Computational Neuroscience: Neuronal Dynamics of Cognition

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

A: ASSOCIATIVE MEMORY in a Network of Neurons

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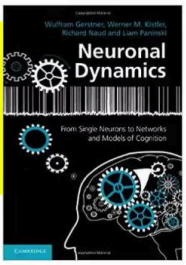
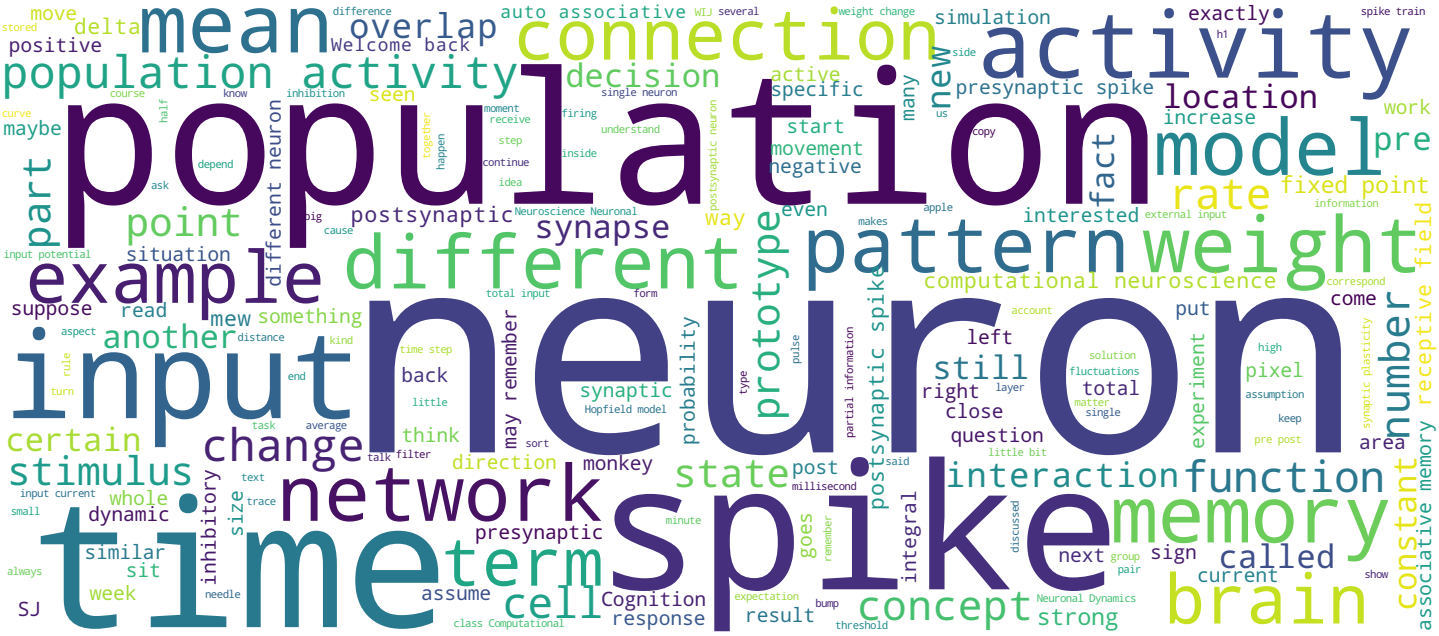
Reading for this week:
NEURONAL DYNAMICS
- Ch. 17.1 - 17.2.4

Cambridge Univ. Press





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Video

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1. memory in the brain

-president
-first day of undergraduate
-apple

Our memory has multiple aspects
- recent and far-back
- events, places, facts, concepts

Welcome to the class on computational neuroscience, neural dynamics of cognition. Cognition has several aspects. One of them is a memory, we can remember different things, you may remember the name of the President of the United States, you may remember your first day at school, and you may remember a concept such as an apple.

