

Bayesian Networks in Educational Assessment

Dynamic Bayesian Networks

Roy Levy
Arizona State University
Roy.Levy@asu.edu

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DBN

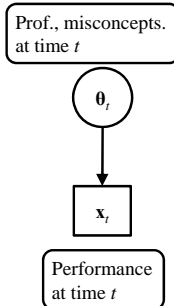
Dynamic Bayesian Networks (DBNs)

- **Dynamic** BNs (DBNs) for modeling longitudinal data
- Bayesian network where variables are repeated, usually over time or related index
- Assessment applications: monitor learning and growth
 - Proficiency and performance on first attempt, on second attempt, etc.
- Knowledge tracing, latent Markov models, latent transition models, growth models

Session IVb -- DBNs

DBN 2

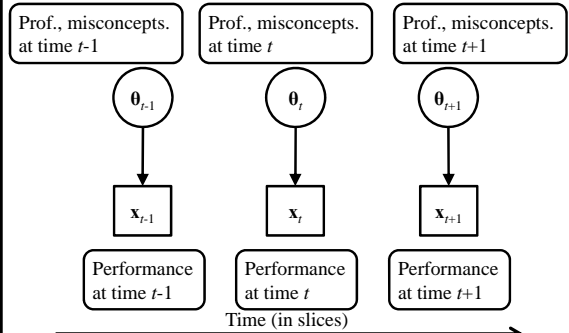
DBN Psychometric Models: Within-Time Component



Session IVb -- DBNs

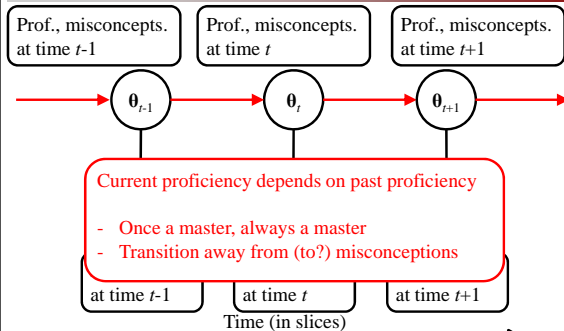
DBN 3

DBN Psychometric Models: Within-Time Component



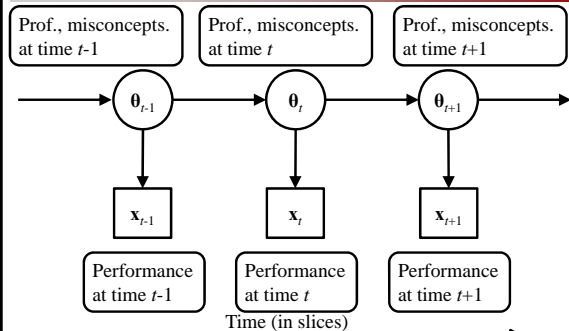
DBN 4

DBN Psychometric Models: Transition Component

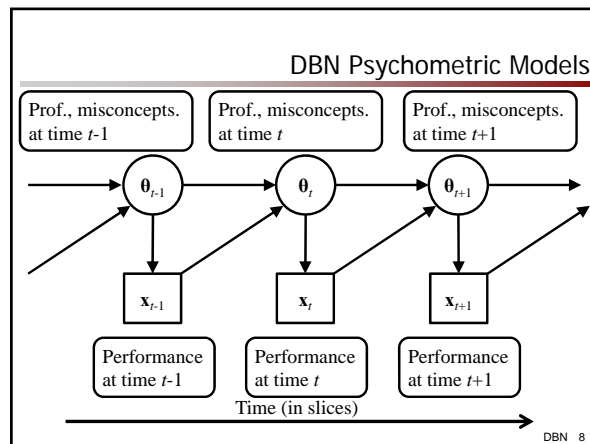
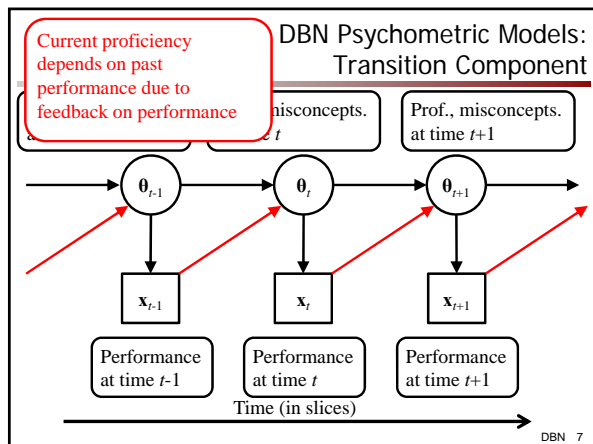


