



Exploring the Multifaceted Challenges of Aging: Unveiling Genetic, Neural, and Alzheimer's Insights in China and Beyond (with a focus on LLMs today)

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Outline

- 1. Aging challenges in China
- 2. Genetic, Neural, and Alzheimer's Insights
(See in backup slides)
- 3. Large language models' significance
- 4. Conclusion

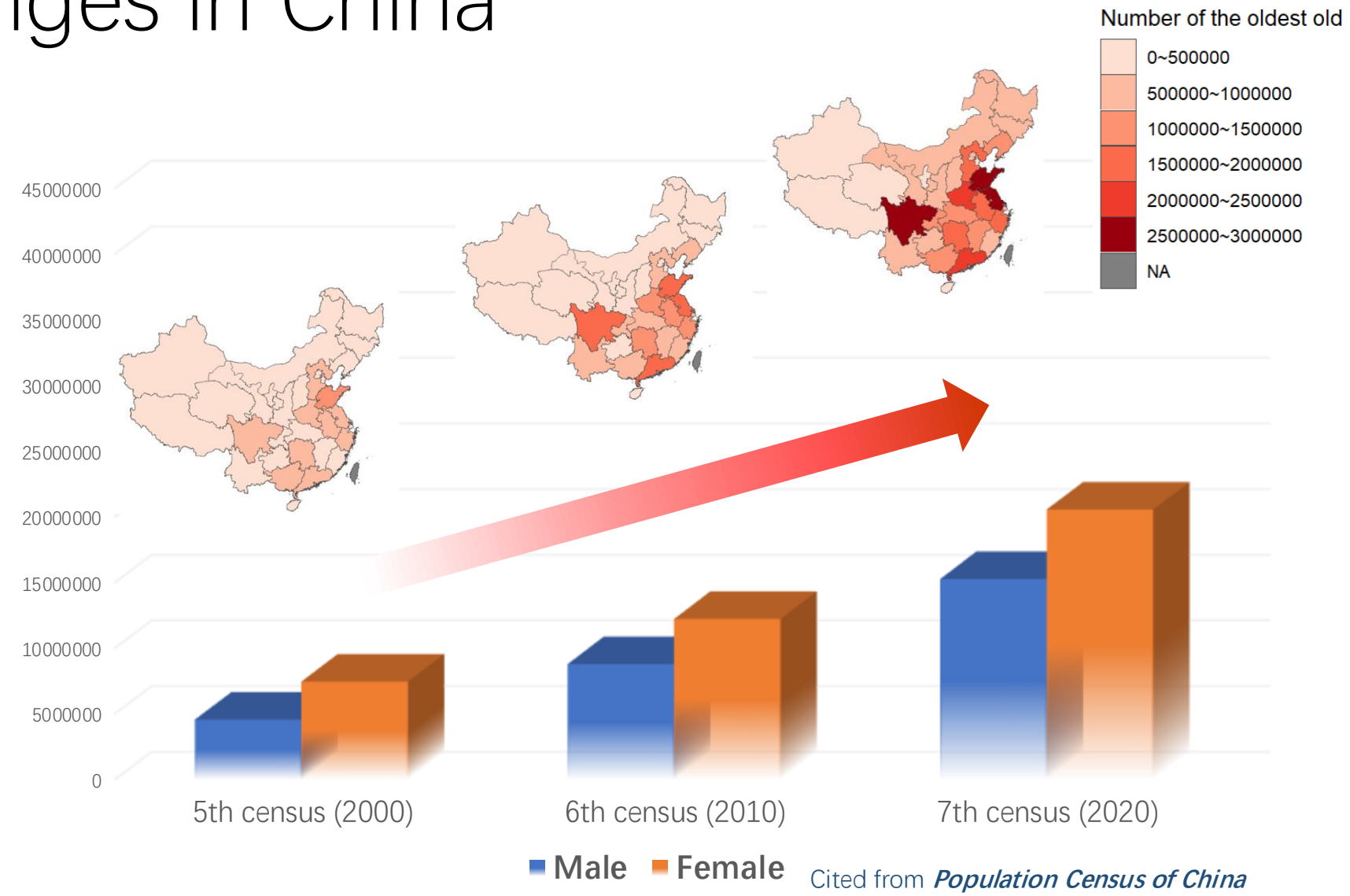
Aging challenges in China

from "1 in 10" to "1 in 5"

obvious gender differences

increasing number of the oldest

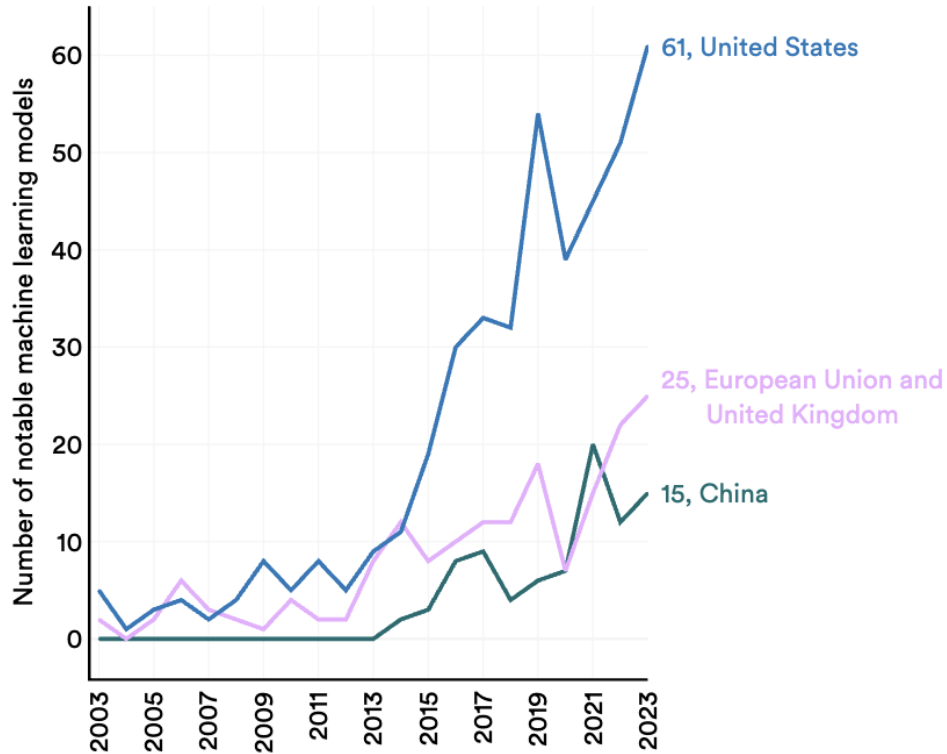
concentrated distribution



AI Race

Number of notable machine learning models by select geographic area, 2003–23

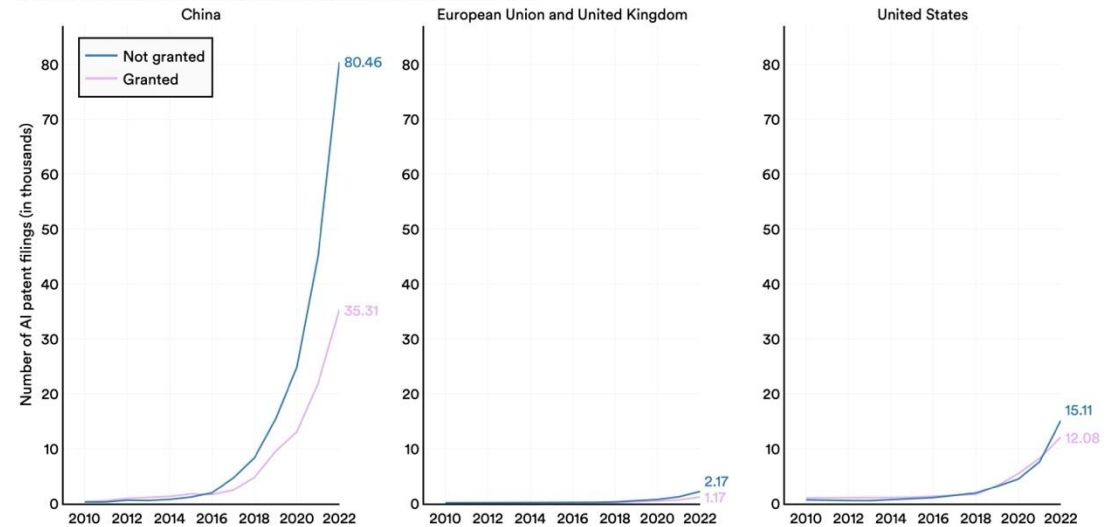
Source: Epoch, 2023 | Chart: 2024 AI Index report