Notes

Summary

0m 04s

1. memory in the brain

-president
-first day of undergraduate
-apple

Our memory has multiple aspects
- recent and far-back
- events, places, facts, concepts

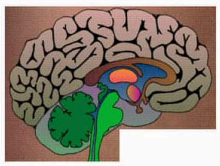
Now, the question is, how do we remember these different things, our memory has different aspects. It has aspects that go far back in time, that are currently recent in time, there are aspects that are more factual, more episodic, this memory of concepts is something I'm interested in.

Notes

Summary

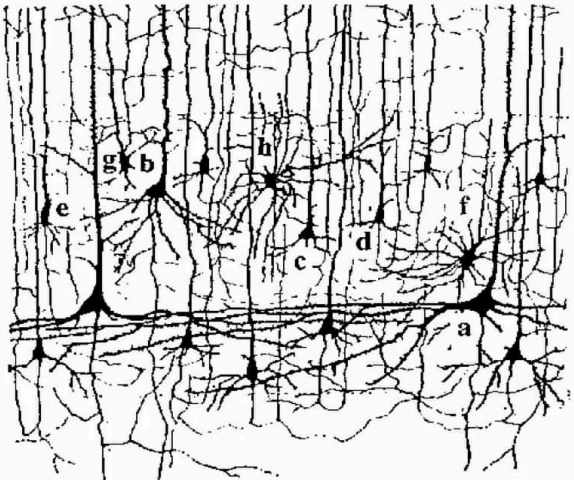
0m 26s

1. Neuronal Networks in the Brain



1mm

10 000 neurons
3 km of wire



Now, memory is stored in the brain more precisely in the network of neurons that we have in the brain. And in fact, each little cubic millimeter of prime material contains already 10,000 neurons or more, and these neurons have these long cables like extensions. And these extensions, you could just look in this cubic millimeter makeup already three kilometers of cable; these cables cell there so that neurons make connections to each other connections to the neighbor's connections that go the long-range.

Notes

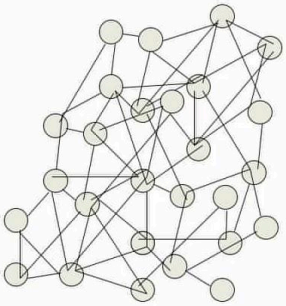
Summary

0m 45s

1. Systems for computing and information processing

1mm

10 000 neurons
3 km of wire



Distributed architecture
10^{10} neurons
10^{4} connections/neurons

No separation of processing and memory

And what I'm going to show you is that the memory actually sits in the connections between the neurons. So memory sits in the brain spread out and this is quite different from the situation that you have. In a classical computer in a classic computer, you have sort of a memory chip that separated from the CPU from the central processing unit. And if you want to process some pieces of information, you have to load it up from memory. Now in the brain, we just have this network of 10^10 neurons, a large number of new neurons, each new neurons makes 1,000 or 10,000 connections or even more and there's no strict separation of memory and the processing. In a way, of course, we do have different areas in the brain. But the memory is spread out across many different neurons. And it sits in the connections. So this fact, that there's no separation of processing in memory that the memory is distributed. This is the central feature that we are going to look at this week. To understand a bit more about the type of memory we are interested in.

