AEP 7: Modeling child growth

Overview

In this AEP, you'll put logarithmic functions to use in modeling data from the CDC about the early growth of an "average" child.

Learning Targets associated with this AEP:

- **D.2 (CORE)**: I can use derivative notation correctly, state the units of a derivative, estimate the value of a derivative using difference quotients, and correctly interpret the meaning of a derivative in context.
- **D.3 (CORE)**: Given information about f, f', or f'', I can correctly give information about f, f', or f'' and the increasing/decreasing behavior and concavity of f (and vice versa).
- **DC.4**: I can compute the derivatives correctly for logarithmic, trigonometric, and inverse trigonometric functions.

Technology Background

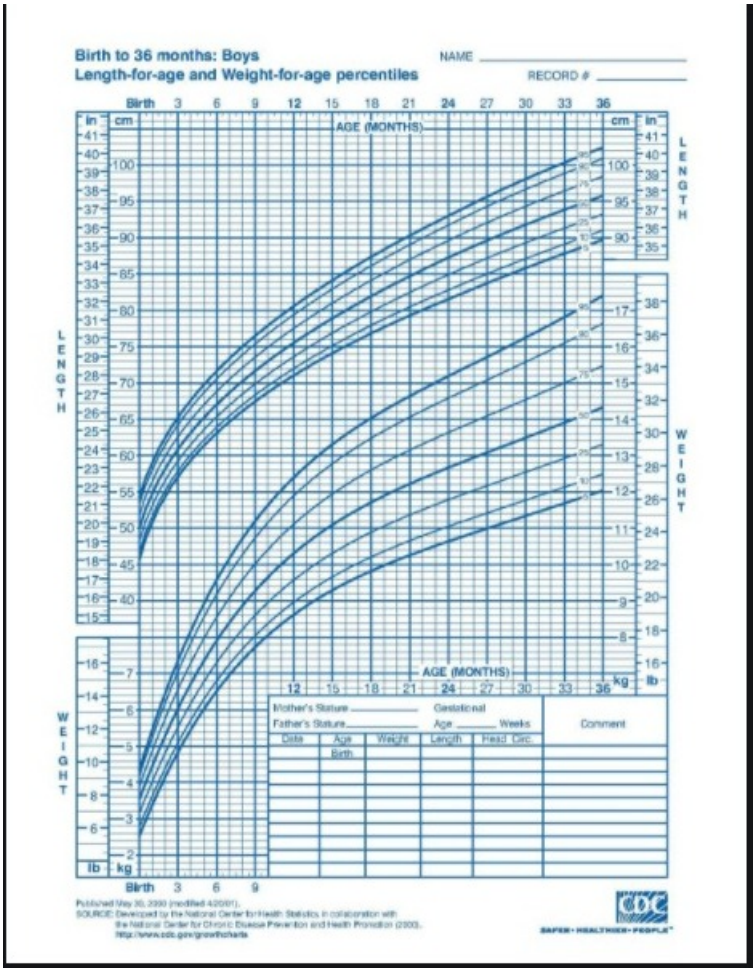
This AEP involves modeling data using *regressions*. These are first discussed in AEP 1 with some instructions and tutorial videos found there. You'll need to be familiar with entering data into Desmos and constructing regression formulas, as well as the usual tasks for graphing functions.

It will also be helpful if you are passingly familiar with using spreadsheets. You will at least need to know how to open and read a Google Sheets spreadsheet.

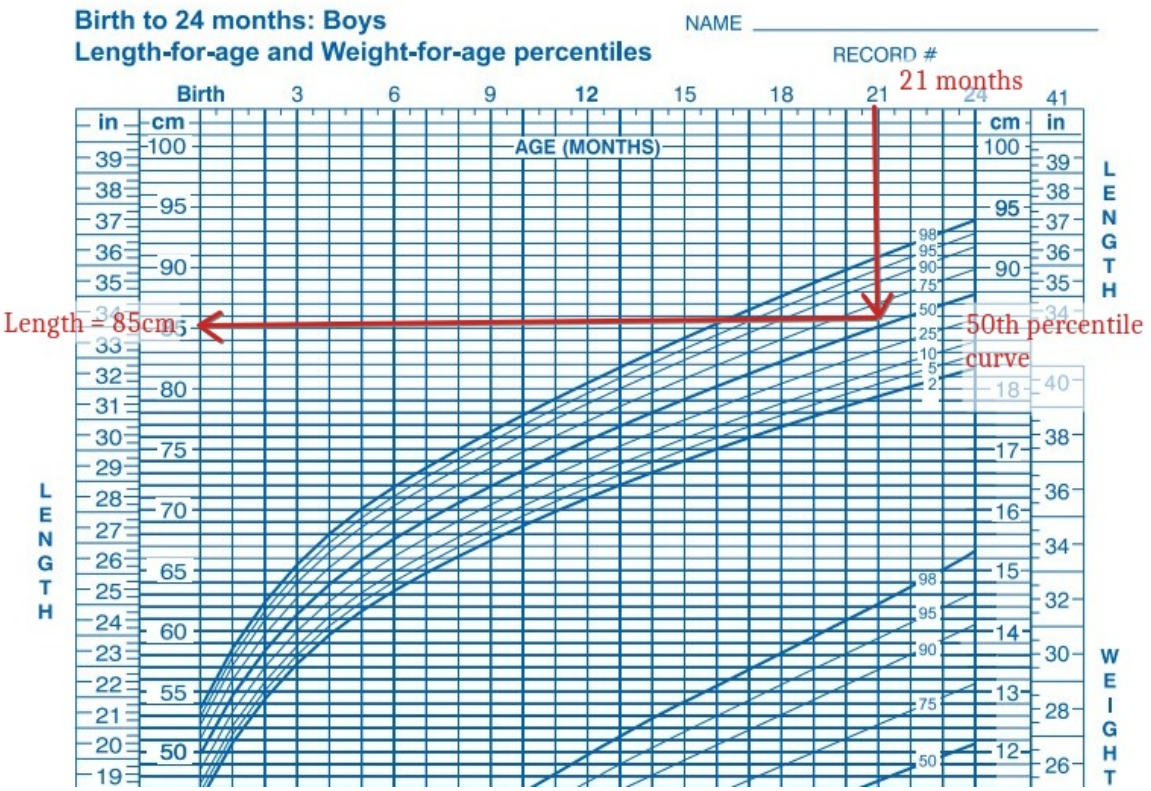
AEP Description and Tasks

What this AEP is about

Doctors, parents, and others for whom the growth of children is important base important health-related decisions about a child in the first few months of its life, on how that child's growth compares to the known growth data for other children. The Centers for Disease Control (CDC) maintains an important chart that is widely used for thinking about the weight of very young children as well as their height (referred to here as "length" since kids that young can't necessarily stand up on their own). You might have even seen this chart handing in a pediatrician's office:



(This one is just for boys; there's another for girls.) The chart actually show 14 different graphs. Notice that along the bottom, the axis is for *age* measured in months. The upper group of seven graphs show the *length* (there's one axis for inches and another for centimeters) for boys of a certain age; each of the seven graphs is a different *percentile*. For example, a 21-month old boy in the 50th percentile for length/height would have a length/height of about 85 cm:



"50th percentile" means that half of the data collected for boys' length will fall below that amount, and half will fall above it. The other curves are for the 2nd, 5th, 10th, 25th,

You can similarly find the length or weight for boy kids in other percentiles and at other ages; and the same for girl kids.

The charts can be found here: https://www.cdc.gov/growthcharts/clinical_charts.htm However, to save the trouble of estimating values from a (very condensed) graph, the data themselves can be found in this spreadsheet:

https://docs.google.com/spreadsheets/d/1BtiaHSG-5yX_9tHqZFk-5rX_jgS8nAs0nheuzArl0Ow/edit?usp=sharing

You should not need to request access to view this spreadsheet, but you will only have viewing permissions — you can't edit it or comment on it, to prevent accidental changes.

The data for length and weight and for boys and girls are located in different sheets that you can access by clicking on the tabs at the bottom of the spreadsheet:

Note that in these data, the ages are given in *half months*; the ages are one month apart (except for the first two) but measured at the halfway point between months. For example there is no entry for a 21-month old

boy, only 20.5 and 21.5 months.

In the AEP, as usual you are going to be asked to think about the *rate of change* in these values — i.e. how fast these values are changing over time. They have a particular shape that makes them amenable to modeling with a function type we haven't worked with much up to now: the *logarithmic* function.

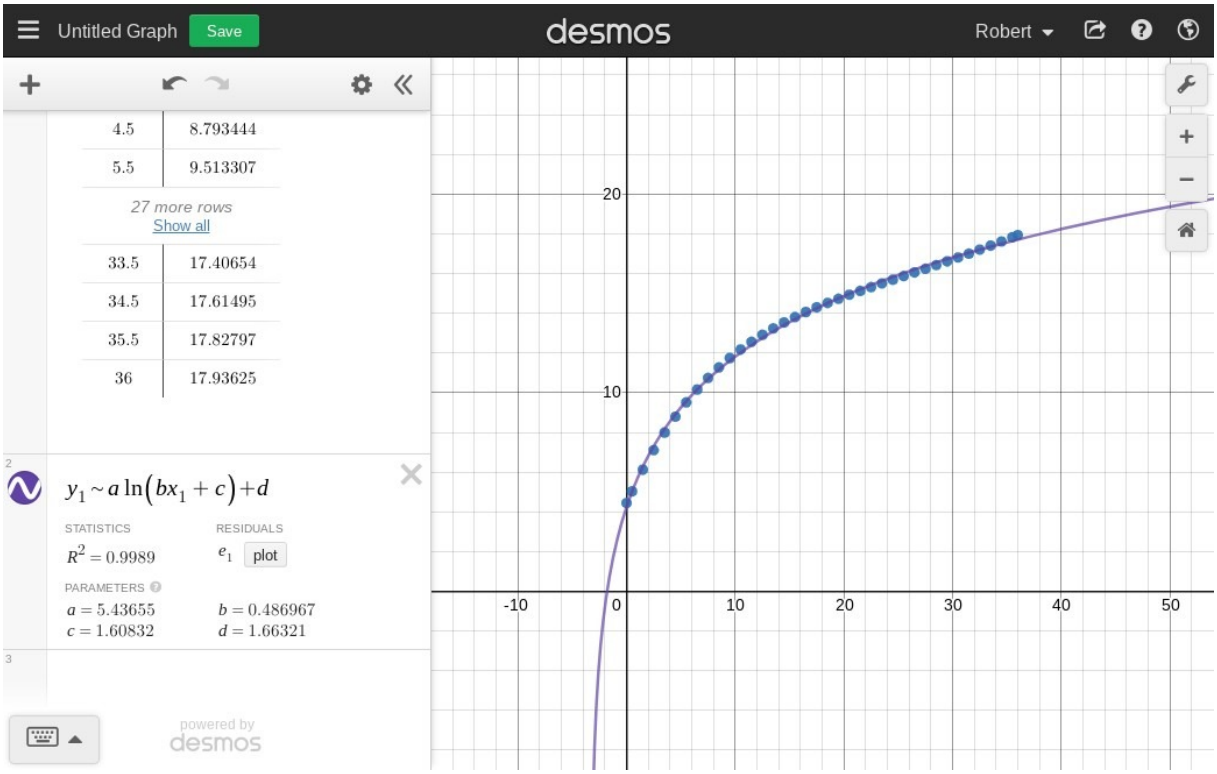
Tasks for this AEP

Note: While not required, you can use spreadsheets to organize or do calculations your data. If you do, please read carefully the guidelines for spreadsheets given in the next section.

1. Choose a gender (boy or girl) and a physical attribute (length or weight). For the gender and attribute you chose, take the data for the 50th percentile and construct tables for the first derivative and the second derivative of those data. Show your work on at least one calculation for each derivative and give a one-sentence summary of what you did. (You may also use a spreadsheet to do these calculations, if you know how.) Put your results either in your writeup, or in a separate Google Sheet.
2. In 3-4 complete and well-constructed sentences, explain what the derivative and second derivative data tell you about the way that the physical attribute you chose is changing as the child ages. You might use terms like "decreasing at an increasing rate" to do this; be as detailed as you can (but keep it brief) and explain why your derivative and second derivative data back up your claim.
3. Keeping the same gender and physical attribute, put your data into a Desmos table with age in the x_1 column and the attribute data in the other. Adjust the viewing window until it's appropriately sized (that is, you can see all the data and there is minimal "dead space" with nothing in it). **Pro tip: Copying and pasting data from the spreadsheet into Desmos makes the table and plots the data on a nice window automatically.** There's nothing to turn in for this part; it's just a setup for the next part.
4. The data from the CDC chart has a particular shape that is well-suited for *logarithmic functions*. (Here's a graph of the basic $y = \ln(x)$ function: https://www.desmos.com/calculator/apy9ucb8ft Notice how it looks like the CDC graphs!) So use Desmos to find a **logarithmic regression** for the data you plotted. To do so, if your data are entered into Desmos in the column labelled x_1, the in a blank cell enter:

$$y_1 \sim a \ln(bx_1 + c) + d$$

Just as in earlier AEPs where we did regressions with other kinds of functions, this will give you numerical values for the parameters a, b, c and d that produce a "logarithmic curve of best fit". For example, the data in this graph are being fit with the function $y = 5.43655 \ln(0.486967x + 1.60832) + 1.66321$:



When you've done your logarithmic regression, copy a link to the Desmos worksheet (not the image, but a link to the entire worksheet) and include this in your writeup along with the formula for the logarithmic function that was created.

5. Using our methods from Chapter 2, find the first derivative of your model. Show all your work and give a 1-2 sentence explanation of your work (for example if you use the Chain Rule, state how you decomposed the function).

