FUNCTIONS AND MODELS

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We'll be starting with a new topic concept for these videos.

Now, in this round of videos, we'll be investigating the idea of modeling.

We'll start off with a discussion of linear models,

move on into exponential models (including both exponential growth

and exponential decay), and finally we'll

Help

talk about logistic growth models.

Now, to get started in this new topic of conversation,

we'll need to investigate two basic ideas: the idea of a function

and the idea of a model.

And to get there, we'll start off with a question.

That's a pretty specific question.

And to get there we'll need to cover some basics first.

First let's talk about the idea of a function.

A function is actually very simple: you take some kind of Input

and you get some kind of Output.

So the Output is, in fact, a function of the Input.

Think about a soda machine, you put in your money, and you hit a button,

and you get a single can of soda out.

In this way, the soda machine is acting like a function: button press, soda.

But here's an important catch: you can only

get ONE specific output from any specific input.

You push the button for Sprite, and you need to reliably get Sprite each

and every time - not one time Sprite and one time water and one time Coca-Cola.

Now when it comes to describing functions,there are in fact several

different ways that we can do so: these include words, a table, a graph,

or a formula.

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Let's describe a function using words first.

Here we go.

On a local street in Austin, there is a food stand.

To sell coffee to students passing by, the vendor

incurs a cost for each cup of coffee sold.

To cover the cost for the amount of coffee sold, the vendor starts at $50

and for every cup of coffee sold, adds 25 cents.

If we wanted to describe this function as a table

we might see something like this.

We can also visualize our function with a graph

that might look something like this.

And finally we can represent our function with a formula that would look

like this: cost as a function of cups sold,

after taking into account an initial "set-up" cost.

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In this case, our function is a linear function.

But we'll talk more about that later.

Now a function is really just a expression.

A way to describe - in several different ways - the "idea" of data.

Sometimes that idea is very straight forward;

our street coffee vendor cost is very straight forward.

And I might actually be hard pressed to say

that this is real "data" in the truest sense.

But what about some actual data?

Here's a graph representing the grip strength of 20 college age

students for both their preferred and nonpreferred hands.

We can see that there's a relationship.

We can even see that this relationship is in fact linear.

Now here's the cool part - can we MODEL this relationship?

Sure - we can find r (the Pearson Correlation Coefficient)

because we satisfy our linearity assumption.

We can say that there's a very strong relationship of 0.971.

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But can we do more?

Can we give our reader a sense of what's really

happening like we did with our coffee vendor?

Well, in order to do that, we need a model.

For this course, there will in fact be three models that we'll focus on.

But, for right now, let's find the linear model to this data.

We can ask RStudio to do this for us.

Now do you notice anything?

How about now?

Our model to this data is really just a function.

It says: to predict the outcome of non-preferred hand strength,

start with a line at (0, 3.6) and for every unit increase

in X (our Preferred Hand Strength value) we increase

by 0.825 units of Non-Preferred Hand Strength.

Using this function we can find a single output value

for any value of our input.

This, remember, is an important characteristic of the function that we mentioned earlier.

And now we can formally identify it with what's called the "vertical line test."

If we draw a vertical line, will our function

only produce ONE output for any value of X?

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Well, yes, it will.

Now, you might be saying "Wait!

Wait!

What about these other values here at X at 28 and 32, and so on?

They don't pass the vertical line test."

Well guess what?

You're absolutely right.

Our data does not pass the vertical line test, but our data is NOT the function.

The function is a MODEL of our data.

It's this straight line.

It tries to represent the data as best as possible.

Our MODEL - the idea of a model - is to find a way

to succinctly describe a relationship in data.

Remember the idea of summarizing our data?

We still want to do that; we still want to summarize what going on here in this particular relationship.

We don't want to give our reader every single point on the graph.

That's not summarizing.

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We already can give our reader r - a summary of the relationship that

describes the extent of the relationship.

Our model expands that idea.

To describe - to summarize - to our reader

what the relationship looks like in terms of the actual variables involved

- the specific input and the specific output.

So, does our data pass the vertical line test?

No.

And that perfectly fine.

Does our model - our function - pass the vertical line test?

Yes.

And that's the important part.

We have data.

We can represent that data with one of a few different models.

And the model is really defined as a function -

some input value for a specific output value.

So to answer our question: Can we model the relationship

between preferred and non-preferred hand in terms of grip strength?

Yes, we can.

We can find the linear model in which non-preferred hand grip strength is

a function of preferred hand grip strength.

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Comprehension Check

1. A national park contains foxes that prey on rabbits. The table below gives the two populations, F and R, over an 11-month period, where t=0 means January, t=1 means February, and so on.

t Month	0	1	2	3	4	5	6	7	8	9	10
R Rabbits	1,000	750	567	500	567	750	1,000	1,250	1,433	1,500	1,433
F Foxes	150	143	125	100	75	57	50	57	75	100	125

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(2/2 points)

1a. Is F a function of t?

- (•) Yes, because for each value of t, there is exactly one value of F. ✔
- ( ) Yes, because the fox population changes over time.
- ( ) No, because the fox population is 75 in both the month of May and the month of September.
- ( ) No, because we cannot predict the fox population from time.

1b. Is R a function of F?

- ( ) Yes, because the rabbit and fox populations vary with each other.
- ( ) Yes, because the table matches one value of R with each value of F.
- ( ) No, because the value R=567 appears twice.
- (•) No, because when F=57, R=750 and R=1250. ✔

Check Hide Answer

2. A mathematical model is

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(1/1 point)

- a data table or a graph of data.
- a function used to describe how data is behaving in an actual situation. ✔
- a line that connects the dots when real data is plotted on a scatterplot.

Check Hide Answer

3. The table below shows the number of female senators at the beginning of seven sessions of Congress.

C Congress	96	98	100	102	104	106	108
S Female Senators	1	2	2	2	8	9	14

(2/2 points)

3a. Is the number of female senators, S, a function of the session of Congress, C?

- (•) Yes, because for each session of Congress, there is exactly one number of female senators. ✔
- ( ) Yes, because the number of senators is independent from year to year.
- ( ) No, because there were the same number of female senators in sessions 98, 100 and 102.
- ( ) No, but Congress is a function of the number of female senators.

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3b. Let f(C) represent the number of female senators serving in the Cth Congress. What does the statement **f(108)=14** mean?

- ( ) There will be 108 female senators when 14 years have passed.
- (•) In the 108th Congress, there were 14 female senators. ✔
- ( ) The average rate of change in female membership is 108 over 14 years.

Check Hide Answer

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