Testing AI Tools for Accuracy in Neuroscience and Beyond

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National Institutes of Health
Turning Discovery Into Health

University of Colorado
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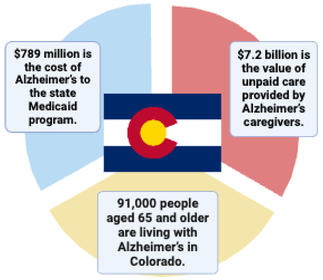
STEAM
https://github.com/fanzhanglab/STEAM

Zhang Lab
fanzhanglab.org

WHY THIS MATTERS

Alzheimer's Is Among the Top 10 Causes of Death for Coloradans:



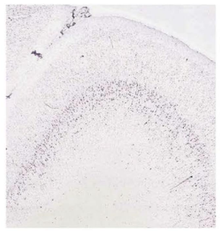
Just as we use maps to navigate our mountains...

... scientists need accurate brain maps to navigate and understand these diseases

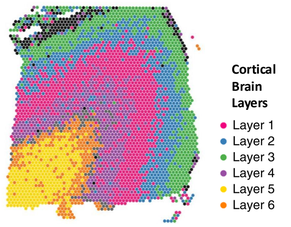
Colorado has one of the fastest-growing aging populations in the U.S., and neurological disorders like Alzheimer's are on the rise. As our population ages, these numbers are expected to rise, posing significant challenges to our healthcare system and communities.

Understanding these diseases requires precise maps of brain cell activity. **Our research focuses on developing AI-powered tools to enhance the accuracy of these brain maps, aiming to improve diagnosis and treatment strategies for neurological conditions affecting many Coloradans.**

THE PROBLEM



Histology slice: Brain Tissue visualized with a microscope

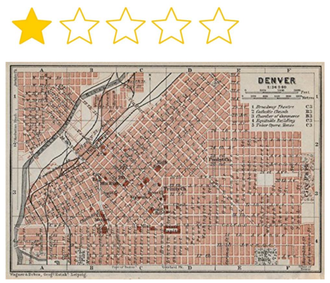


Spatial Transcriptomic slice: Brain tissue after using AI to map cell types

The Challenge:
The brain is made of billions of cells, each with unique functions. To understand how they work, we need a way to keep track of where each cell is located. **A cellular and genetic atlas** of the brain helps us understand diseases and personalize treatments.

The Breakthrough:
Sequencing technology allows us to read the genes and location of cells within tissue at the same time, like a **map for the brain.** Applying AI-approaches to these cell datasets can rapidly and accurately give insight into healthy and diseased cell associations.

OUR APPROACH



1880

2025

Navigating by using an old city map is not as good as a new map, but we know this just by looking at it. **Scientists do not have a current way of assessing which cell map would be better to use for treatments.**

STEAM, developed by the Zhang Lab, is a standardized way for scientists to tell which cell map is the most accurate by using AI to assign accuracy ratings to different cell maps

STEAM RATES CELL MAP ACCURACY

STEAM groups similar cells together and helps scientists understand cell types based on genetic activity:

★☆☆☆☆

Cells in this map are not evenly grouped. We don't want to use this map because the biological data is not accurate.

★★☆☆☆

Cells are grouped by layers of the cortex. But the layers are not clearly defined. We need to see accurate layers to understand their different biological functions.

★★★★★

Cells are clearly defined and represent different cortical layers. Scientists can now begin to understand the roles of these different layers.

STEAM HELPS UNDERSTAND CELL DIVERSITY, LEADING TO INSIGHTS ON DISEASES LIKE ALZHEIMER'S

The brain tissue samples come from a part of the Cortex, which integrates many different signals from other brain regions together. In Alzheimer's, there is a decline in this brain region's **executive function, working memory, decision-making, and cognitive flexibility.**

The Cortex is like a **brain "command center"** with different cell layers playing unique roles:

- Layer 1
- Layer 2
- Layer 3
- Layer 4
- Layer 5
- Layer 6

Layer 1 manages communication between the layers
Layer 2 and **Layer 3** handle receiving and distributing information
Layer 4 brings in sensory and cognitive data
Layer 5 sends out instructions for action
Layer 6 provides feedback to ensure everything runs smoothly

WHAT THIS MEANS FOR SCIENCE AND MEDICINE

Applications to other Science Fields:

For Cancer Research: Can help identify cancerous vs. healthy cells for better treatments.

For Cardiology: Can identify damaged or diseased tissue to improve treatment for heart failure and arrhythmias.

For Immunology: Can track immune cell activity in tissues, helping scientists understand autoimmune diseases and develop more targeted therapies for conditions like rheumatoid arthritis and multiple sclerosis.

- Testing STEAM with different cell tissue datasets
- Improving its speed and computational efficiency by testing STEAM on smaller portions of a dataset

What This Means for Colorado & Beyond
- Pioneering cutting-edge research in computational biology advances treatments and precision medicine by giving doctors more accurate genetic insights
- Improving tools that can benefit labs, hospitals, and biotech companies worldwide

Investment in AI-driven biology tools like STEAM helps scientists decode the brain, accelerate medical breakthroughs, and improve lives.

FURTHER READING

[1] **Colorado Alzheimer's Statistics:** https://www.alz.org/professionals/public-health/state-overview/colorado?utm
[2] **Brain Dataset**: Maynard, K. R., et al. (2021). Transcriptome-scale spatial gene expression in the human dorsolateral prefrontal cortex. In Nature Neuroscience (Vol. 24, Issue 3, pp. 425–436). Springer Science and Business Media LLC. https://doi.org/10.1038/s41593-020-00787-0
[3] **Check out the STEAM Paper on BioRxiv**: