High Risk High Reward Research: history, challenges and a look forward

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Outline

Historical Background
Challenges
Looking forward
High-Risk High-Reward

**EVOLUTIONARY**
“Persistent, step-wise work built on the discoveries and advances of others”

**HIGH RISK**
“bold innovation ... challenging existing paradigms”

**HIGH REWARD**
- Pure science breakthroughs
- Breakthroughs fueling an economic engine

research portfolio, risk management
Earlier US focus on HRHR

ARISE: Advancing Research In Science and Engineering: Investing in Early-Career Scientists and High-Risk, High-Reward Research
AAAS, January, 2009

House Committee on Science and Technology: Investing in High-Risk, High-Reward Research. October, 2009
Federal HRHR efforts: NIH, NSF

https://commonfund.nih.gov/highrisk

- EAGER: EArly-concept Grants for Exploratory Research
- RAISE: Research Advanced by Interdisciplinary Science and Engineering
- RAPIDS: Rapid Response Research
- Interdisciplinary center-scale programs: Engineering Research Centers, AI Institutes, Science and Technology Centers

https://www.nsf.gov/about/transformative_research/
Outline

Historical Background  Challenges  Looking forward
HRHR: merit review challenge

HRHR at NSF: an explicit merit-review question for every proposal; part of reviewer training:

“To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts?”

Panel discussions tend to average
  • Be on lookout for high-variance evaluations

Science expertise of program managers critical: mix of federal and rotating scientists
Challenges for HRHR proposers

- **Common (?) wisdom:** Play it safe, have significant initial results in hand, particularly with decreasing funding rates

- **Timing:** potentially long time from idea to funded proposal; three-year award duration is short

- **Interdisciplinary** proposals (and careers) require special evaluation

**Non-problems:**
- proposals on all topics welcome
- research direction of funded award can change (with PD approval)
Metrics: challenges

- How to measure HRHR impact?
- Time until HRHR impact is long (often decades)

Software-Defined Networking (SDN)

- SDN Market: $18B in 2019 (IDC)
- SDN started with 2008 NSF-funded foundational research

Open Programmable Mobile Internet
2020 project funded by NSF/CISE Expeditions program, 2008, N. McKeown, Stanford U.

Machine Learning

- Much of today’s machine learning advances rooted in government-funded research on neural networks, reinforcement learning

Yearly citations to *Reinforcement Learning: An Introduction* (Sutton, Barto)
Looking Forward

- **Importance of portfolio of funding:** even paradigm-changing research (usually) builds on the work of others:
  - ingredients “in the air,” connections/leaps made when area is ripe for change

- **Importance of time scale:**
  - 5-10+ years needed for recognition/foundation of successful HRHR research

- **Importance/challenges of convergence, interdisciplinary research:**
  - high-reward and “grand” challenges increasingly at the boundaries
  - longer-time collaborations, timeframe needed
  - challenge: evaluation, silo’ed disciplines (hiring, promotion)

- **High-level support, enablement of HRHR critical**
THANKS!