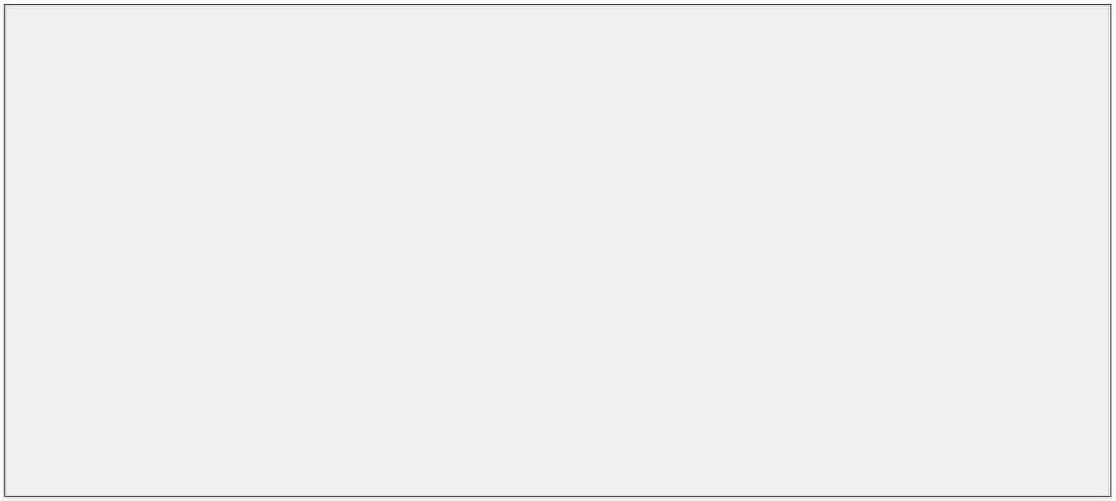
Notes

Summary

1m 21s

1. Associations, Associative memory

*Read this text **NOW**!*



Let's look at the little text; I give you a few seconds just to read this text.

Notes

Summary

2m 31s

1. Associations, Associative memory

*Read this text **NOW**!*

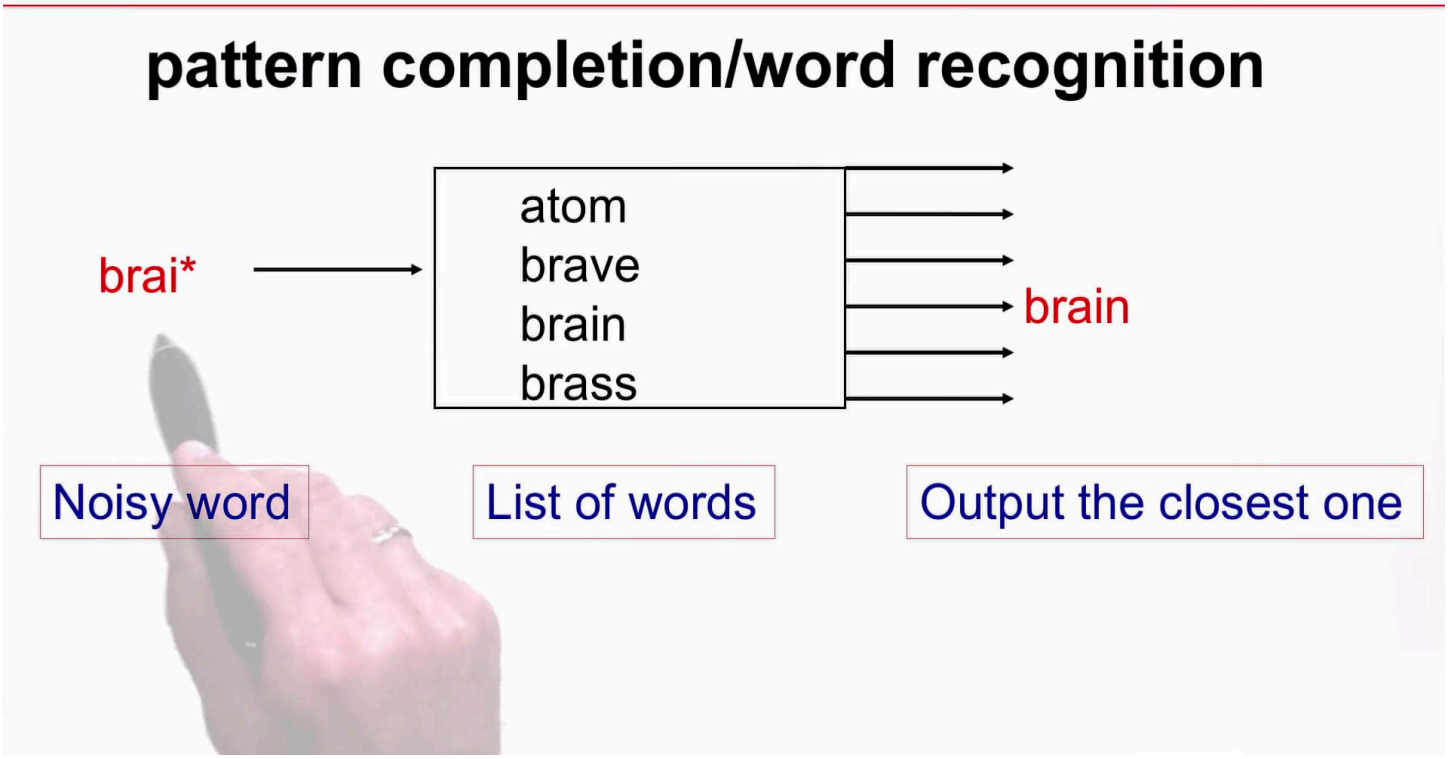
I find it rea*l* amazin* t*at y*u ar*
abl* to re*d t*is tex* despit* th* fac*
*hat more t*an t*ent* perc*n* of t**
char*cte*s a*e mis*ing.
his mean t*at you* brai* i* abl* ** fill
in missin* info*matio*.

