

## **Description of Thematic Areas of the BRICS YSF**

### **\*\*\*Nature-like and Convergent Technologies as drivers for sustainable future**

The intersection of nature-like and convergent technologies is poised to revolutionize the pursuit of a sustainable future. As the world grapples with the challenges of climate change, resource depletion, and environmental degradation, researchers are turning to nature-inspired solutions to inform the development of cutting-edge technologies. Nature-like technologies, which mimic the intricate patterns and processes found in nature, have already shown remarkable potential in addressing complex environmental issues.

Nature-like and convergent technologies promise unprecedented and previously unimaginable possibilities. The basis of convergent technology is connecting the capabilities of modern digital technologies, such as microelectronics, with the creations of nature. Advances in electronics, nanoscience, bioscience, information technology, cognitive science, social sciences and humanities, and their integration, will allow us to develop previously unachievable human-centred utilities and services to improve our lives and leapfrog traditional impediments. These technologies are also referred to as frontier technologies since they are innovative, fast-growing, deeply interconnected and interdependent.

The areas of nature-like technologies are interdisciplinary and may include, but are not limited to:

- Technological reproduction of living nature systems, including nature-like energy systems.
- Developing materials, devices, and systems that mimic the properties and functions of biological systems, such as self-healing materials, adaptive structures and responsive surfaces.
- Neuromorphic artificial intelligence systems.
- Cyber-physical additive manufacturing complexes.
- Medical systems, including those based on regenerative technologies.
- Forming key elements of anthropomorphic and group bio robotics.

As these nature-like and convergent technologies continue to evolve and intersect, they will undoubtedly accelerate our ability to address the pressing challenges facing our planet, ultimately paving the way towards a more resilient and sustainable future.

### **\*\*\*Environmental and Climate Technologies**

It has been recognized that climate change is one of the most significant threats to the future of well-being and prosperity of our planet and all its inhabitants. Climate change affects ecosystems, society, food and water security, exacerbates disease outbreaks and increases natural disasters. It is imperative for science to focus its efforts on researching climate adaptation and mitigation technologies, such as:

- Monitoring the state of the climate system based on Earth observation technologies and AI methods.
- Enhancing ecosystem resilience and increasing sequestration potential of ecosystems.
- Climate change mitigation technologies in information and communication technologies aiming to reduce their energy use and carbon footprint.
- Reduction of greenhouse gas emissions related to energy generation, transportation and buildings, e.g. housing, house appliances or related end-user applications.
- Climate change mitigation technologies related to wastewater treatment or waste management.
- Capture, storage, sequestration or disposal of greenhouse gases.

As the technology continues to evolve, we can expect to see even more innovative applications, one of them being digital twin technologies. The digital twin is an emerging technology that builds on the convergence of computer science, mathematics, engineering, and the life sciences. Digital twins have the potential to revolutionize climate sciences in particular, as they could be used, for example, to create global-scale interactive models of Earth to predict future climate conditions over longer timescales.

Earth system digital twins require exceptional digital technologies to address the opportunities and challenges associated with extreme scale computing and big data. Higher-resolution simulations of the Earth system are based on models that are more realistic than those in the past; better ways to combine observed and simulated information from the Earth system; and interactive and configurable access to data, models, and workflows.

More realistic simulations at the global scale could translate to information at the regional scale that better supports decision-making for climate adaptation and mitigation through tight integration and interaction with impact sector models.

### **\*\*\*Digital Humanities**

Contemporary social science and humanities investigate human beings as complex subjects of social relationships, encompassing biological, psychological, political, and socio-economic aspects. They also examine the evolution of complex social and cultural systems, various types of social interactions and the means by which they are realized: linguistic, cultural, political, and economic mechanisms.

The last 20 years saw the revolution in modern social science and humanities associated with the use of big data analysis methods and new digital tools for mathematical modeling. Digitalization has introduced new highly efficient analysis methods not only for statistical data, but also for narrative sources, expanding the research toolbox and bringing the studies to a new level. Moreover, mathematical methods have enhanced linguistic research and created powerful technologies for machine translation and text processing.

The use of electronic computer systems featuring elements of artificial intelligence for analyzing and modeling long-term development dynamics represents another area of studying. By analyzing long statistical series, one can build verifiable dynamic models, which opens up unique opportunities for the forecasting based on the combination of mathematical models and expert assessments of socio-economic development.

### **\*\*\*Artificial Intelligence**

Artificial Intelligence is a field of research in computer science that deals with the development of programs and systems capable of performing tasks that require human-like intellectual abilities. These systems can perceive their environment, learn, make decisions, and tackle challenges that previously only humans could handle. Artificial intelligence finds applications across various domains such as medicine, finance, manufacturing, transportation, and more. Over the past few decades, the field of artificial intelligence has witnessed significant advancements, revolutionizing how we approach complex problems and tasks. With the advent of big data analysis methods and cutting-edge digital tools, artificial intelligence has enabled researchers to understand human behavior, societal structures, and cultural dynamics. By harnessing the power of machine learning algorithms, neural networks, and natural language processing, artificial intelligence has empowered machines to comprehend language, translate text, and process information at unprecedented speeds and accuracy. Moreover, the integration of artificial intelligence into computer systems has paved the way for studying long-term development dynamics through advanced analytical tools. By leveraging artificial intelligence capabilities to analyze extensive statistical data sets, researchers can construct dynamic models that offer insights into socio-economic trends and facilitate forecasting based on a combination of mathematical models and expert assessments. New steps in the field of Artificial Intelligence are related to the use of advanced computational tools, such as photonic and quantum co-processors.