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Comparing Paths: Bayesian Sequence Analyses in a Microgenetic Study of Student Learning

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Assessment & NGSS

The National Academies envision an assessment platform that supports “three-dimensional learning” (NRC, 2013)

They envision a bottom-up process whereby students are tracked over time

The recommended assessment protocol is more formative and, within domains, is similar in ways to microgenetic analyses

Microgenetic Analyses

Microgenetic analyses involve the repeated measurement of single students over a short period of time (Siegler, DeLoache, & Eisenberg, 2010).

Siegler (1996) envisions an overlapping wave approach to microgenetic assessment

- Path
- Rate
- Breadth
- Source
- Variability

Funny Bunny

Grotzer et al. (2011) microgenetically assessed student learning of a seemingly probabilistic board game.

- The student (Rajon) moved from a deterministic to a more probabilistic explanation of the game's mechanism

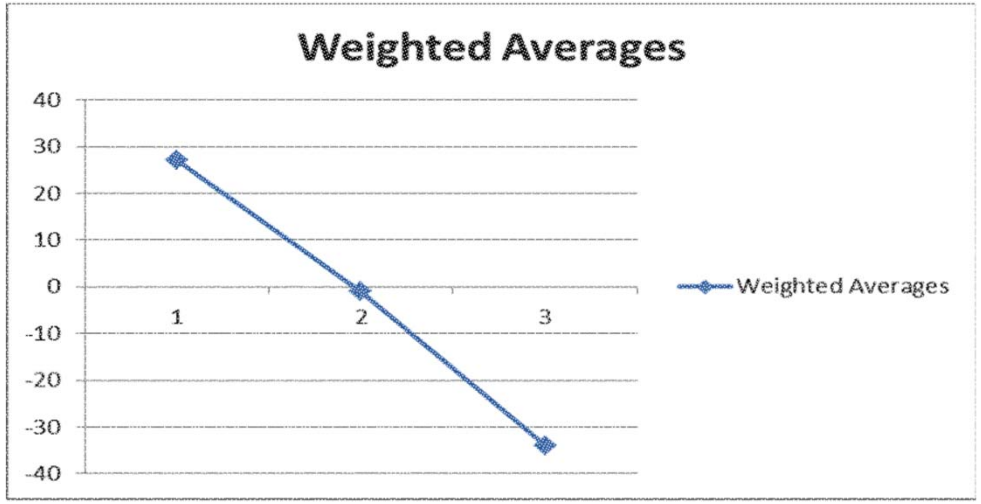
The Question

To what degree do Rajon's choices on the game board support his shifting explanations?

Funny Bunny

The distance of Rajon's chosen position from the actual open hole also gives us information.

- "Edit distance" can be a proxy for learning (Dukas, 2009)



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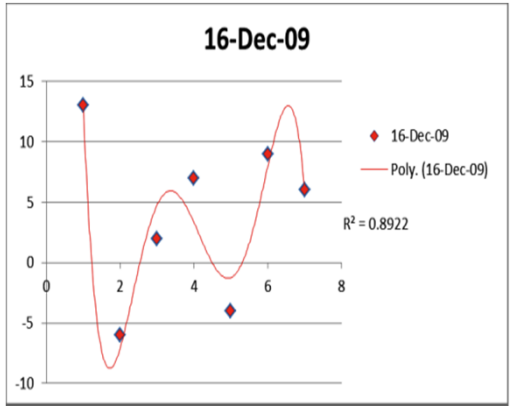
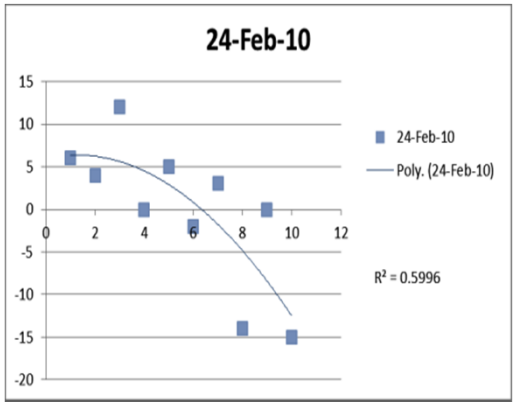
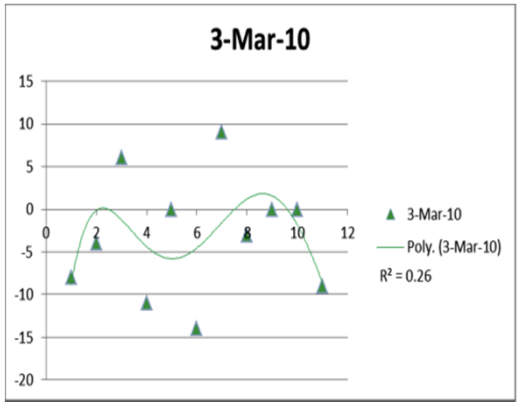