6. The data in the CDC charts ends at 36 months. But we can use the derivative to make predictions for data not on the charts. Using the results of your work in the previous step, predict the value of the physical attribute you chose (length or weight) for a child who is 4 years old. Show your work and explain in 1-2 complete sentences what you did.

Assignment Expectations and Grading Criteria

Guidelines for using spreadsheets: The use of spreadsheets is not required on this AEP (other than reading data off of the one that's provided), but you are also free to use spreadsheets to organize your data or make computations with it. There are many extremely good YouTube tutorials available for basic spreadsheet use if you need to refresh yourself on how to use a spreadsheet for making data computations, or if you're starting from zero and want to take this opportunity to pick up a useful new skill. **If you use a spreadsheet**, please abide by these rules:

- **Use Google Sheets only.** If you are an Excel person, you can import an Excel sheet into Google Sheets. But we use Google Sheets since they are much easier to share.

- **Change the permissions on your Google Sheet** so that *Anyone with the link* has access, and the access is *Editor* not "Viewer". You can do this by clicking the green "Share" button in the upper right. **I can't grade your work until I have this level of permissions.**
- **In your writeup** (which, remember, should be 100% typed) **include a link to your Google Sheet**.

Now for the rest of the guidelines:

AEPs are graded using the "EMRN" rubric found in the syllabus. Please note, it is the case with all AEP's that **your grade is primarily based on your explanations and writing, and only secondarily on the precision and correctness of your computations.** Correct computations with insufficient explanation will need to be revised and may receive an "N" grade.

Also, **significant incompleteness will result in a grade of "N".** This includes the following:

- **Giving answers with no explanations.** As mentioned above, you are being graded on explanations and writing, not so much on answers. Submissions that contain items where there is an answer with no explanation or insufficient explanation, will be graded "N" and returned without comment.
- Leaving items blank (even accidentally)
- Leaving large gaps in computations (skipping important steps)
- Giving only partial attempts at tasks (for example, working down to a certain point in a solution and then stopping because you need help)

A grade of E or M requires all of the following to be met:

- All the links you provide work — including the link to your spreadsheet, if you use one.
- All your derivative calculations (both the numerical and the algebraic) must be correct. There are tools available to check your work; use them.
- All work needs to be shown *and* your thought processes clearly expressed in all of the tasks of the assignment.
- All the information needed for an "outsider" to understand your work needs to be self-contained within the work. **The reader should not have to do any work to fill in gaps.**
- Explanations must be given in clearly written and grammatically correct English. Multiple instances of failure to capitalize beginnings of sentences, subject-verb agreement, misuse of punctuation, etc. will result in a grade of R or N.
- Some simple mistakes in calculations are allowed, but significant errors and those that lead to incorrect explanations will probably result in a grade or R or N.

There are some additional formatting requirements in the "Submitting your work" section below.

A grade of "E" is given if all of the above expectations are met, and the work is of superior quality in terms of the clarity of explanations and work, appearance of the writeup, and precision of the mathematics.

Submitting your work

AEP submissions must be typewritten and saved as either a PDF or MS Word file. No part of your

submission may involve handwriting; work that is submitted that contains handwriting will be graded N and returned without feedback. This includes electronic handwritten documents, for example using a stylus and a note-taking app. To type up your work, you can use MS Word or Google Docs (both of which have equation editors for mathematical notation) or any other computer-based math typesetting tool. Just make sure you save your work as a Word document or PDF (no `.odt`, `.rtf`, or other file extensions are allowed).

When you have your work typed up, double-check it for neatness, correctness, and clarity. Then, go to Blackboard, then **Assignments**, then **AEP**, then **AEP 7**. Clicking on the text "AEP 7" will take you to a place on Blackboard where you can upload your work. All grading and revisions of labs are done entirely on Blackboard. **Do not email your work to the professor** – only Blackboard submissions are accepted.

Getting Help

Please note that according to the syllabus, for AEP's **"no interactions at all with another person or with unauthorized sources on the internet is allowed."** Violations of this rule include *any* consultation with other students or former students, including Math Center tutors; using work from another student or former student; submitting the problem set to an online help site such as Chegg or Coursehero; or asking for help in an online forum. All such violations will be treated as academic dishonesty and will result in a grade of "N" and being banned from revising the work.

You **may** ask me (Talbert) for help on this assignment in the form of **specific mathematical or technical questions**. If I cannot answer a question because it would give too much away, I'll tell you so. **However please note: I will not "look over your work" before you submit it to give you feedback on the overall submission**; the expectations are clearly laid out above, so just follow those directions and submit your best work, and you'll be allowed to revise it if needed.

You can ask technology related questions to anyone at any time. For example if you need help with Desmos, or with figuring out how to type up your work, there are no restrictions on that. I recommend the `#tech` channel on Campuswire so that you'll reach a large audience.