DBN 5

DBN Psychometric Models



DBN 6



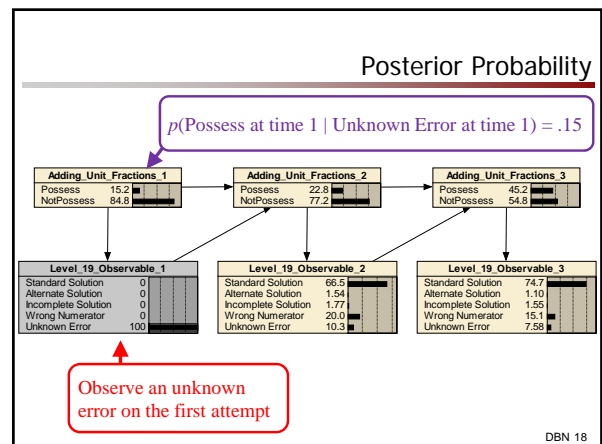
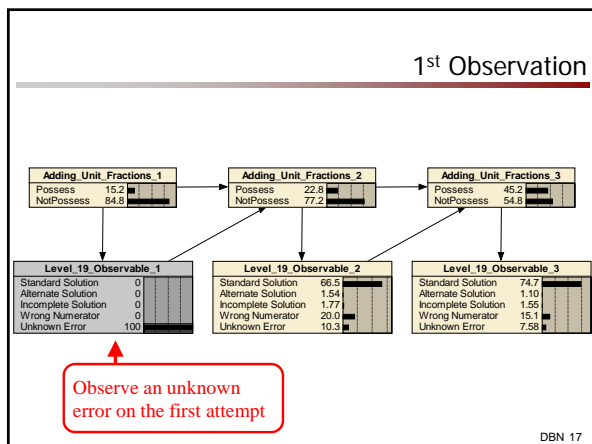
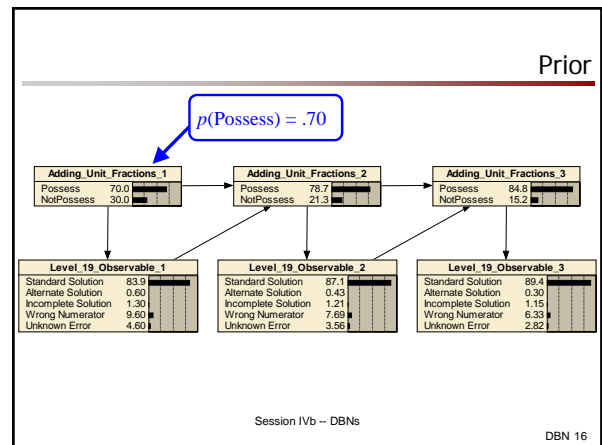
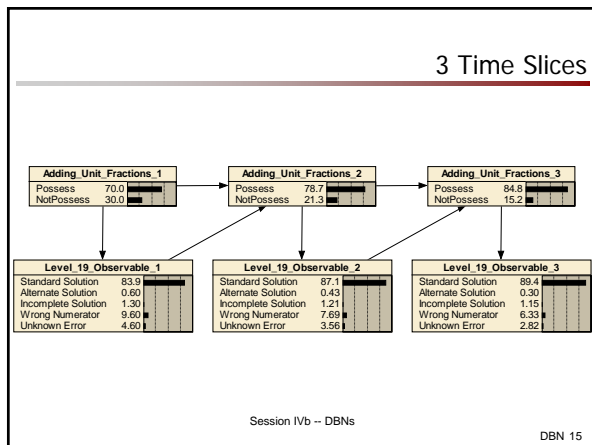
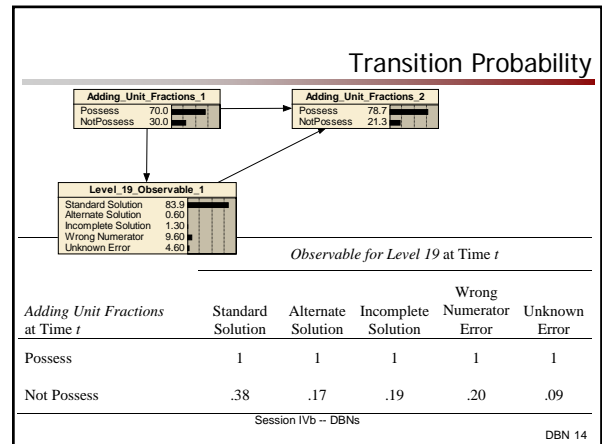
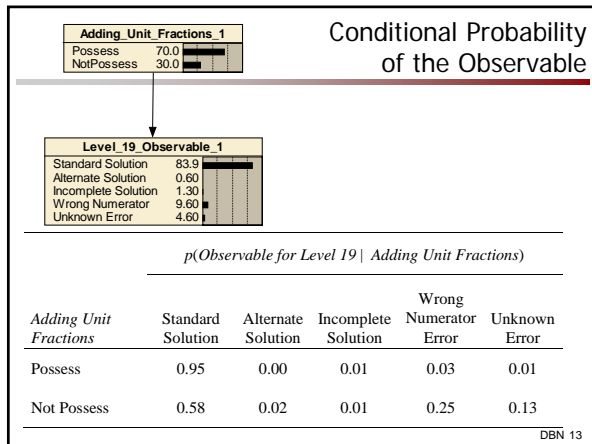
Example

