Simulations & Probabilistic Models

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Agenda

- Purpose
- Simulations in Excel
- Assignments and Student Examples
- Extension Topics
- Creating Data from Probabilistic Models

Purpose

Build a simulation

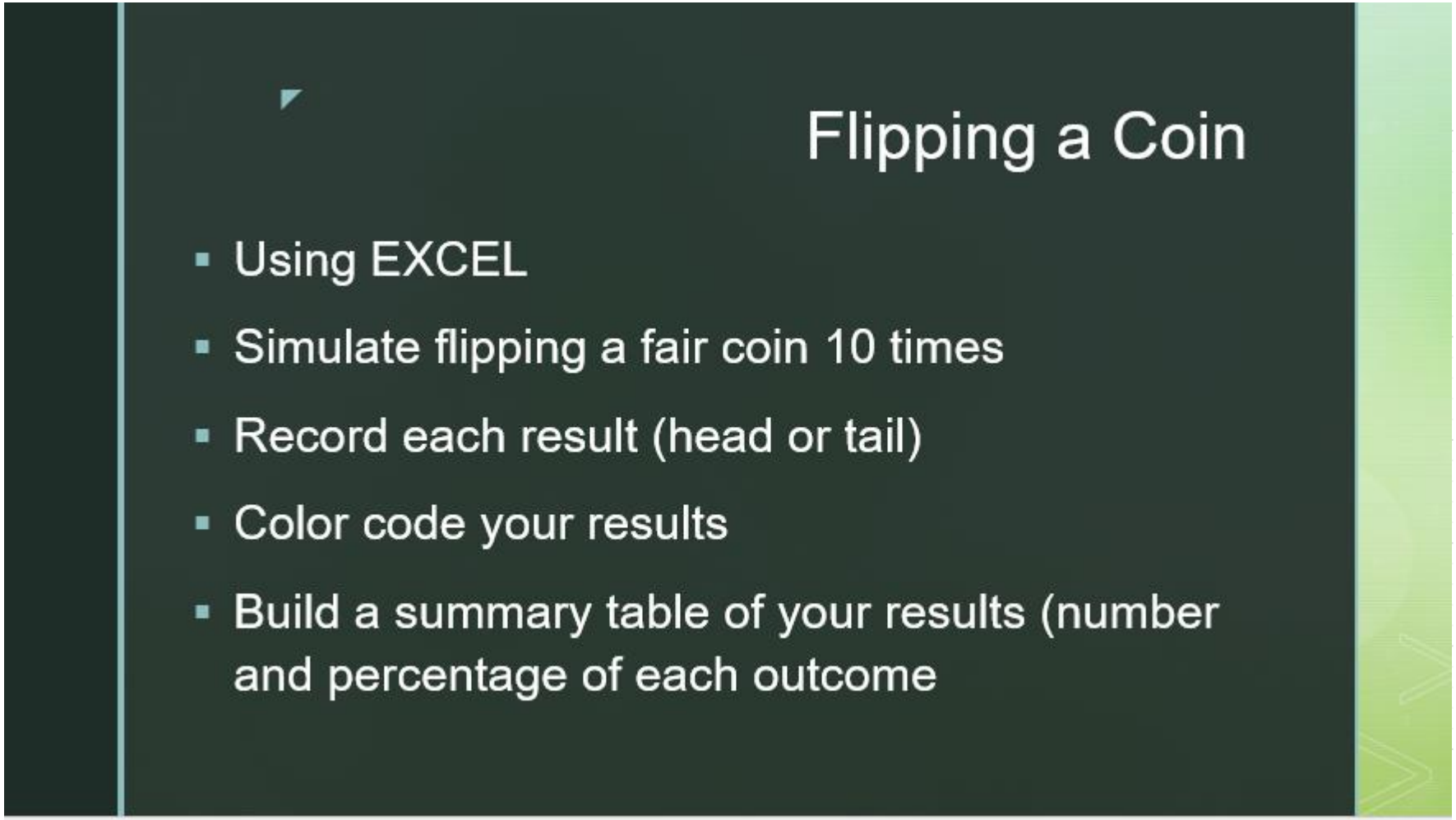
Model a probability (random) event

Improve Excel skills

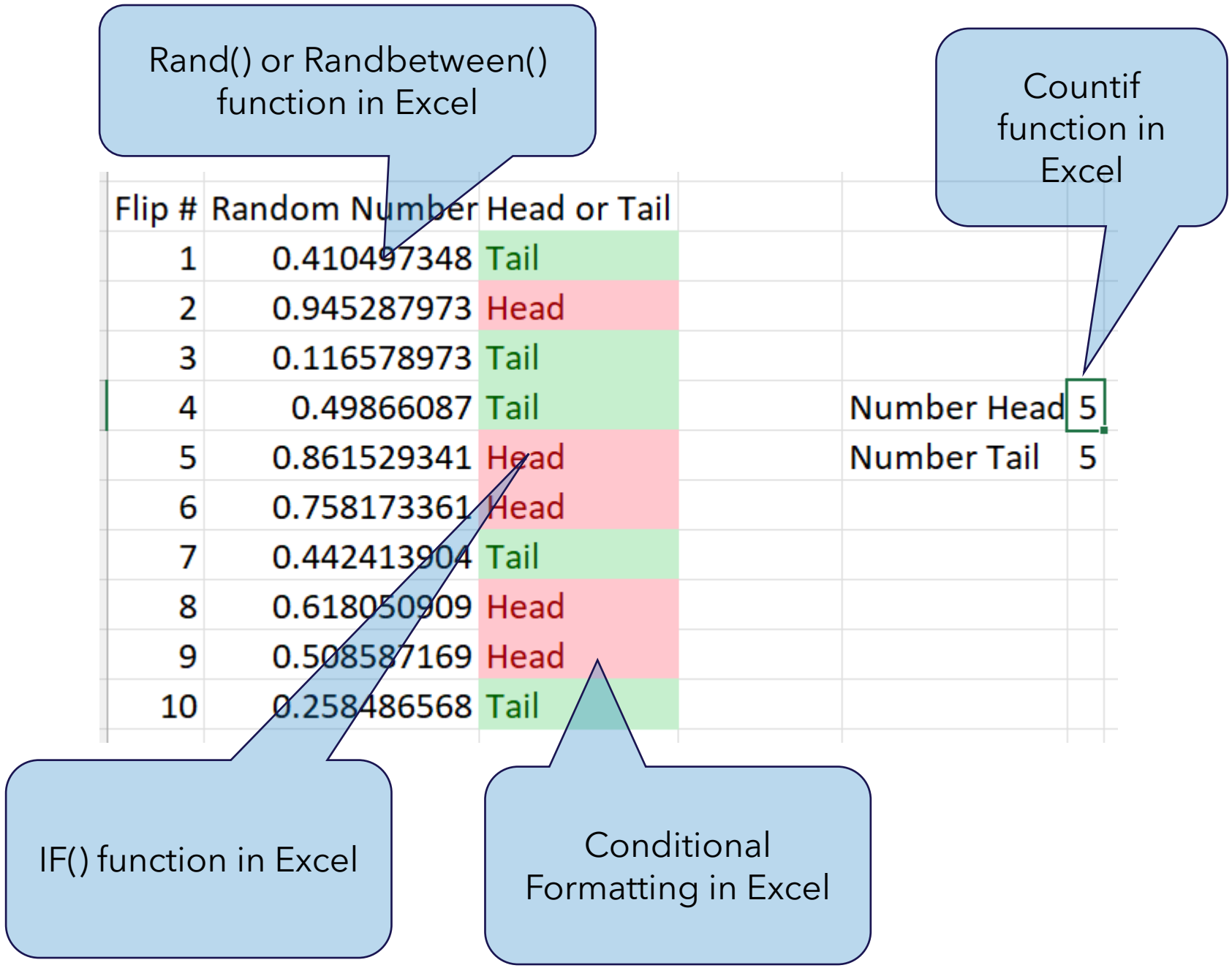
Build a Simulation

From Deterministic Models to Probabilistic Models

Actual Class Assignment



Answer


Rand() or Randbetween() function in Excel
Countif function in Excel
Flip # Random Number Head or Tail
1 0.410497348 Tail
2 0.945287973 Head
3 0.116578973 Tail
4 0.49866087 Tail
5 0.861529341 Head
6 0.758173361 Head
7 0.442413904 Tail
8 0.618050909 Head
9 0.508587169 Head
10 0.258486568 Tail
Number Head 5
Number Tail 5
IF() function in Excel
Conditional Formatting in Excel

Flipping a Coin Part 2

- Keeping everything from the first part of flipping a coin
- Change it for an unfair coin (70% chance of a head)
- Increase the number of flips to 1000
- Run 10 trials with recording your results from each trial of 1000 flips