United States: the leading source of top AI models

AI patents by application status by geographic area, 2010–22

Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



China dominates AI patents

Stanford H.A.I. (2024). *2024 AI Index report*

Large language models' significance

Industrial significance

- Automatic AD detection

	Precision		Recall		F1		Acc
	Non-AD	AD	Non-AD	AD	Non-AD	AD	
Baseline ()	0.700	0.830	0.870	0.620	0.780	0.710	0.750
BERT0p	0.742	0.941	0.958	0.667	0.836	0.781	0.813
BERT3p	0.793	0.947	0.958	0.750	0.868	0.837	0.854
BERT6p	0.793	0.947	0.958	0.750	0.868	0.837	0.854
ERNIE0p	0.793	0.947	0.958	0.750	0.868	0.837	0.854
ERNIE3p	0.852	0.952	0.958	0.833	0.902	0.889	0.896

Yuan, J., et al. (2021). *Frontiers in Computer Science*.

Intellectual significance

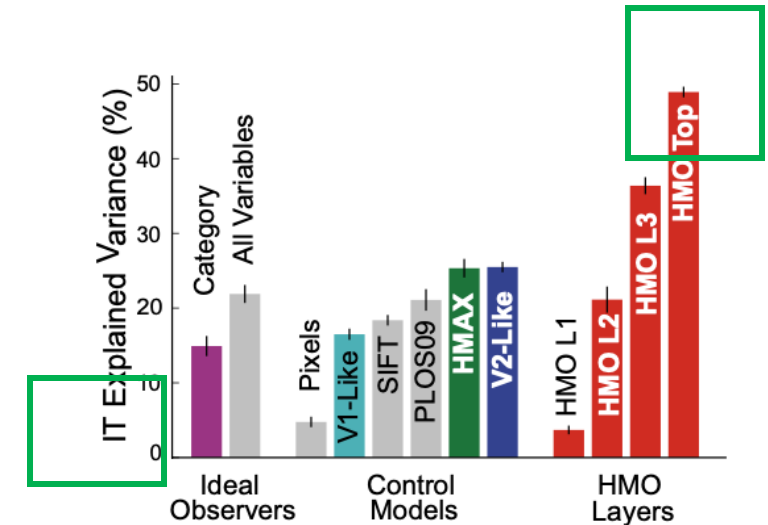
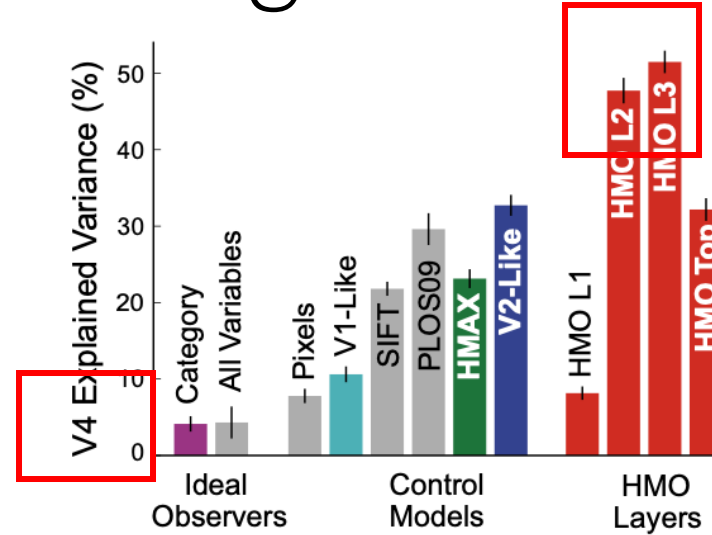
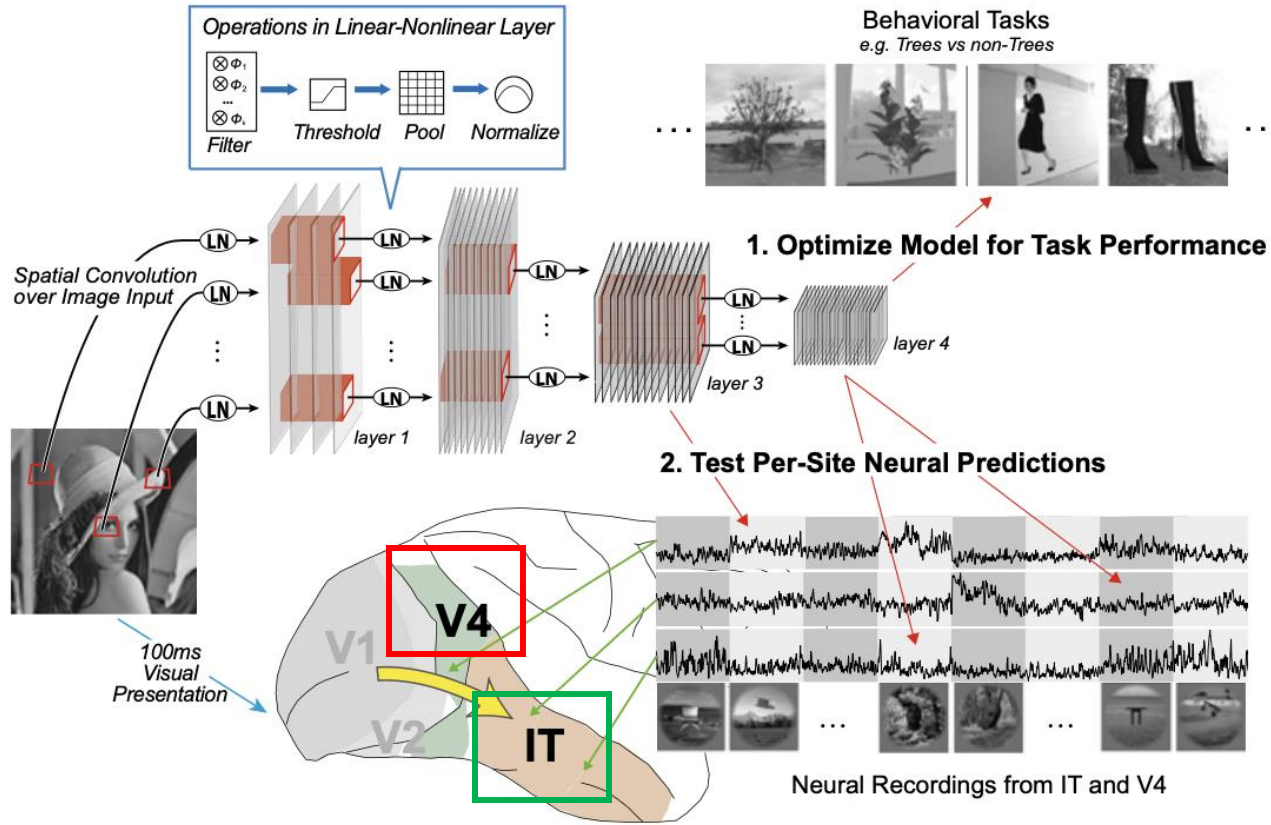
- (1) Damaged/degenerated brain simulation

Hinton, G. E., et al. (1993). *Scientific American*.

Li, C., et al. (2024). *Neuroscience Informatics*.

