# Hard Problems: Young Math Talents in the U.S. and Their Choices of Higher Education

Siyuan Lyu

Department of Economics,
SUNY Stony Brook University, USA

# Roadmap

# Take-away

- **Nearly half** of the **USAMO awardees** obtained a **Ph.D. in mathematics-related STEM fields** such as Pure Math, Applied Math, Physics, Computer Science, and Economics, compared to **58.49% of the Putnam awardees**. **42.86%** of the **USAMO awardees** become **professors**, and **20.31%** of the **Putnam awardees** have won **NSF research funding**.

# Take-away

- **Nearly half** of the **USAMO awardees** obtained a **Ph.D. in mathematics-related STEM fields** such as Pure Math, Applied Math, Physics, Computer Science, and Economics, compared to **58.49% of the Putnam awardees**. **42.86%** of the **USAMO awardees** become **professors**, and **20.31%** of the **Putnam awardees** have won **NSF research funding**.
- **USAMO Gold Medalists** were significantly **more likely** than Honorable Mention recipients to pursue **higher degrees** in these fields and remain in academia.

# Take-away

- **Nearly half** of the **USAMO awardees** obtained a **Ph.D. in mathematics-related STEM fields** such as Pure Math, Applied Math, Physics, Computer Science, and Economics, compared to **58.49% of the Putnam awardees**. **42.86%** of the **USAMO awardees** become **professors**, and **20.31%** of the **Putnam awardees** have won **NSF research funding**.
- **USAMO Gold Medalists** were significantly **more likely** than Honorable Mention recipients to pursue **higher degrees** in these fields and remain in academia.
- There is **no significant pattern** in **Putnam awardees**, in terms of both **absolute performances and relative rankings**.

# Table of Contents

# USA Mathematical Olympiad (USAMO)

- Starting from 1972, USAMO serves as the final round to select top students into National Team to compete at International Mathematical Olympiad (IMO).
- Lasts for 9 hours with 6 questions in college-level math fields; invited only, covering around 500 U.S. or Canada citizens.
- Before 2022, Top 12 awarded with Gold Medals; Top 13-24 awarded in Honorable Mention (HM); 6 National Team members will be selected from them.
- Awardees receive opportunities to a high-ranking university. E.g.: 27/121 students graduated from Harvard, and 44 from MIT. (16/39 of HM-onlys graduated from MIT.)

# William Lowell Putnam Mathematical Competition (Putnam)

- From 1938, Putnam now is one of the most important and famous math competitions among university students in the U.S. and Canada.
- Lasts for 3 hours with 12 questions that require specific knowledge and talents in mathematics.
- Any undergraduates at a participating college could enroll the competition as they wish, while a majority of the individual winners are undergraduates from prestigious universities famous for their math departments.
- Individual awardees will be divided as the following levels: Top 5, Next 5, Next 6, Next 8, and Honorable Mention (HM).

# Why should we care?

- Screening of talents through specially-designed challenges (Agarwal and Gaule, 2020; Agarwal et al., 2023; 2024).
- Pushing knowledge frontiers forward and motivating scientists (Borjas and Doran, 2012; Azoulay et al., 2011; Azoulay et al., 2019).
- Effects of peer spillover effect (Calvó-Armengol et al., 2009; Borjas and Doran, 2015; Moreira, 2016) and self-belief on choices of higher education (Bradler et al., 2016; Sequeira et al., 2016; Elsner and Isphording, 2017)

# Table of Contents

# USAMO

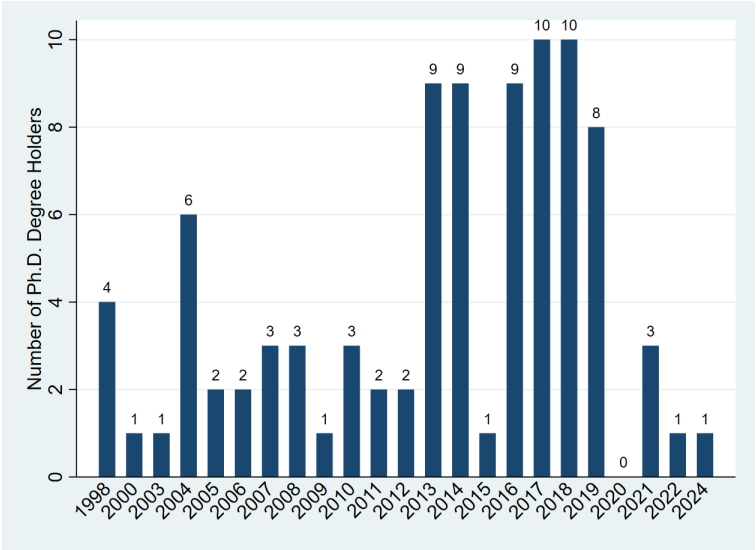
- List of awardees of USAMO in the year of 1989, 1994-1998, and 2003-2010.
- Manually search and collect personal information of the names, including their education and career information, from their personal profiles. ▸ Example
- Searched each of the names on ProQuest Dissertations & Theses database, and for every search result, scrape its Title, Author, Degree year, Subjects, etc. ▸ Example
- Filter and match the Ph.D. dissertations with the awardees with certain rules on Degree Year and Subjects.
- Result: 172 observations with their undergraduate and graduate paths, as well as career choice. 91 of them are double-checked to have a Ph.D. degree in math-related fields.