- Build a summary output for your 10000 flips

Locking a cell & referencing that cell throughout the worksheet

	Prob of He	0.7					Overall Results				
							Head	6991	0.6991		
							Tail	3009	0.3009		
Table of results				Table of results				Table of results			
	Number	%age			Number	%age			Number	%age	
Head	716	72%		Head	714	71%		Head	707	71%	
Tail	284	28%		Tail	286	29%		Tail	293	29%	
	Trial 1				Trial 2				Trial 3		
Flip #	Rand #	Outcome		Flip #	Rand #	Outcome		Flip #	Rand #	Outcome	
1	0.787168	Head		1	0.999102	Head		1	**0.26129**	Tail	
2	0.504593	Head		2	0.48566	Head		2	0.439738	Head	
3	0.499249	Head		3	**0.255382**	Tail		3	0.945737	Head	
4	0.43283	Head		4	0.496566	Head		4	**0.235155**	Tail	
5	0.628816	Head		5	0.599471	Head		5	**0.05768**	Tail	
6	0.931964	Head		6	0.46501	Head		6	**0.069608**	Tail	
7	**0.16066**	Tail		7	0.475654	Head		7	0.975265	Head	
8	0.483285	Head		8	0.565425	Head		8	0.952123	Head	

Building Knowledge

Home Work

Roulette

https://www.youtube.com/watch?v=bNqs17-clm4

- You start with 100 Culver Bucks
- Pick a strategy to play Roulette
- Calculate your expected results
