Using EEG to Predict Affect, Activity, and Cognitive Effort While Using a Math Tutor
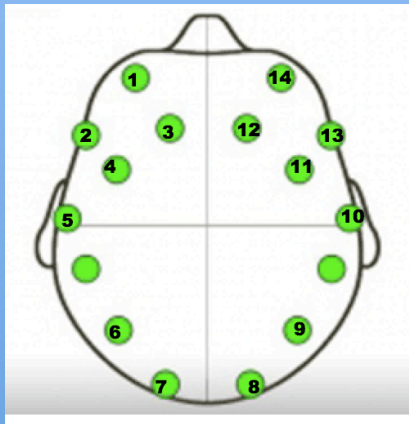
Judith Azcarraga, Jessica Nelson,
Geoff Gordon, & Jack Mostow

Input Data

25 College Students using Aplusix Tutor
185 Inputs:

14 EEG Sensors X 4 Frequency Bands X 3 FFT band measures

- alpha
- low beta
- high beta
- gamma

- Peak Magnitude
- Peak Power
- Mean Spectral Power

14 EEG Sensors x Mean Amplitude
Number of Clicks, Distance Mouse Travelled, Duration of Each Click

Dependent Variables

Self Report & Tutor Records
7 unique dependent variables:

- Tutor Activity
  - Answering
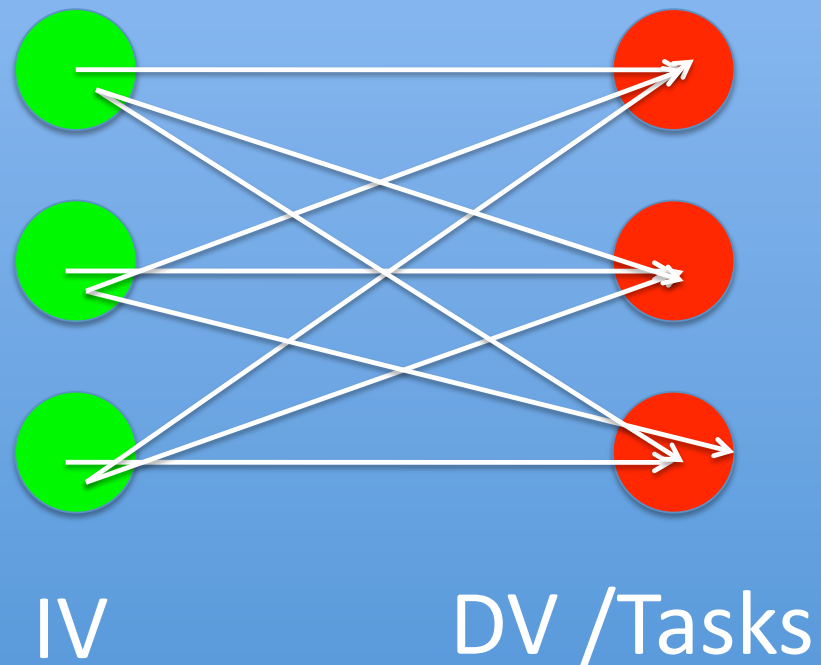 - Thinking
  - Hinting

- Confidence (1-100)
- Excitement (1-100)
- Frustration (1-100)
- Interest (1-100)
- Difficulty (1-100)

Linear Regression

Method: Use the set of independent variables (IV) to independently predict each dependent variable (DV)

