Analysis of reaction time during pattern learning

Estevão Uyra Pardillos Vieira
Advisor: André Frazão Helene

May 5, 2015

Outline

Outline

Equiprobable choices

- Simple choices are faster than complex ones
- What matters is the number of possibilities η
- Reaction time increases logarithmically with η

$$T = b.log_2(\eta + 1)$$

Unequal probabilities

- Can be generalized using the Entropy H
- Reaction time increases linearly with H

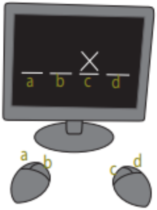
$$T = bH$$

$$H = \sum_{i}^{\eta} p_i log_2(\frac{1}{p_i} + 1)$$

Problems

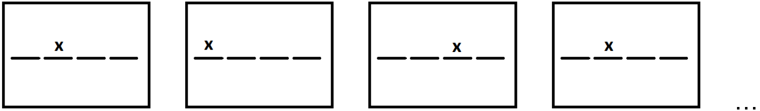
- There is no upper bound for reaction time
- It takes no account of the learning process

Outline



The reaction time is the time between the marking on the screen and the pressing of the correct button.

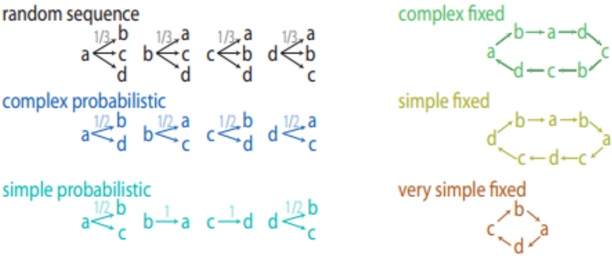
If we let a sequence be fixed as S=213, the first events would be:

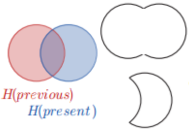


Outline

- Testing sigmoidal fits to compare with Hick's linear
- Using simple sequences to see learning

Methods





joint entropy

$$H(previous \cup present) = -\sum_{X} p(x_{-1}, x_0).log_2[p(x_{-1}, x_0)]$$

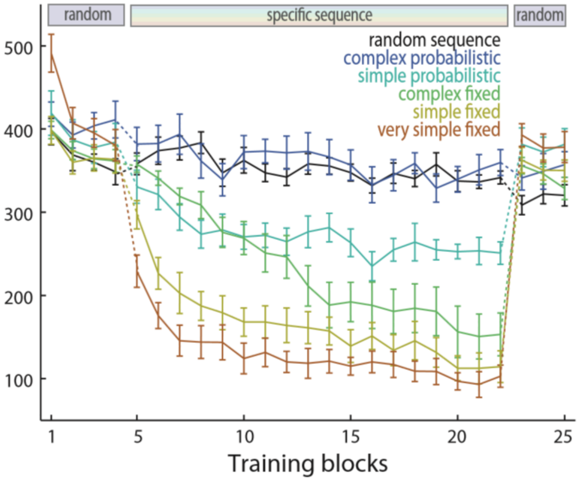
conditional entropy

$$H(present \mid previous) = -\sum_{X} p(x_{-1}, x_0).log_2[p(x_0 | x_{-1})]$$

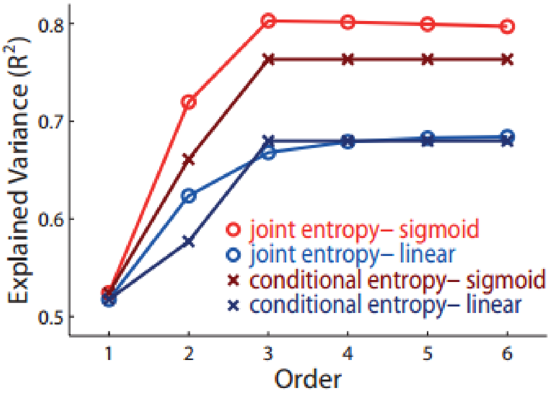
Outline

1. Introduction
   - Hick's Law
   - SRT Task
2. Previous work
   - Methods
   - Results
3. Work in Progress
   - Distinct probabilities
   - Hypothesis

