# Deep learning approaches to associate neural structure with spatial navigation function

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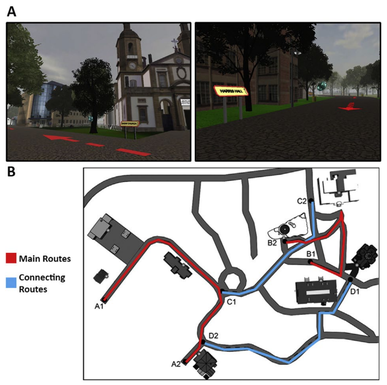
## 1. Introduction

- Relation between structure of the brain and function (behavior) we experience is a fundamental question in neuroscience.
- Hippocampal structure may relate to spatial navigation ability; however, there is no link between hippocampal volume and navigation skills in healthy population.[1, 2]
- Structural features more granular than volume may be responsible for differences in navigational ability.
- Deep learning approaches may learn features from structural data predictive of behavioral performance.

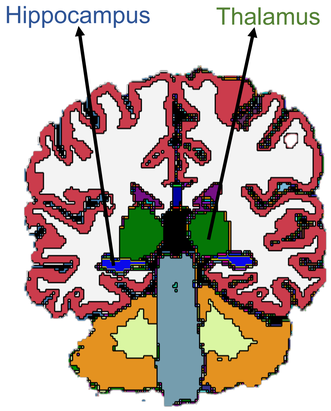
**H1 – T1 Hippocampal structure beyond volume is associated with navigational ability**

## 2. Method

- **Input data**: T1 structural scans from 90 healthy participants (54 female, mean = 23.1, SD = 3.9). Hippocampus, thalamus (control region) and whole brain analyzed.
- **Target:** Model Building Total – bidimensional regression based navigational measure from virtual silcton.[2]
- **Models:**
  - **Base models**: Pointnet++[3] (Graph CNN) and Densenet[4] (3D CNN). Additional Random forest model using pyradiomics features as input. 5-fold cross-validation used across all models.
  - **Ensemble models**: Simple average, weighted average via linear regression and optimized multi-layer perceptron (MLP).
- **Comparison metric:**
  - **Base models:** Correlation over 15 runs per model with 5 folds each (75 correlation values per model).
  - **Ensemble models:** Correlation between predicted values and target.



