Earth and Atmospheric Science in a World of Rapid Changes to Academia and Labor Dynamics

Christopher Keane

13 October 2022



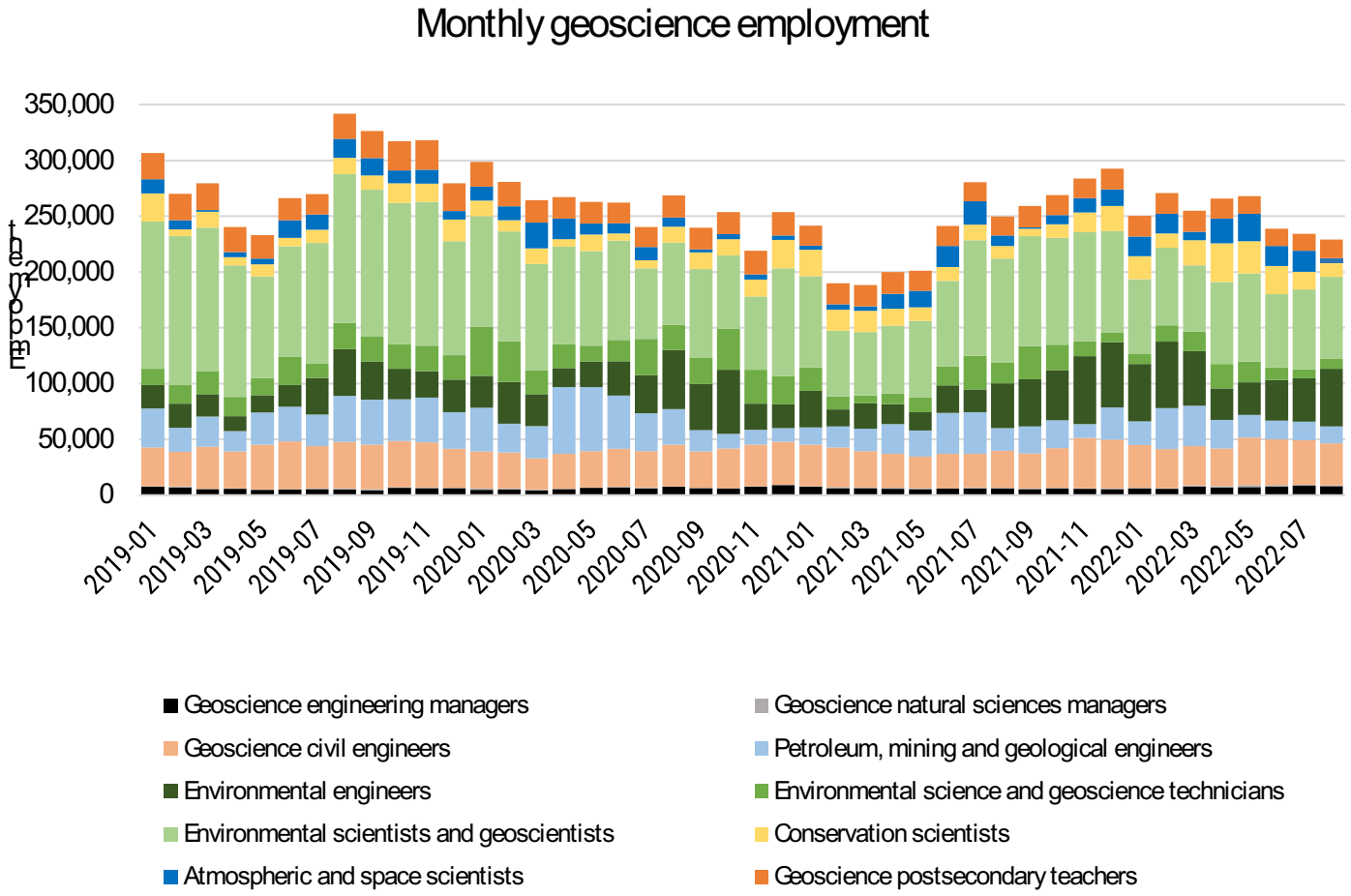
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Headwinds

- Demographic and social challenges for departments
  - Enrollment cliff
  - Pandemic hangover
  - Evolving motivations for college degrees
  - Unforced errors in the case for college
- The nature of science work is changing
  - Occupational evolution
  - Skills-focused employment
  - Wholesale changes to industry structure

