

# IEEE Neuroethics Framework

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



Over the last decade, the field of neuroscience has seen great advancements. Multiple efforts, both public and private, are underway to develop new tools to deepen our understanding of the brain and to create novel technologies that can record, decode, and sense brain signals as well as stimulate, modify, and augment brain function with improved efficacy and safety.

Although current research into and early deployment of neurotechnologies has predominantly focused on medical and therapeutic uses, there are already examples pointing to the push for the commercialization of these technologies for other applications, such as wellness, education, or gaming. As part of our effort to support the neuroengineering community, the IEEE Brain Neuroethics Subcommittee is developing a neuroethical framework for evaluating the ethical, legal, social, and cultural issues (ELSCI) that may arise with the deployment of such neurotechnologies.

The IEEE Brain neuroethical framework is organized as a matrix of specific types of contemporary neurotechnologies and their current and potential applications. In this framework, the columns represent different types of neurotechnologies, and the rows represent applications of these technologies.

The documentations that support this matrix provides examples of existing neurotechnologies and explores the ethical, legal, social, and cultural issues generated by a particular neurotechnology when used in specific contexts. The resulting documents are intended to facilitate further discussion by inviting input and new perspectives from a wide range of individuals with an interest in neurotechnologies. The long-term goal is that these documents will provide the basis for the development of a set of guidelines for engineers, researchers, applied scientists, practitioners, and neurotechnology companies that will help ensure the responsible development and use of new neurotechnologies. The guidelines will also be of interest to a wide range of audiences and stakeholders interested in neuroethics and the ELSCI of these emerging technologies.

We recognize that neurotechnologies are constantly changing, both in terms of the translational pathway and the scope of applications for which they are used. Accordingly, this framework is intended to serve as a living document, capturing a particular moment in time and will need to be revised as neuroscience, neurotechnologies, and their uses evolve.

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# IEEE Neuroethics Framework

Guiding Responsible Neurotechnology Innovation

Technologies/Methods

Applications/  
Purpose



## Recording/Sensing

Technologies to capture information about or from the nervous system



## Stimulating/ Actuating

Technologies to stimulate or modulate the nervous system



## Closed-Loop

Technologies that combine recording / sensing with stimulation / actuation to control the nervous system



## Direct Physical and Biological Modification

Technologies to physically alter the nervous system by modifying physiology, and/or specific systems or sub-systems



### Medical

Technologies for diagnostics or treatment of infirmity and disease, including direct-to-consumer



### Wellness

Technologies for active pursuit of a healthy and fulfilling life; improving physical, mental, and social well-being



### Education

Technologies to improve and/or facilitate learning; assist in remedial learning strategies; cognitive enhancement



### Work and Employment

Technologies to monitor or modify brain in the workplace; efficiency improvements, evaluation and monitoring



### Military/National Security

Technologies to augment or improve the ability to fight or defend through soldier enhancement, intelligence, and/or debilitate the enemy



### Sports and Competitions

Technologies impacting success in sports or competition, including before, during or after competition



### Entertainment

Technologies for use in entertainment, including virtual/augmented reality and brain-controlled video games



### Analytics, Marketing, & Advertising

Technologies used to inform decision making, including data used to profile and influence consumers



### Legal System

Technologies for use in civil and criminal adjudication, as well as in the correctional context, including to detect, modify and/or surveil brain states

## IMPLICATIONS FOR Wellness

Neurotechnologies in the wellness field are used to monitor, stimulate, and otherwise adjust the human brain and nervous system in order to help individuals achieve wellness goals, including relaxation, mindfulness, stress reduction, attention enhancement, and sleep, among others.

### GENERAL ISSUES TO CONSIDER:

#### Ethical Considerations

- Safety, Wellbeing & Risk
- Justice and Fairness
- Agency and Identity
- Authority and Power
- Surveillance and Privacy

#### Legal Considerations

- Security and Privacy Laws
- Safety Laws
- Liability and Responsibility

#### Social Considerations

- Social Benefits vs Social Disruptions
- Peer and Social Pressure

#### Cultural Considerations

- Cultural Differences in Acceptance and Use
- Potential to Foster or Threaten Intra-group Culture

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