Computational Neuroscience: Neuronal Dynamics of Cognition

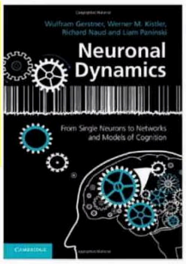
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Decision models:
Competitive dynamics

Wulfram Gerstner

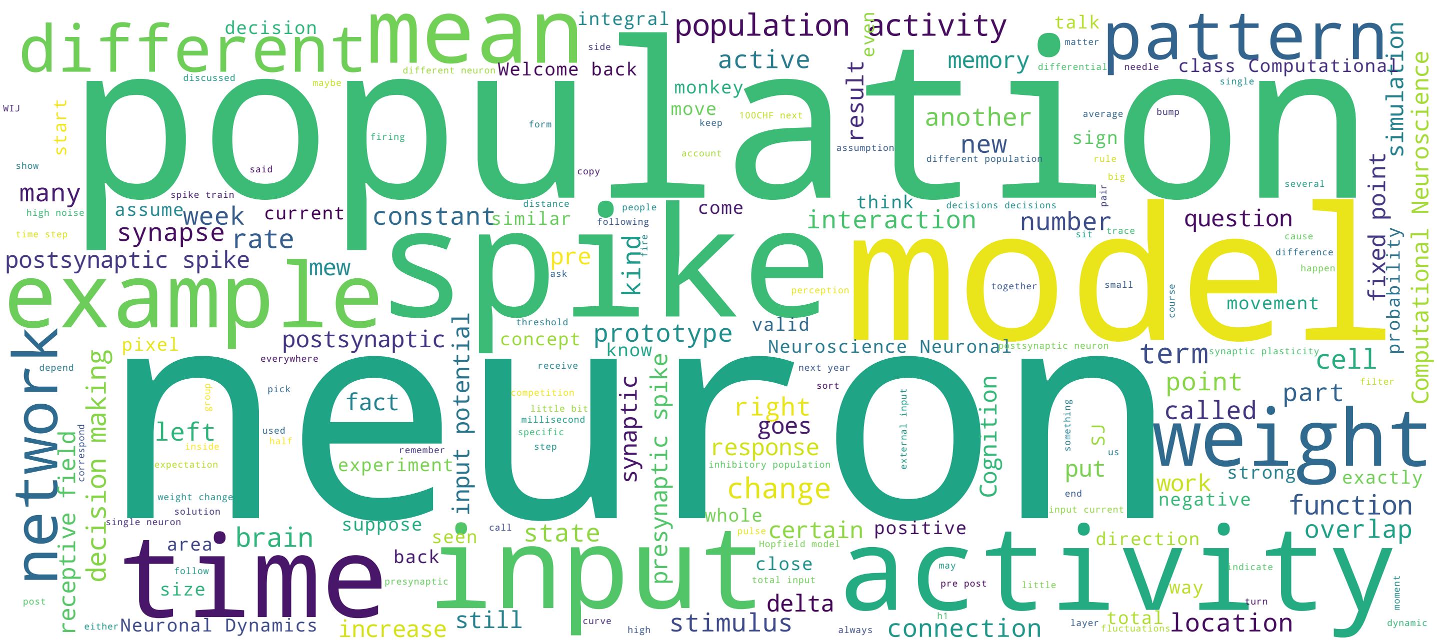
EPFL, Lausanne, Switzerland

Reading for week 9:
NEURONAL DYNAMICS
Ch. 16 (except 16.4.2)



Cambridge Univ. Press

1. **Introduction**
   - decision making
2. **Perceptual decision making**
   - V5/MT
   - Decision dynamics: Area LIP
3. **Theory of decision dynamics**
   - competition via shared inhibition
   - effective 2-dim model
4. **Solutions**
   - symmetric case
   - biased case
5. **Simulations and Experiments**
   - simulations and theory
   - simulations and experiments
6. **Decisions, actions, volition**
   - the problem of free will