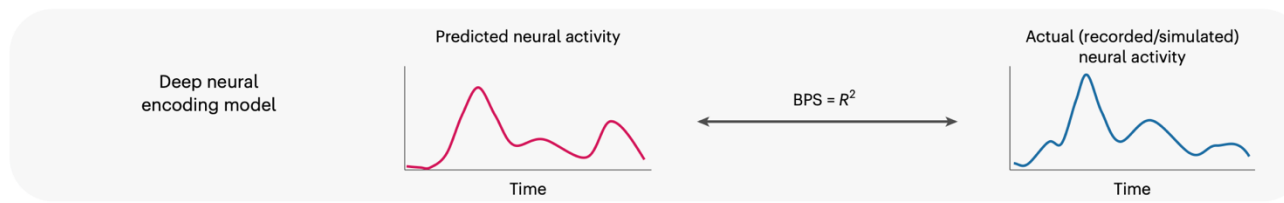
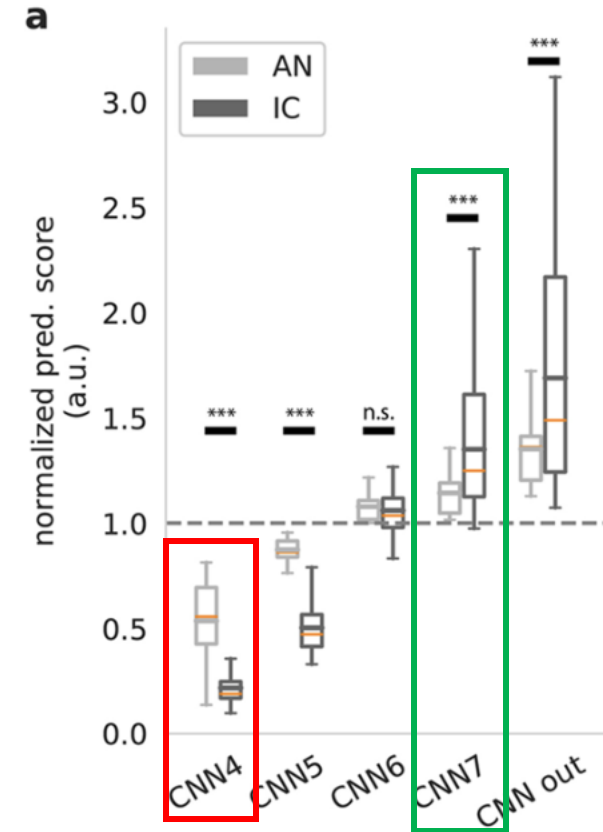
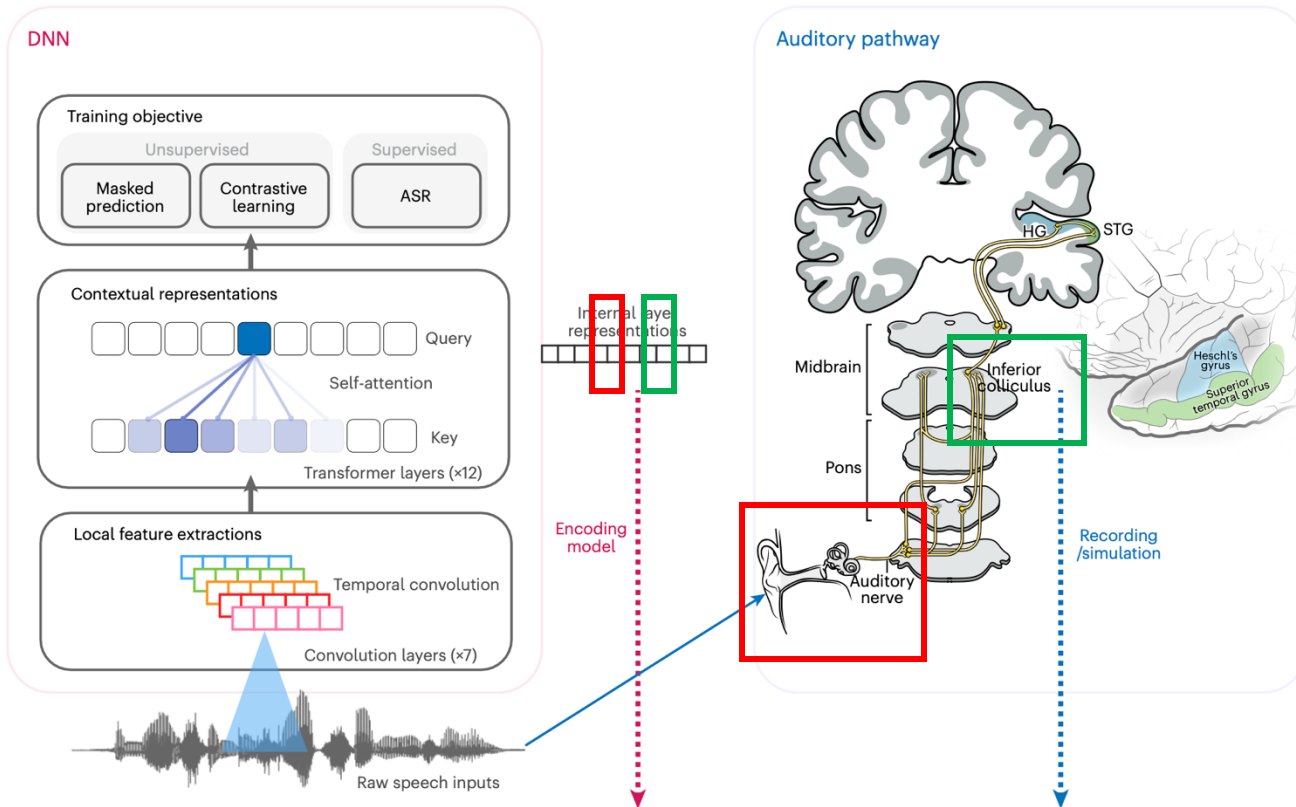
- (2) Brain and model alignment

Alignment in vision processing



“the model’s intermediate layers are highly predictive of neural responses in the V4 cortex, a midlevel visual area ...” Yamins, D. L. K., et al. (2014) *Proceedings of the National Academy of Sciences*.

Alignment in auditory processing



“Representations in **hierarchical layers** of the DNN correlated well with the neural activity throughout the ascending auditory system.” [Li, Y., et al. \(2023\) Nature Neuroscience.](#)

Ongoing project: linguistic alignment?

I want to go to the **bank**.



I want to go to the grassy **bank**.

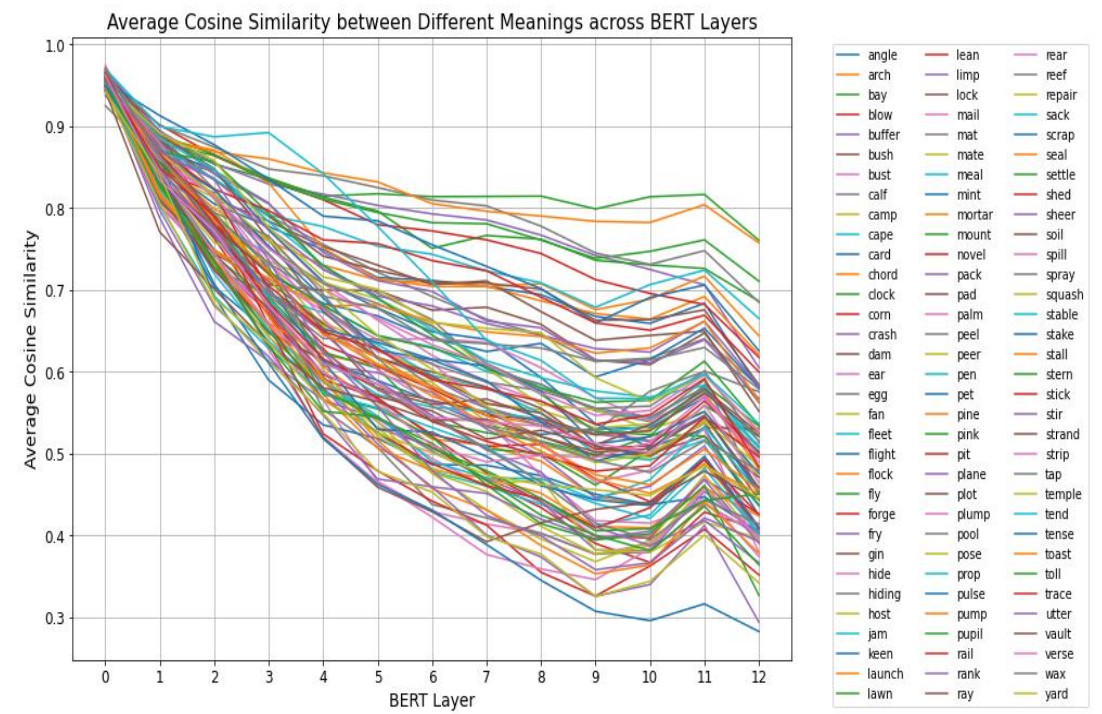
I want to go to the local **bank**.