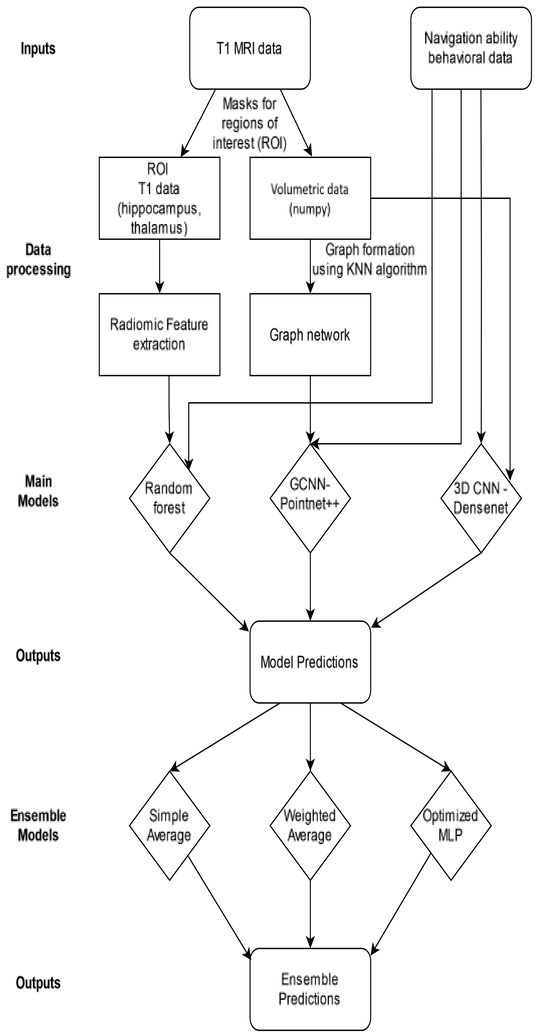

Virtual Silcton



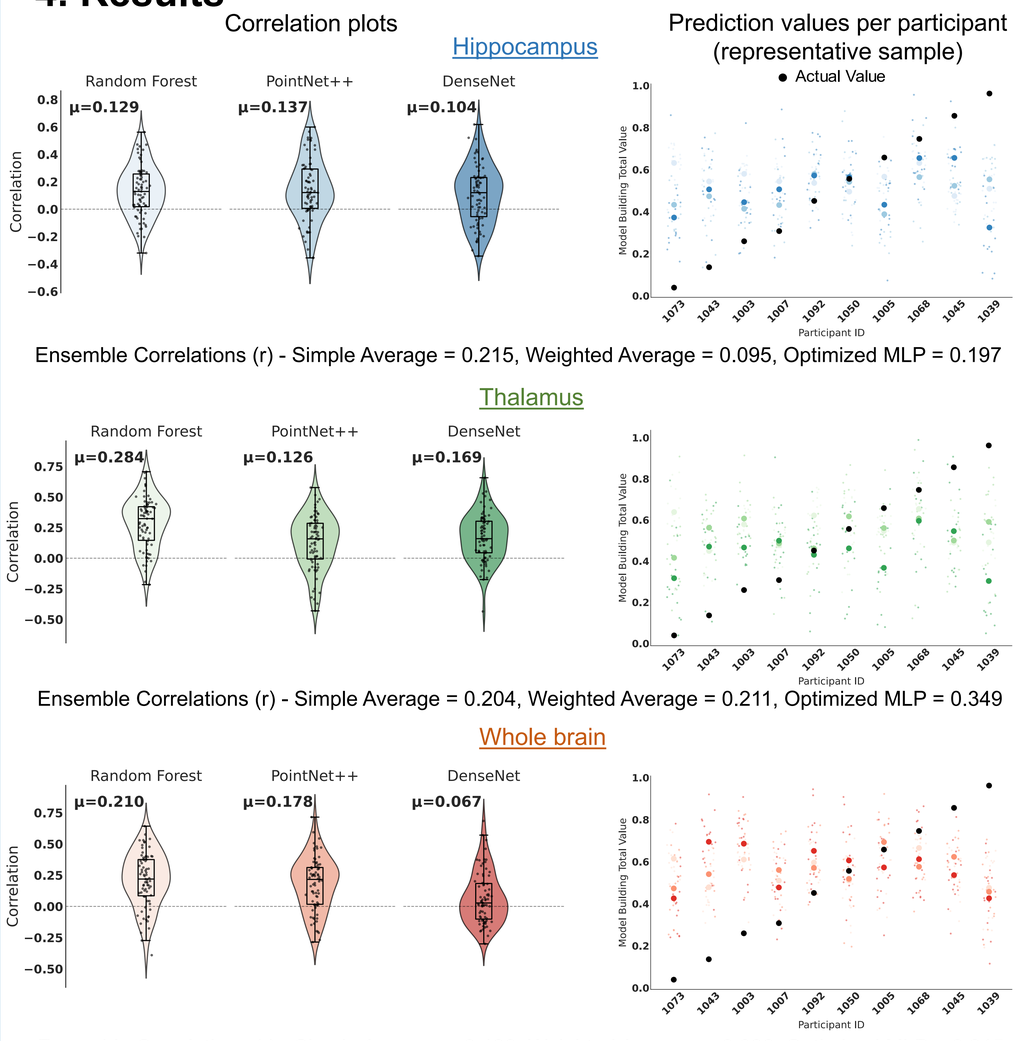

Coronal labeled MRI image

Whole brain includes all voxels within the brain mask

## 3. Analysis Pipeline




## 4. Results




## 6. Conclusions

**Weakly positive correlation across all models for all regions – hippocampus, thalamus and whole brain**

- Supports prior work indicating hippocampal volume/structure may not be indicative of navigation ability with similar correlation values across models and regions of interest.
- Individual differences in navigation may require significantly large sample sizes to analyze structure-function relation as suggested by Brain wide association studies (BWAS).[5]

## 7. References

1. Maguire et al., (2000) *PNAS*
2. Weisberg et al., (2019) *Cortex*
3. Qi et al., (2017) *arXiv*
4. Huang et al., (2018) *arXiv*
5. Marek et al., (2022) *Nature*

## 8. Acknowledgements

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