

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

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Roadmap

- 1 Introduction
- 2 Construction of Data
- 3 Results
- 4 Conclusion

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**.

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- **USAMO Gold Medalists** were significantly **more likely** than Honorable Mention recipients to pursue **higher degrees** in these fields and remain in academia.

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- **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**.

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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)

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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.

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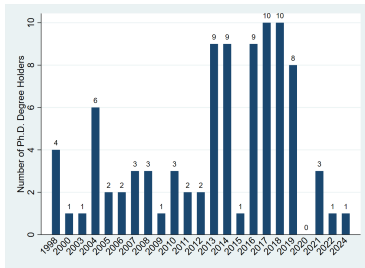
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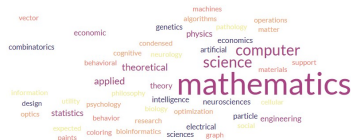
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USAMO



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

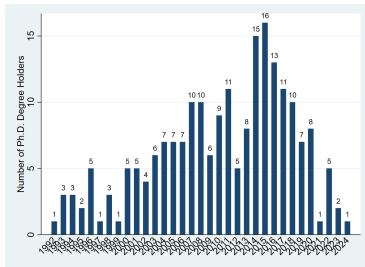


(b) Wordcloud of doctorate dissertation subjects from USAMO awardees

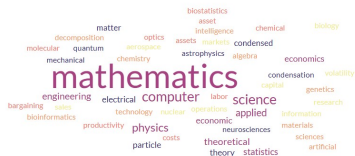
	Number	Selecting maths as undergraduate major		Obtaining a Ph.D. degree		Becoming a professor after graduation	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
IMO winners	62	40	64.52	41	66.13	23	37.10
USAMO gold medalists	110	67	60.91	66	60	37	33.64
USAMO gold medalists without IMO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

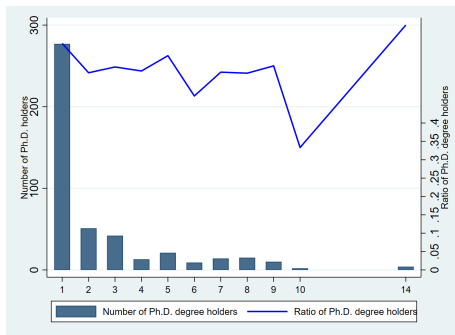


Figure: Overall choices of higher education by different awardees in Putnam (Relative ranking)

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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!

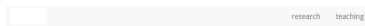
Thank you!



Contact me: siyuan.lyu@stonybrook.edu

Website: siyuanlyu.github.io

An example of manual information collection



ABOUT

I am on academic leave as of January 2023 to start a company based on novel applications of zero-knowledge proofs.

I am an Assistant Professor in the Department of Statistics at The University of Chicago. My research is supported by NSF Grants No. DMS-1701654/2039183 and DMS-2054838. My CV is here.

My research interests are in probability and its applications to machine learning and high-dimensional statistics. My papers are on my research page.


Before I was a Simons Fellow and Ritt Assistant Professor in Department of Mathematics at Columbia University. I received my Ph.D. in mathematics from MIT, advised by Pavel Etingof. I completed my undergraduate studies in mathematics and economics at Harvard, advised by Dennis Gaitsgory, and spent a year studying mathematics at Cambridge supported by the Churchill Scholarship.

EDUCATION

Ph.D., Mathematics Massachusetts Institute of Technology, 2016.
 M.A.St., Mathematics with distinction, University of Cambridge, 2011.
 A.M., Mathematics, Harvard University, 2010.
 A.B., Mathematics with secondary field in Economics, Harvard University, 2010.

Education

 **Harvard University**
 Bachelor of Arts (B.A.), Mathematics
 Grade: Magna cum laude
 Mathematics

 **University of Chicago**
 MS, Mathematics
 Activities and societies: I-House cultural coordinator.
 Mathematics

Show all 4 educations →

Skills

Fixed-Income Investing

2 experiences across iSAM and 1 other company

Trading

2 experiences across iSAM and 1 other company

Show all 24 skills →

Honors & awards

Gold Medal

Issued by International Mathematical Olympiad (IMO) Committee

Top 10 in North America

Issued by William Putnam Mathematics Competition Committee
 Associated with Harvard University

(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

Details	
Subject	Mathematics, Statistics
Classification	0405: Mathematics 0463: Statistics
Identifier / keyword	Pure sciences; Asymptotic separation; Contiguity; Dichotomy; Nonstandard characterization
Title	A nonstandard characterization of contiguity and asymptotic separation
Author	
Number of pages	62
Degree date	2000
School code	0005
Source	DAI B 61/07, Dissertation Abstracts International
ISBN	978-0-699-83455-2
Advisor	Ross, David A.
University/institution	University of Hawaii at Manoa
University location	United States -- Hawaii
Degree	Ph.D.
Source type	Dissertation or Thesis
Language	English
Document type	Dissertation/Thesis

(d) Details of the dissertation result

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Collecting Putnam awardees' NSF experiences

Recipient Information

Principal Investigator First Name:

Principal Investigator Last Name:

☒ Include Co-Principal Investigator in name search

Organization:

State:

Zip Code:

Country:

Program Information

NSF Organization:

Element Code:

Reference Code:

Program:

Program Officer:

Additional Information

Keyword:

☒ Active Awards ☒ Expired Awards

HINT: The Keyword field searches on the title and abstract only.

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

Export up to 3,000 Awards:

Sort By: Relevance Results size: 30 per page Table List

Collaborative Research: Network Formation and Bargaining with Exclusionary Commitments
Award Number: 2049737; Principal Investigator: [redacted]; Co-Principal Investigator: [redacted]

Intermediation, Information, and Diversity in Networks
Award Number: 1260744; Principal Investigator: [redacted]; Co-Principal Investigator: [redacted]

Export up to 3,000 Awards:

Sort By: Relevance Page size: 30 per page Table List

(f) Result of the search

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