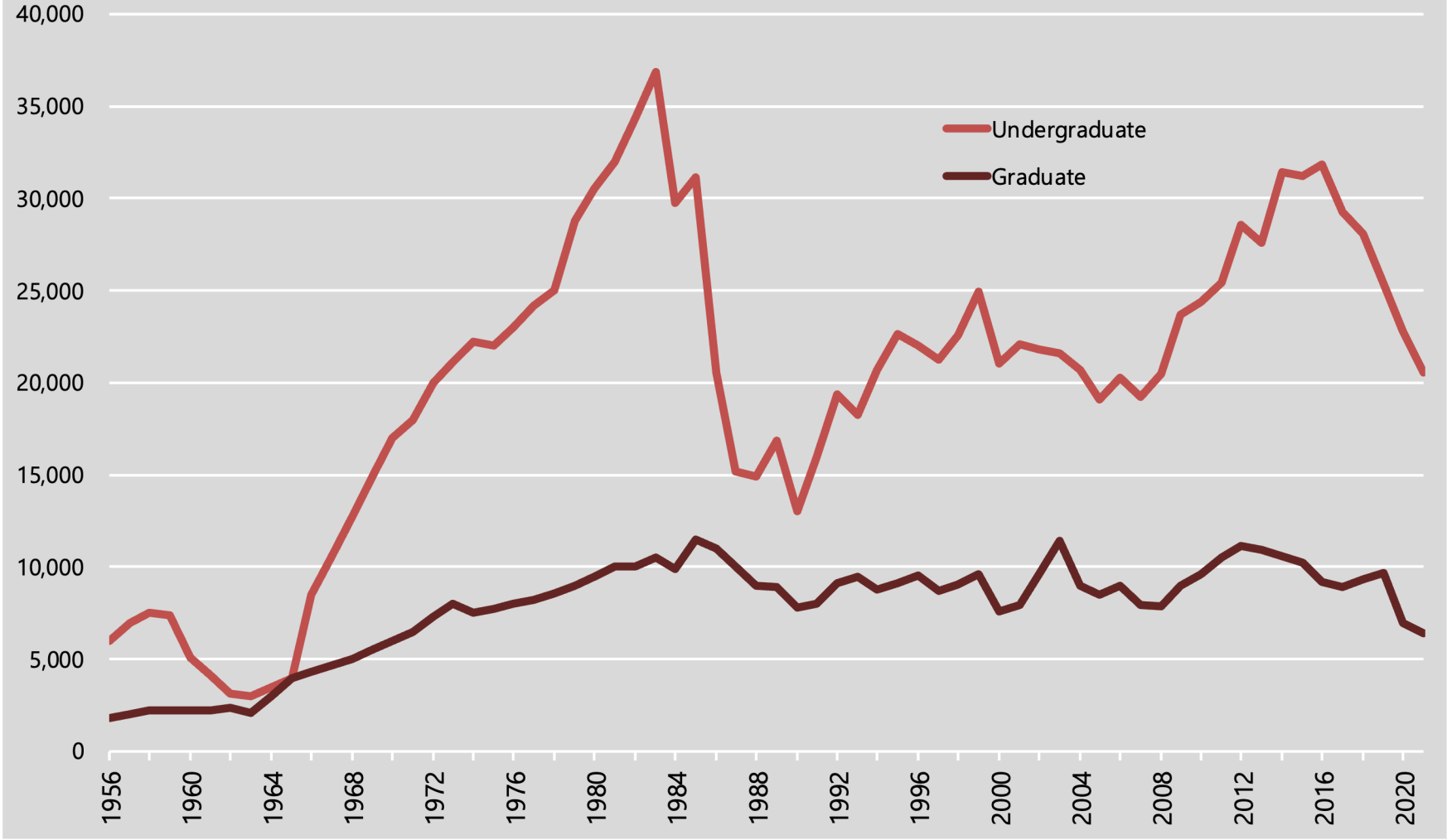
Employment in the Pandemic

- 88% of geoscience employers received government assistance
- Effective geoscience unemployment rate was 4%.