- Simulate the results for playing 1000 times
- Compare your results with your expected results

Student Examples

0.47368421	0.961883	Lose	100			Expected results:
prob of winning on red or	0.60088	Lose	98			Chance of winning: 9/19
black	0.669018	Lose	96			Chance of losing: 10/19
	0.380833	Win	94			In 19 trials, one will lose two dollars
	0.759043	Lose	96			E(x)= (2/19)*100
	0.261197	Win	94			E(x)= 10.5263158 dollars lost
	0.941961	Lose	96			
	0.581181	Lose	94			Percent error:
	0.02528	Win	92			100*(50-(-10.5263158))/(50) = 121% error
	0.756285	Lose	94			
	0.600409	Lose	92			
	0.984657	Lose	90			
	0.814087	Lose	88			
	0.176518	Win	86			
	0.465654	Win	88			

Output#	Bet on	Yes/No	Remain Money#	Validity		Winning chance	Loosing chance	
20	0	No	99			1/38	37/38	
14	0	No	98					
33	0	No	97			expected result	100-1000/38*2:	47.3684
10	0	No	96			actual result	136	
16	0	No	95			Percent error	1.871111175	
18	0	No	94					
8	0	No	93					
17	0	No	92					
21	0	No	91					
4	0	No	90					
19	0	No	89					
10	0	No	88					
15	0	No	87					
5	0	No	86					
3	0	No	85					
0	0	Yes	121					
9	0	No	120					
0	0	Yes	156					

