Mathematical Foundations of Digital Twins (MATH-DT)
NSF 24-559

Deadline: **June 20, 2024**

5pm submitters local time

Program Contacts

MPS/DMS: Yuilya Gorb, Jodi Mead
Yulia Gel, Dmitry Golovaty

ENG/CMMI: Daan Liang, Siqian Shen

AFOSR

Fariba Fahroo

WEBINAR LOGISTICS

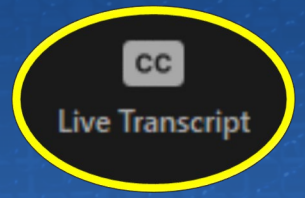
- Webinar (including Q&A) will be recorded and posted on the MATH-DT program page:

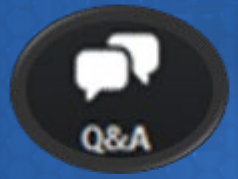
  https://new.nsf.gov/funding/opportunities/mathematical-foundations-digital-twins-math-dt

- Following the presentation, time will be provided for general Q&A (next slide)

- We do not anticipate answering proposal-specific questions. There will be a follow-up Virtual Office Hour in May and FAQ posted on the MATH-DT program page

Zoom Webinar Set-up

- All attendees are muted and webcams are disabled.
- To enable live transcript, click on the 

feature.
- To ask a question, please use the 

feature.
  - You may submit questions at any time.
  - You may send questions anonymously:

DIVISION OF MATHEMATICAL SCIENCES (DMS)

David Manderscheid
Division Director

PROGRAM OVERVIEW

Topics to be covered

- Motivation
- Scope of MATH-DT
- Priorities
- Relationship to other opportunities
- Proposal preparation

MOTIVATION

Decision making in various fields in science, engineering, medicine, urban planning, and more

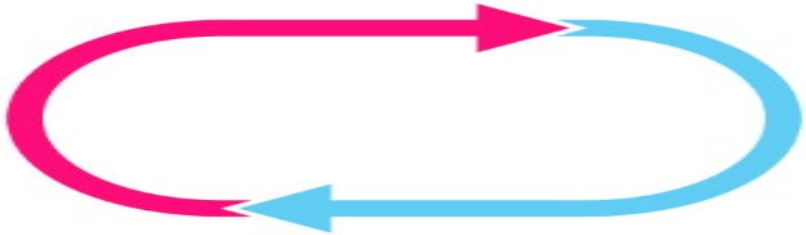
Earth System

Significant advancements in a range of fields, e.g:

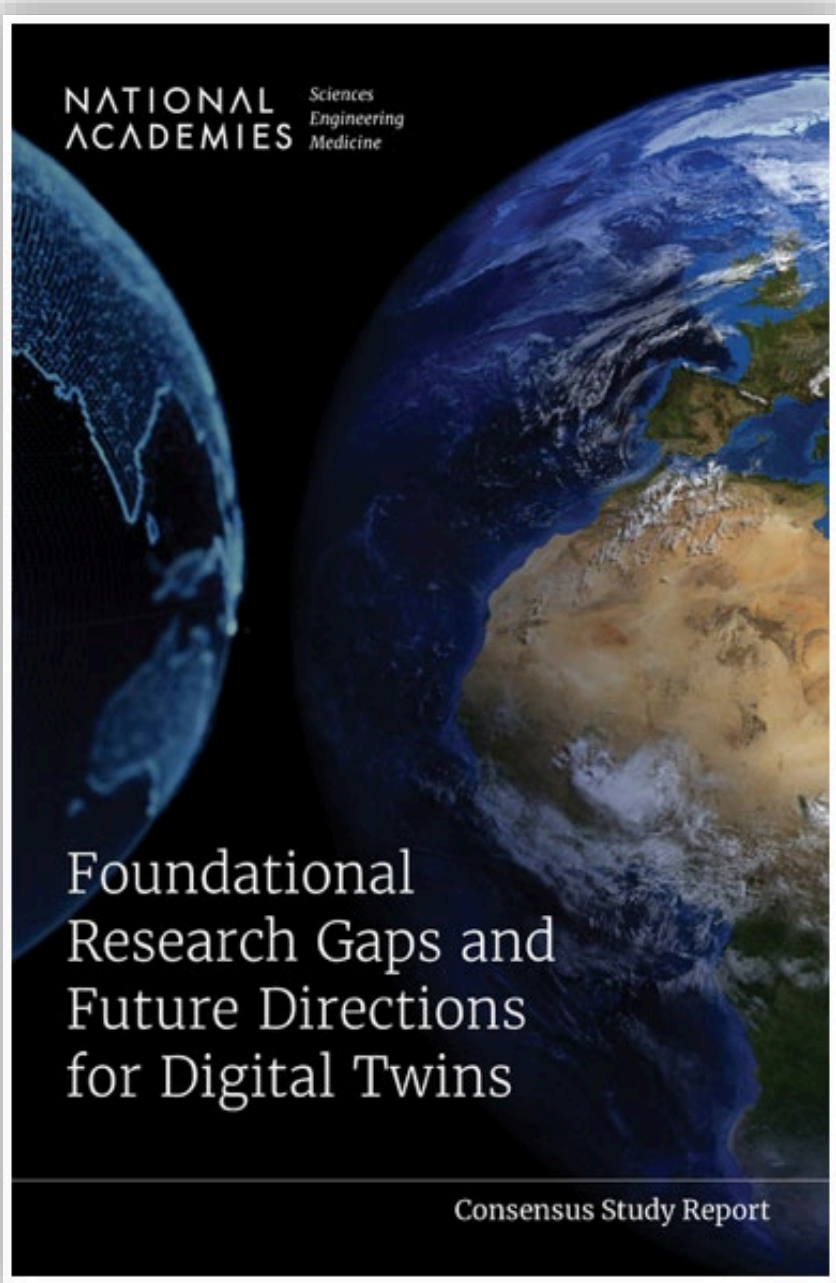
AI, SciML, PDEs, UQ, HPC, experimental design, inverse methods, data assimilation, imaging, control, optimization

A DIGITAL TWIN

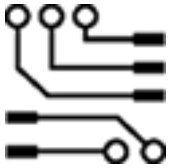
- *is a set of virtual information constructs that mimics the structure, context, and behavior of a natural, engineered, or social system,*
- *is dynamically updated with data from its physical twin,*
- *has a predictive capability and informs decisions that realize value.*



The bidirectional interaction between virtual and physical is central to the Digital Twin



SCOPE OF MATH-DT

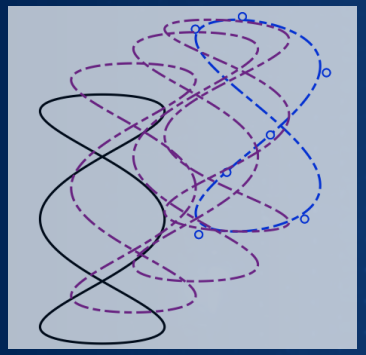


Application introduces constraints and objectives that necessitate new Mathematical, Statistical and Computational approaches to Digital Twins

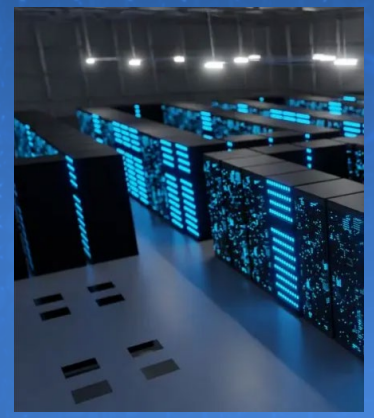
Mathematics and Statistics guides Digital Twin models and methods for their evaluation while also serving as a problem-solving tool

MATHEMATICAL, STATISTICAL AND COMPUTATIONAL CHALLENGES

Integration of models and data across various scales and levels of fidelity



Quantification of uncertainty to assess model inadequacy when dealing with limited and noisy data



Comprehensive evaluation of computational costs and scalability within the overarching framework

