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Model Free Based learning for eye trajectory optimization

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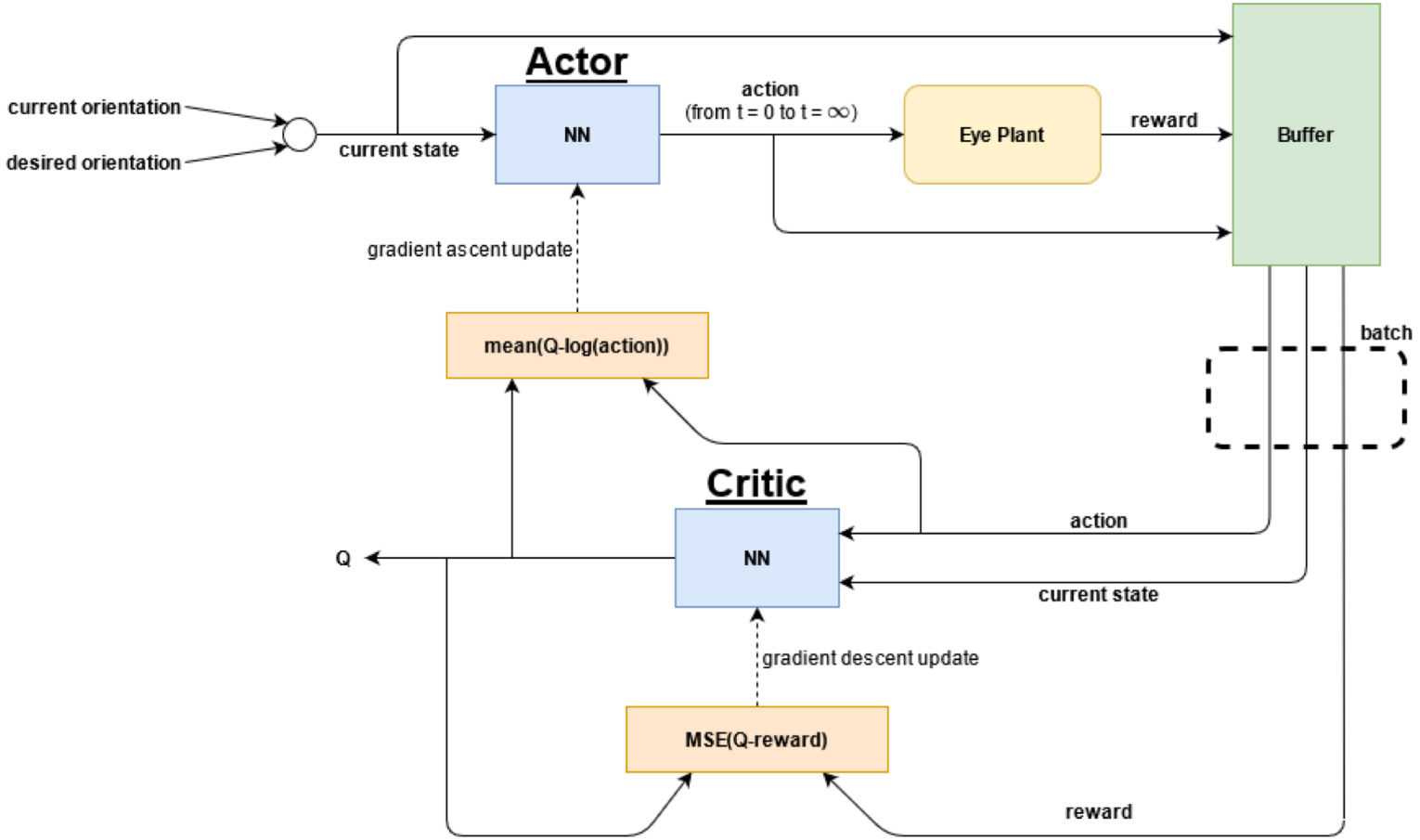
13 June 2021

VISLAB

Outline

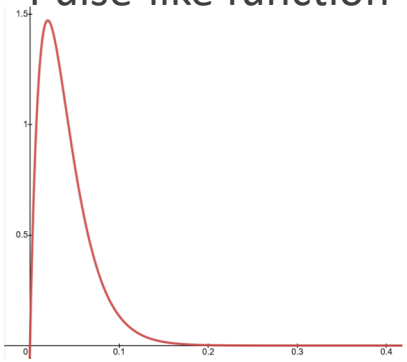
- Actor-Critic Algorithm
  - Action
  - Reward
- Results
- Current Work