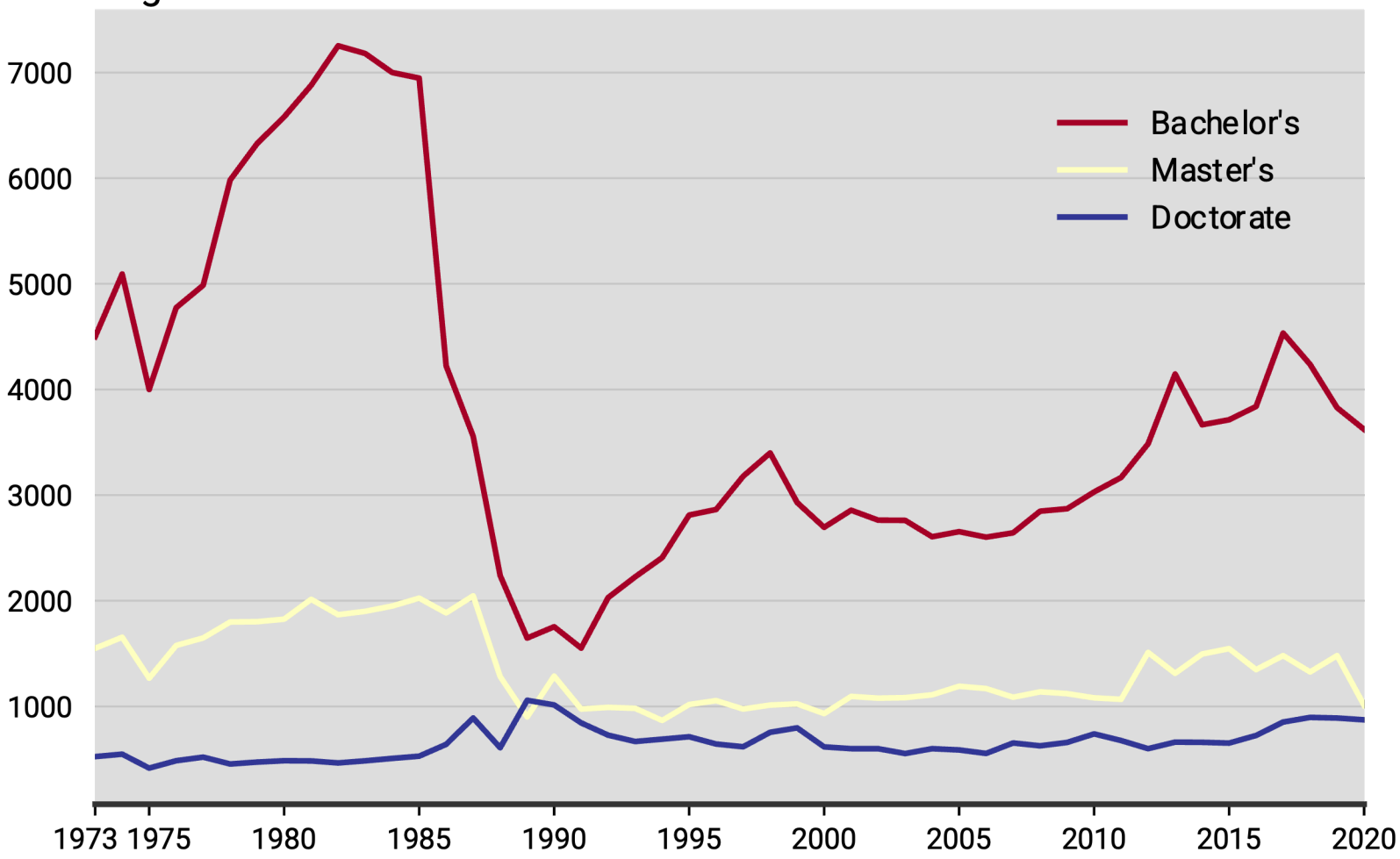


Geoscience Student Enrollment 1956-2021

United States Colleges and Universities



Geoscience Degrees Awarded in the United States, 1973-2020



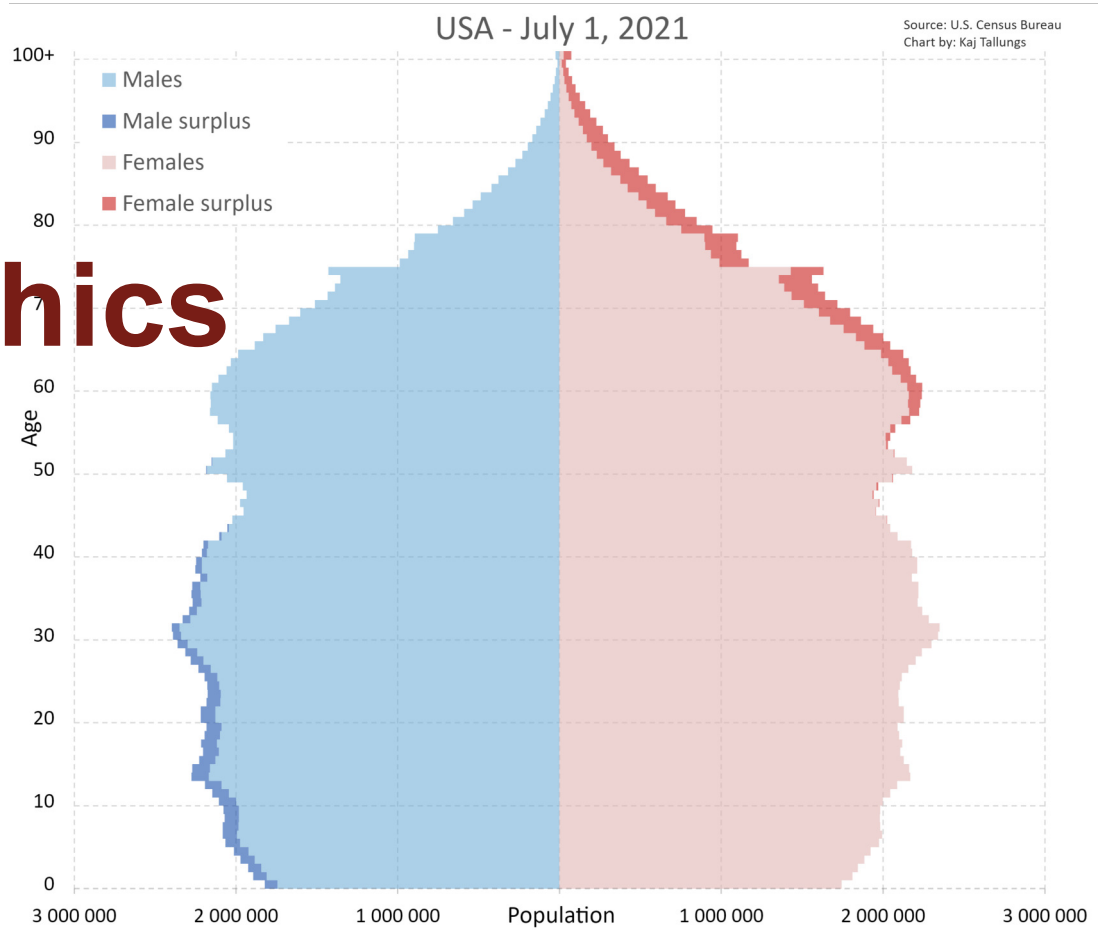
The Enrollment Cliff

External and Internal Factors

- Demographics of College-Age Students
  - Each generation requires a new higher ed business model
  - Its hard to cut back….
- Complications from the Pandemic
- Obvious Pathways to Employment
- The Loan Forgiveness Marketing Debacle

