Future of Neural Engineering Forum - Question Analysis

This moderating document defines the structure of the Future of Neural Engineering Forum on November 18th, 2024, at the University of Texas at Austin. The forum will explore critical philosophical and practical issues surrounding the rapid evolution of neurotechnology. Discussions will delve into topics such as the intersection of neuroengineering and AI, and their implications for human health, creativity, identity, ethics, and governance.

The forum will feature a panel of seven distinguished professors:

- *Joshua Chang, M.D., Ph.D* — Medical, Electrical and Computer Engineering
- *Sahotra Sarkar, Ph.D* — Philosophy, Bioethics
- *Jose del Millan, Ph.D* — Neuroengineering, Neurotechnology, Neurology
- *Benjamin Gregg, Ph.D* — Politics, Social, Bioethics
- *Risto Miikkulainen, Ph.D* — Computer Science, Neuro AI
- *Huiliang Evan Wang, Ph.D* — Material Science, Neural Devices
- *Jordan Amadio, M.D., MBA* — Neurosurgery, Industry

This event marks the first public forum organized by **Longhorn Neurotech**, a brain-computer engineering organization, and **Synapse**, a neuroscience organization at the University of Texas at Austin. The key questions were initially raised by Tony Chae and further developed in collaboration with Sofiya Borodina and Julian Weaver.

We look forward to the professors' valuable insights that will help shape the future of this rapidly evolving field.

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LONGHORN NEUROTECH

SYNAPSE

EVENT AGENDA

Date: 7:00 pm - 9:00 pm (CDT), Monday, 11/18/2024
Location: Welch Hall (WEL) 2.224, University of Texas at Austin
Duration: 2 hour (120min)

Moderators (3): Tony Chae, Rishi Swaminathan, Julian Weaver

Opening Session (15 minutes)

- **Welcome Address and Event Introduction** (10 minutes)
  - Overview of the event, its goals, and its significance in advancing neural engineering.
  - Introduction to the interdisciplinary nature of the forum, bridging neuroscience, AI, engineering, ethics, and art.
- **Introduction of Panelists** (5 minutes)
  - Brief introduction of the 7 professors participating in the panel discussion.
  - Highlight their expertise and contributions to neural engineering.

Panel Discussion (75 minutes total)

Theme 1: "Frontiers of Neurotech: Where are we?" (25 minutes)

- **Question:** Varies by panelist.
- **Format:** A series of questions directed at individual panelists and their backgrounds, serving as an introduction to each panelist's relationship with neurotechnology.

Theme 2: "Human Augmentation" (25 minutes)

- **Question:** How do you envision the future progression of neuro-augmentation technologies, and what potential challenges- whether technical, social, ethical, or otherwise- do you foresee arising from their integration into human life?
- **Format:** Free-form discussion between panelists.

Theme 3: "What can we do?" (25 minutes)

- **Question:** As neural engineering rapidly advances and shapes human progress, what steps do you think should be taken right now- by governments, industry, academia, or other stakeholders- to guide this technology toward a positive and beneficial trajectory?
- **Format:** Free-form discussion between panelists.

Audience Q&A Session (20 minutes)

- Open floor for audience questions to any of the panelists.
- Moderate to ensure a balanced and engaging discussion.

Closing Remarks (5 minutes)

- Thank you note to panelists, sponsors, and attendees.
- Highlighting upcoming events and opportunities to engage with the neural engineering community.

1. Frontiers of Neurotech: Where are we?

Background and Research:

Neurotechnology is advancing rapidly, transforming how we understand and interact with the brain. Material science has made strides in creating biocompatible, flexible neural implants, enhancing their safety, effectiveness, and ability to integrate seamlessly with brain tissue for long-term applications. Meanwhile, techniques like optogenetics have revolutionized neuroscience by enabling precise control of neural circuits, allowing researchers to activate or inhibit specific neurons with unprecedented accuracy. This has been instrumental in understanding brain function and driving the development of brain-computer interfaces (BCIs).

Artificial intelligence has also emerged as a cornerstone of neurotechnology, decoding complex neural data in real-time and improving BCI precision. AI models have made it possible to interpret brain signals with remarkable accuracy, revealing previously hidden patterns in neural activity. Paired with high-resolution neuroimaging techniques, such as advanced fMRI and two-photon microscopy, we now have the tools to map neural activity at unparalleled levels of detail. Alongside these advancements, brain organoids, or lab-grown miniature brain structures, are now opening new frontiers for studying neural disorders and testing technologies, bridging theoretical models with real-world applications.

These technologies have positioned neurotechnology as a rapidly growing field with immense potential—and profound implications. With this in mind, we'll begin by asking each of our panelists a question that highlights the unique perspective and expertise they bring to neurotechnology.

Questions (PER PROFESSOR) - Each panelist will have **<u>three minutes</u>** to respond to their question.