The man saw the girl **with the telescope**.



The man saw the **girl holding** the telescope.

The **man** saw the girl by **using** the telescope.



Which layer is responsible for the ToT phenomenon?

meaning



sound

Take home messages

- China is undergoing demographic aging, characterized by significant gender imbalances and a rising proportion of individuals in the oldest age cohorts.
- Converging research from genetic, neural, and pathological perspectives, both within China and internationally, elucidates the underlying mechanisms of aging (for details see the abstract).
- Large language models contribute both intellectually and societally to addressing the challenges associated with an aging population.

References

- di Lego, V., Lazarevič, P., & Luy, M. (2019). The Male-Female Health-Mortality Paradox. In D. Gu & M. E. Dupre (Eds.), *Encyclopedia of Gerontology and Population Aging* (pp. 1-8). Springer International Publishing.
- Xirocostas, Z. A., Everingham, S. E., & Moles, A. T. (2020). The sex with the reduced sex chromosome dies earlier: a comparison across the tree of life. *Biology Letters*, *16*(3), 20190867.
- Harrison, T. M., et al. (2012). Superior Memory and Higher Cortical Volumes in Unusually Successful Cognitive Aging. *Journal of the International Neuropsychological Society*, *18*(6), 1081-1085.
- Yang, Z., et al. (2016). Age-associated differences on structural brain MRI in nondemented individuals from 71 to 103 years. *Neurobiology of Aging*, *40*, 86-97.
- Yuan, J., et al. (2021). Pauses for Detection of Alzheimer's Disease [Original Research]. *Frontiers in Computer Science*, *2*.
- Pudas, S., et al. (2013). Brain Characteristics of Individuals Resisting Age-Related Cognitive Decline over Two Decades. *The Journal of Neuroscience*, *33*(20), 8668.
- Zhao, W. X., et al. (2023). A survey of large language models. *arXiv preprint arXiv:2303.18223*.
- Pulido, M. L. B., et al. (2020). Alzheimer's disease and automatic speech analysis: A review. *Expert Systems with Applications*, *150*, 113213.
- Yamins, D. L. K., et al. (2014). Performance-optimized hierarchical models predict neural responses in higher visual cortex. *Proceedings of the National Academy of Sciences*, *111*(23), 8619-8624.
- Li, Y., et al. (2023). Dissecting neural computations in the human auditory pathway using deep neural networks for speech. *Nature Neuroscience*.



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THANKS FOR YOUR ATTENTION!

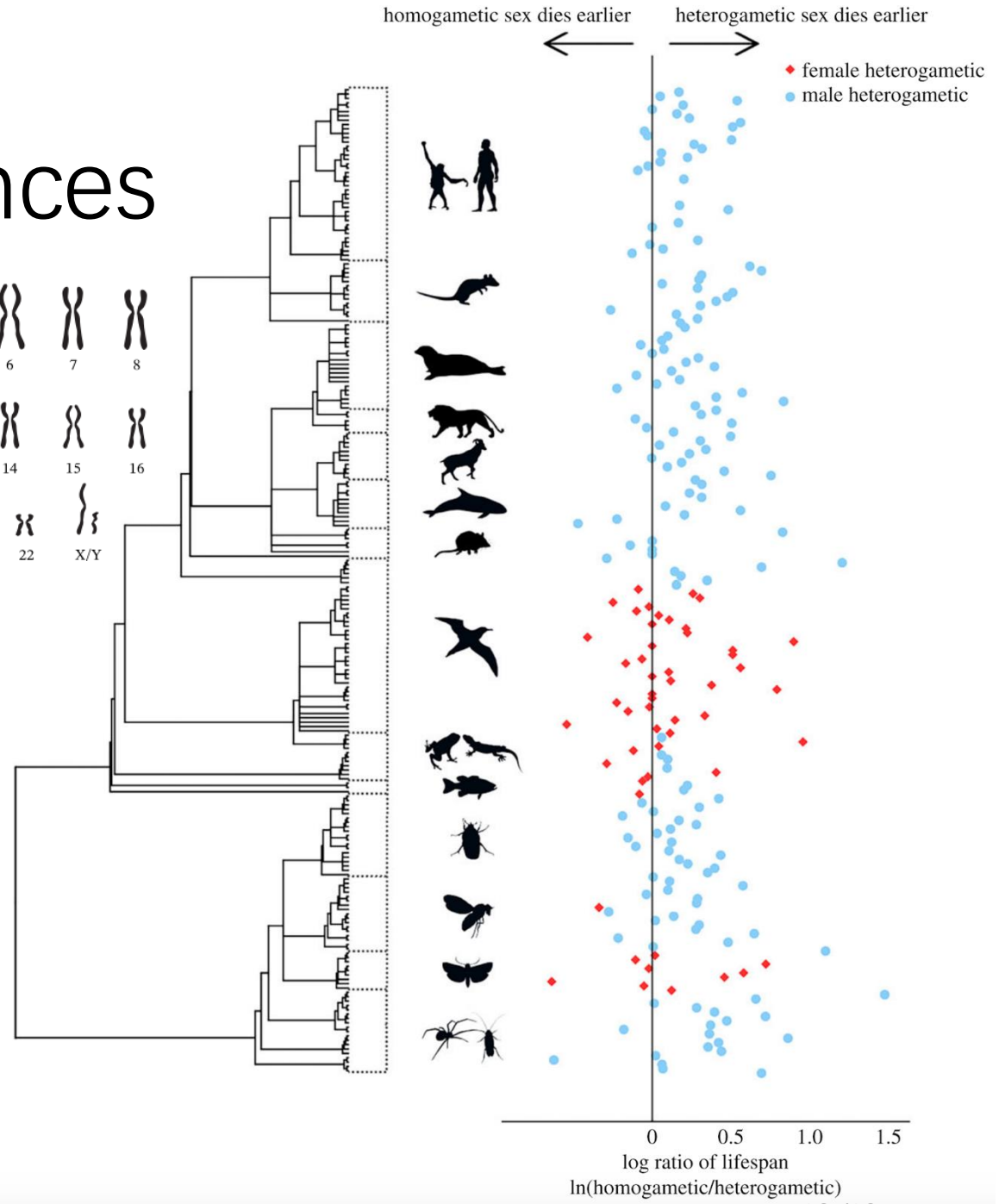
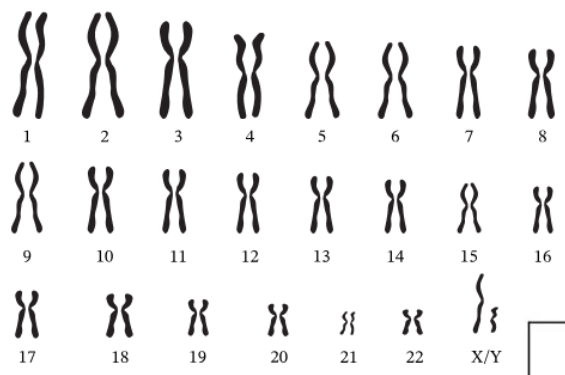
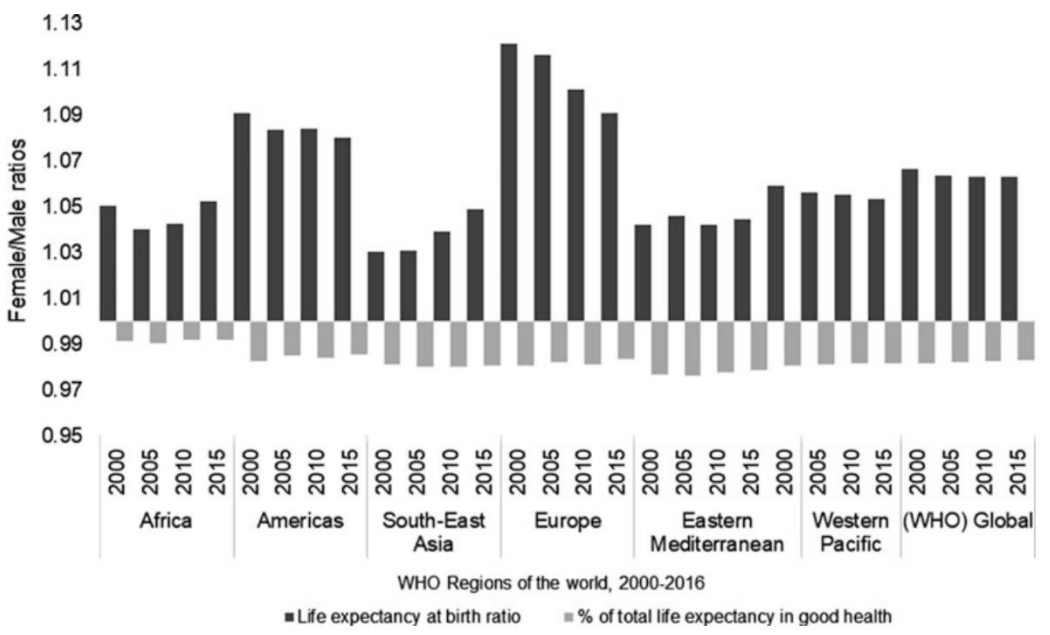
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15601718 awarded to Wang William Shiyuan.