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Video

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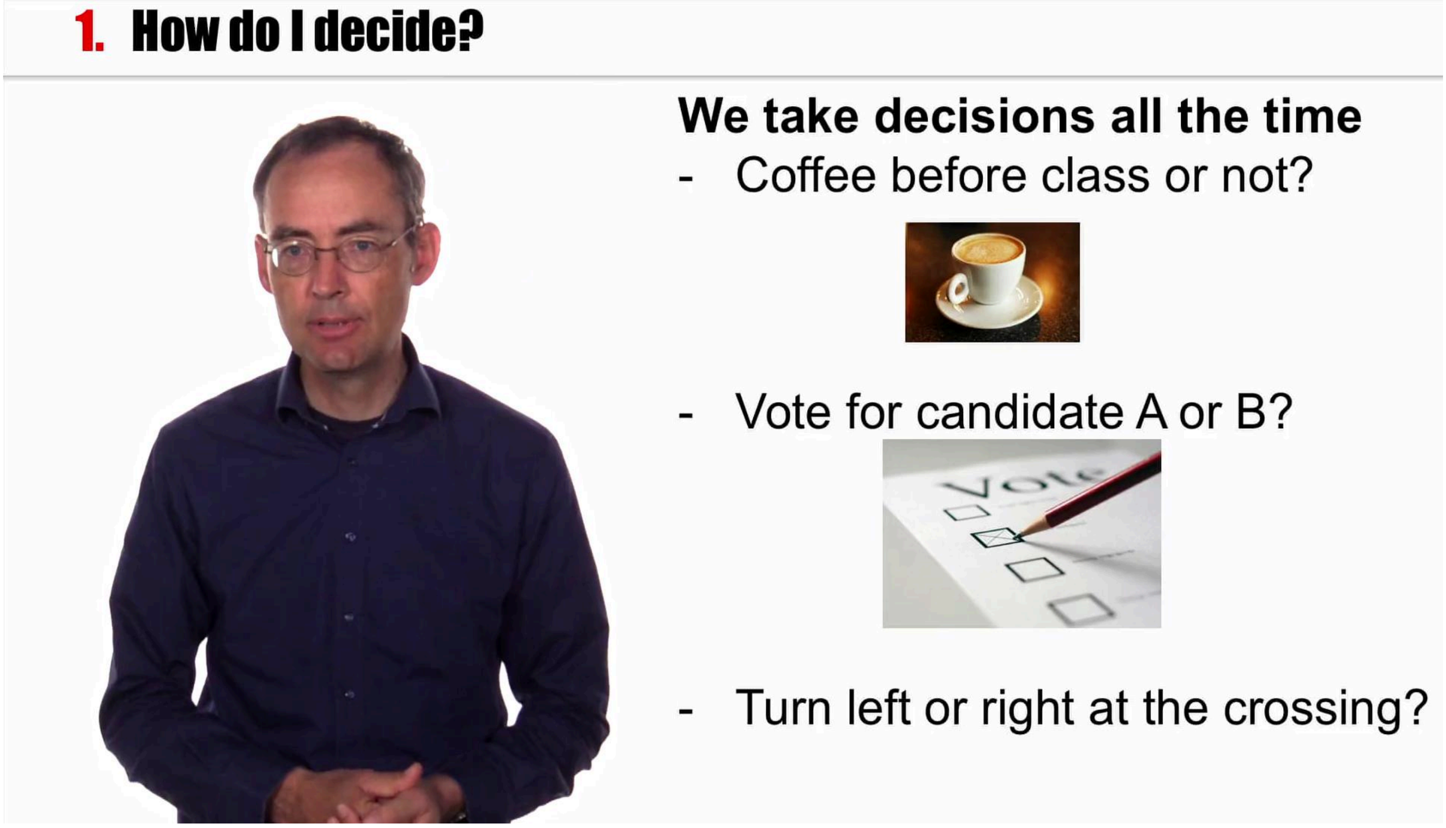


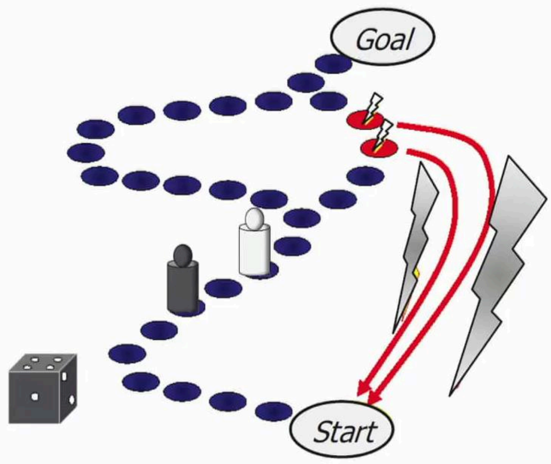
Welcome to the class Computational Neuroscience: Neuronal Dynamics of Cognition. This week, I would like to talk about decision models. We will look at competitive dynamics to explain decision making. Now we take decisions all the time. Should I take a coffee before going to class or not? Should I vote for candidate A or B? Should I turn left or right at the next crossing?