Actor-Critic



Actions

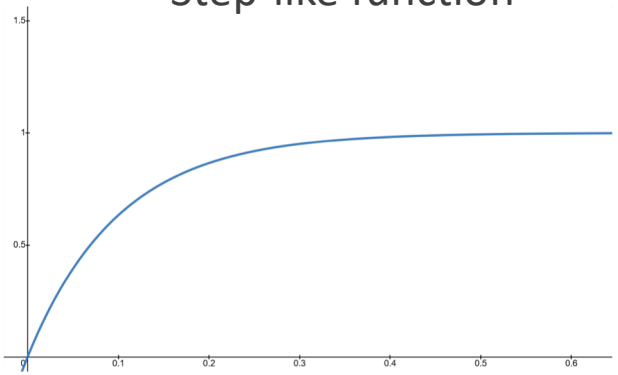
Pulse-like function



$$f_1(x) = A \cdot x \cdot e^{-B \cdot x}$$

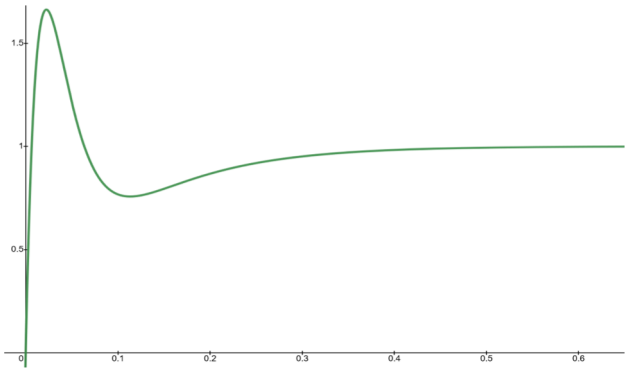
+

Step-like function



$$f_2(x) = (D - F) \cdot (1 - e^{-C \cdot x}) + F$$

=



$$f(x) = A \cdot x \cdot e^{-B \cdot x} + (D - F) \cdot (1 - e^{-C \cdot x}) + F$$

A - $]-\infty, \infty[$
B - $]0, \infty[$
C - $]0, \infty[$
D - Final Motor Position

Determined by the Actor

F - Initial Motor Position ← Known

Reward

Accuracy:

$$\boldsymbol{regret_A = -(1 - (q_f \cdot q_d)^2)}$$

$q_f - final\ orientation$

$q_d - desired\ orientation$

Energy:

$$\boldsymbol{regret_E = -\sum_{i=0}^{N} (\Delta \tau_i)^2 / \Delta t}$$

$\Delta \tau_i - change\ in\ motor\ command/rotation$

Duration:

$$\boldsymbol{regret_D = -(1 - \frac{1}{1+\beta p})}$$

$p\ - time\ taken\ to\ reach\ final\ orientation$

$$total\ regret = \lambda_A \cdot regret_A + \lambda_E \cdot regret_E + \lambda_D \cdot regret_D$$

First Steps

Check viability of algorithm:

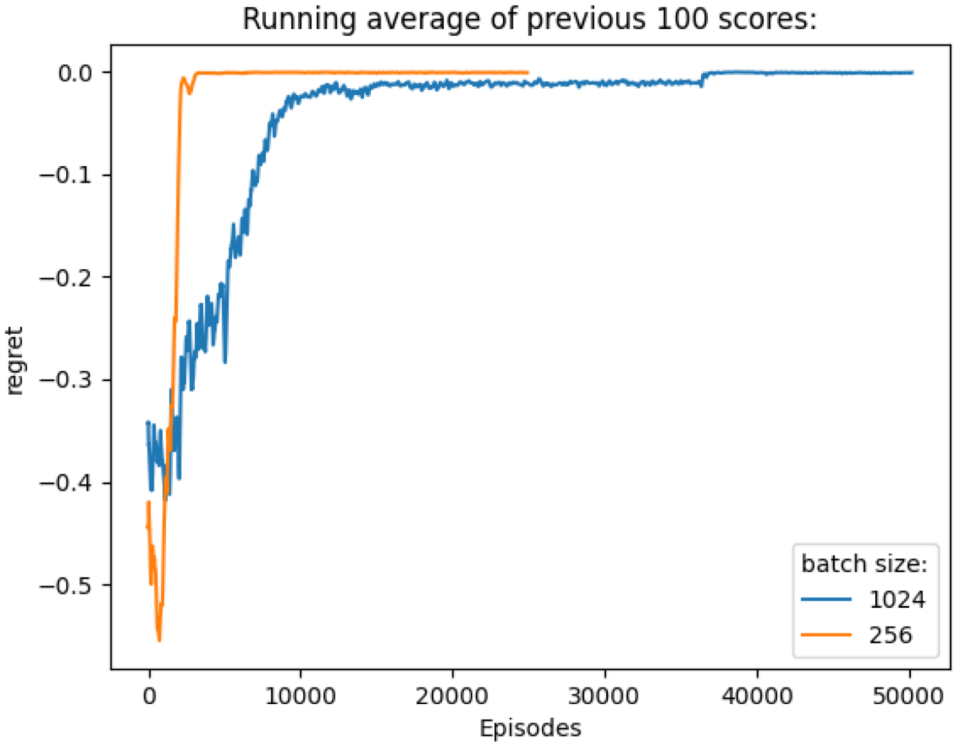
Train only 1 parameter (D) for accuracy only for horizontal movements:

- $Motor\ Position\ =\ f(t) =\ (D - F)H(t) + F$
  - D – Final Motor Position
  - F – Initial Motor Position
  - H(t) – Heaviside Function
- $total\ regret = -\left(\mathbf{1} - \left(\boldsymbol{q_f} \cdot \boldsymbol{q_d}\right)^{\mathbf{2}}\right)$
  - $q_f - final\ orientation$
  - $q_d - desired\ orientation$

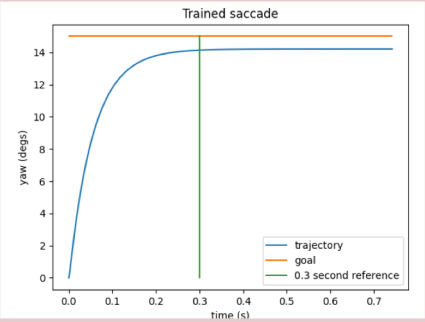
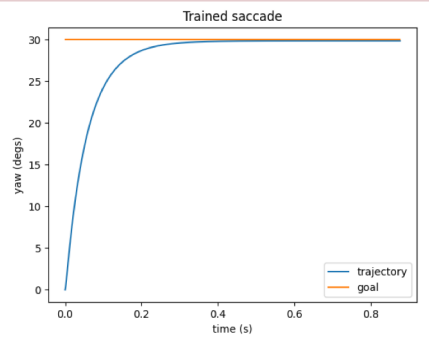
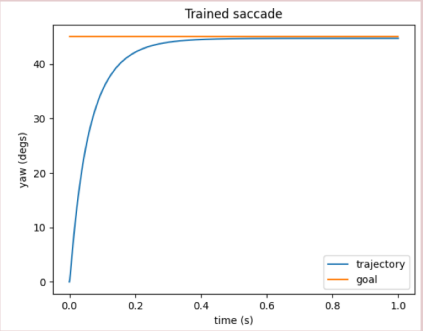
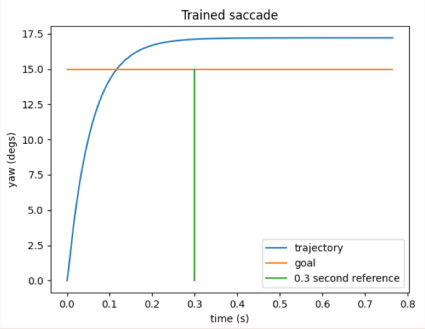
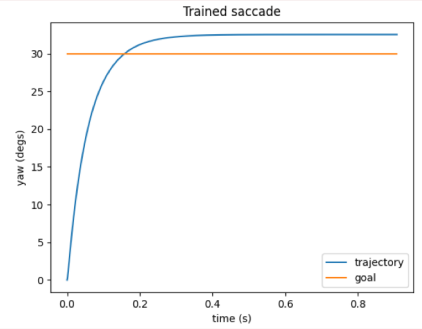
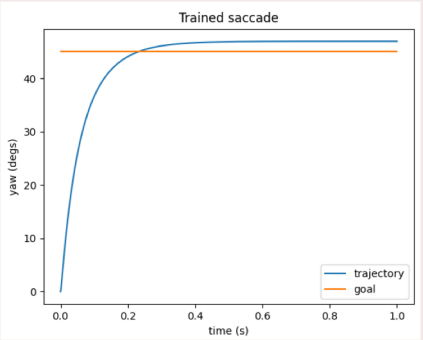
Results

Two runs of training 1 Actor-Critic for all sized horizontal saccades:

- Actor: MLP with 2 hidden layers with a size of 16 neurons each
- Critic: MLP with 2 hidden layers with a size of 16 neurons each



Verifying Results

Goal	15º	30º	45º
1st Run (1024 batch size)			
2nd Run (256 batch size)			

Current Work

- $Motor\ Position\ =\ f(t) = (D - F) \cdot (1 - e^{-C \cdot x}) + F$
- $total\ regret = \lambda_A \cdot regret_A + \lambda_E \cdot regret_E + \lambda_D \cdot regret_D$
- Focusing on finding a good set λ that lead to a good result

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Thank you

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