Genetic Gender differences

unguarded X chromosome hypothesis

biological and cultural evolution

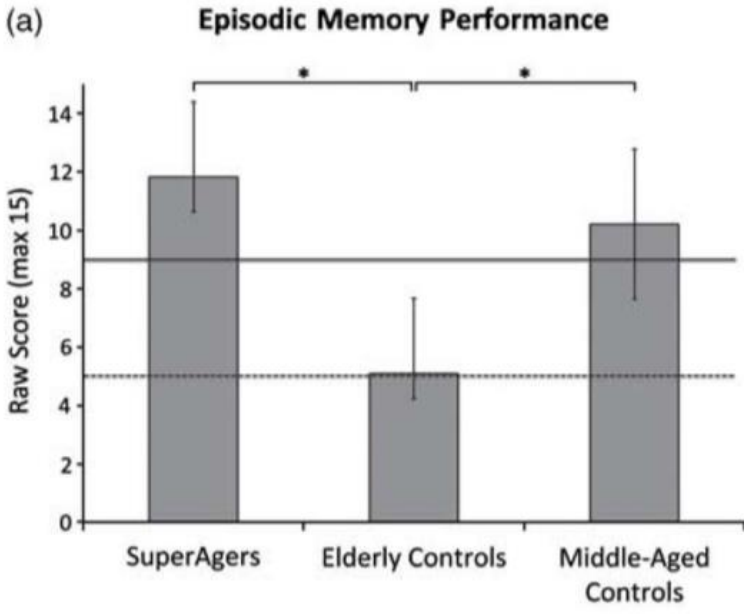
male-female mortality-morbidity paradox



(di Lego, V., Lazarević, P., & Luy, M. 2019)

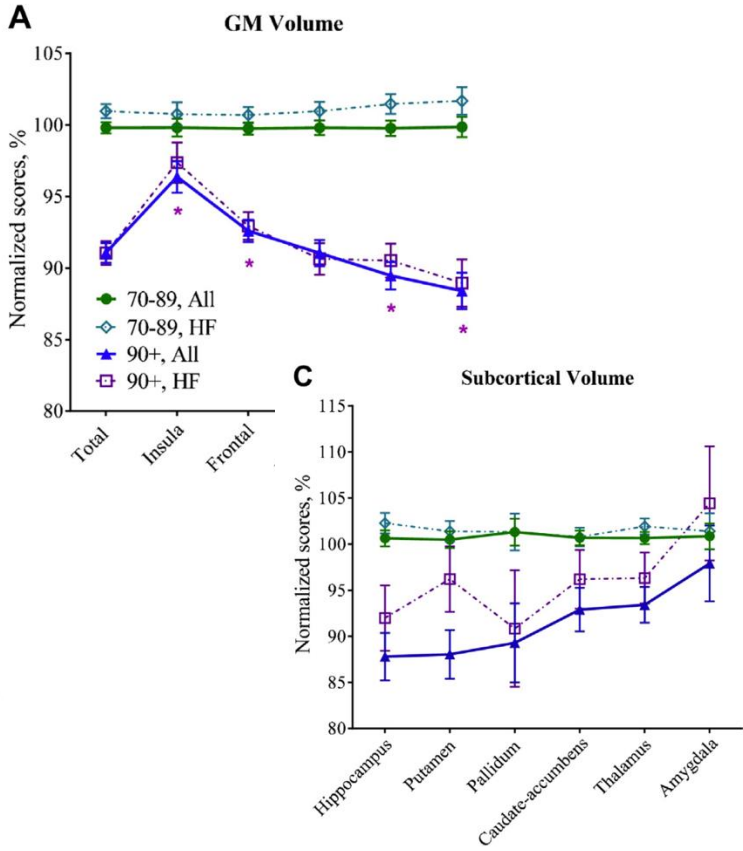
Xirocostas, Z. A., Everingham, S. E., & Moles, A. T. (2020)

Neural preservation in SuperAgers



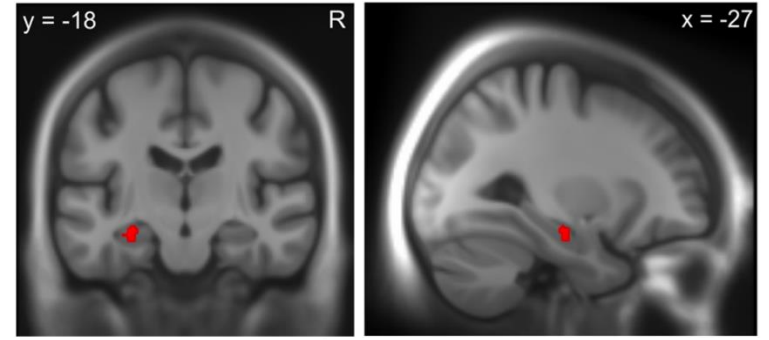
immune to age-related memory impairment

Harrison, T. M., et al. (2012)

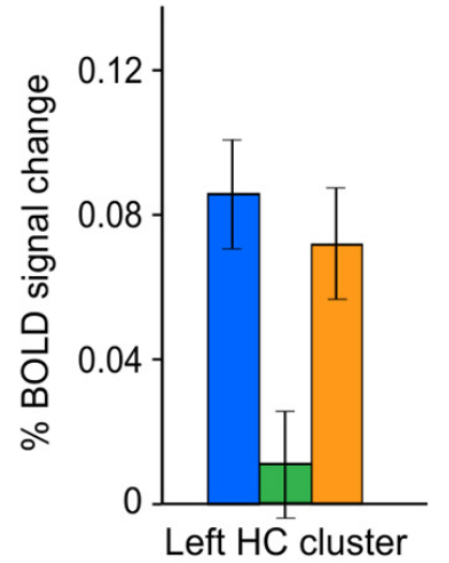


Preserved brain volume

Yang, Z., et al. (2016).



