Announcements

- **COME UP TO FRONT** and pick up a table (LAB 4) to turn in on at the **beginning** of Thursday's at Recitation!

- SL 4 + 5 on Thursday Feb 7
  - Percent change
  - Rankings + weighted averages
- Peer revisions in Lab 6, Feb 14--start working on your paper!
- Extra office hours Friday from 3-4 in C100WH

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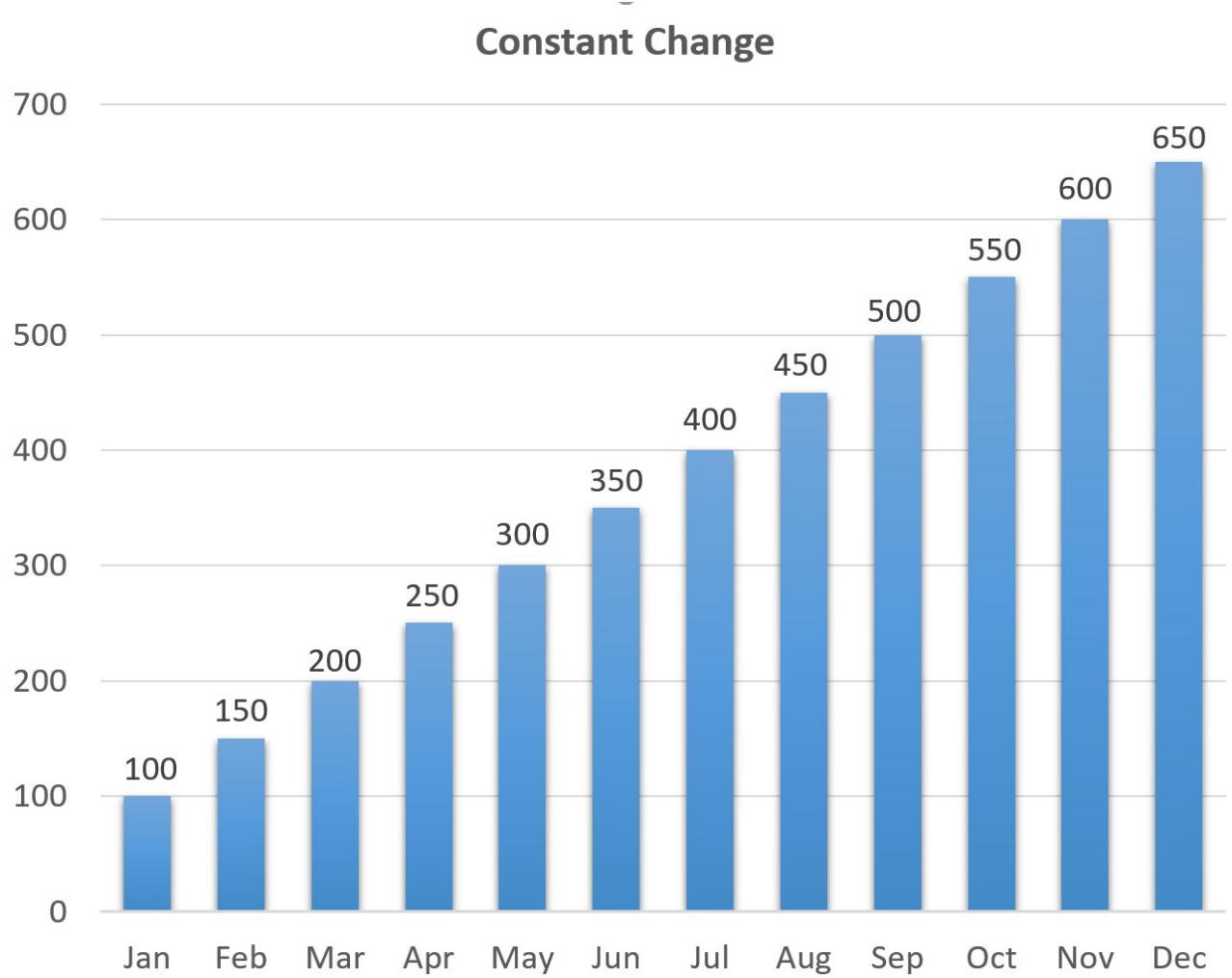
METRIC NAME	Weight	Negative or Positive?	Website used	Relative or Absolute?	How will you refine the metric if absolute?

Lecture 5

Linear + Exponential Models



Month	Savings
Jan	100
Feb	150
Mar	200
Apr	250
May	300
Jun	350
Jul	400
Aug	450
Sep	500
Oct	550
Nov	600
Dec	650

Linear Growth

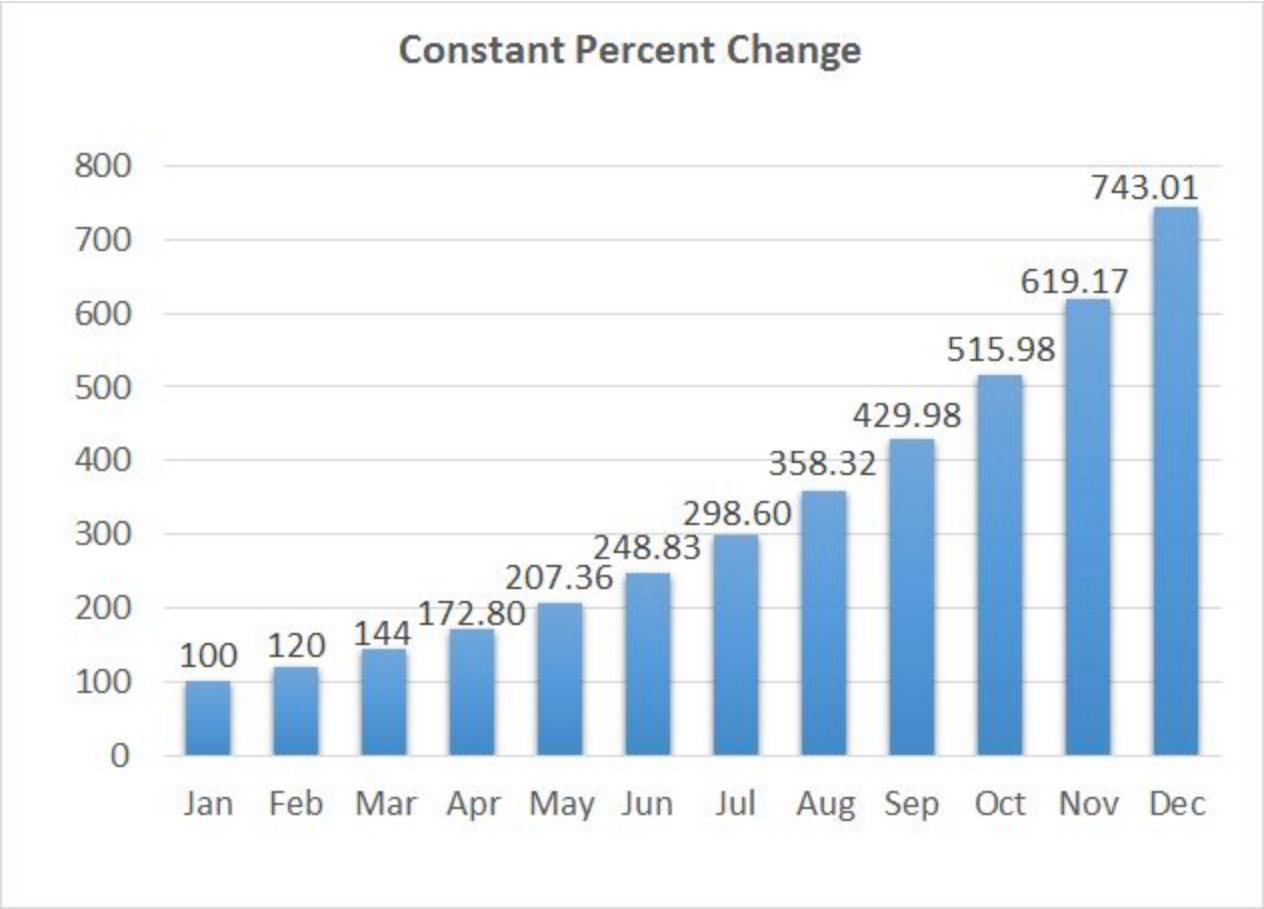
We saw the previous slide when discussing percent change.