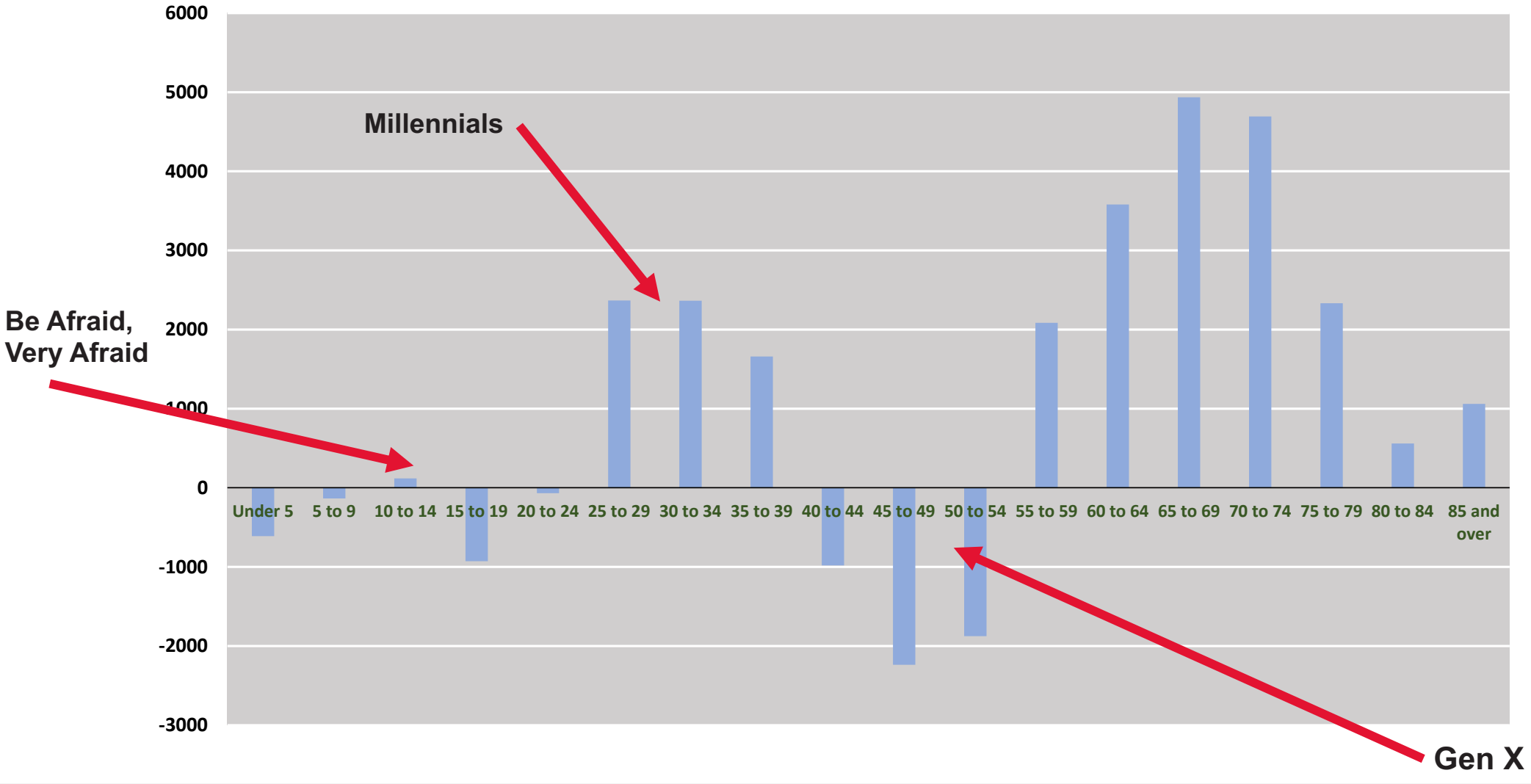
There will be winners and losers

The Curse of Demographics



US Population Change from 2010-2019 by Age

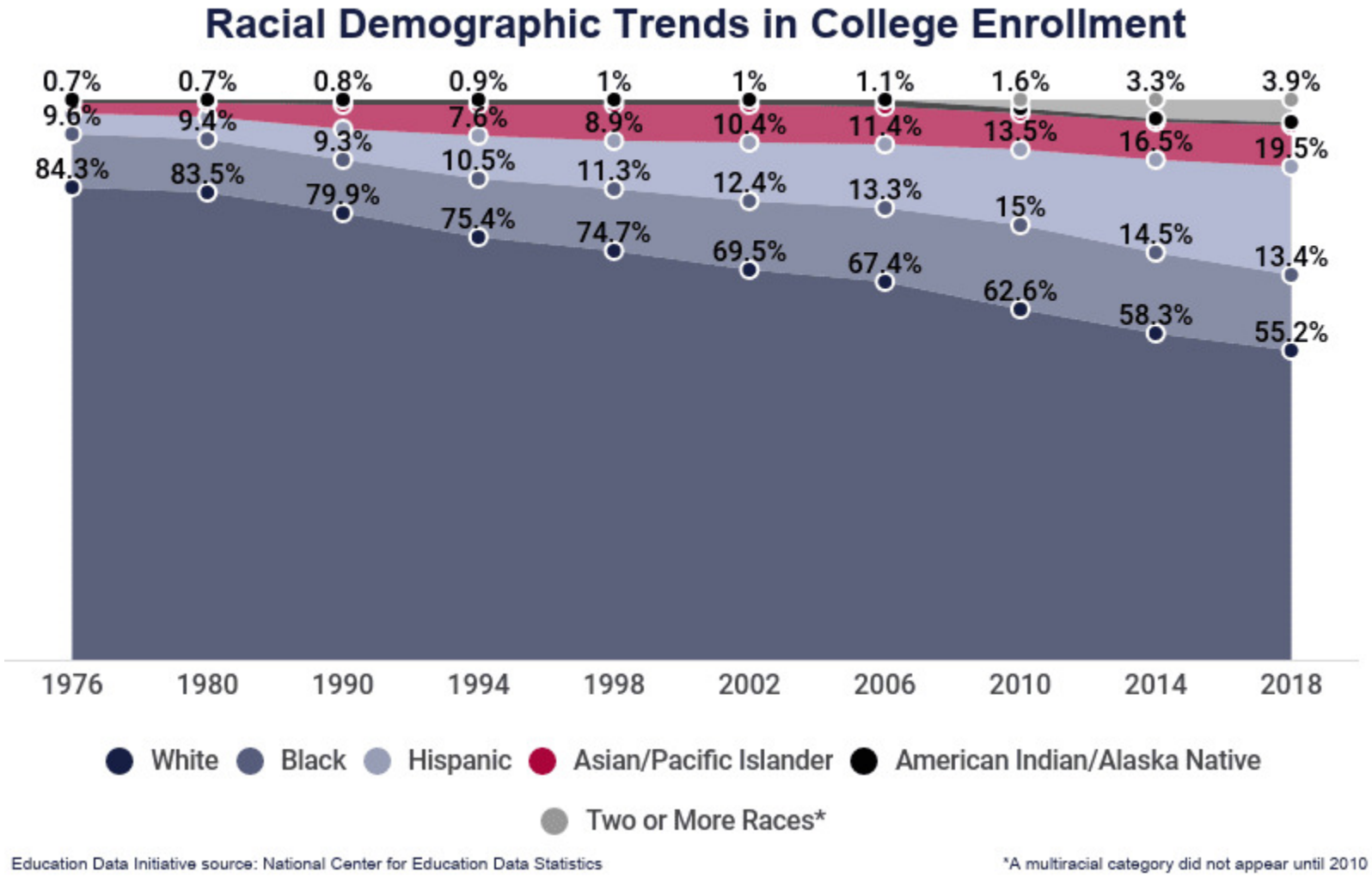
Hundreds of thousands of people



Demographics Drive University Business Models

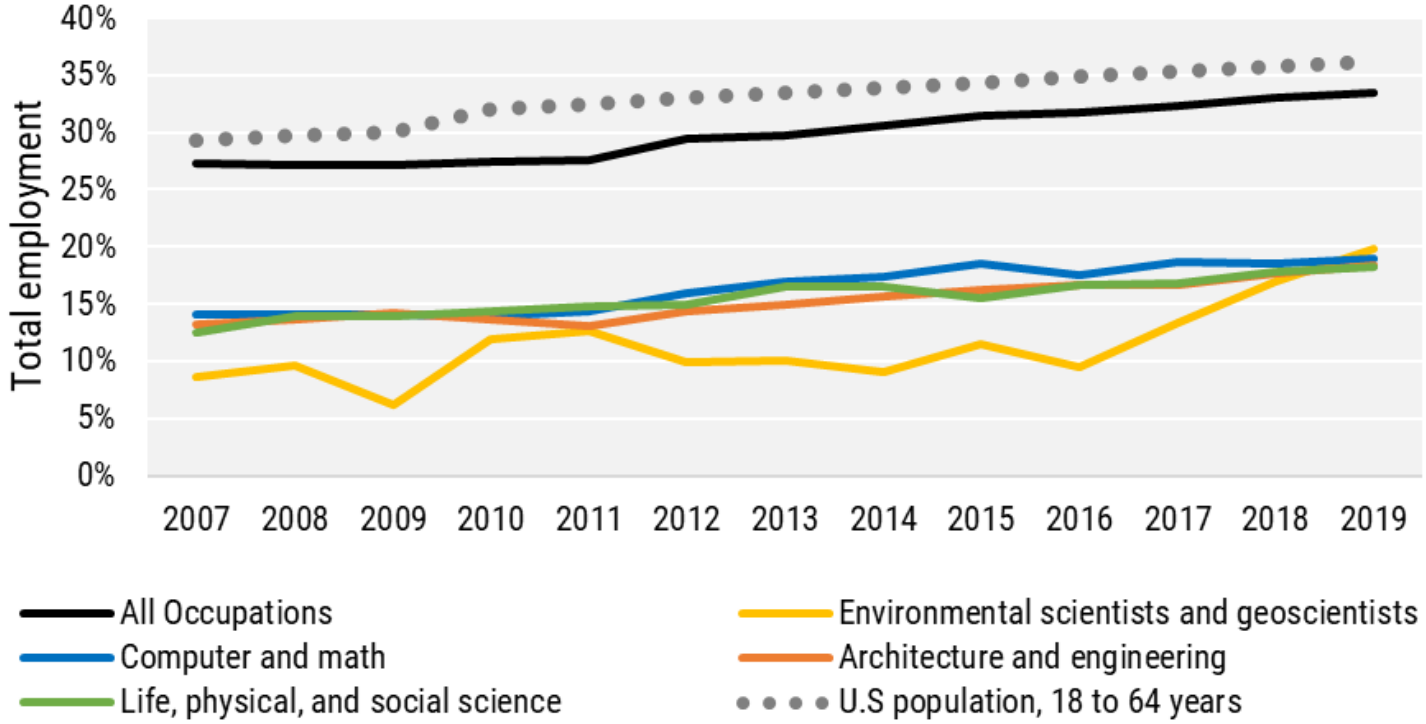
- Gen X remembers the mass budget cuts and losses in education
- The Millennial years fueled a binge
  - Debt loading
  - Focus on “experience” and broadening of education’s role
  - Big budgets, big overhead, and…. It was a different time
- More than 25 years ahead of at best no-growth