# Putnam

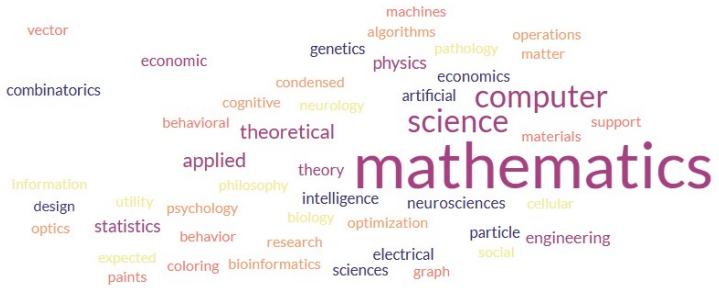
- Putnam has a much larger list of awardees. Due to time and effort limitation, we only automatically collect their Ph.D. dissertations using the same web-scraping methods and match them with the names.
  Result: 783 observations, 458 of which are matched with a Ph.D. dissertation.
- To measure their career path into the academia, we design a specific indicator: the experience of winning NSF research awards. Search for PI's first name and last name, including Co-PI, for their active and expired awards. For each result, collect the basic information.
  Filter and match the results with the awardees. ▸ Example
  Result: 601 NSF awards to promote research in mathematics, computer science, economics, etc.

# Table of Contents

# USAMO




(a) Annual Number of USAMO awardees obtaining a Ph.D.

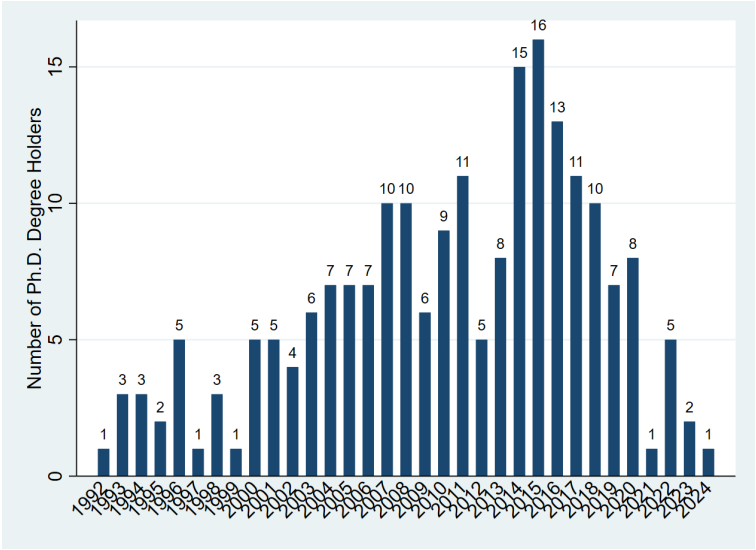



(b) Wordcloud of doctorate dissertation subjects from USAMO awardees

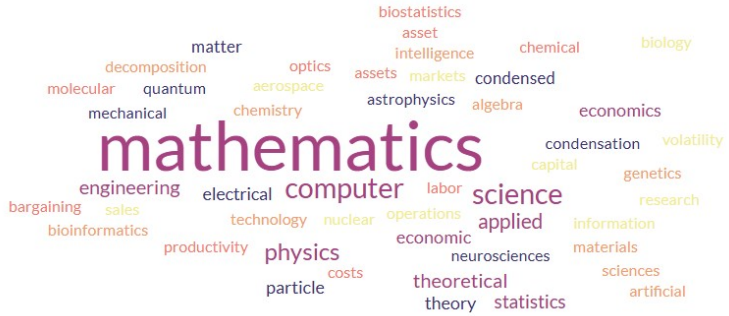
| | | Selecting maths as undergruaduate major | | Obtaining a Ph.D. degree | | Becoming a professor after graduation | |
|---|---|---|---|---|---|---|---|
| | Number | Number | Percentage (%) | Number | Percentage (%) | Number | Percentage (%) |
| IMO winners | 62 | 40 | 64.52 | 41 | 66.13 | 23 | 37.10 |
| USAMO gold medalists | 110 | 67 | 60.91 | 66 | 60 | 37 | 33.64 |
| USAMO gold medalists without IMO | 48 | 27 | 56.25 | 25 | 52.08 | 14 | 29.17 |
| Honorable Mentions only | 62 | 31 | 50 | 25 | 40.32 | 11 | 17.74 |