This is CONSTANT growth-add $50 each time. Not CONSTANT percent change

Linear Growth

A function is called **linear** if it has a constant growth rate

From lecture 2: A person add $50 to their bank account every month.



Month	Investment amount
Jan	100
Feb	120
Mar	144
Apr	172.80
May	207.36
Jun	248.83
Jul	298.60
Aug	358.32
Sep	429.98
Oct	515.98
Nov	619.17
Dec	743.01

Exponential Growth

A function is called **exponential** if it has a constant percent growth rate

From lecture 2: A person adds 20% into their bank account every month

Would You Rather....

Option 1: Take $10,000 each day for 31 days?

OR

Option 2: Start with 1 penny in your account. The amount that you have in your account every given day is double what you had the previous day. For example, on day one your account contains 1 penny, on day two it contains 2 pennies, on day three it contains 4 pennies, and so on for 31 days.

Would you rather... Question 1- PollEverywhere

Make a guess for how much you would have on Day 31 choosing Option 1.

Would you rather... Question 2- PollEverywhere

Make a guess for how much you would have on Day 31 choosing Option 2.

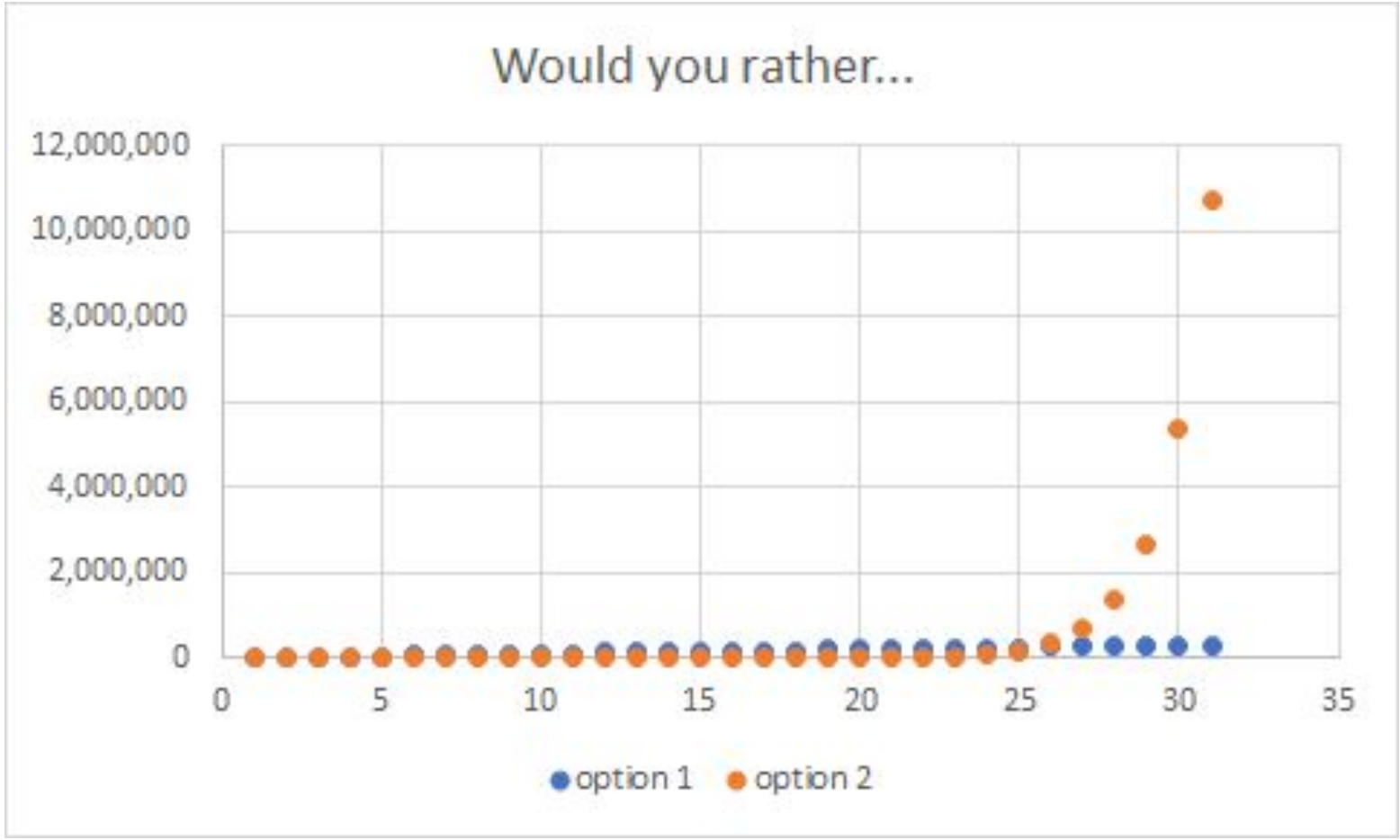
Review Using Excel….