Pros: Very flexible

Cons: May overfit the data

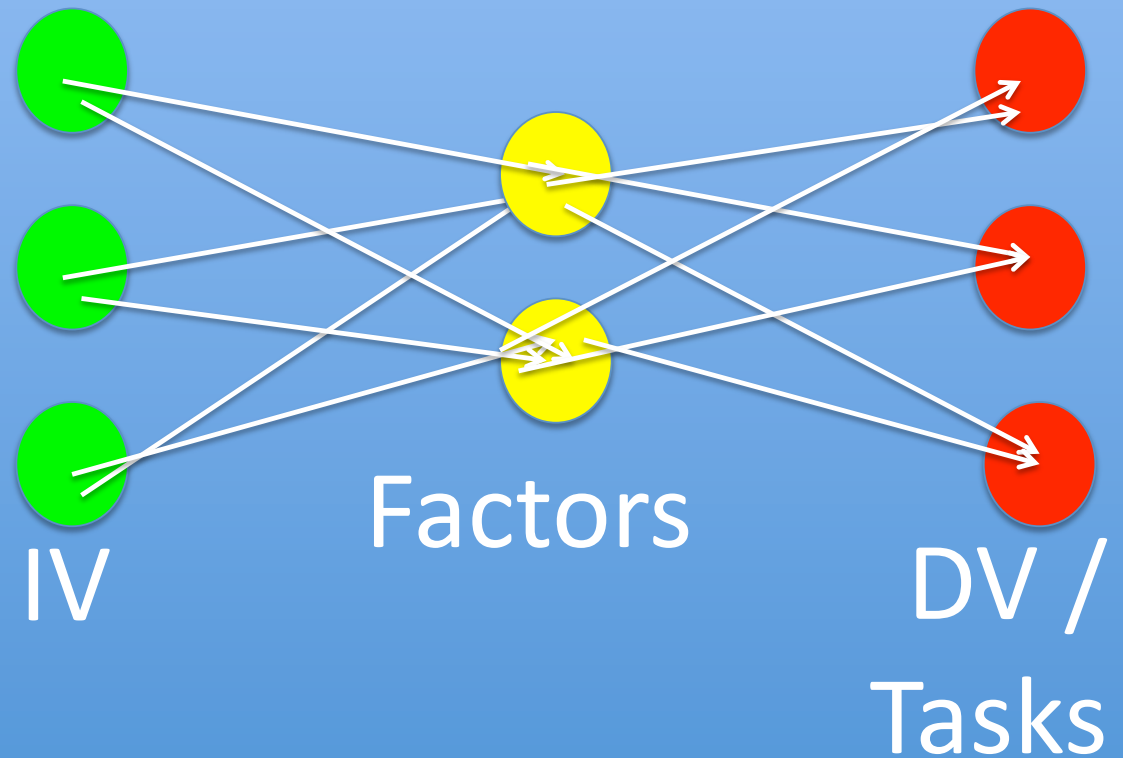IV   DV /Tasks

Regression Implementation:

- Normalized the means and variances of input data per student

- Normalized the means and variances of DV's

- Added related tasks (EEG and mouse click data for time t+1) to the set of DV's to constrain the latent factor values in multi-task regression

- Down-weighted the t+1 EEG data by (1/n)

- Used first 10 latent factors

- Divided into 80% training set (20 students)
      20% test set (5 students)

Multi-Task Linear Regression

Method: Use the set of independent variables to simultaneously predict all dependent variables via a smaller set of latent factors

