SOLVING FOR "T"

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Now that we know how linear and exponential models are different

- and how to interpret the parameters from each model

- we can use the models to our advantage.

We can use them, such that we can not only

predict the amount of an outcome variable at a specific input value,

but, as we'll see, we can also use the

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functions

to determine at what value of our input variable

we have a certain level of outcome.

Here's the data and graph from our solar panel installations.

Now, we know that extrapolation is not a great idea.

But let's play with the linear, the exponential, and the logistic functions

a bit - and if we happen to extrapolate, well that's okay for right now.

Here's the linear model to the data again.

To answer our question of interest, we need to rearrange the function.

Instead of solving for the f(x) by plugging in a value for x,

we need to do the opposite: we need to plug in an outcome value

and solve for the value of x.

With the linear model, that's pretty straight forward.

We use our algebra to solve for x.

Now, if we do that, we'll end up exceeding 70 Gigawatts

at 10.92 years since 2007 - almost into year 2018.

That's pretty straight forward.

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Now, let's move on to the exponential model.

Here's the exponential function and corresponding graph.

Again, we see that we can use the parameters of the function

to solve for any outcome, given a particular time after 2007.

For example, we can solve for the number of Gigawatt installations in 2014

- year 7.

It's 58.37.

But what if we wanted to solve our question of interest?

We have an outcome value - so how do we solve for "t" in our function?

Well, we need to turn to our log rules.

Here's the formal definition of a log function: If x is positive,

then log(x) is the exponent of 10 that gives x.

For me that's a little bit of a mind-bender.

So I like to think of the equations for this definition:

y= log(x) then 10^y = x.

It's like adding and subtracting: if I exponentiate y,

then I need to log to back out.

For example, if we exponentiate 10 to 3.5, we get a result of 3,162.28

Now if we take the log of that 3,162.28, we get - you guessed it - 3.5.

What's great about this is that we can extend the property of the logarithm

to to following: The log(ab) = log(a)+log(b).

It's opposite: log(a/b) = log(a) - log(b).

And now for the property that will really help us out:

log(b^t) = t * log(b).

See something familiar?

Right here: b^t.

This term b^t is in our exponential function of f(t) = ab^t.

And we can see that our log properties can apply here.

So let's actually answer our question of interest

using the exponential function: When will

the predicted model of solar installations exceed 70 Gigawatts?

We can place 70 as the outcome value and our parameters into the function,

and we get the following.

First, we apply our algebra, and get 16.796 = 1.458^t.

Then we apply our log rule - and remember

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to apply it to both sides of the equal sign.

We get log(16.796) = t * log(1.458).

Now, we solve for t and get 7.48.

So, to answer our question: according to our model, in 2014 -

or in 7.48 years after 2007 - we will have

70 Gigawatts of solar installations.

Now for the big one - the logistic model.

Here's the logisticFit function results for the solar data,

and again we'll answer our question: When

will the predicted model of solar installations exceed 70 Gigawatts?

We can place 70 as the outcome value and our parameters

into the logistic function.

The first thing we need to do is re-arrange.

Then, we subtract the 1 from the left hand side.

And then, divide by our "a" parameter.

Now we're left with something that looks very manageable with our log rules.

We apply the log to both sides and get the following,

and then isolate our negative "t."

Solving for "t" now gets us 11.612.

So, to answer our question: according to the logistic model, in 2018 -

or in 11.6 years after 2007 - we will have

70 Gigawatts of solar installations.

And that's how we use our log rules to solve for "t" in both

our exponential and our logistic functions.

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Comprehension Check

1. The tadpole population (in thousands) in a small pond is decreasing according to the following equation:

$$Q(t) = 10(0.85)^t$$

(1/1 point)

1a. What is the initial population size (at t=0)? *(Report without commas.)*

10000

10000

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Check Show Answer

(1/1 point)

1b. What is the annual decay rate as a percent? *(Do not write **%** sign.)*

15

15

Check Show Answer

1c. How many tadpoles remain after **5 years** have passed? *(Report without commas and round to a whole number.)*

4437

4437

Check Show Answer

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(1/1 point)

1d. How many years does it take for population to drop **below 1,000**? *(Round to 2 decimal places.)*

14.17

14.17

Answer: 14.17

Check Hide Answer