Learning


random
specific sequence
random
random sequence
complex probabilistic
simple probabilistic
complex fixed
simple fixed
very simple fixed
500
400
300
200
100
1
5
10
15
20
25
Training blocks

Sigmoidal fits better

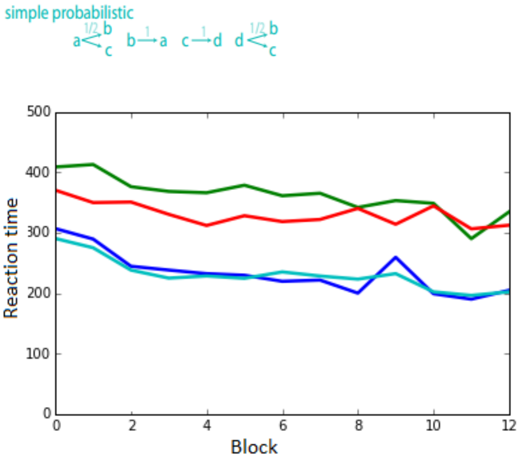


What is missing

- The sigmoidal entropy fit explains the variance, but still doesn't explain the learning process.
- Is reaction time the same on events with distinct probabilities from the same source?

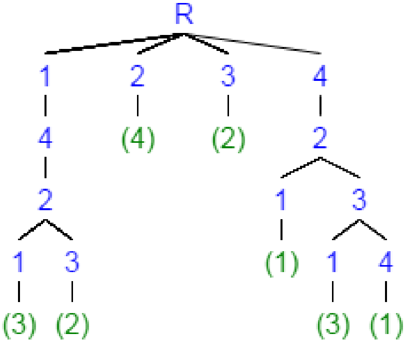
Outline

Simple probabilistic sequence



- Reaction time strongly differs throughout same sequence's distinct events
- Can we use context trees? Will depth explain reaction time?

1241324324



Results

- Will depth explain reaction time?

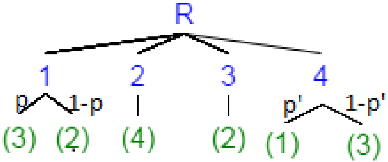
Results

- Will depth explain reaction time? Not at all.

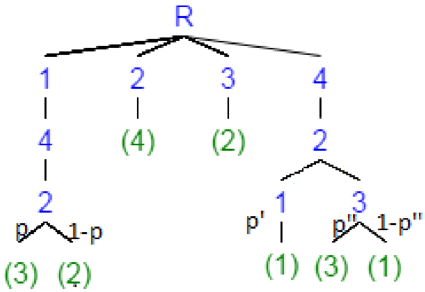
Outline

- We may use context trees, but subject-made (Rissanen)
- The tree should be updated during learning

Early Learning



Late Learning

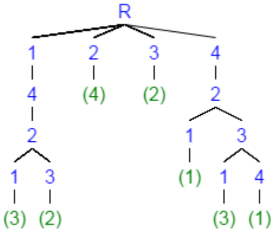


To analyze

- The probabilities of the roots could explain intra-sequence variance (?)

Problems

- Upper levels must be considered



Problems

- Upper levels must be considered
- Learning rate changes with subject

References

- Rissanen, J., A universal data compression system, IEEE Trans. Inform. Theory 29, Number 5, 656–664, 1983.
- Pavão R, Savietto JP, Sato JR, Xavier GF, Helene AF. Entropy and probability measures describe sequence learning performance
- Shannon, C. (1948) A mathematical theory of communication. Bel l System Tech. J. 27, 379–423.