1): Number of heads from tossing 4 coins

Make a copy of the second spreadsheet and modify it to do the following:

- Design a spreadsheet to simulate the throwing of four coins 100 times, representing a 'tail' by 0 and a 'head' by 1.
- Record your results in four columns.
- Add a column to represent the total of the four scores.
- Use the function =COUNTIF(Start cell : Finish cell , *x*-cell) to record the frequency of each *x*-value, where *x* represents the number of heads.
- Use the "chart wizard" to produce a bar chart to illustrate the frequency distribution.
- Repeat the simulation many times by pressing F9.
- Which is the most popular number of heads? Is it always the same? Should it be the same "in the long run"?
- Extend the simulation to 1000 groups of tossing 4 coins.
- Are there any differences between the pattern for 100 groups and 1000 groups?
- Use a row of Pascal's Triangle to generate a column of expected frequencies for your simulation.
- Plot both "observed frequencies" and "expected frequencies" on your chart.
- Are your "observed frequencies" similar to the "expected frequencies"?

Simulating coin tossing (2): Number of heads from tossing 5 coins

Make a copy of the last spreadsheet and modify it to simulate the tossing of 5 coins, rather than 4 coins.

- What changes will you have to make to your previous spreadsheet?
- What differences are there in the expected outcomes for each number of heads?

COIN SIMULATION : Tossing 5 coins : Observed and Expected Frequencies

	1st coin	2nd Coin	3rd coin	4th coin	5th coin	Total
1	0	0	0	1	0	1
2	1	1	1	1	0	4
3	0	0	0	1	1	2
4	0	1	1	1	1	4
5	0	1	1	0	0	2
6	1	1	0	1	0	3
7	1	0	1	1	1	4
8	1	0	1	0	1	3
9	1	1	0	1	0	3
10	1	1	0	1	1	4
11	0	0	0	1	0	1
12	0	0	1	1	0	2
13	1	1	0	1	1	4
14	0	0	1	1	1	3
15	1	1	0	1	0	3
16	1	0	1	1	1	4
17	1	0	0	0	1	2
18	0	0	0	1	1	2
19	1	0	0	1	0	2
20	0	0	0	1	0	1
21	0	1	1	0	1	3
22	1	1	1	1	0	4
23	0	0	1	1	0	2
24	0	1	1	1	1	4
etc.	etc.	etc.	etc.	etc.	etc.	etc.

x	f observed	f expected
0	0	3.125
1	20	15.625
2	30	31.25
3	37	31.25
4	13	15.625
5	0	3.125
Total	100