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Flexible user model for human's cognitive judgment in video streaming applications

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Introduction

Recently, the volume of mobile traffic is rapidly increasing and it is expected to be seven times from 2016 to 2021, and video traffic will account for about 75% of it in 2021 [1]. Then it becomes more difficult for networking providers to guarantee Quality of Service (QoS) such as network throughput and delay time. Under such circumstances, Quality of Experience (QoE) is proposed as a network performance indicator that substitute for QoS. QoE is a measure of the overall level of user satisfaction for application. In considering QoE, we are paying particular attention to the decline in QoE caused by misperception in human brain.

Purpose

The purpose of our research is QoE improvement by detecting and preventing user's wrong operation caused by recognition error of QoS.

Then we propose a human's cognition model that reflects some misperception characteristics of human to analyze its behavior in video streaming applications.

Approach

3 steps for creating human's cognition model in video streaming applications

1.We clarify the reason of why misperception in human brain occurs.

2. We propose a user agent model where the agent observes information about network performance, estimates the probability that observed performance is obtained, and makes some decisions on the operation for a video streaming application.

3. We reveal that the model proposed in step 2. has the misperception features of step 1.

Features in human perception

Decision making from small samples [2]

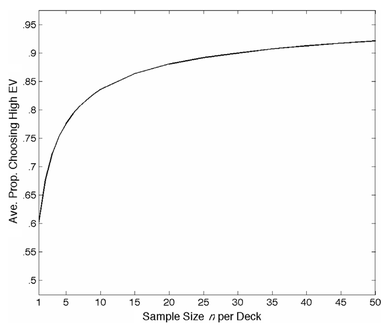
It has been pointed out that human often tends to make decisions from a small number of observed information and makes erroneous decisions due to such less observation.

This is because

- Limited short-term memory
- Opportunity costs (people don't want to take much time to take samples)
- Decision makers focus, but not exclusively, on the strength of evidence as opposed to the weight of evidence in decisions from experience

Trade-off relation between opportunity costs and accuracy of decisions

The analysis assumes that a person samples from two payoff distributions (decks) and select the deck with the higher expected value. Right figure summarizes the results of this effort–accuracy analysis. According to the increase in the sample size (opportunity costs), a person can increase the likelihood of selecting the higher expected value gamble (accuracy).

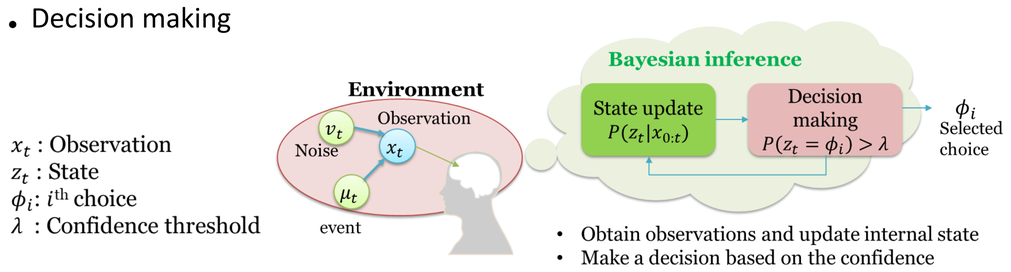


Bayesian Attractor Model (BAM) [3]

The overview of BAM

BAM represents human-brain's perceptual decision making

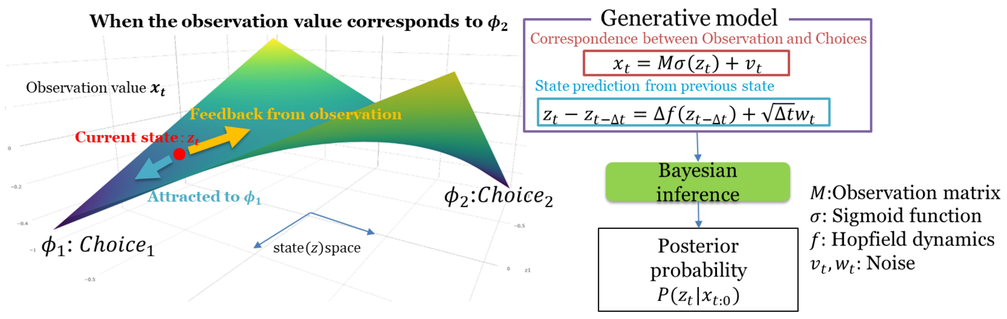
- Event sensory
- Probability estimation for the event
- Decision making



State update in BAM

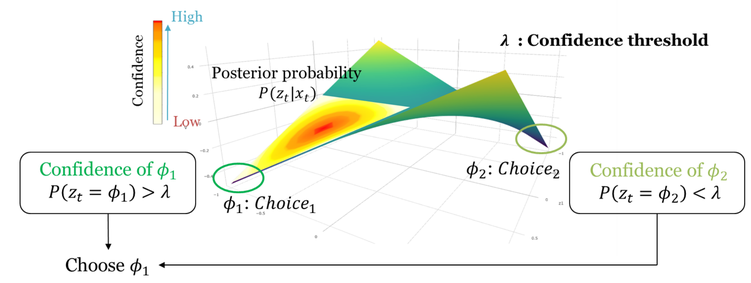
Update the state every time BAM obtains observation value

- To approach decision-making state corresponding to observation
- To be attracted to the choice close to the current state



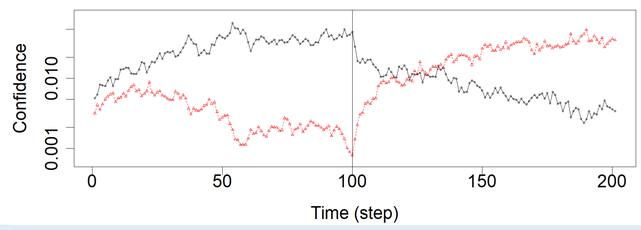
Decision making in BAM

- Calculate posterior probability as a confidence of a choice
- Choose a choice with higher confidence than threshold



Example trial showing evolution of confidence

An example is shown in the figure below. From time step 1 to 100, observation information corresponding to ϕ_1 is given to BAM. From 101 to 200, BAM is given observation information corresponding to ϕ_2. Each confidence corresponding to ϕ_1 and ϕ_2 changes in accordance with observation information, and BAM makes a decision when the confidence of ϕ_1 or ϕ_2 exceeds the set threshold of confidence.

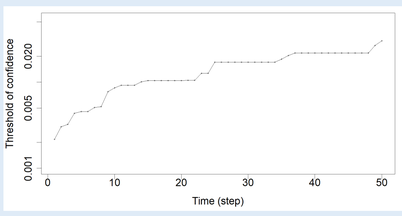


Validation

BAM can express "Decision making from small samples" model by adjusting the threshold of confidence. Then we verified whether the trade-off relation between opportunity costs and accuracy of decisions appears in BAM

1. Prepare an environment where there are two choices (ϕ_1, ϕ_2).
2. At first, BAM receives observation value corresponding to ϕ_1, and the state is shifted to a state where ϕ_1 is adopted.
3. After this, BAM receives observation value corresponding to other choice, ϕ_2.
4. The confidence of ϕ_2 changes. Then, the time taken for making decision ϕ_2 is measured for various confidence threshold

In Right figure, according to the increase in the time taken for making decision ϕ_2 (opportunity costs), BAM make decision with higher confidence (accuracy of decisions). In summary, the trade-off relation also appears in BAM.



Future work

We show that our proposed model represent the typical characteristic of human's misperception. In the future, we capture the features of human perception by BAM with fitted parameter and prevent human error of misrecognition.

Reference

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