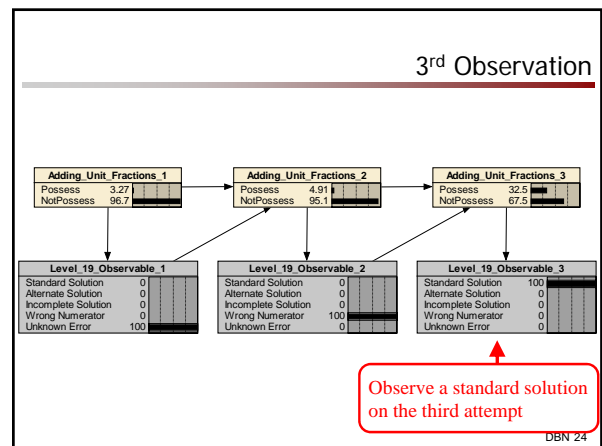
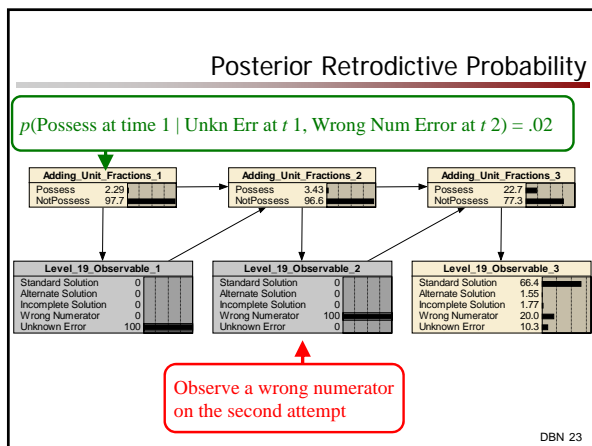
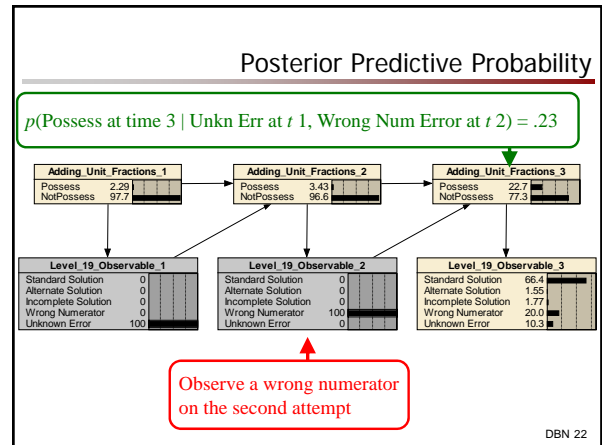
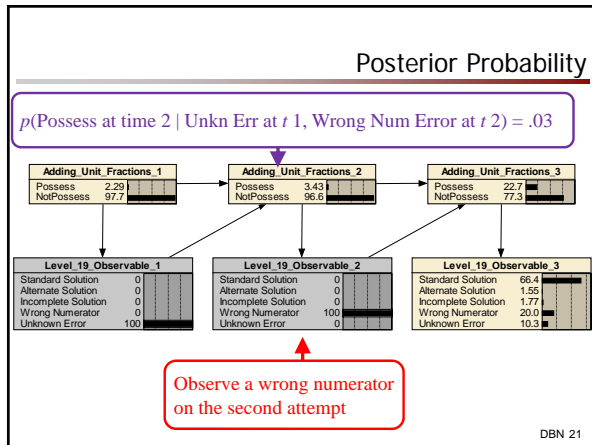
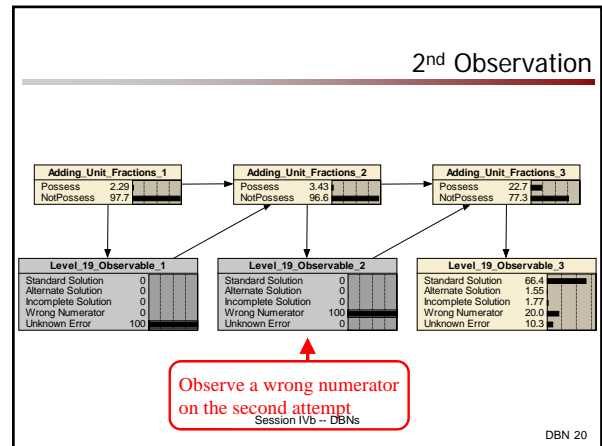
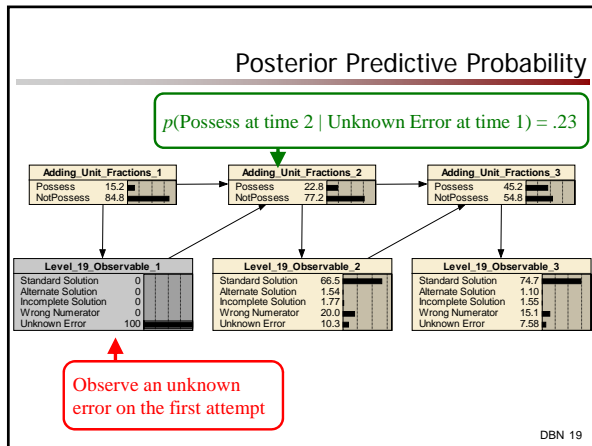
DBN