Notes

Summary

0m 12s

1. How do I decide?



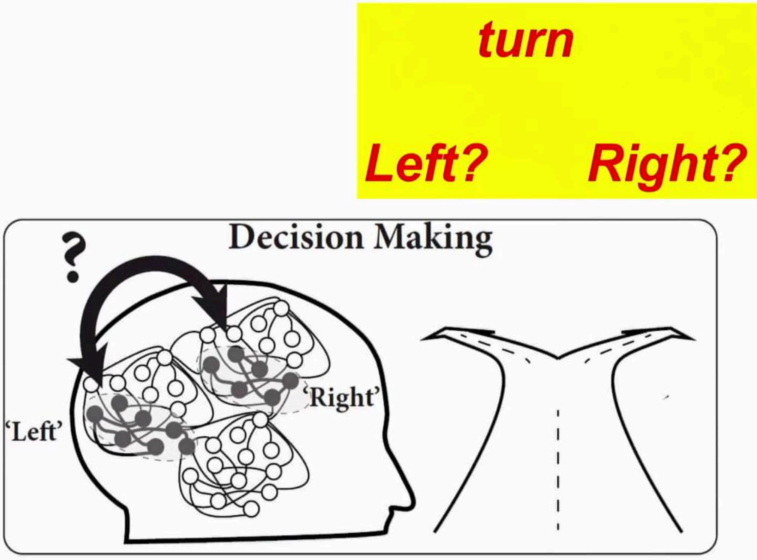
So as a child, I used to play games, and often, there was a decision to make. Should I make the long detour, or should I take the risky shortcut?

