

# IEEE Neuroethics Framework

## Addressing the **Ethical, Legal and Social** Implications of Neurotechnology

The Institute of Electrical and Electronics Engineers (IEEE) is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.

IEEE Brain was formed as a Future Directions initiative within IEEE, with the mission of facilitating cross-disciplinary collaboration and coordination to advance research, standardization and development of innovative tools and technologies in the field of neuroscience to treat diseases and improve lives.

As part of our effort to support the neuroengineering community, the IEEE Brain Neuroethics Subcommittee was established to create a neuroethical framework to facilitate the development of guidelines for engineers working on new neurotechnologies. The goal for this framework is to educate engineers, applied scientists, and practitioners about the ethical, legal, and social issues and implications of their specific area of work without the need to digest a large body of neuroethical literature. To this end, the IEEE Brain neuroethical framework is organized as a matrix of specific types of neurotechnologies and their current and potential applications. In this framework, the columns represent different types of neurotechnology, and the rows represent applications of these technologies. Each element in the matrix will expand to highlight the ethical, legal, and social issues generated by a particular neurotechnology when used in specific contexts and applications.

The details within this matrix are being developed through ongoing collaboration with a team of engineers, scientists, clinicians, and ethicists. The resulting guidelines are intended to act as a "living document" that evolves with new technology and new ethical, legal, and social issues, ideas, and perspectives. Because each element can stand alone, we can update the elements of the matrix to address change, and add new rows and columns as new technologies and applications emerge. In this way, the IEEE Brain neuroethical framework will provide an iteratively current, practical resource for informing and guiding ethically sound research and use of neurotechnologies.

### IEEE Brain Neuroethics Subcommittee

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Addressing the **Ethical, Legal and Social Implications of Neurotechnology**

## TECHNOLOGIES / METHODS

	 <b>Recording/Sensing</b> Technologies to capture information about or from the nervous system	 <b>Stimulating/Actuating</b> Technologies to stimulate or modulate the nervous system	 <b>Closed-Loop</b> Technologies that combine recording / sensing with stimulation / actuation to control the nervous system	 <b>Direct Physical and Biological Modification</b> Technologies to physically alter the nervous system by modifying physiology, and/or specific systems or sub-systems	 <b>Augmentation and Facilitation</b> Technologies to support or expand the existing function of the nervous system
 <b>Medical</b> Technologies for diagnostics or treatment of infirmity and disease, including direct-to-consumer	TBD	TBD	TBD	TBD	TBD
 <b>Wellness</b> Tools for active pursuit of a healthy and fulfilling life; improving physical, mental, and social well-being	TBD	TBD	TBD	TBD	TBD
 <b>Education</b> Technologies to improve and/or facilitate learning; assist in remedial learning strategies; cognitive enhancement	TBD	TBD	TBD	TBD	TBD
 <b>Workplace</b> Technologies to monitor or modify brain in the workplace; efficiency improvements, evaluation and monitoring	TBD	TBD	TBD	TBD	TBD
 <b>Military/National Security</b> Technologies to augment or improve the ability to fight or defend through soldier enhancement, intelligence, and/or debilitate the enemy	TBD	TBD	TBD	TBD	TBD
 <b>Sports and Competitions</b> Technologies impacting success in sports or competition, including before, during or after competition	TBD	TBD	TBD	TBD	TBD
 <b>Entertainment</b> Entertainment technologies, including virtual/augmented reality and brain-controlled video games	TBD	TBD	TBD	TBD	TBD
 <b>Analytics, Marketing, &amp; Advertising</b> Technologies used to inform decision making, including data used to profile and influence consumers	TBD	TBD	TBD	TBD	TBD
 <b>Justice System</b> Technologies for use in civil and criminal adjudication, as well as in the correctional context, including to detect, modify and/or surveil brain states	TBD	TBD	TBD	TBD	TBD

APPLICATIONS / PURPOSE

**IMPLICATIONS FOR**

**Education**

**Stimulating/Actuating**

Neuroscience and technology are being considered and used to optimize learning, memory, and performance of certain cognitive and behavioral tasks. This has led to ethical, legal and social concerns about how and when neuro-engineering should be used in educational settings.

Issues to consider include:

- » Unknowns stemming from use of frontier science and technology
- » Long-term effects of use in children/adolescents
- » Trade-offs of cognitive “gains” vs “losses”
- » Viability, validity and value of “informed” consent
- » Implicit or explicit coercion
- » Development of “super-scholars” and its limitations, vulnerabilities and liabilities
- » Establishment of a “new normal” of optimized cognitive performance
- » Issues/concerns surrounding “fairness”
- » Stigma/bias (for and/or against those receiving interventions)
- » Implications of “mind control”
- » Escalation and brinkmanship

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