Diversity, We can't "Don't Look Up"



Workforce Participation by Occupation

All Underrepresented Populations



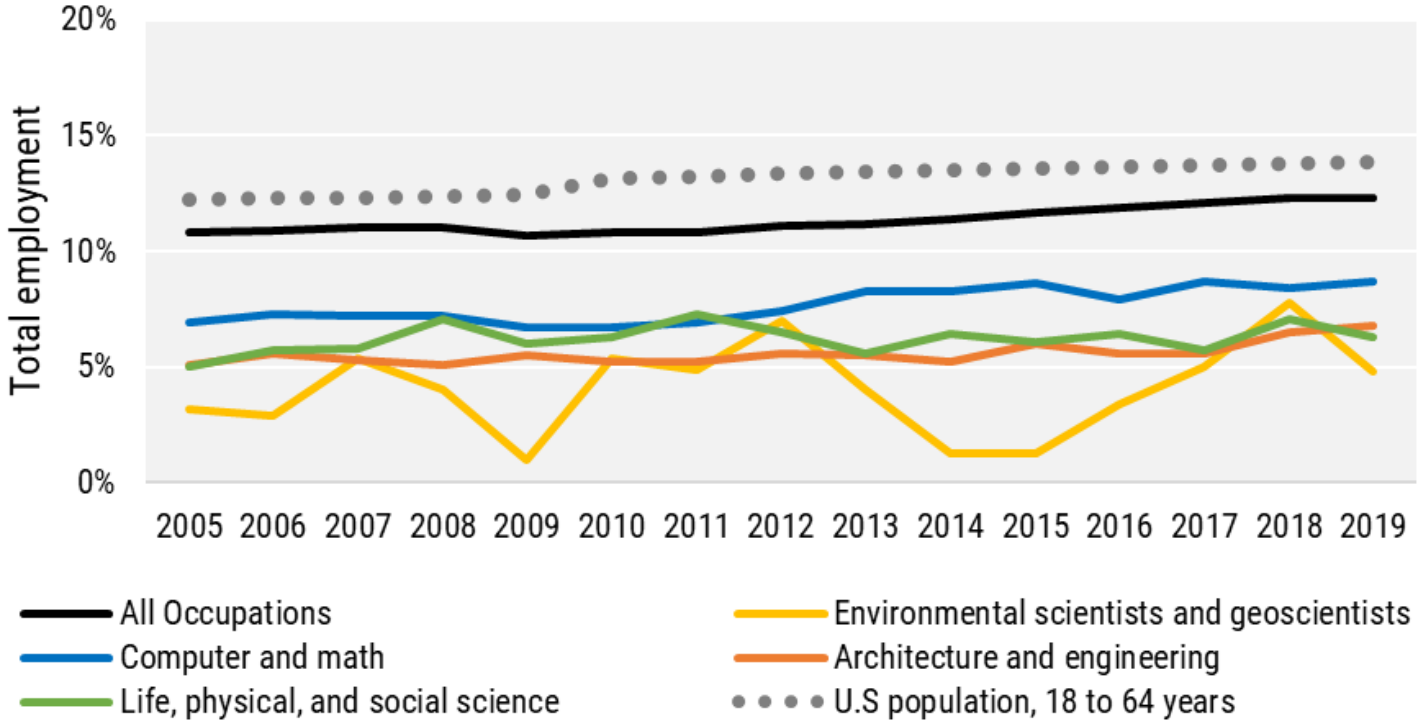
In 1972, underrepresented populations was 2% of the geoscience workforce.