Notes

Summary

0m 24s

1. Decision making

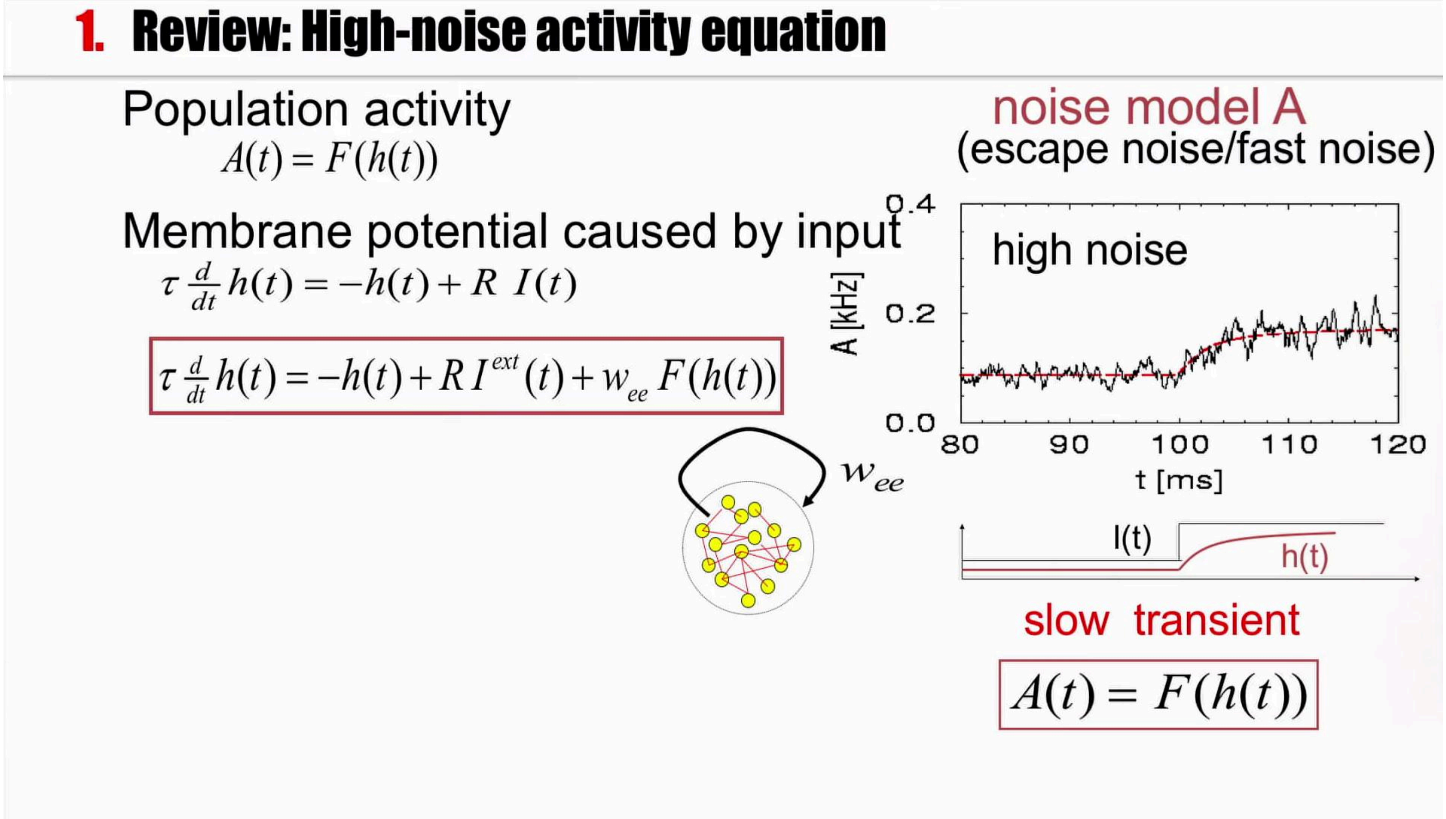


So we believe that decision making takes place in the brain and it takes place by interaction between different populations.