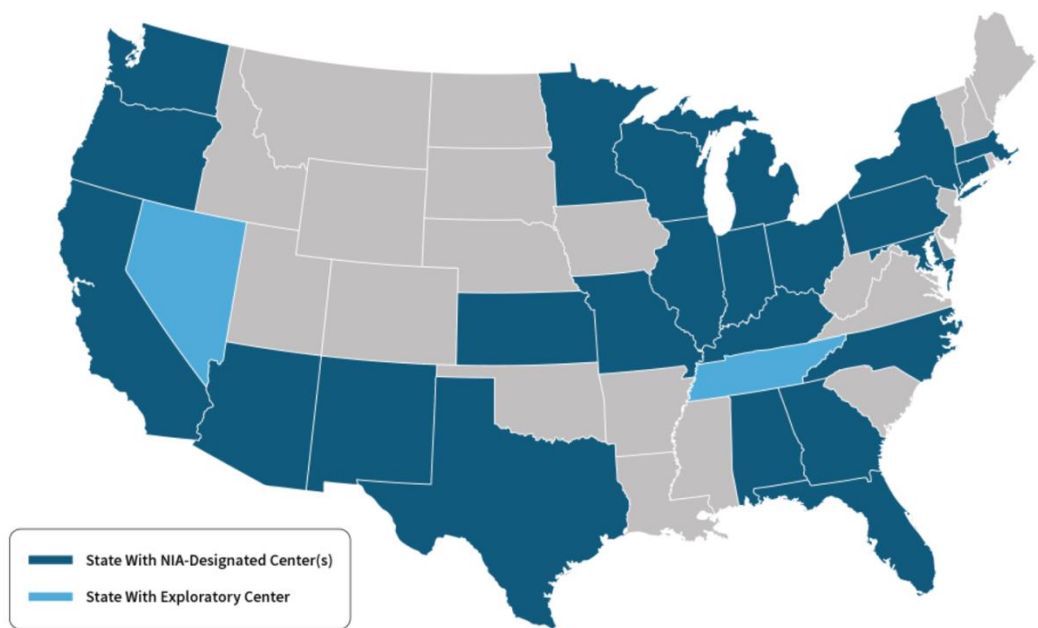
■ Successful older
■ Average older
■ Young



Preserved hippocampal activation

Pudas, S., et al. (2013)

AD research centers



35 Alzheimer's Disease Research Centers (ADRCs) initialized in 1984

2 Exploratory ADRCs



国家老年疾病临床医学研究中心(宣武医院)
National Center Research Center Of Geriatric Diseases (Xuanwu Hospital)



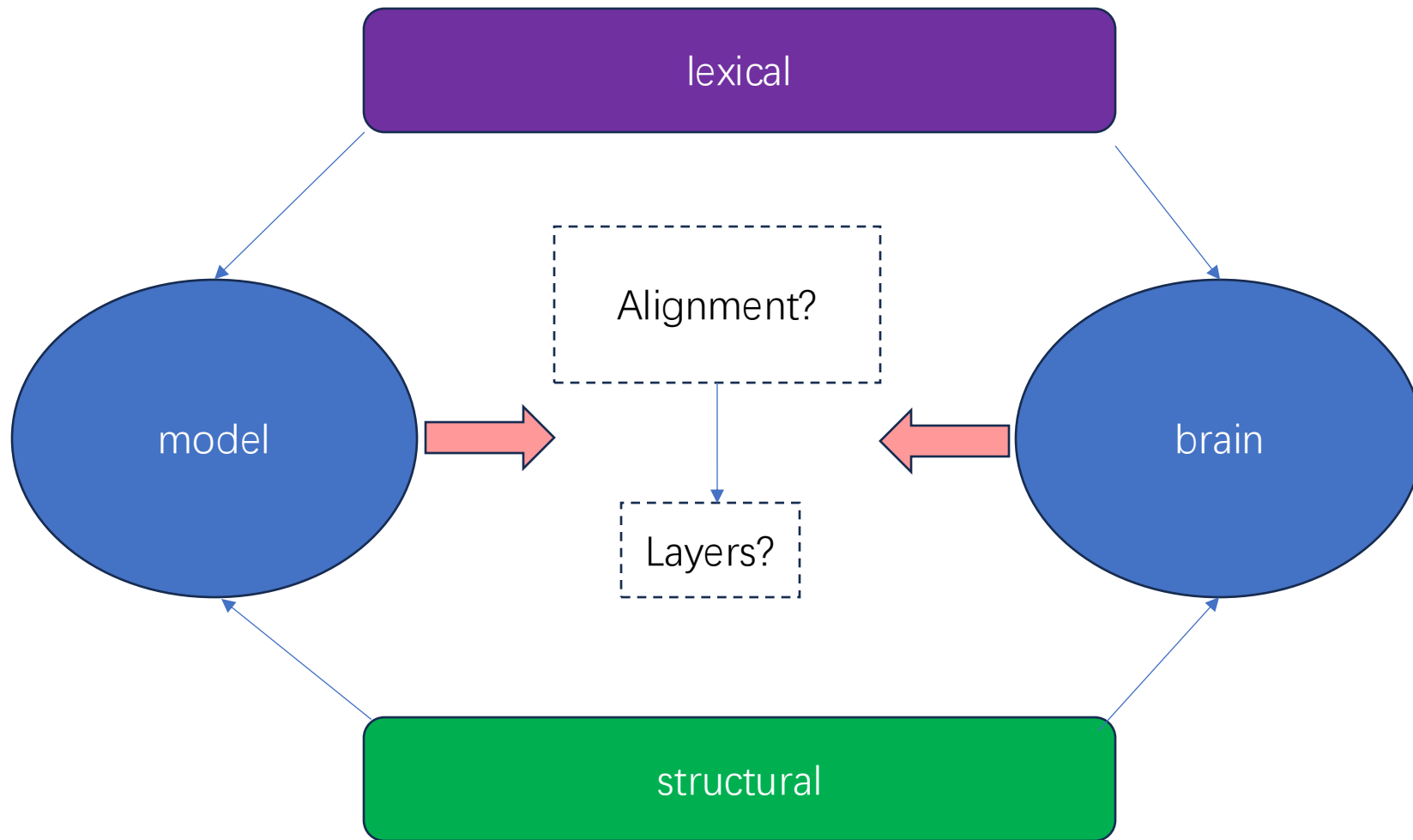
国家老年疾病临床医学研究中心 (四川大学华西医院)
National Clinical Research Center for Geriatrics (West China Hospital, Sichuan University)



国家老年疾病临床医学研究中心 (湘雅医院)
National Clinical Research Center for Geriatric Disorders (XiangYa Hospital)

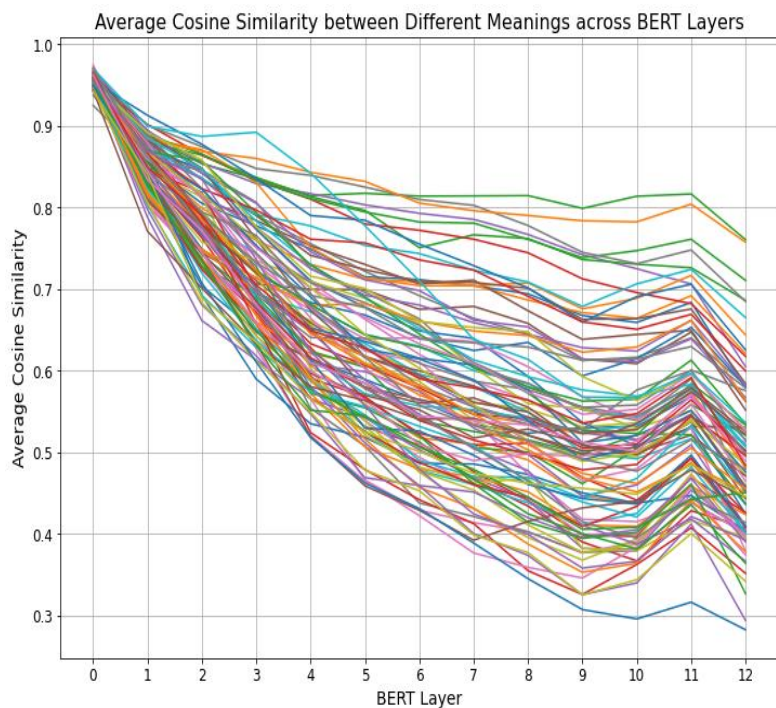


6 basements initialized in 2016
(General Hospital of the People's Liberation Army & Beijing Hospital)