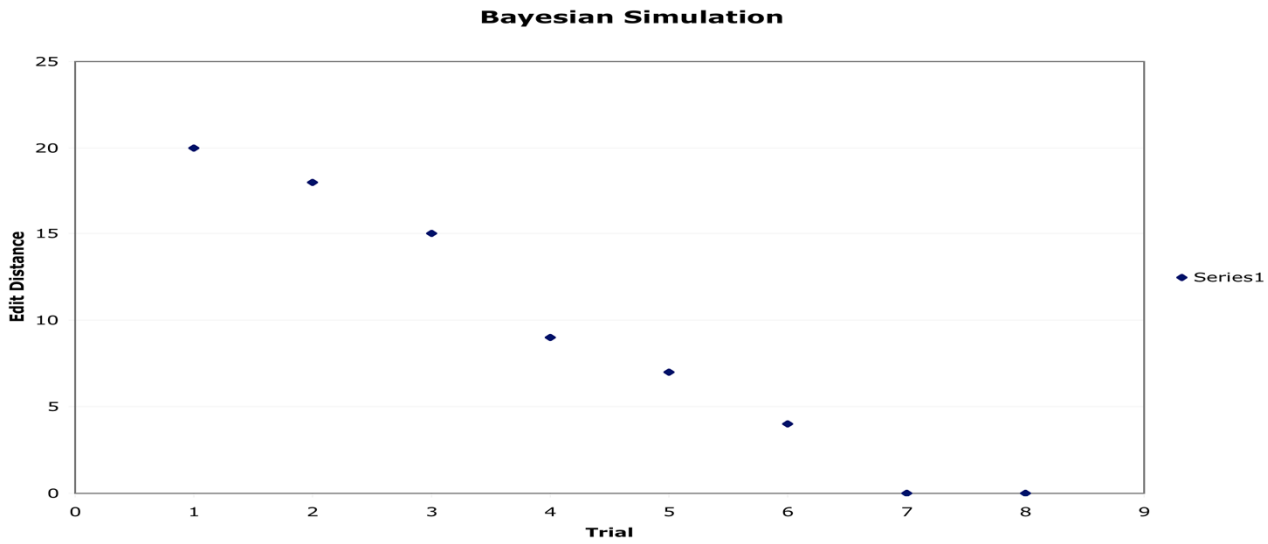
The edit distance is a comparison to someone who knows the model, not someone learning it

Bayes' Theorem

$$P(H|D) = \{P(D|H)P(H)\}/P(D)$$

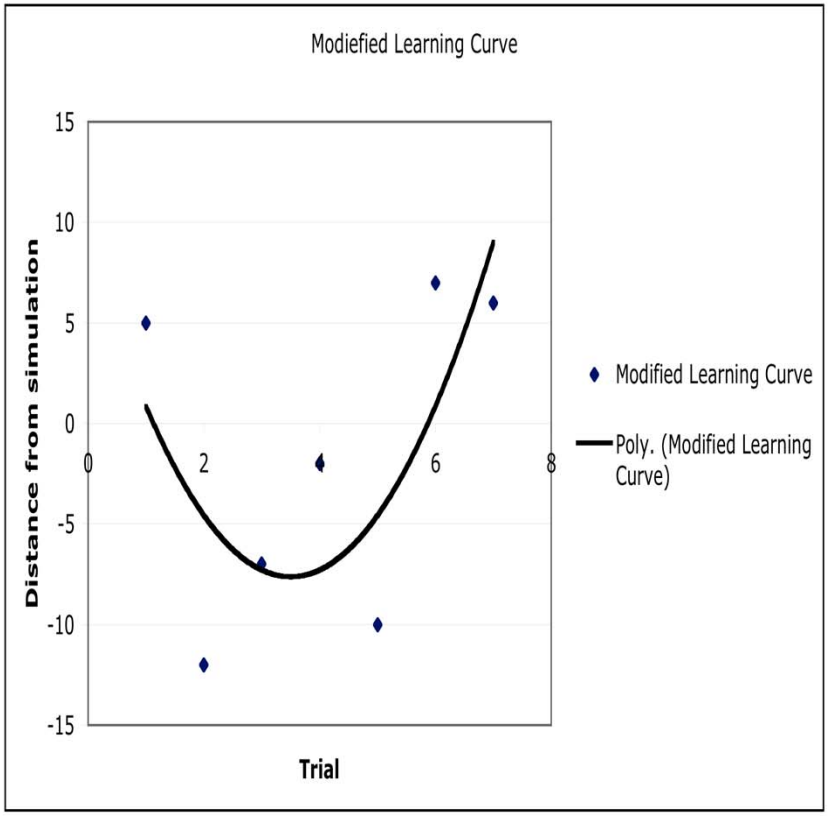
Where:

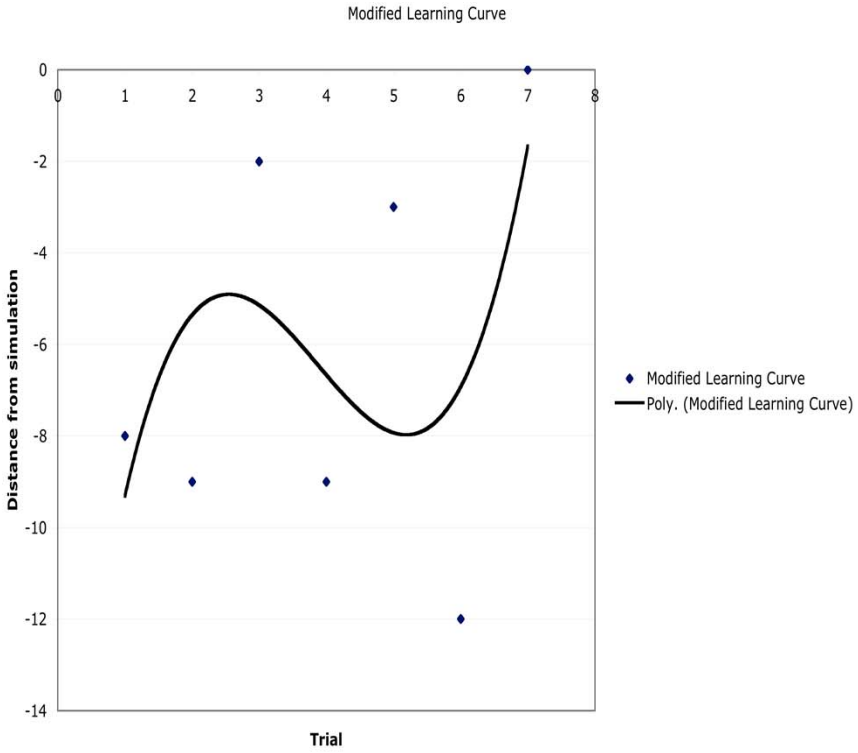
- P(H) is the prior probability, which is a measure of your belief that some hypothesis H is true prior to observing data D.
- P(D|H) is the probability that the observed data D will occur, given hypothesis H. This is known as the "likelihood", and represents the impact of new data on belief.
- P(D) is the probability that data D will occur, which is also known as the evidence.
- P(H|D) is the posterior probability, which is a measure of your belief in hypothesis H after you have observed data D.



Rajon's path vs Bayes' path

Rajon's curves now reflect the distance between his understanding and that of an “ideal learner”





Take-Aways

Exploration of the edit distance as well as the distance from the simulated curve give us more fine-grain details about the aspects of Siegler's(1996) “Overlapping Waves”, especially variability

- Humans employ Bayesian reasoning in some decision making (e.g., Luca, 2011)
- Rajon didn't look very Bayesian, why?

This method of comparing emergent student learning to various types of learning curves, vice an omniscient other that answers correctly every time, could be valuable information for teachers within the NGSS framework (akin to comparison to Normative distributions)

Future work will involve applying this technique to other learning scenarios

Disclaimer

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Citations

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Thank You!

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