Notes

Summary

0m 33s

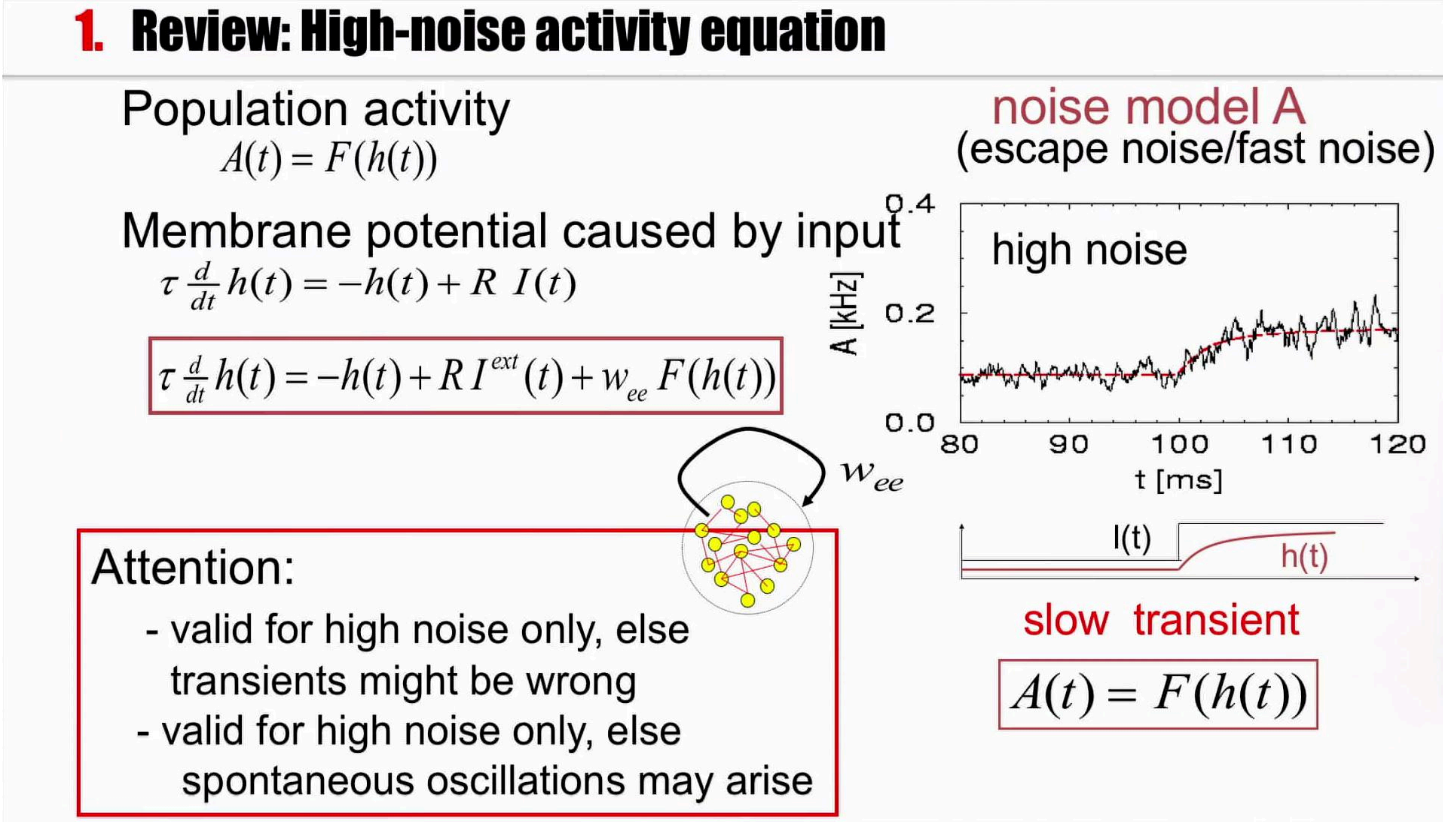


Now for populations, we have already developed a model. We have population activity that follows the input potential, and the input potential is given by differential equation. Now, this kind of model is the model we are going to use this week, and we should remember that this is a model that's valid only to a certain limit. It neglects fast transient oscillations, involves a slow, low transient, in fact it's valid for a model that's high noise -- escape noise, or so-called a fast noise model.

Notes

Summary

0m 43s



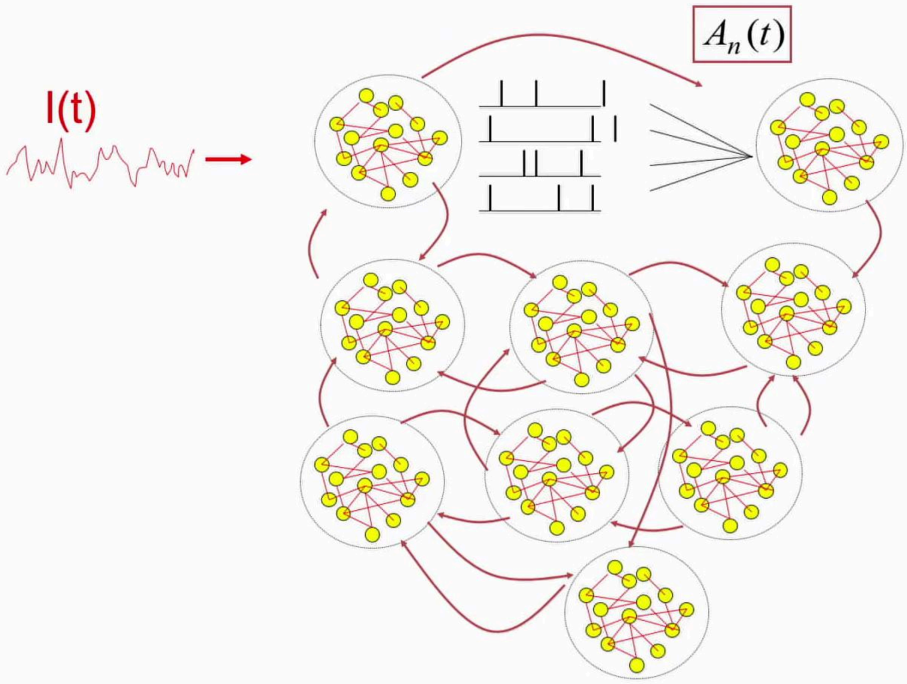
So, even though we know it has limitations, it's valid for high noise only, once it's maybe wrong, it may neglect spontaneous oscillations, nevertheless, despite its limitations, this is the model we are going to use this week.