Pros: Less overfitting, Can generalize from one task to another, (possibly) interpretable latent factors
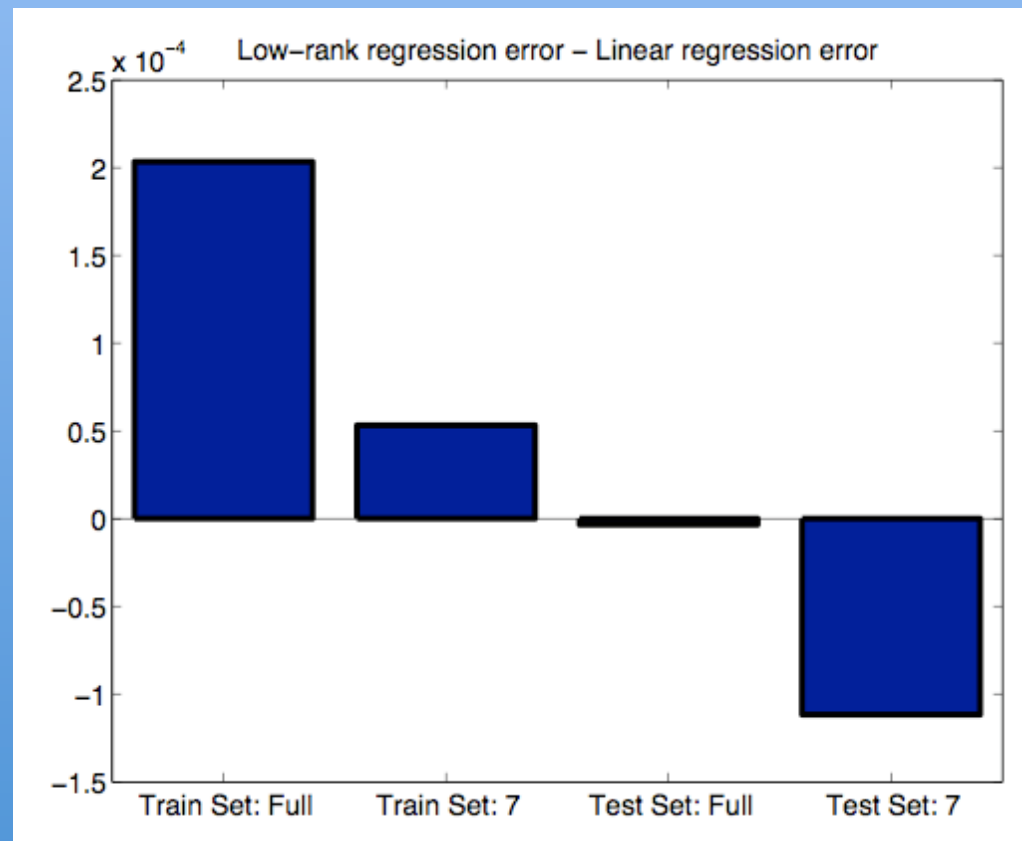
Cons: Less flexible
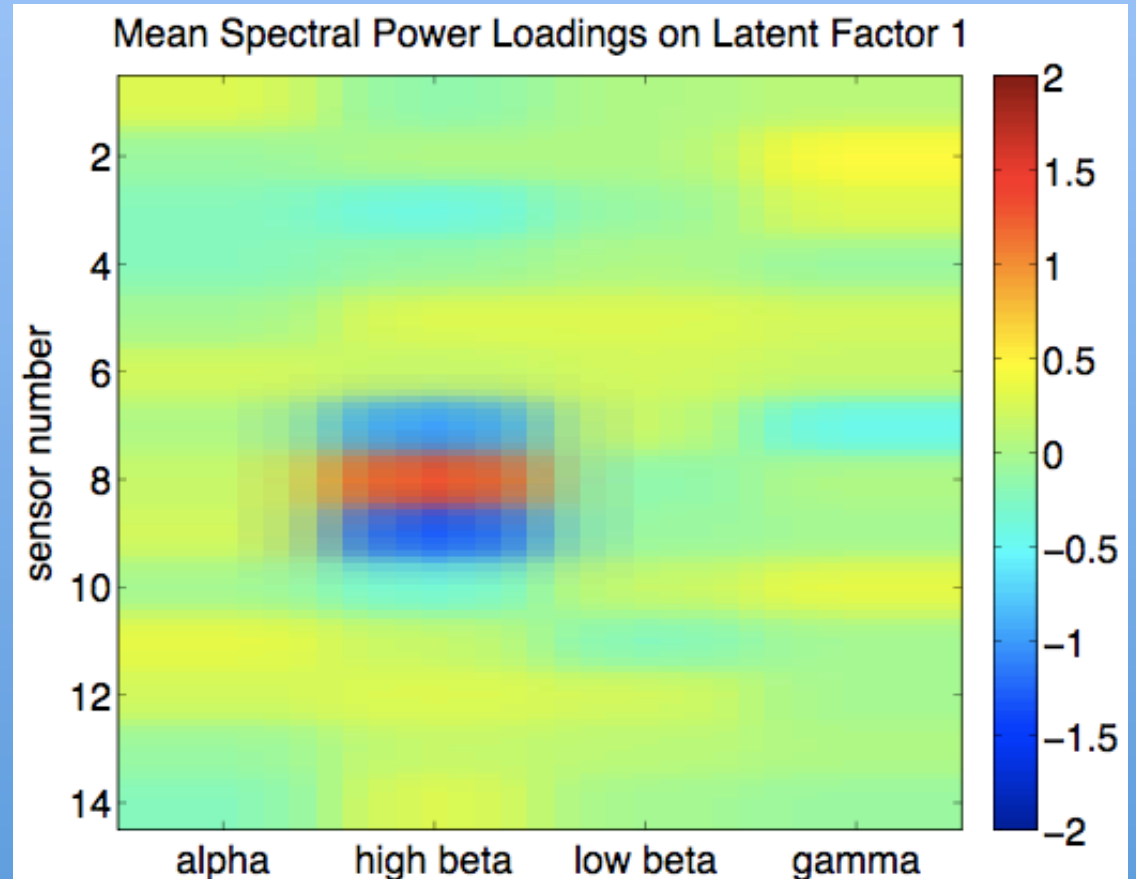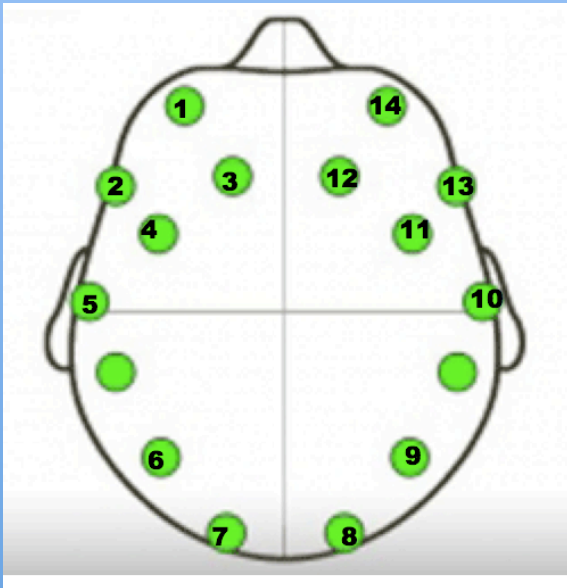
IV