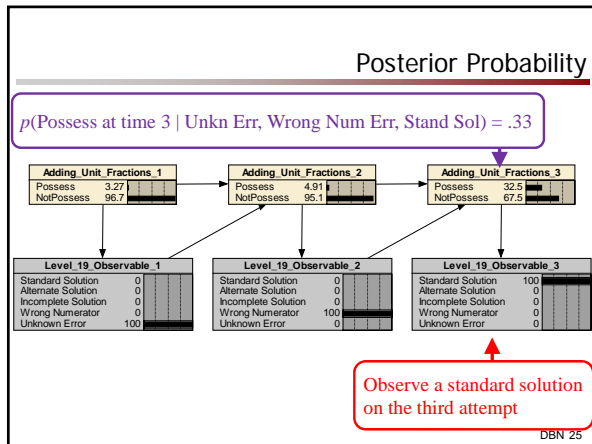
- ### Example Context: Save Patch
- Educational video game targeting rational number equivalence
 - Adding whole numbers
 - Finding appropriate denominators, fractions < 1
 - Finding appropriate denominators, fractions > 1
 - Adding fractions given correct ingredients
 - Adding fractions greater than 1
 - Student lays out ropes for character to navigate across to end
 - Success on a level leads to more complicated levels
 - Advanced levels involve converting ropes (fractions), more complicated layouts, and gaming features (picking up keys, coins)
- Session IVb -- DBNs
- DBN 10

- ### Example Context: Save Patch
- Complete a level, move on to the next level
 - Don't complete a level, try again (and again, and again,...)
 - Constructed as a learning tool
 - Assesses proficiency of various skills (converting fractions, adding fractions, etc.) and
 - Assesses various misconceptions/errors (inclusion, partitioning, etc.)
 - Game-playing strategies relevant too (e.g., everything in order)
 - Key departures from standard assessment paradigm
 - Feedback (student knows if correctly or incorrectly completed)
 - Learning during assessment (by design!)
 - Performances not conditionally independent (you know what you did, and how it turned out, for the most part)
- DBN 11

- ### Dynamic Bayesian Networks (DBNs)
- Characterization of performance
 - Standard solution
 - Alternate solution
 - Incomplete solution
 - Errors (many different kinds)
 - Skipped key
 - Wrong direction
 - Reset solution
 - Example: performance on Level 19
 - Assuming the examinee does not have the misconception
 - 2-class latent variable for mastery of whole numbers
 - Probabilities estimated using MCMC, input to Netica
 - Analysis of first four types of performance, attempts resulting in others ignored
- Session IVb -- DBNs
- DBN 12