Notes

Summary

1m 17s

1. Review: microscopic vs. macroscopic



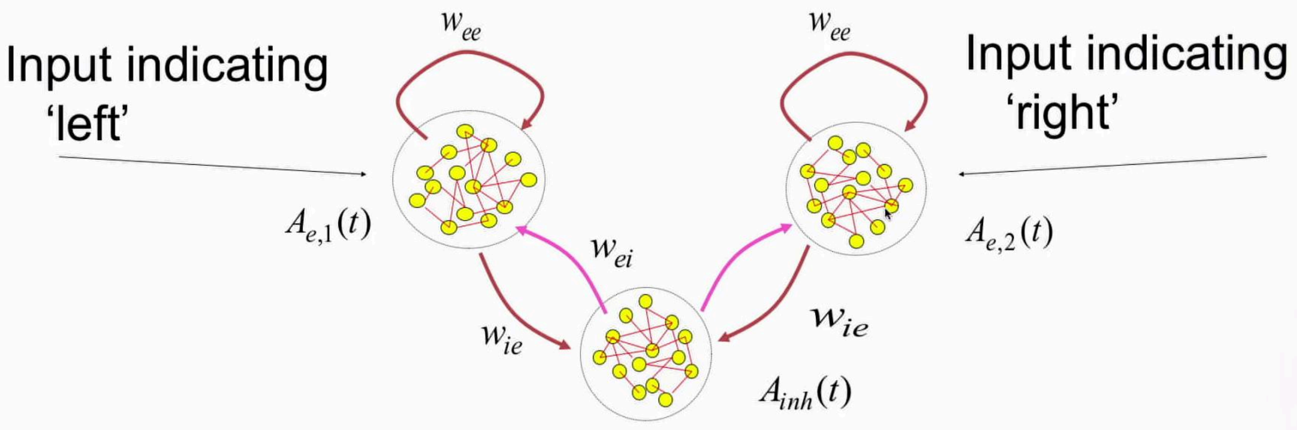
And, what we are going to do is we either make simulations or we directly work with patients for the populations activity, and different populations interact with each other, and specifically, we'll have two populations, both of these are excitatory populations.

Notes

Summary

1m 32s

1. Competition between two populations



There's one that would indicate, for example, movement to the left, and there's another one that, for example, would indicate movement to the right. And these populations are in competition with each other because they both share a pool of inhibitory neurons. So if one of the populations is active, it sends strong signals to the inhibitory population, which in turn sends signals to the other one, so that this population, if it has strong activity will effectively suppress the other population.

Notes

Summary

1m 50s

1. How do YOU decide? Make a commitment and indicate choice

Suppose you got a winning ticket,
pick your money at closest post office

30CHF tomorrow / 100 CHF May first next year

90CHF tomorrow / 100 CHF May first next year

'Neuro-economics'

Decision making is everywhere. For example, you may win, you get a winning ticket, and you're asked to pick up your money at the closest post office, and you have two choices. Either you pick up 30CHF tomorrow, or 100CHF next year. Now, which one would you choose? Maybe you think Switzerland is a reliable country, so it's worthwhile waiting for a year, and 100CHF next year is more worth than 30CHF tomorrow. Now, how about this, 90CHF tomorrow, or 100CHF next year? Your decision might be slightly different. So there's a whole field of neuro-economics where people look at this kind of questions and look at the decision making that people make, and this decision making is based on neurons. You can look at the neural activity during this kind of decision making. But these are very specific decisions, decisions involving money.

Notes

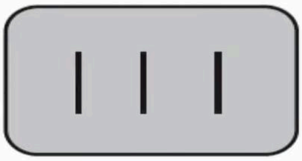
Summary

2m 25s

1. Perceptual decision making?

Bisection task:

‘Is the middle bar shifted to the left or to the right?’

