Project 1: Deep learning models for training attention with a real-time BCI

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Summary:

How does the brain process visual images, and how does it pay attention to particular objects in cluttered scenes? In this project, we will have participants view and pay attention to particular objects in cluttered scenes or movies. We will simultaneously record their brain activity with functional MRI (fMRI). We will also use data from existing fMRI databases (e.g. UK Biobank, Human Connectome Project). From this activity, we will decode and reconstruct pixel-for-pixel what object the participant was paying attention to inside the MRI scanner. In the second part of this project, we will build a brain-computer interface (BCI). The BCI will provide neurofeedback to the participant in real-time in the MRI scanner to help them improve their attention-related brain activity, thereby improving the quality of the image reconstructions. For this project, we will use deep AI models, including generative adversarial networks (GANs) and diffusion models.

Additional reading:

- https://proceedings.neurips.cc/paper/2019/file/7d2be41b1bde6ff8fe45150c37488ebb-Paper.pdf
- https://sites.google.com/view/stablediffusion-with-brain/