Figure: Overall choices of higher education by different USAMO awardees

# Putnam




(a) Annual Number of Putnam awardees obtaining a Ph.D.




(b) Wordcloud of doctorate dissertation subjects from Putnam awardees

Table: Overall choices of doctorate degrees by different awardees in Putnam (Absolute ranking)

| | Count | Ph.D. degree | Percentage (%) |
|---|---|---|---|
| Top 5 | 73 | 57 | 78.08 |
| Rank 6-16 | 149 | 99 | 66.44 |
| Rank 17-25 | 148 | 106 | 71.62 |
| HM | 648 | 159 | 55.09 |
| Never rank Top 5 | 710 | 401 | 56.48 |
| Never rank Top 16 | 595 | 329 | 55.29 |
| HM only | 494 | 259 | 52.43 |

Table: NSF winners by different awardees in Putnam (Absolute ranking)

| | Count | NSF winner | Percentage (%) |
|---|---|---|---|
| Top 5 | 73 | 33 | 45.21 |
| Rank 6-16 | 149 | 45 | 30.20 |
| Rank 17-25 | 148 | 41 | 27.70 |
| HM | 648 | 112 | 17.28 |
| Never rank Top 5 | 710 | 126 | 17.75 |
| Never rank Top 16 | 595 | 97 | 16.30 |
| HM only | 494 | 73 | 14.78 |

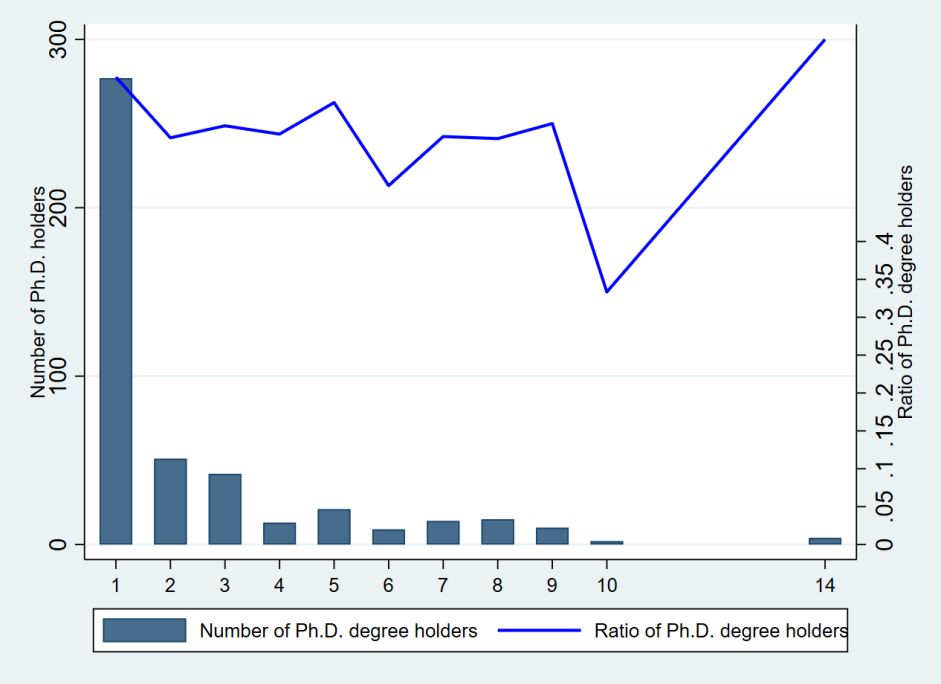



Figure: Overall choices of higher education by different awardees in Putnam (Relative ranking)