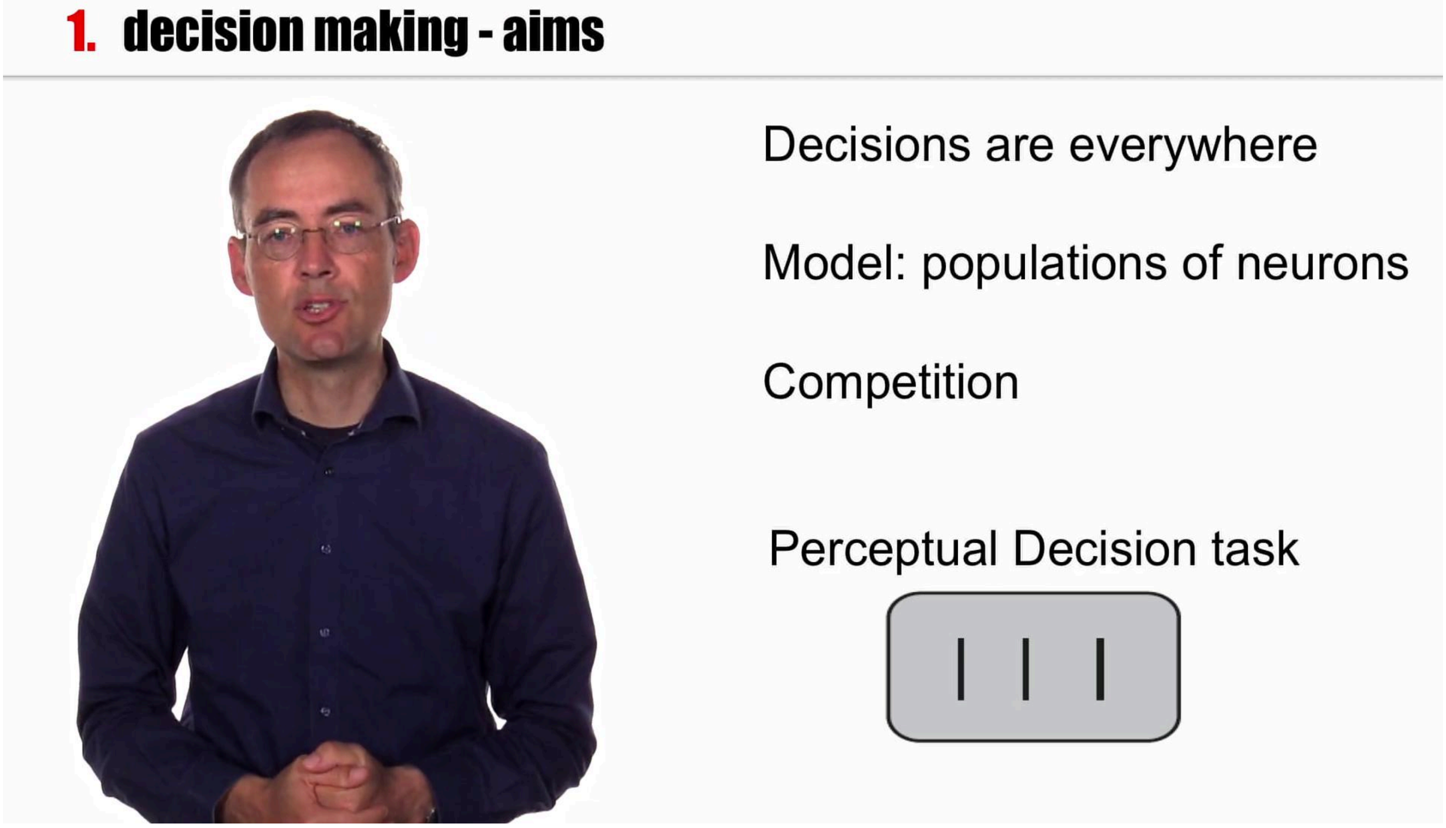


We'll more look at simpler decisions, decisions that are related to perceptions. For example, I can show you three bars, three vertical bars, and the question is, is the middle bar slightly shifted to the left or to the right?

Notes

Summary

3m 29s



So, to summarise, there are all sorts of decisions, decisions are everywhere, and we are going to model these decisions by using populations of neurons, and these populations of neurons will interact. So if a first population is very active, it will affectively suppress the second population. On the other hand, if the second population is active, it will suppress the first one. So the two populations are in competition with each other. Decisions are everywhere, that's neuro-economics, but we will mainly focus in following on perceptual decision tasks. Stay tuned to understand the models involved in decision making.

Notes

Summary

3m 43s