Student Examples

1000 Trials of Roulette			Rule: First column of 2 to 1 (1,4,7,10,13...34)			
			Expected winning possibility: 12/38 =0.315789 = 31.5789%			
Trial #	Rand #	Outcome				
1	0.57320314	lose	Table of Results			
2	0.02782296	win		Number	%age	
3	0.52655285	lose	win	312	31%	
4	0.48654784	lose	lose	688	69%	
5	0.28993015	win				
6	0.15164657	win	Calculated winning possibility:			31%
7	0.52723597	lose	Difference (Expected-Calculated) =			0.378900%
8	0.4192702	lose				
9	0.62819612	lose				
10	0.77217815	lose				
11	0.81065493	lose				

Expected probability of winning should be 18/38, which is around 47%. This means that in 1000 games, there will be 470 wins and 530 loses. Supposing wins and loses happens alternatively, the maximum rounds the person can play is 950 rounds. However, the simulation shows that only using this strategy, the player is only able to play 98 rounds. The code automatically stops when it first hits zero.

simulation ros.py

C: > Users > mikey > Desktop > Honor in Math > advance math > simulation ros.py > ...

```
# always use bet 10 bucks on 1-18
import random
money = 100

for i in range (0, 1000):
    result = random.randint(1, 38)
    if money == 0:
        break
    if result < 19:
        money += 10
    else:
        money -= 10
    print("Round ",i+1, ": " ,end=" ")
    print(money)
print("the final round played is", i)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL JUPYTER