APPLICATIONS

MATH-DT accepts proposals in a broad range of applications

Proposals should

- Tackle applications characterized by substantial complexity and challenges, e.g
  multi-physics, multiscale, high-dimensional components
- Show clear evidence of Digital Twins' potential to address real-world problems


Smart Cities


Earth System

PRIORITIES

- New and existing collaborative research
- Mathematical, statistical and computational advancements
- Clear evidence of Digital Twins' potential to address real-world problems
- Innovative research that addresses problems characterized by substantial complexity
- Improved policy and decision-making

Relationship to other opportunities

FDT-BIOTECH: Foundations for Digital Twins as Catalyzers of Biomedical Technological Innovation (NSF/FDA/NIH)

- Mathematical foundations for biomedical technology
- Synthetic human models in healthcare with focus on regulatory relevance

ACED: Accelerating Computing-Enabled Scientific Discovery

- Computing and computational technologies that advance scientific discovery beyond targeted use cases or domains

NSF/AFOSR Core Programs

- Potentially transformative research and education which does not require foundational Digital Twin research that (i) is dynamically updated with data, (ii) has predictive capability, (iii) informs decisions that realize value

PROPOSAL PREPARATION

MERIT REVIEW CRITERIA

Intellectual Merit

The potential to advance knowledge

Broader Impacts

The potential to benefit society and contribute to the achievement of specific, desired societal outcomes

Additional Solicitation Specific Review Criteria

1. Explores synergistic relationship between Digital Twin applications and mathematical, statistical, computational innovation
2. Addresses how math guides creation of Digital Twin models and their evaluation, OR how application constraints and objectives necessitate development of new mathematical, statistical or computational approaches
3. Involves at least one Key Personnel leading mathematical, statistical or computational challenges and at least one other serving as the expert in modeling or data relevant to Digital Twin application

GENERAL PREPARATION INSTRUCTIONS

- **Title:** Please note that titles should be proceeded with "MATH-DT: "
- **Project Description:** Include separate section(s) with text describing how the proposal meets *Additional Solicitation Specific Review Criteria*
- **Budget:** There is no specific limit, but please keep in mind
  - Projects may be **up to 3 years in duration**.
  - NSF expects to fund **6-10 projects** with anticipated **$5,000,000**
  - Awards are expected to fund interdisciplinary teams of at least **2 lead collaborating Senior Personnel**.

SUBMISSION ELIGIBILITY

Eligible Organizations

- Institutions of Higher Education (IHEs)
- Non-profit, non-academic organizations
- Tribal Nations

Senior Personnel

- An individual may be designated as Senior Personnel (which includes but is not limited to PI or co-PI) **on no more than one proposal**.
- A minimum to two PIs on proposal is required: one expert in mathematical, statistical or computational aspects and the other specialized in application.
- AFRL and its staff are ineligible, including as unfunded collaborators.

FUTURE PLANS FOR MATH-DT

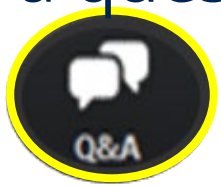
- This program solicitation announces an initial 2024 competition for MATH-DT proposals.
- Subject to the availability of funds there will be a second 2025 competition for MATH-DT proposals with deadline March 17, 2025.

RESOURCES FOR PROPOSERS

- Read the solicitation carefully! (NSF 24-559)
- This presentation will be posted on MATH-DT program page
- A FAQ will be posted on MATH-DT program page
- There will be a Virtual Office Hour in May, TBA

MATH-DT Q&A

To ask a question, please use



You may submit questions at any time, and anonymously

Webinar / Q&A will be **recorded** and posted on the MATH-DT program page

https://new.nsf.gov/funding/opportunities/mathematical-foundations-digital-twins-math-dt

Program Contacts

NSF/MPS/DMS:
Yuilya Gorb, Jodi Mead
Yulia Gel, Dmitry Golovaty
NSF/ENG/CMMI:
Daan Liang, Siqian Shen
AFOSR:
Fariba Fahroo