1. Dr. Chang: How are advancements in neurotechnology affecting the daily lives of patients, and what promising neuro-devices are transforming healthcare?
2. Dr. Sarkar: Why is it crucial to understand past biases and history when developing future technologies, and how can we create more inclusivity?
3. Dr. Millán: What is BCI (Brain-Computer Interfaces)? What is the role of both human and AI agents in BCI?
4. Dr. Gregg: From your perspective, what are the most significant social and political structural changes we are witnessing due to rapid technological advancement?
5. Dr. Miikkulainen: How do neuroscience and biology impact AI development, and how does AI help us understand the human brain?
6. Dr. Wang: How do you foresee future advancements in this field impacting the development of neurotechnology? What breakthroughs might we anticipate that could revolutionize neural interfaces and devices?
7. Dr. Amadio: As the director of Neurosurgery at Neuralink, how do you envision the future market for neurotechnology evolving?

Scope:

This series of questions is designed to explore each professor's unique expertise and perspective on the evolving fields of neurotechnology and AI. By addressing topics ranging from medical devices and material science to the ethical, social, and industrial implications of neurotechnology, this section provides a comprehensive view of the current state and future potential of neurotechnology.

2. Human Augmentation

Background and Research:

The field of human augmentation, powered by brain-computer interfaces (BCIs) and neural technology, extends far beyond treating neurological disorders. It is the science of unlocking human potential, enabling capabilities that once belonged to the realm of science fiction. Future advancements could redefine what it means to be human.

One area is direct brain-to-brain communication, where interfaces allow individuals to directly share cognitive and sensory information. Research has already demonstrated this in humans. Additionally, memory augmentation is moving forward with programs like DARPA's NESD, TNT, and RAM, which aim to restore and enhance memory through neural implants, addressing both degradation and enhancement.

Prosthetic vision is another transformative innovation. Cortical visual prostheses map light intensities directly onto the visual cortex, offering individuals with blindness a pathway to regain functional vision. In work environments, neuro-ergonomics and advanced exoskeletons are combining neuroimaging with signal acquisition to unlock human cognitive and motor abilities, enhancing productivity and safety.

Recent breakthroughs in thought and speech decoding have demonstrated the ability of brain implants to interpret internal speech, translating neural activity into text or vocalized words. This technology enables individuals with conditions like ALS to communicate in ways previously thought impossible. Finally, the frontier of neural visualization uses fMRI and computational modeling to reconstruct dynamic visual experiences, including dreams, offering a glimpse into the visualization of abstract cognitive processes.

These advancements are pushing the boundaries of human potential, and raising profound questions.

Question: How do you envision the future progression of neuro/human-augmentation technologies, and what potential challenges- whether technical, social, ethical, or otherwise- do you foresee arising from their integration into human life? We invite you to discuss freely- we have 25 minutes.

Scope:

This section explores the transformative potential of human augmentation technologies powered by brain-computer interfaces (BCIs) and neural advancements. Moving beyond therapeutic applications, it delves into innovations that fundamentally change the way people interact with the world. By examining these breakthroughs, this section highlights the ways in which human capabilities are being redefined, while addressing the profound technical, ethical, and societal challenges posed by their integration into everyday life.

3. What can we do?

Background and Research:

With these thoughts in mind, we must act now to design solutions that ensure neural engineering benefits society equitably in the future. As technology progresses, the choices we make today will determine whether it becomes a force for widespread empowerment or a driver of our own ruin. Establishing frameworks for equitable access, robust regulations, and ethical standards is necessary to navigate the challenges ahead and prevent irreversible harm.

For example- concerns about equitable access to augmentation technologies are intensifying. Socioeconomic and demographic disparities risk creating a “neurodivide,” where those with access to advanced neural augmentations gain significant advantages over others. This disparity could give rise to a new class of augmented individuals, say *‘Homo deus’*, forcing us to reconsider the meaning of humanity in an era of profound technological transformation. Such developments force us to confront profound societal questions.

The rise of BCI also introduces critical security risks. These technologies can capture highly sensitive neural and cognitive data, raising concerns about misuse by employers, institutions, or other entities. The potential for discrimination and loss of autonomy looms large if these systems are not adequately protected. Emerging research has even demonstrated system vulnerabilities in neural devices, allowing them to be hacked. Without robust regulations and transparent practices surrounding neural data, these risks could undermine public trust, slowing the adoption of otherwise beneficial innovations.

These, among many other factors, necessitate immediate action.

Question:

Thus, as neural engineering rapidly advances and shapes human progress, what steps do you think should be taken- by governments, industry, academia, or other stakeholders- to guide this technology toward a positive and beneficial trajectory? We again invite you to discuss freely- we have 25 minutes.

Scope:

The final section investigates the broader societal impacts of neurotechnology and AI, addressing ethical dilemmas, regulatory challenges, and the long-term implications for humanity. Topics such as equitable access, privacy concerns, and workforce disruptions will be explored to provide a nuanced understanding of the societal shifts these technologies may cause. This section thus aims to foster critical discussions on how to navigate the complex relationship between innovation and societal well-being.

Reference & Bibliography

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