Summary of A tutorial or the free-energy framework for modelling perception and learning

Marco Casari

Introduction

Single variable model

Multiple variable model

Canalusia

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Marco Casari

University of Turin

Complex system in neuroscience, 12 December 2023

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2023-12-09

Introduction

-Introduction

Marco Casari

Introduction

• Predictive coding model of Rao and Ballard.

1. Prior predictions are compared to stimuli and the model parameters are updated considering prediction errors, features corresponding to receptive fields in the the primary sensory cortex are learned.

Summary of A tutorial on the free-energy framework

Introduction

Introduction

Summary of A tutorial on the free-energy framework 2023-12-09 for modelling perception and learning by Rafal Bogacz Introduction

-Introduction

1. Prior predictions are compared to stimuli and the model parameters are updated considering prediction errors, features corresponding to receptive fields in the the primary sensory cortex are learned.

. Predictive coding model of Rao and Ballard

2. Weight stimuli by their noise, learn features using their covariance, implement attentional modulation changing the variance of attended features.

Predictive coding model of Rao and Ballard.

• Free-energy model of Friston.

Introduction

Introduction

- Predictive coding model of Rao and Ballard.
- Free-energy model of Friston.
- Hebbian learning.

Summary of A tutorial on the free-energy framework for modelling perception and learning by Rafal Bogacz 2023-12-Introduction

-Introduction

1. Prior predictions are compared to stimuli and the model parameters are updated considering prediction errors, features corresponding to receptive fields in the the primary sensory cortex are learned.

. Predictive coding model of Rao and Ballard

Hebbian learning

- 2. Weight stimuli by their noise, learn features using their covariance, implement attentional modulation changing the variance of attended features.
- 3. Synaptic strenght is changed proportionally to activities of pre-synaptic and post-synaptic neurons.



Introduction

Marco Casari

Introduction

Predictive coding model of Rao and Ballard.

- Free-energy model of Friston.
- Hebbian learning.
- Free energy minimization.

Summary of A tutorial on the free-energy framework for modelling perception and learning by Rafal Bogacz

Introduction

2023-1

-Introduction

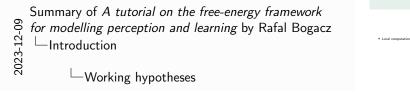
. Predictive coding model of Rao and Ballard

- 1. Prior predictions are compared to stimuli and the model parameters are updated considering prediction errors, features corresponding to receptive fields in the the primary sensory cortex are learned.
- 2. Weight stimuli by their noise, learn features using their covariance, implement attentional modulation changing the variance of attended features.
- 3. Synaptic strenght is changed proportionally to activities of pre-synaptic and post-synaptic neurons.
- 4. Minimization of free energy can be seen as the base of many theories of perception.

Introduction

Working hypotheses

Local computation.



1. The state of a neuron is determined only by the synaptic weight and the state of its input neurons.

Working hypotheses



Introduction

Local computation.

Local plasticity.

Working hypotheses

2023-12-09

Summary of A tutorial on the free-energy framework for modelling perception and learning by Rafal Bogacz -Introduction

· Local plasticity.

Working hypotheses

-Working hypotheses

- 1. The state of a neuron is determined only by the synaptic weight and the state of its input neurons.
- 2. Synaptic plasticity depends only on the activities of pre-synaptic and post-synaptic neurons.

Introduction

Working hypotheses

Local computation.

- Local plasticity.
- Basic neuronal computation.

2023-12-

Summary of A tutorial on the free-energy framework for modelling perception and learning by Rafal Bogacz -Introduction

Local elasticity

Working hypotheses

-Working hypotheses

- 1. The state of a neuron is determined only by the synaptic weight and the state of its input neurons.
- 2. Synaptic plasticity depends only on the activities of pre-synaptic and post-synaptic neurons.
- 3. The state of a neuron is the result of the application of a monotonic function to the linear combination of states and synaptic weights of input neurons.

Summary of *A tutorial on the free-energy framework* for modelling perception and learning by Rafal Bogacz —Single variable model

2023-12-09

Exact solution of the inference problem

perception and learning by Rafal

Marco Casari

Introductio

Single variable model

Multiple variables model

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2023-12-09

Approximated solution of the inference problem

Approximated solution of the inference problem

framework for modelling perception and learning

by Rafa Bogac

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Introduction

Single variable model

Multiple variables

Neural implementation

2023-12-09

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Neural implementation

☐Neural implementation

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Introduction

Single variable model

Multiple variables model

Learning model parameters

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Learning model parameters

Learning model parameters

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Introduction

Single variable model

Multiple variables model

Learning relation between variable and stimulus

Summary of *A tutorial on the free-energy framework*for modelling perception and learning by Rafal Bogacz
Single variable model

Learning relation between variable and stimulus

Learning relation between variable and stimulus

Marco Casari

Introductio

Single variable

model Multiple

Multiple variables model

Summary of A tutorial on the free-energy framework for modelling perception and learning by Rafal Bogacz —Single variable model

Free energy framework

2023-12-09

Marco Casari

Introductio

Single variable model

Multiple variables model

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└─Multiple variables model

-Multiple variables model

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Multiple variables model

Learning parameters

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Learning parameters

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Learning parameters

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Multiple variables model

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-Multiple variables model

2023-12-09

 $\label{eq:hierarchical} \ensuremath{\,\sqsubseteq\,} \ensuremath{\mathsf{Hierarchical}}\xspace \ensuremath{\mathsf{structure}}\xspace \ensuremath{\mathsf{implementation}}\xspace$

Hierarchical structure implementation

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Introductio

Single variable model

Multiple variables model

Recover local plasticity

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Recover local plasticity

—Multiple variables model

2023-12-09

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by Kafal Bogacz

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Introduction

Single variable model

Multiple variables model

Conclusion

Conclusion

Summary of A tutorial on the free-energy framework for modelling perception and learning by Rafal Bogacz Conclusion

-Conclusion

2023-12-09

└─ Conclusion