# Table of Contents

# Summary

**Sylvia Nasar, 'A Beautiful Mind'**

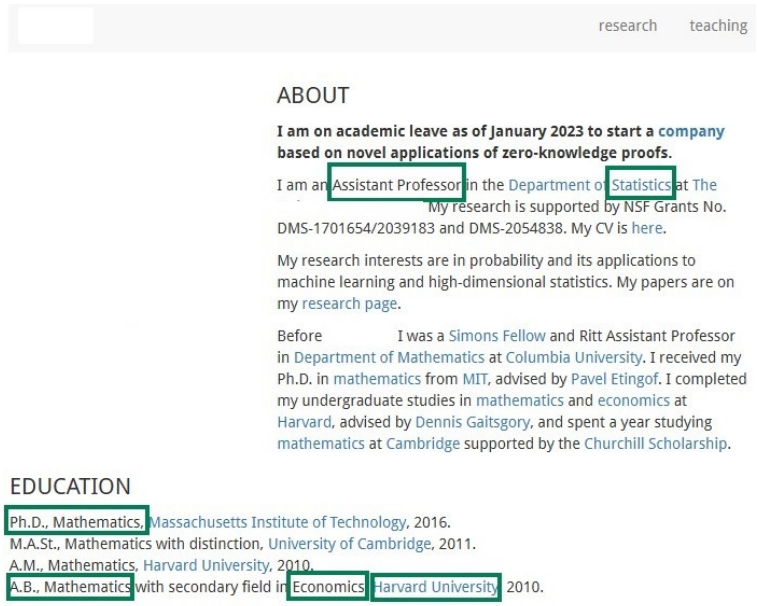
*Decades later, after he had acquired a worldwide reputation in pure mathematics and had won a Nobel Prize in economics, Nash hinted in his Nobel autobiography that the Putnam still rankled and implied that the failure played a pivotal role in his graduate career. Today, Nash still tends to identify mathematicians by saying, "Oh, So and So, he won the Putnam three times."*

Mathematics competitions for talented high-school students and undergraduates do matter!

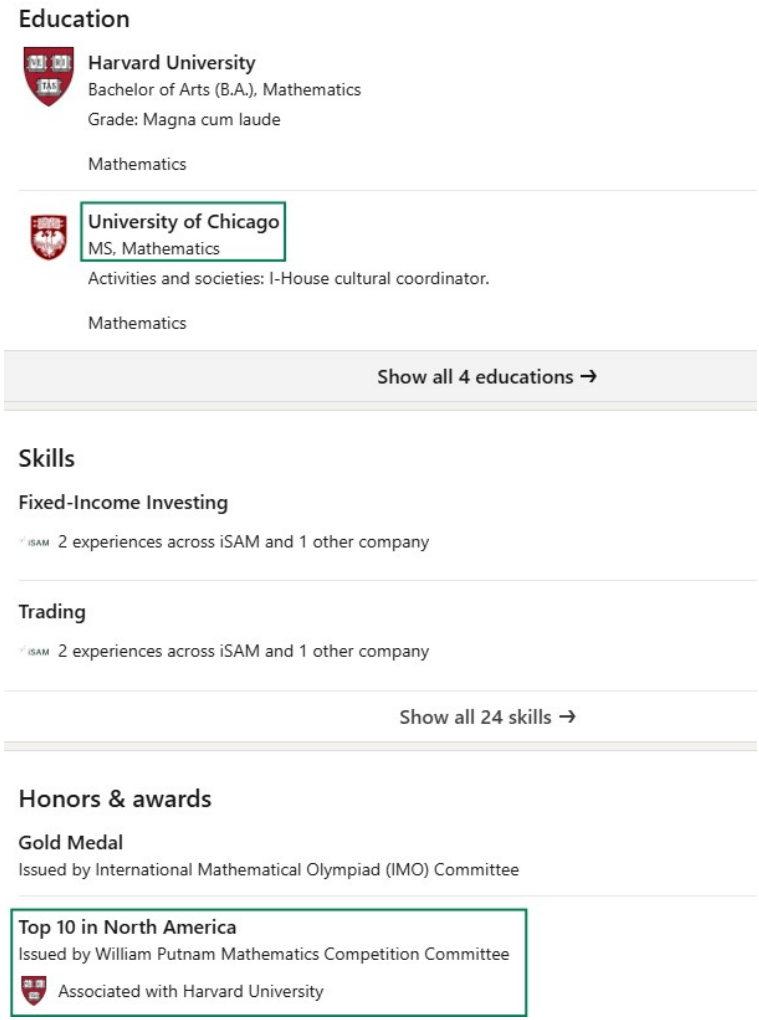
Thank you!