```
Round  76 :  60
Round  77 :  70
Round  78 :  60
Round  79 :  50
Round  80 :  60
Round  81 :  70
Round  82 :  60
```

Extension Topics

Probability or Decision Tree

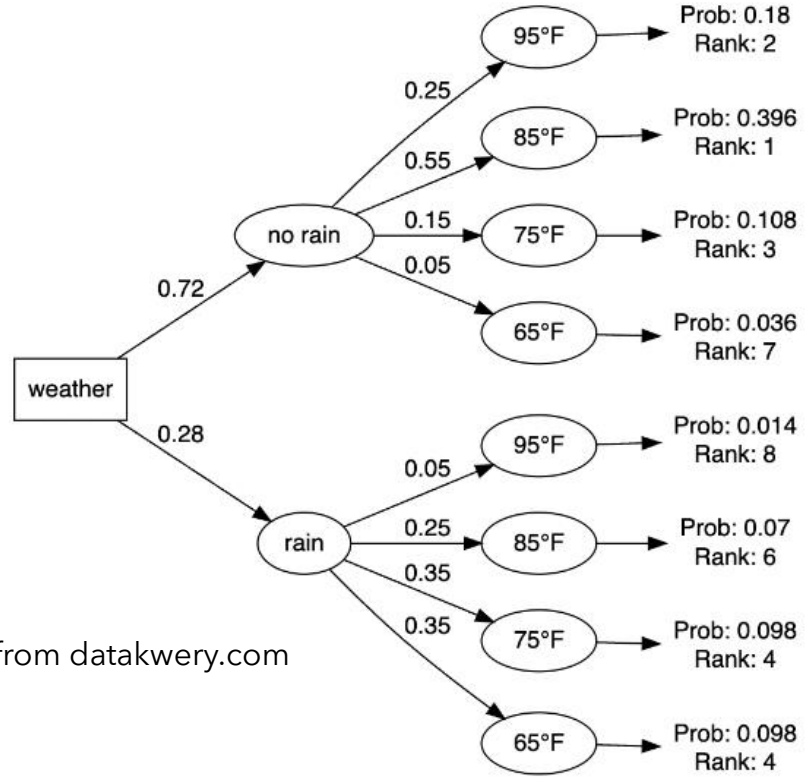
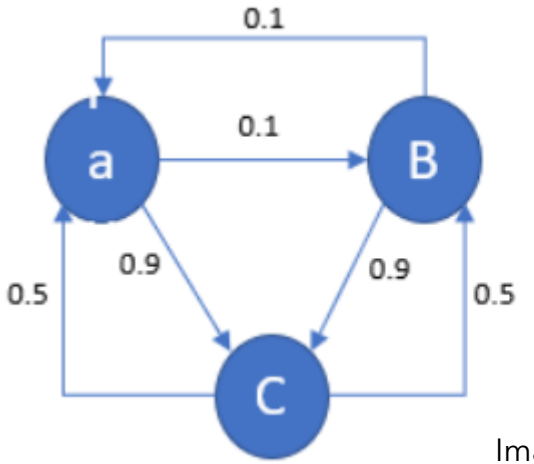


Image from datakwery.com

Markov Chain or Probability Transition Matrix



$$P = \begin{bmatrix} 0 & 0.1 & 0.9 \\ 0.1 & 0.0 & 0.9 \\ 0.5 & 0.5 & 0.0 \end{bmatrix}$$

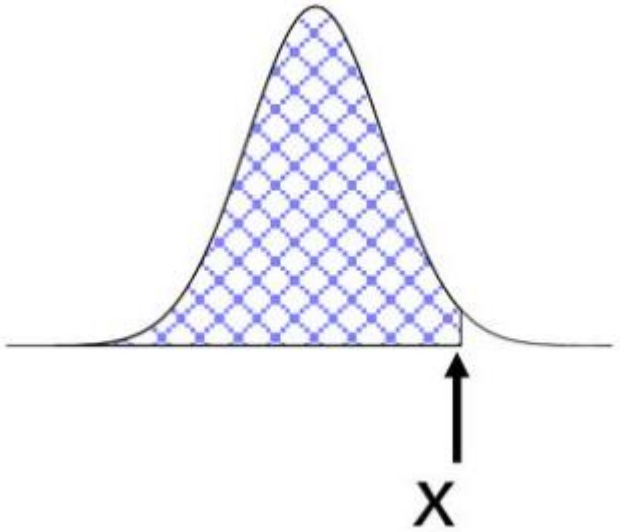
Image from Towardsdatascience.com

Linking with Binomial Distribution

Additional content

Using Random Number Generators to create data