What formulas should you use to get the correct values for the future days?

day	option 1	option 2
1	10,000	0.01
2		
3		

Let's look at the growth!

day	option 1	option 2
1	$10,000	$0.01
2	$20,000	$0.02
3	$30,000	$0.04
4	$40,000	$0.08
5	$50,000	$0.16
6	$60,000	$0.32
7	$70,000	$0.64
8	$80,000	$1.28
9	$90,000	$2.56
10	$100,000	$5.12
...	...	...
15	$150,000	$163.84
...	...	...
20	$200,000	$5,242.88
...	...	...
25	$250,000	$167,772.16
...	...	...
30	$300,000	$5,368,709.12
31	$310,000	$10,737,418.24


Would you rather...
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
0
5
10
15
20
25
30
35
option 1
option 2

Think about it...

- Is “doubling” actually exponential growth?

Example 1

In 2015, the world population was about 7.2 billion people. The current average population change is about 80 million people per year. Fill in the table below with the estimated populations based on this rate of growth. Plot the points.

Year	Population (in millions)
2015	
2016	
2017	
2018	
2019	
2020	
2025	
2030	
2035	

Example 1 cont …

Year	Population (in millions)
2015	7200
2016	7280
2017	7360
2018	7440
2019	7520
2020	7600
2025	8000
2030	8400
2035	8800

Example 2

The table gives the population of the US in millions for certain years. Find the population change.

Year	Approximate US population	Population Change
1960	181 million	
1970	205 million	
1980	228 million	
1990	250 million	
2000	282 million	
2010	309 million	

Example 2 cont...

Estimate the US population in 1995.

Estimate the US population in 2030.

Is the linear model a good model for population?

Year	Approximate US population	Population Change
1960	181 million	
1970	205 million	
1980	228 million	
1990	250 million	
2000	282 million	
2010	309 million	

Interpolation

Extrapolation

Example 3

The population of the world in 2016 was 7.4 billion and growing at a rate of 1.13% per year. Fill in the table below with that information.

Year	World Population (if the trend continues)	Work
2016	7400 million	
2017		
2018		
2019		

Example 3 cont...

Is this a good model for population?

Year	World Population (if the trend continues)	Work to get to next year
2016	7400 million	=1.0113 x 7400
2017	~7483.6 million	=1.0113 x 7483.86
2018	~ 7568.2 million	=1.0113 x 7568.2
2019	~7653.7 million	

PollEverywhere - Question 3

A population of eagles grows at a rate of 10 eagles per year. The growth is

A. Linear
B. Exponential
C. neither

PollEverywhere - Question 4

A population of bacteria grows at a rate of 15% per hour. The growth is

A. Linear
B. Exponential
C. neither

Percent Growth Formula

$$Q = Q_0 \times (1 + r)^t$$

Q = the value of exponentially going (or decaying) quantity at time *t*

Q_0= initial value of quantity (at *t=0*)

r = fractional / decimal growth rate (decay if r < 0)

t = time

Example 4

The 2010 census found a U.S. population of about 309 million, with an estimated growth rate of 0.9% each year. Write an equation for the US population in 2100.

Q_0

Q

r

t

Example 5

There are 100 bacteria in a jar growing at a rate of 5% per hour. When will the population be 200 bacteria? How long will it take for the population to reach 400 bacteria?

Key vocab

Interpolation

Extrapolation

Linear

Exponential

Doubling time

- Doubling is _____ percent growth

- Halfing is _____ percent decay

Example 6

A town with a population of 10,000 loses residents at a rate of 0.3% per month because of a poor economy. How many residents will be left after 5 months?

Q_0

Q

r

t