So please press the pause button and read the text. So I suppose that you have read the text that you understand its meaning, isn't our brain.

Notes

Summary

2m 36s



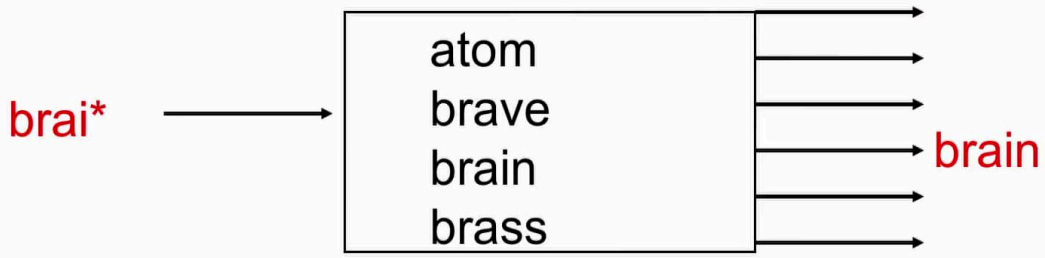
Amazing? Isn't it fascinating? So basically, what he does is he takes partial information.

Notes

Summary

2m 47s

pattern completion/word recognition



Noisy word | List of words | Output the closest one

Your brain fills in missing information: 'auto-associative memory'

And out of his partial information, it makes complete inflammation. So your brain fills in the missing information.

Notes

Summary

2m 53s

1. Associations, Associative memory

brai* → brain ***'auto-associative memory'***

bird → swan

vacation → beach ***'associative memory'***

And that's what we call auto-associative memory, auto-associative memory because it's different from a situation where I associate one thing with the next. The general concept of a bird with a specific example or your concept of vacation may trigger your ideas of a beach. This is associative memory. The specific case is auto-associative memory where we fill in missing information of the same concept of the same item.

Notes

Summary

3m 04s

Quiz 1: Connectivity and Associations

Tick one or several answers

A typical neuron in the brain makes connections

[ ] To 6-30 neighbors

[ ] To 100-500 neurons nearby

[ ] To more than 1000 neurons nearby

[ ] To more than 1000 neurons nearby or far away.

Associative memory is involved

[ ] If you think of palm trees when you think of a beach

[ ] If partial information helps you to recall a complicated concept

[ ] If a cue helps you to recall a memory

And just before we continue, take a few minutes to take your answers on this quizz.

Notes

Summary

3m 35s