- Given a NORMAL distribution, the total area under the curve is 1.
- Use Rand() in Excel to represent the area under the curve



- Use Norm.Inv in Excel
- Inputs are Probability or area, Mean, and Standard Deviation

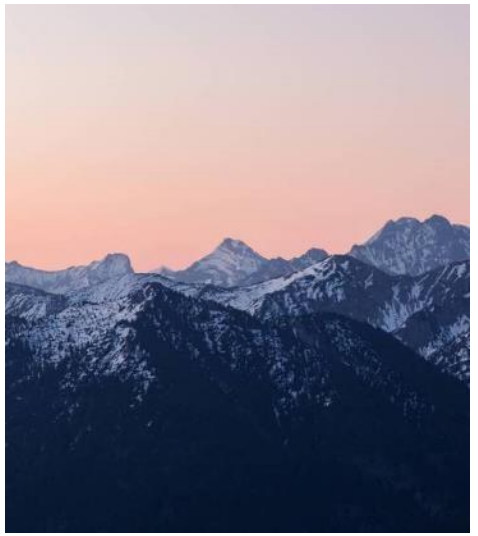
Summary

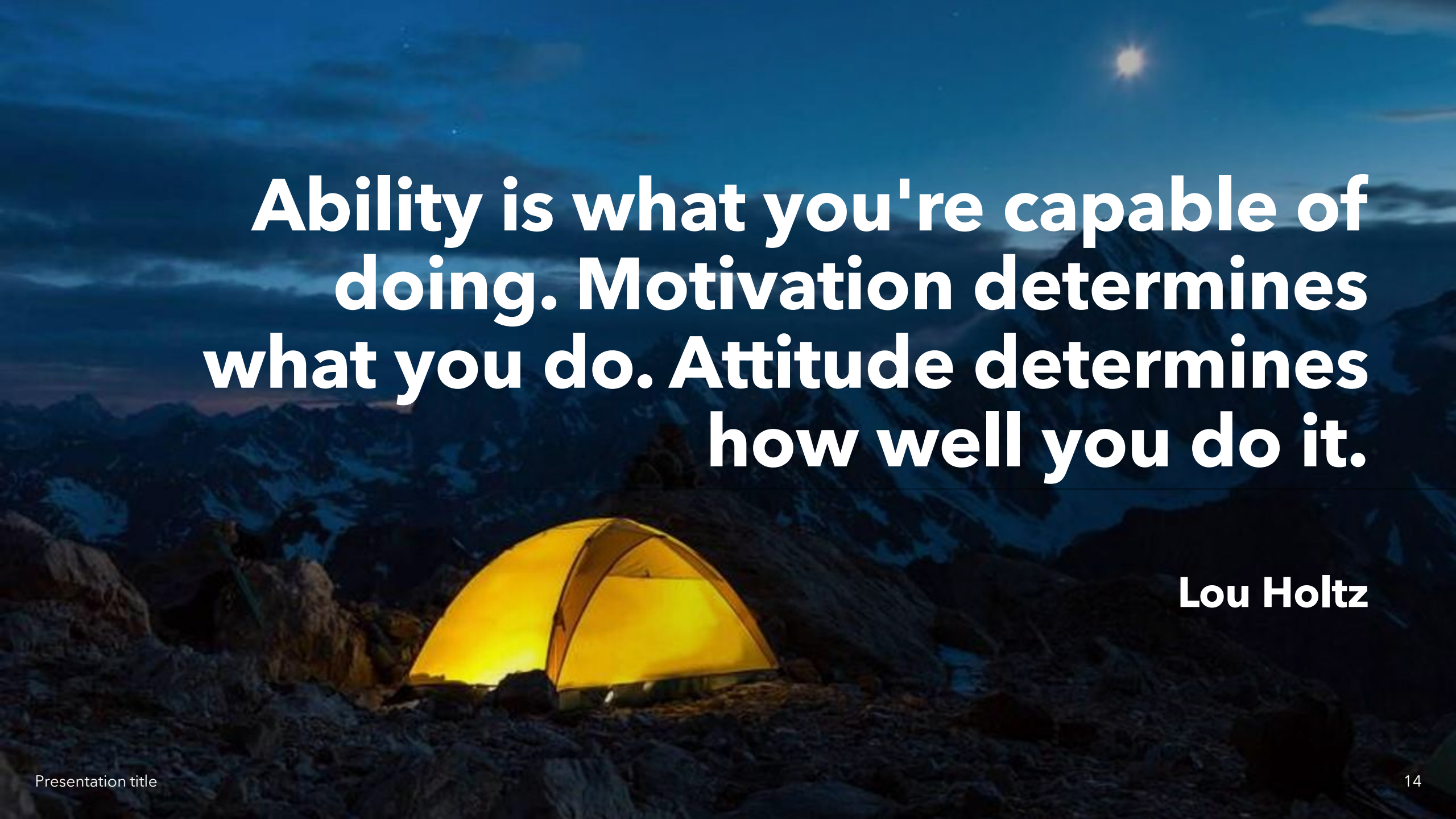
Simulations in Excel

Assignments and Student Examples

Extension Topics

Creating Data from Probabilistic Models




Ability is what you're capable of doing. Motivation determines what you do. Attitude determines how well you do it.
Lou Holtz

William Farmer

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Culver Academies

Thank you