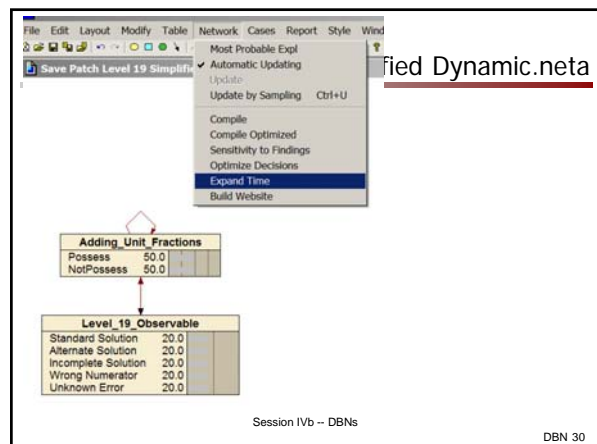
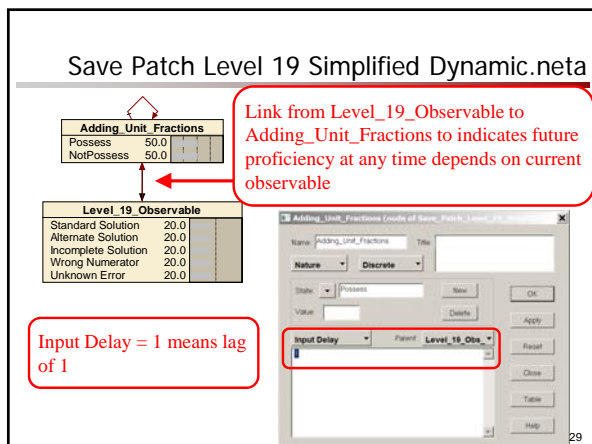
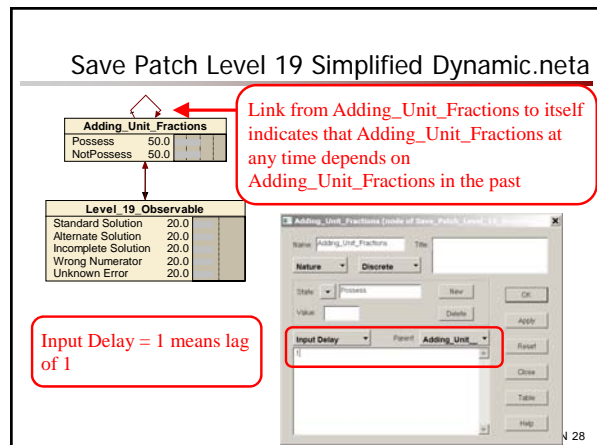
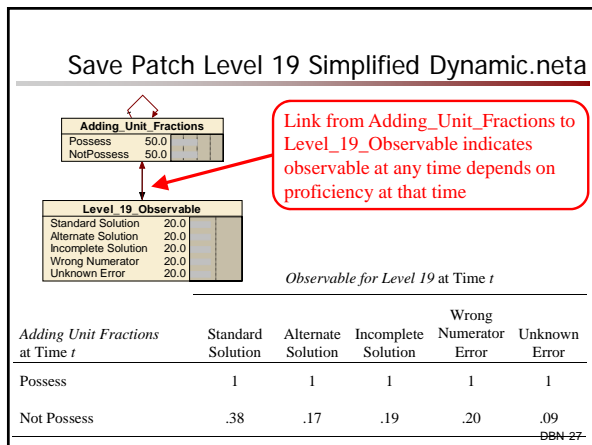






Netica Files:
 Save Patch Level 19 Simplified Dynamic.neta
 Save Patch Level 19 Simplified Dynamic Expanded 3 Time Points.neta

DBN



Save Patch Level 19 Simplified Dynamic.neta

How many additional time slices?

Session IVb -- DBNs

DBN 31

Save Patch Level 19 Simplified Dynamic.neta

When to start?

Session IVb -- DBNs

DBN 32

Save Patch Level 19 Simplified Dynamic.neta

Must edit the table for the first time point

Session IVb -- DBNs

DBN 33

Save Patch Level 19 Simplified Dynamic.neta

Must edit the table for the first time point

Session IVb -- DBNs

DBN 34

Save Patch Level 19 Simplified Dynamic.neta

See
'Save Patch Level 19 Simplified Dynamic Expanded 3 Time Points.neta'

Session IVb -- DBNs

DBN 35