Scalable Computational Seismology for All  
- an OAC CAREER proposal-

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Interdisciplinary background

B.S. in math, B.S in computational physics (2008-12)

Ph.D. in computational and mathematical engineering (2012-18)

M.S. in geophysics (2016-17)

Assistant professor of math (2018-21)

Assistant professor of geophysics, and of applied math and statistics (2022-24)
First attempt – DOE YIP in **early 2019**

- **B.S. in math, B.S in computational physics** (2008-12)
- **Ph.D. in computational and mathematical engineering** (2012-18)
- **M.S. in geophysics** (2016-17)
- **Assistant professor of math** (2018-21)
- **Assistant professor of geophysics, and of applied math and statistics** (2022-24)

**Motivation? Better sense of what DOE cared about from prior experiences.**

- **DOE CSGF Fellow** (2012-2016)
- **Affiliate, geophysics department** (2016-20)
1st attempt – DOE YIP in early 2019

unsuccessful

• Proposed topic:
  "Real-time Compression and Summarization for Large-scale Streaming Sensor Networks"

• Reviewers:
  o 4 x encourage funding
  o 1 x discourage funding

• Lessons learned from reviewer comments:
  o Have a concise statement of objectives
  o Articulate connections and dependencies between tasks
  o Need a gradient of specificity
  o Make it clear what new work requires funding to continue
    (especially when using startup $ for preliminary results)
Late 2019 – struggle to find an NSF program

• Computational Math:
  o My colleagues told me this was the program I needed to apply to
  o The program manager gave me clear, discouraging comments:
    ▪ I needed to do less algorithms and applications, and more math
    ▪ I needed to get a regular computational math NSF grant before applying for a CAREER grant

• Geophysics:
  o Most applications I work on require new geophysical methods
  o I had a strong reputation in the geophysics community, but I was a math faculty
  o Geophysics program didn't support methods research

• Civil, Mechanical and Manufacturing Innovation:
  o Aligned with urban geophysics and infrastructure applications
  o I had gotten an EAGER grant on a different computational civil eng. problem
  o Reviews would be extremely dependent on openness of civil engineer reviewers to new geophysical/computational methods
Considering program(s):

Did you know you can apply for a CAREER grant with a secondary program review?

Thanks for this advice, Leah Johnson!
Looked at recent CAREER awardees' programs and tried to look for researchers "like me"

Found computational scientists with OAC CAREER grants with titles indicating applications:

- Amanda Randles  
  - Biomedical engineering
- Tan Bui-Thanh  
  - Aerospace engineering
- Aparna Chandramowlishwaran  
  - Electrical engineering, computer science

- Sent a one-pager to program manager, Alan Sussman
- Had a phone call and confirmed alignment with OAC, with ability for secondary review by EAR/Geophysics
Planning process on giant paper — happening while choosing program

Research objectives
- Suitability of compression and data products for seismology
- Fast algorithms using compressed big data
- Fast algorithms using full big data
- Open source software to implement new algorithms
- Theoretical and computational error analysis

Education and outreach objectives
- Targeted science community outreach activity I want to continue
- Education activity I want to start new
- Outreach activity I want to grow

Fast algorithms using compressed big data
Fast algorithms using full big data
Targeted science community outreach activity I want to continue
Project ideas
Research pipeline
Tutorials
Dependency
Outreach activity I want to grow
Research objectives
Planning process on MORE giant paper

Example Gantt chart, figure from Garrybooker on Wikipedia
Process to refine writing

• Junior faculty proposal writing group
  o Focused on summary and intro
  o Questions from people in other fields
  o Reduced jargon

• Got copies of successful CAREER proposals from coworkers
  o Organizational structure
  o Ways to make important points stand out
  o Strategies to integrate research with education/outreach

Source: Jeremy Keith, Wikipedia
Showing connection to targeted science community

Start discussions at least one month (ideally more) before application due

Use case #1: urban seismology
Penn State FORESEE Array Data

Use case #2: cryoseismology
Rhonegletscher Data

Figure from Idefix on Wikipedia

Education and outreach:
EarthScope

Education and outreach:
DAS Research Coordination Network (RCN)
Summary of preparation and award timeline:

- August 2019, Got rejection and reviews from DOE YIP
- October 2019, Started slowly planning for NSF CAREER
- March 2020, Re-learned how to teach and support students
- Mid-to-late April 2020, resumed working on proposal
- July 2020, Submitted NSF CAREER proposal
- January 2021, "Recommended for funding" note
- June 2021, Actually got notified of funding moving forward
- July 2021, Award started at VT
- January 2022, Moved to Mines and replanned education/outreach
Biggest impact: continuously sustained funds in this key research theme helped support critical mass of research on related projects

Sam Paulus
undergrad at VT, now at Northrop Grummon

Joseph Kump
MS at VT, now PhD student at UT Austin

Julius Grimm
MS in IDEA League, now PhD student at ISTerre Grenoble

Seunghoo Kim
undergrad at Mines, now PhD student at Stanford

Ahmad Tourei
MS & PhD at Mines

Shihao Yuan
Postdoc at Mines

Nikhil Punithan
MS at Mines

Georgia Brooks
MS at Mines

Hafiz Issah
PhD at Mines

Rachel Willis
PhD at Mines