Factors

DV / Tasks

Results:

Linear regression resulted in lower error for the *training* set only

Low-rank linear regression resulted in lower error for the test set, especially for the 7 variables of interest
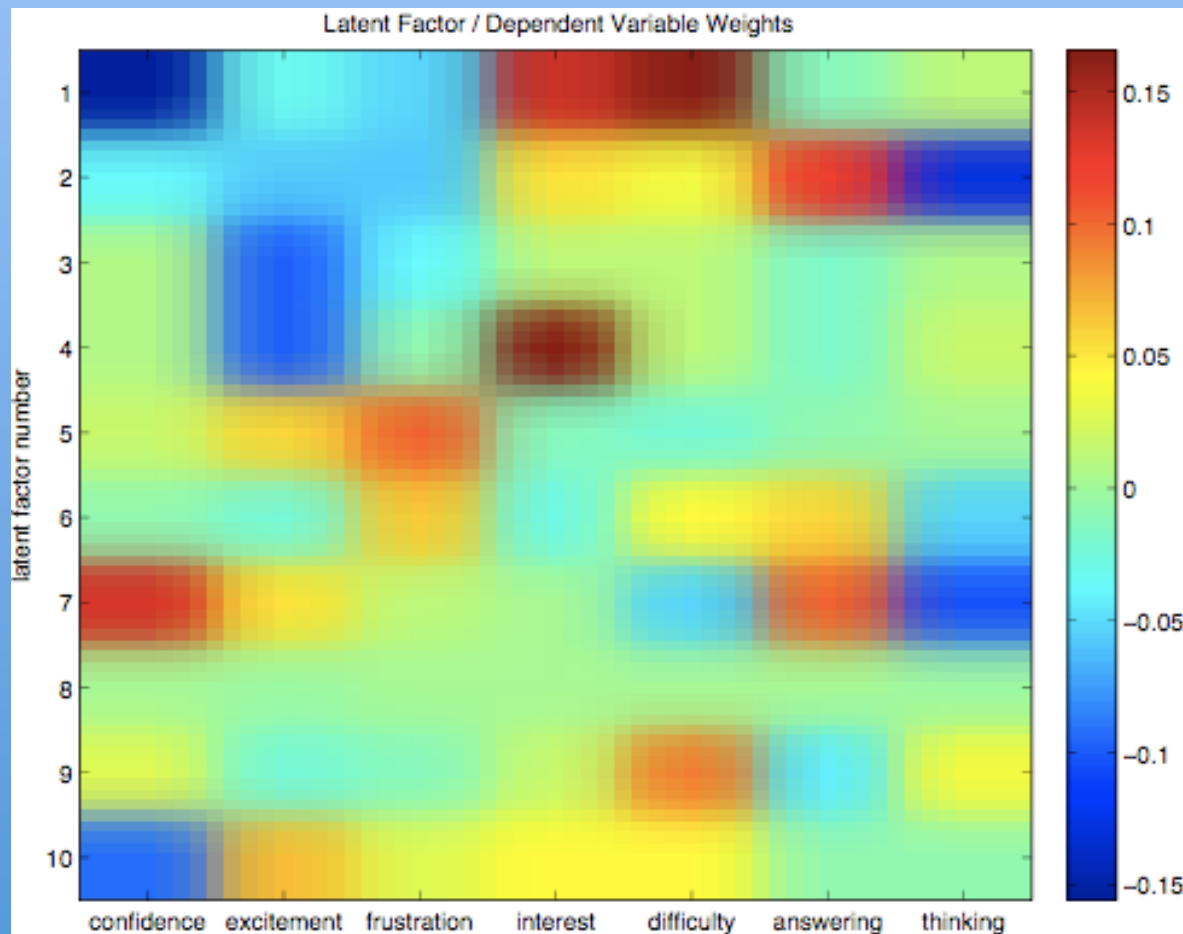

Low-rank regression error – Linear regression error

Interpreting Factors:
IV loading on Factor 1

Mean Spectral Power Loadings on Latent Factor 1

Factor 1 comprises mean spectral power from sensors 7-9, the right occipital area

Interpreting Factors:
Latent Factor / DV Weights

Factor 1 predicts interest and difficulty and is negatively related to confidence