FUTURE SCIENTIFIC METHODOLOGIES

Virtual Community of Interest Workshop
November 2, 5, 10, 2020

Tomorrowland Vision: What new technologies may emerge to enable dramatic shifts in how science is done in the future?

- Technologies that will democratize science (such as miniaturized particle accelerators) What may be the future of experimental facilities and discovery science if technologies that were formerly “big science” and “big facilities” become ubiquitous?
- Technologies that will change how we collaborate: What may be the impacts on science and scientists of being able to have interpersonal interactions in a virtual environment comparable to interacting in person?
- New energy production, delivery, and storage methods: How may fundamental changes in the energy and power sector will drive changes in experimental facilities?

Interfaces of the Future: In a world with ubiquitous AI, novel computing systems, and societal changes, how will scientists and digital agents interact and communicate?

- ‘Self-driving’ facilities: ‘Who’ will do ‘what’ in automated and/or autonomous facilities?
- Workforce development: What basic skills will all scientists need to teach and learn from AI collaborators as well as human collaborators?
- Characterizing the relationship with AI: With increasing sophistication, digital agents will represent a competitive advantage in conducting research, just as human collaborators do today.

Future Scientific Methodologies: What are the broader implications of these and other factors for scientific methodologies and the role of computing?

- Data management and sharing: With an increasing number of sources of scientific data, how do we approach ‘FAIR’ data management principles <findable, accessible, interoperable, reusable>
- Executing the scientific method with the convergence of physical science (experimental & computational) and data science: How does hypothesis generation change? How do we insure reproducibility of results? How are results validated?
- Collaborative scientific research: How will collaborations change in terms of skills? What role will citizen science play in a world with more accessible data?

Computing Facilities of the Future: How will scientists and computers generate, process, move, find, repurpose, and store data in a future global computation fabric?

- Extreme heterogeneous and disaggregated HPC architectures: What if we could mix-n-match heterogeneous accelerators/memory at runtime?
- Multiple co-existing computing paradigms: What is the development and delivery model for future computing facilities to deliver classical, quantum, neuromorphic computing and other specialized or highly targeted computing systems.

- Deep integration of data, computation and networking: What if experimental apparatus and models were co-integrated to the point that an experiment and a “digital twin” that interact with each other more or less in real-time?
- Linked facilities: Will the computing and data facilities of the future be more distributed and integrated more closely with experimental facilities.

Future Missions: What new activities may be pursued by DOE and the National Labs?

- Innovation: how do we incubate science at the intersections of data sets, scientific disciplines, and federal sectors
- Societal imperatives: How will DOE evolve and interface with other agencies and private partners to tackle societal grand challenges?
- Interplay of applied and basic research: Some of the Tomorrowland visions assume a robust interplay of basic and applied research; What would facilitate this interplay?
- Basic research: What open questions in basic scientific research will become tractable in 30 years because of technological changes?