Contact me: siyuan.lyu@stonybrook.edu
Website: siyuanlyu.github.io

# An example of manual information collection

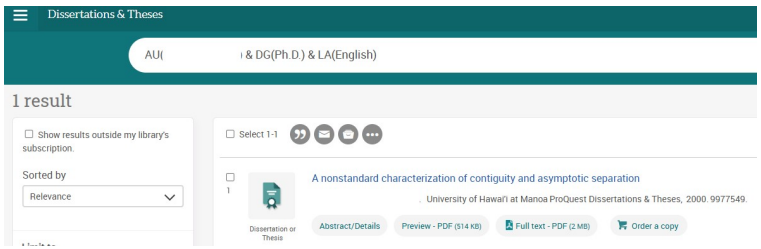



(a) Information collection from an awardee's personal website

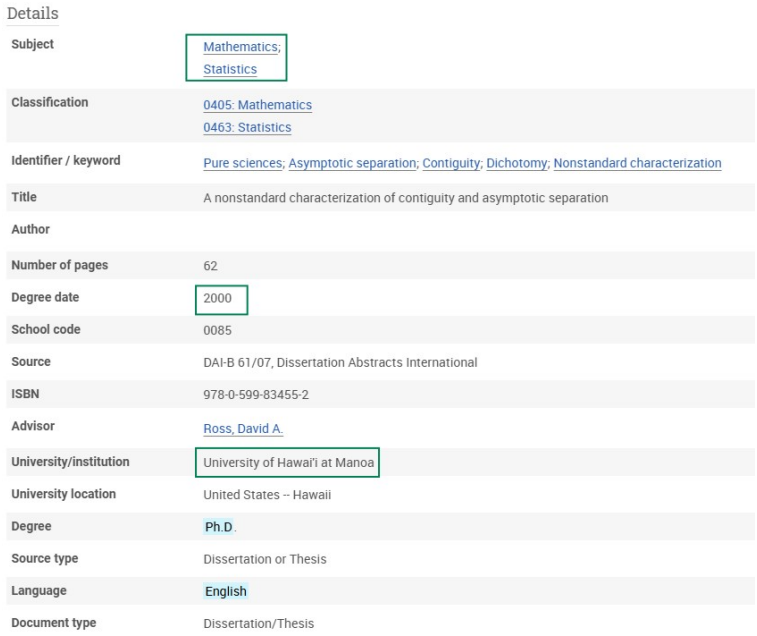



(b) Information collection from an awardee's LinkedIn profile

# An example of automatic information collection



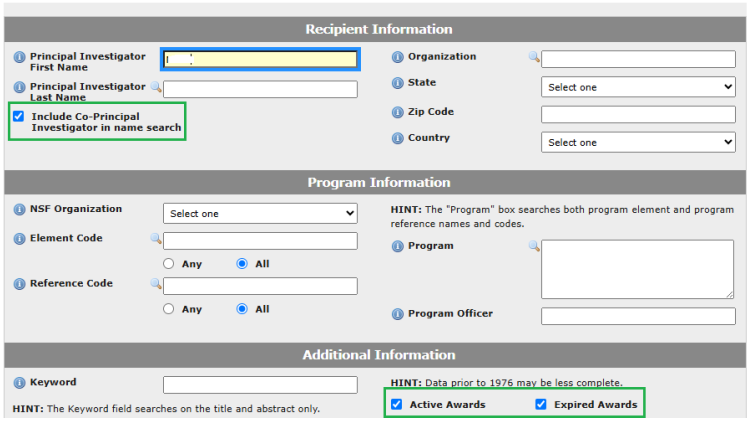

(c) Search result of an awardee's name



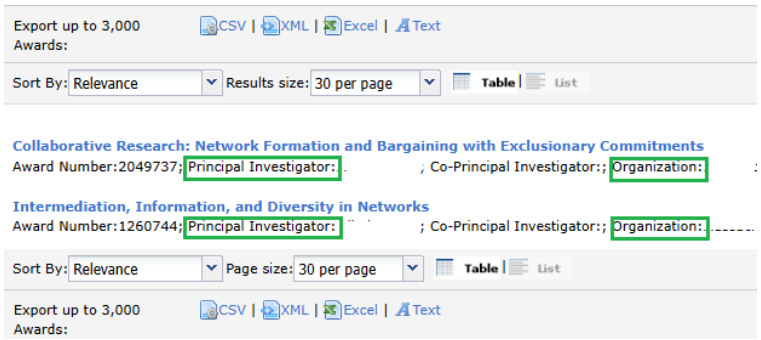

(d) Details of the dissertation result

Back

# Collecting Putnam awardees' NSF experiences




(e) Search for Putnam awardees' name in NSF database




(f) Result of the search

Back