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Applied Machine Learning

Professor Matthews Jacob

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Final Project Proposal

*1. Title of the project*

**Cross-Species Transfer Learning of T1 T2 Modality Translation**

*2. Main problem you will be solving and why it is significant*

We will be performing efficient and accurate MR modality translation. The significance of this endeavor entails the potential to generate multi-modal images from a single scan which would reduce the number of scans needed.

*3. Relevant papers with links*

MRI Cross Modality neuroimage to neuroimage translation: <https://arxiv.org/abs/1801.06940>

MedGAN: Medical Image Translation using GANs: <https://arxiv.org/abs/1806.06397>

*4. Links to datasets that will be used*

Private human brain MRI dataset generated by the PREDICT-HD study: <https://clinicaltrials.gov/ct2/show/NCT00051324>

Private minipig brain MRI dataset:

<https://research-git.uiowa.edu/SINAPSE/MiniPigMALF/-/tree/master/original_project>

*5. Relevant software tools (github repositories etc) that you will be using*

<https://github.com/Project-MONAI/tutorials/blob/master/modules/mednist_GAN_tutorial.ipynb>

<https://docs.monai.io/en/latest/index.html>

<https://www.pytorchlightning.ai/>

<https://itk.org/>

*6. Brief description of how your work will be different from the above*

Our work will distinguish itself from existing methods by incorporating a cross-species transfer learning component. One potential idea is to generate a species-agnostic latent space that effectively represents the modality translation process. This would then allow anyone to generate their own species-specific model by only needing to generate an anatomical latent space and tune the modality translation to the characteristics of their data.

By demonstrating the application of our proposed GAN to other species, such as mini-pigs, we hypothesize the GAN can also be applied to other relevant species, such as pediatric and large-animal cases, for which fewer data samples exist.

*General Project Steps:*

1. *Human brain generation in one modality*
2. *Modality Translation in Humans*
3. *Hard Transfer Learning of Modality Translation from Humans to Mini-Pigs*
4. *Multi-Task learning of Humans and Mini-Pigs*
   1. *Potential use of species-specific auto encoders*
   2. *Potential to encode modality and anatomy in different latent spaces*

7. Group members and their roles

1. Alex Powers
   1. Primary Role: Species Specific Autoencoders / Transfer Learning
   2. Responsibilities:
      1. Design species to species model transfer system
      2. Explore multi-species modality translation GAN (MTL)
      3. Explore isolating anatomical and modality latent spaces
2. Chase Johnson
   1. Primary Role: Modality Generation
   2. Responsibilities:
      1. Generate human data from noise for both T1 and T2 data
      2. Generate mini-pig data from noise
      3. Generate T2 mini-pig data from a latent space derived from T1 data
3. Michal Brzus
   1. Primary Role: Modality Translation Discriminator
   2. Responsibilities:
      1. Design Discriminator structure for different types of data (modalities, species)
      2. Engineer extensive evaluation process (use medical imaging specific metrics)
      3. Explore possibility for a universal discriminator (for different modalities and species)