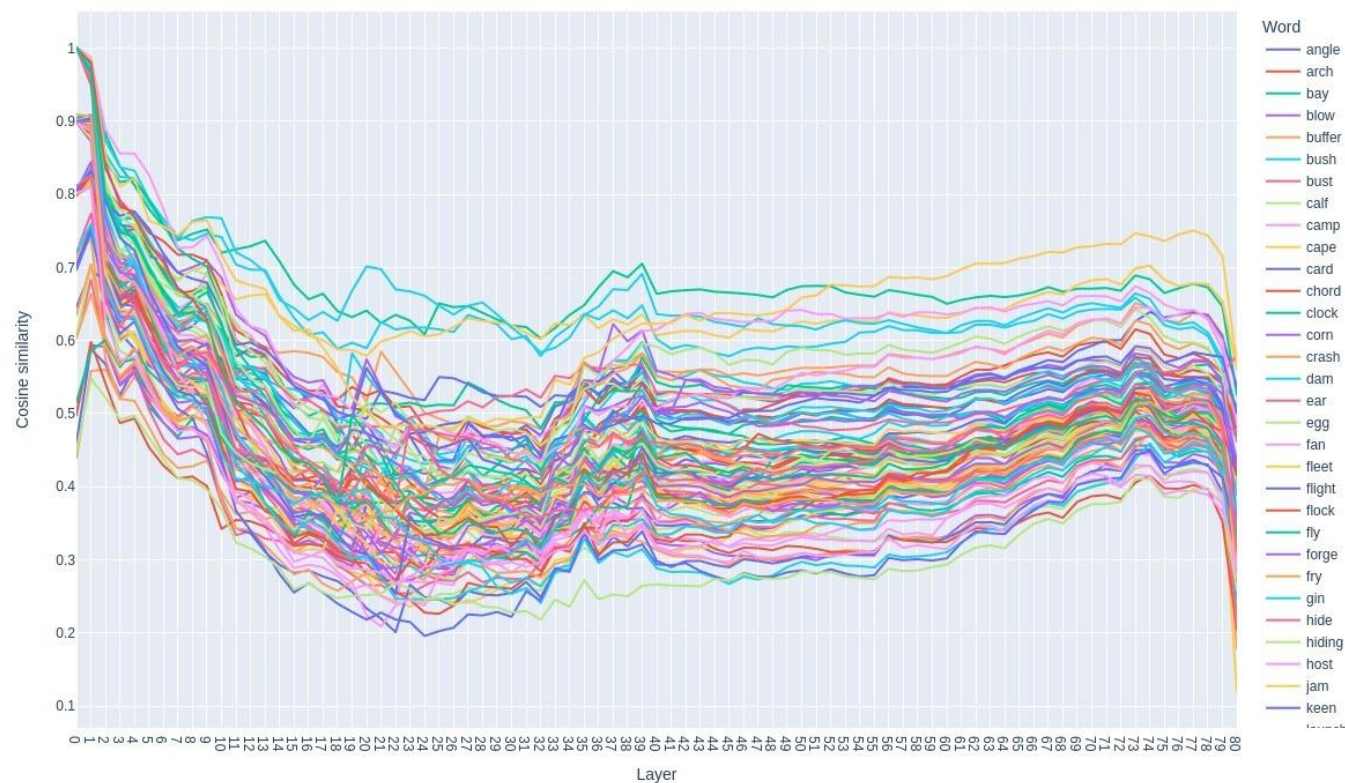


Cosine similarity of word embeddings for different meanings of homonyms

bert-base-uncased

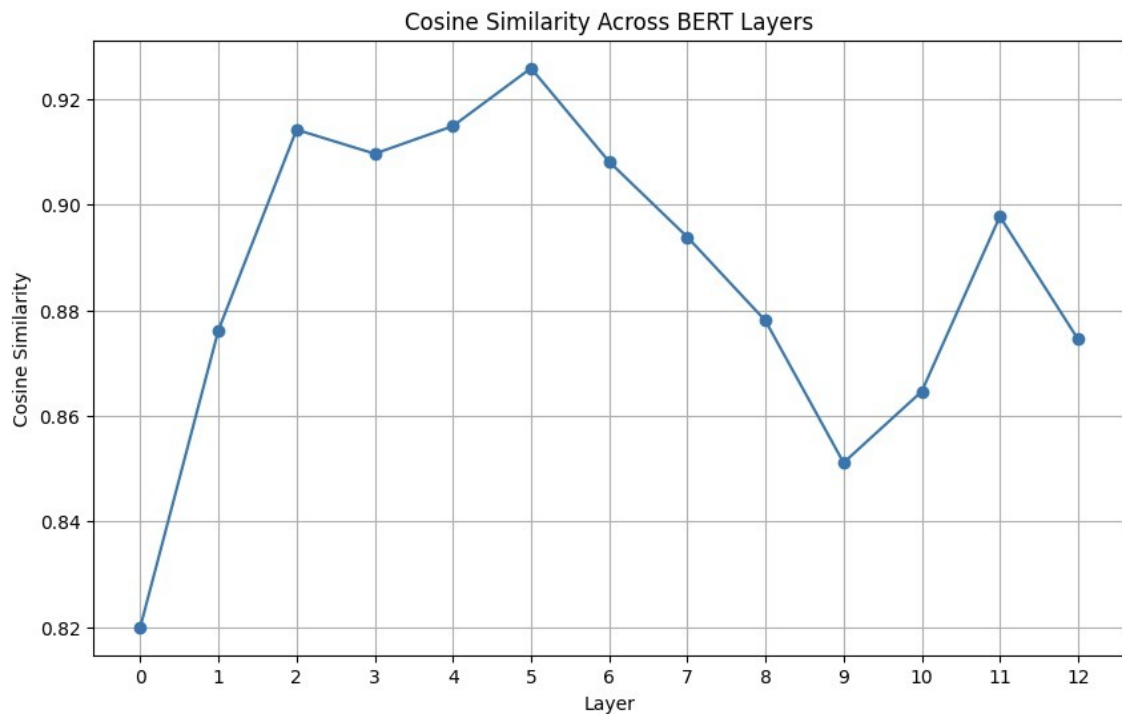


meta/meta-llama-3-70b(compressed)



bert-base-uncased

Cosine similarity of sentence embeddings between different meaning

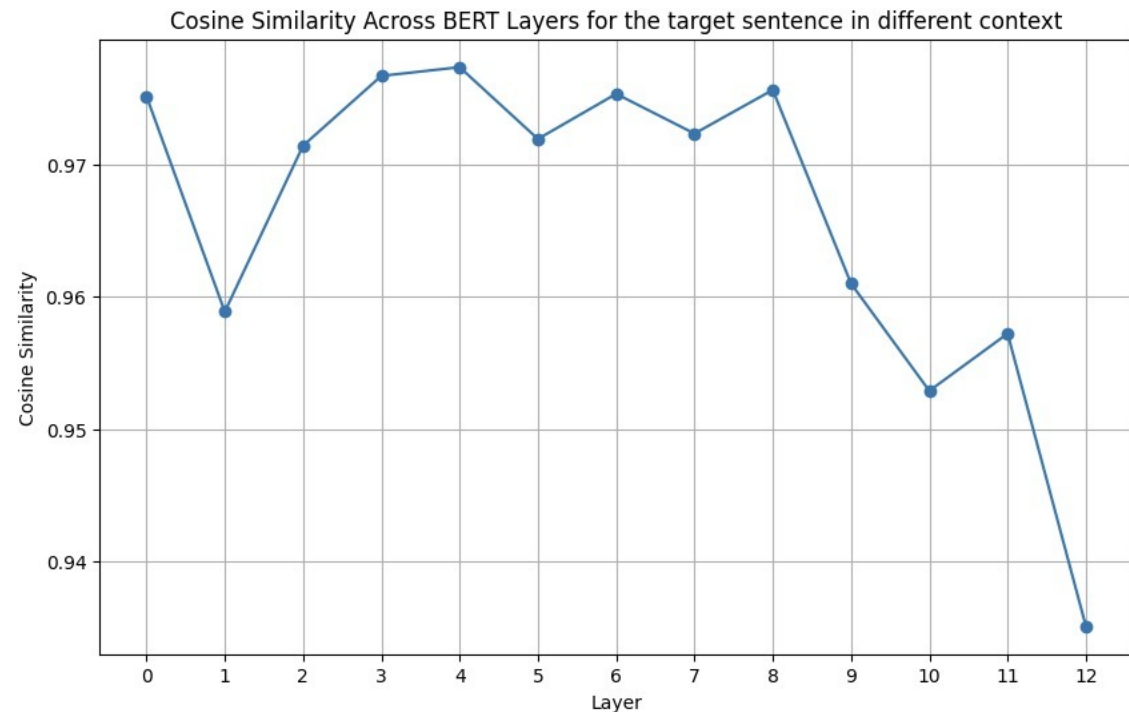


They made a report on the ship.

Meaning1: "They made a report about the ship."

Meaning2: "They made a report while they were on the ship."

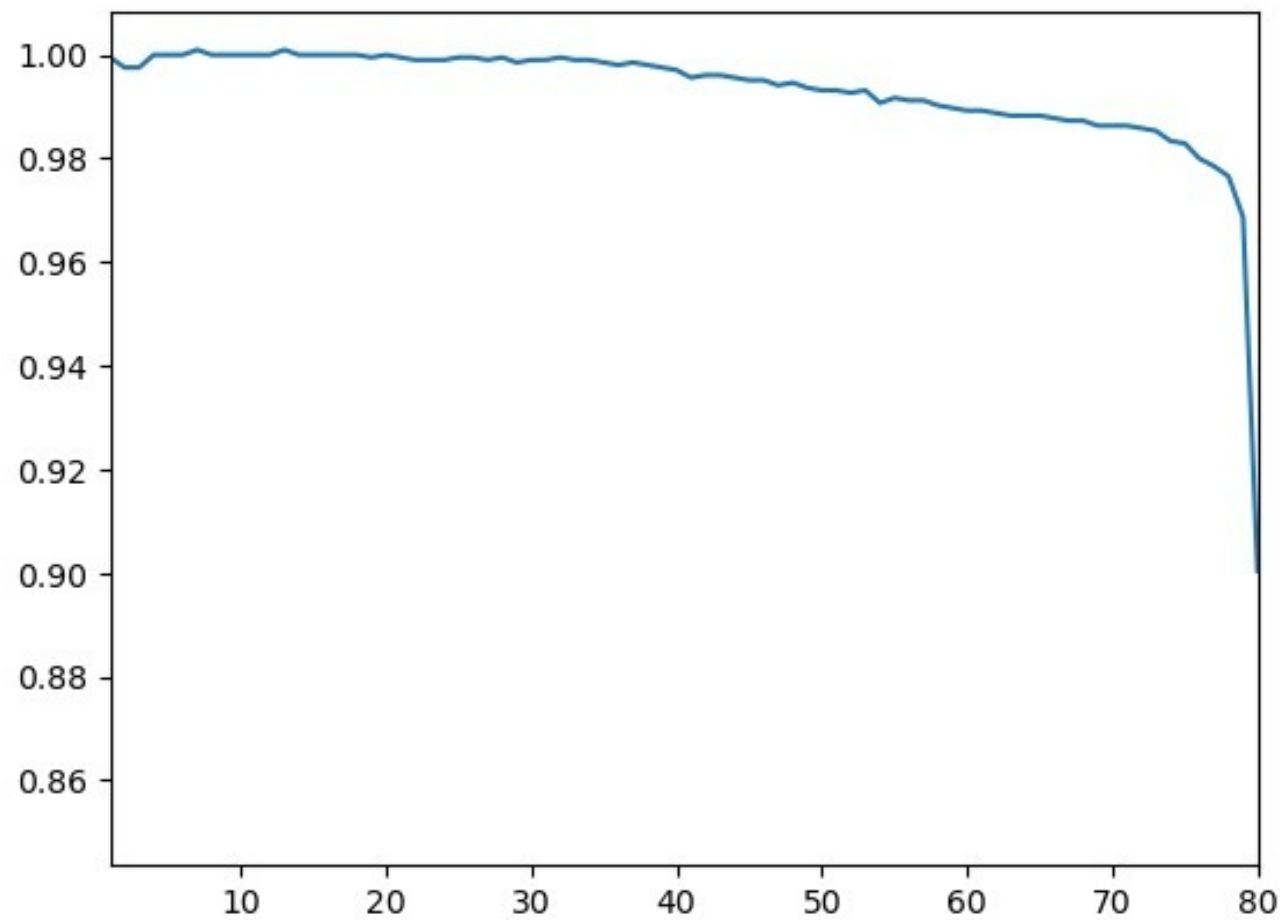
Cosine similarity of sentence embeddings in different context



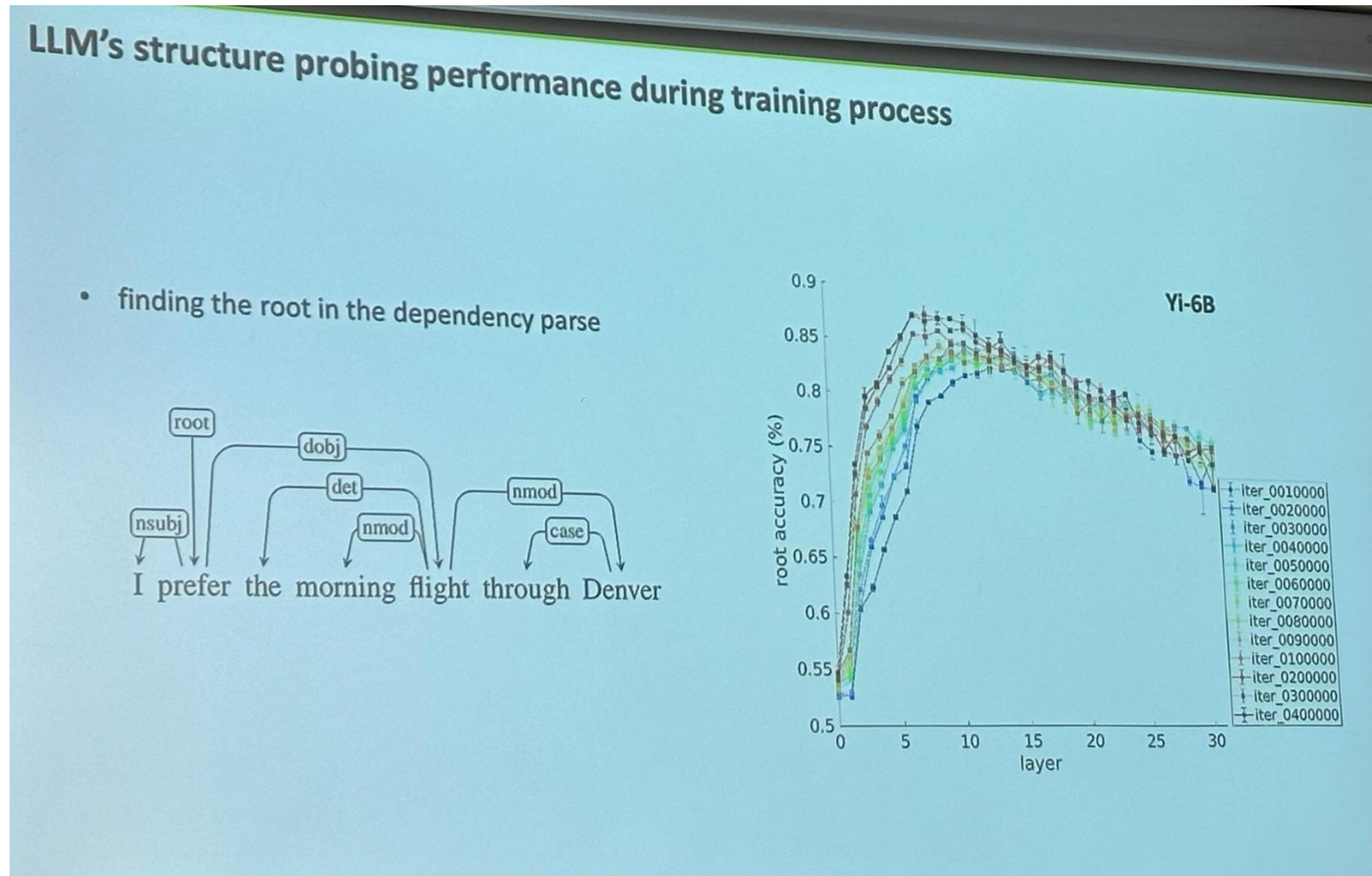
context1 = "During their voyage, they spent several hours each day documenting their findings. They made a report on the ship."

context2 = "After inspecting the vessel thoroughly, they compiled all their observations. They made a report on the ship."

meta/meta-llama-3-70b(compressed)



Syntactic processing located at early layers



Cited from Qin Lang's talk in CBS PolyU, "Decoding language structural representation in human brain and LLM".