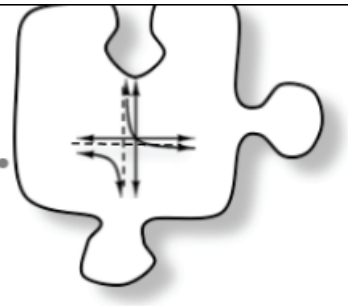
2.2.5 How can I model the relationship?



Developing a Mathematical Model

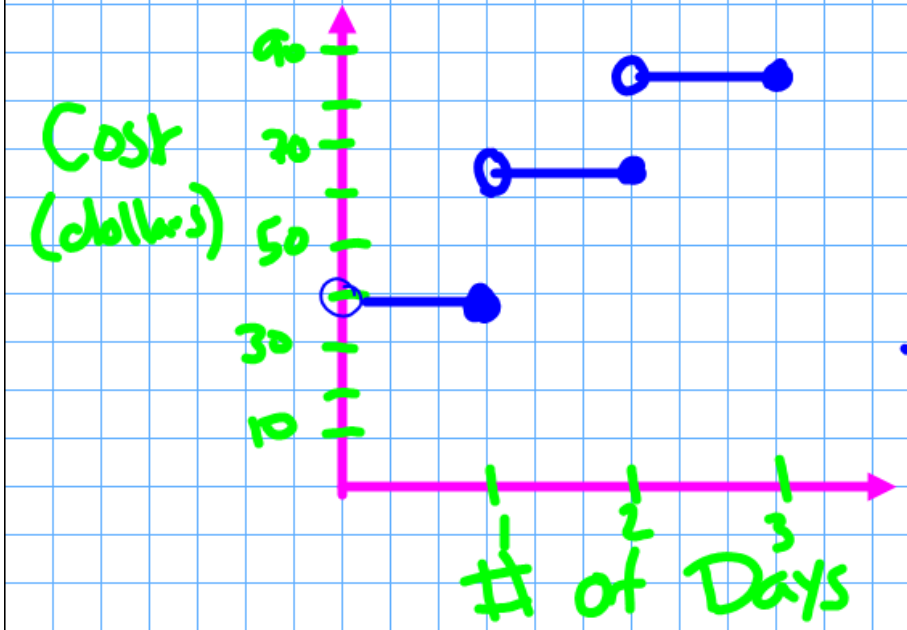
In Lesson 2.1.2 you modeled a variety of situations, including the jump of a jackrabbit and the path of a soccer ball, using quadratic functions. But, as you will see today, one step in creating a mathematical model is deciding what type of function or functions will best describe a relationship. In fact, some situations require us to piece together different functions, or to combine functions to model a situation completely and accurately.

2-109. At Zoom Rent a Car, the average cost to rent a car is \$39 for the first day and an additional \$23 for each additional day.

a. Make an accurate graph of this situation.

b. Write a complete description of your graph including the appropriate domain and range for this situation. What kind of function can you use to model the relationship between the price of renting a car and the number of days you rent it?

c. Write an equation or set of equations to model the relationship. Be sure to include the domain for each piece.



$D: \{x > 0\}$

$R: \{y = \$39, \$62, \$85, \ldots\}$

First Step: $y = 39$ $0 < x \leq 1$

Second Step: $y = 62$ $1 < x \leq 2$

Third Step: $y = 85$ $2 < x \leq 3$

2-111. The Marketing Director of Zoom Rent a Car, Tess LaCarre, has branched out to form a new company. Ms. LaCarre has created an app that allows its users to comparison shop for a rental car, but she is not sure whether the app should be free or not. She has hired your research team to make predictions about the future of apps in 2020, using the following data.

a. Graph the data on separate axes.

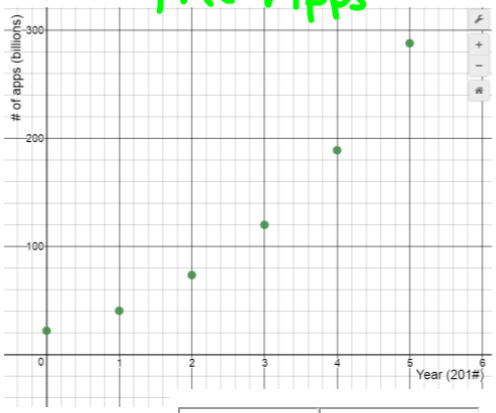
b. The **average rate of change** is the change in the dependent quantity divided by the change in the independent quantity for two distinct points on a graph (i.e., the slope of the line containing those points). Using the data in the tables, what is the average rate of change for each type of app from 2010 to 2015?

c. Can you use the average rate of change to help you predict the number of apps that will be downloaded in 2020? Why or why not?

Year	# of downloads of free apps (billions)
2010	22
2011	40.5
2012	73.5
2013	120
2014	189
2015	288

Year	# of downloads of paid apps (billions)
2010	3
2011	5
2012	8
2013	12
2014	16.5
2015	22

Free Apps



Year	# of downloads of free apps (billions)
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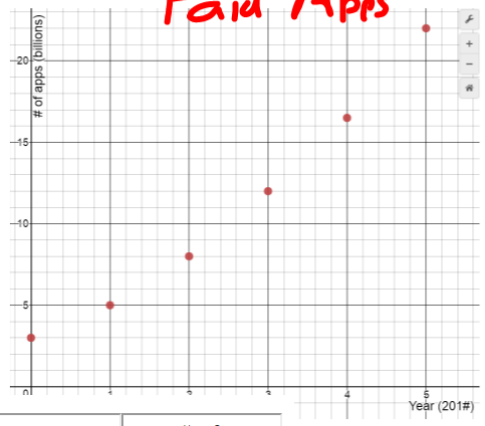
Paid Apps



Year	# of downloads of paid apps (billions)
2010	3
2011	5
2012	8
2013	12
2014	16.5
2015	22

Avg. Rate of Change = $\frac{288-22}{2015-2010}$

$= \frac{266}{5}$

$= 53.2$ billion downloads per year

Avg. Rate of Change = 3.8

2-112. Think about what type of model would you use to model the number of downloads over time for each type of app.

a. Write a function to model the number of free apps downloaded based on the year. Graph your function with the data. Justify why you chose your particular model.

b. Write a function to model the number of paid apps downloaded based on the year. Graph your function with the data. Justify why you chose your particular model.

c. Use each of your models to calculate the average rate of change from 2010 to 2015.

d. Based on your models, how many free apps will be downloaded in 2020? How many paid apps? Are your predictions reasonable?

e. Based on your analysis, what recommendation would you make to Ms. LaCarre? What other information does she need to make an informed decision?

Free Apps

Linear: $y = 52.057x - 7.976$

Quad: $y = 9.759x^2 + 3.263x + 24.555$

y=ax+b
a=52.05714286
b=-7.976190476

QuadReg
y=ax²+bx+c
a=9.758928571
b=3.2625
c=24.55357143