1972-2016, really was negligible progress

Credit: AGI, data derived from the U.S. Census Bureau and U.S. Bureau of Labor Statistics

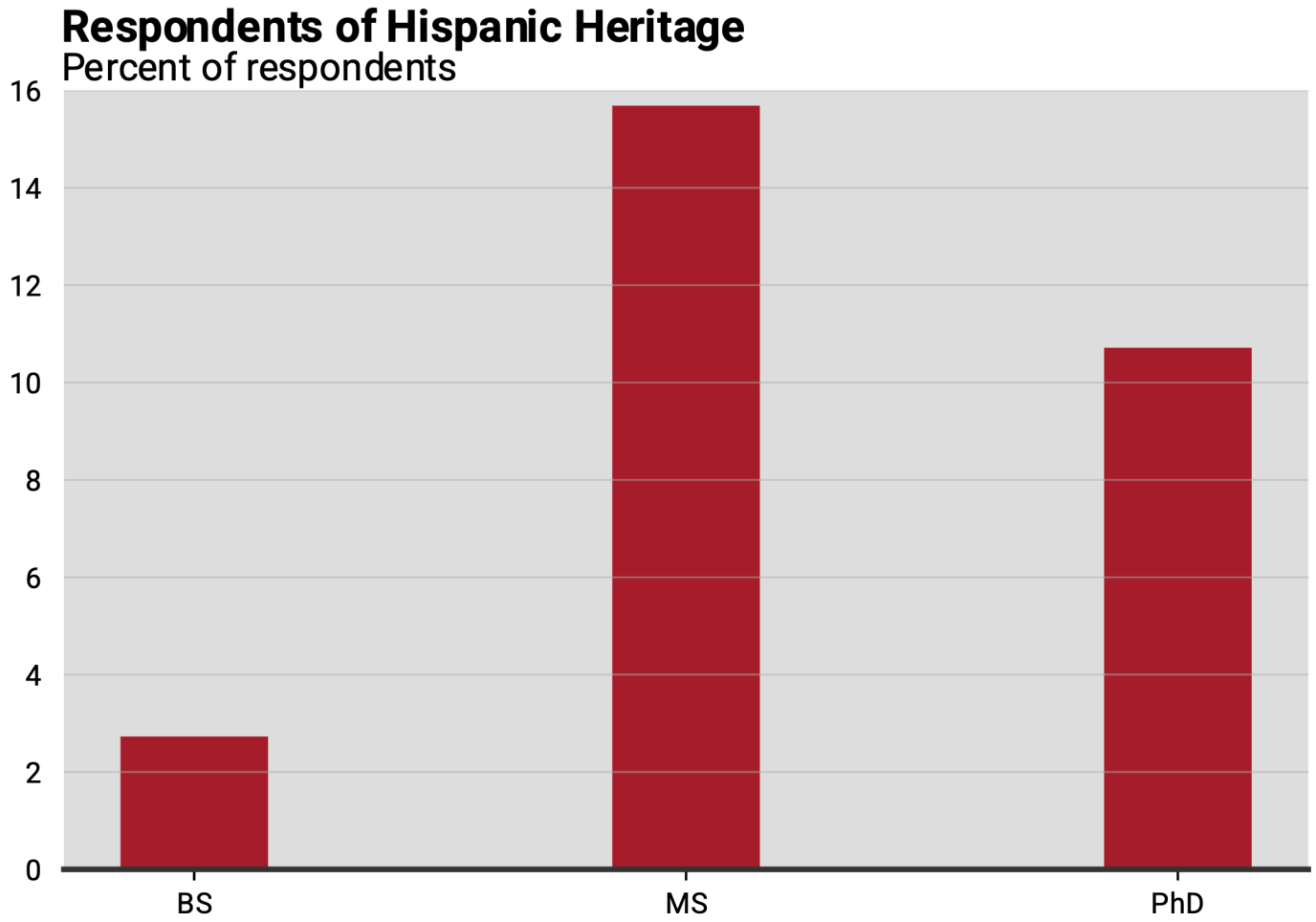
Workforce Participation by Occupation

Black and African-American



Credit: AGI, data derived from the U.S. Census Bureau and U.S. Bureau of Labor Statistics

2020 Geoscience Graduates

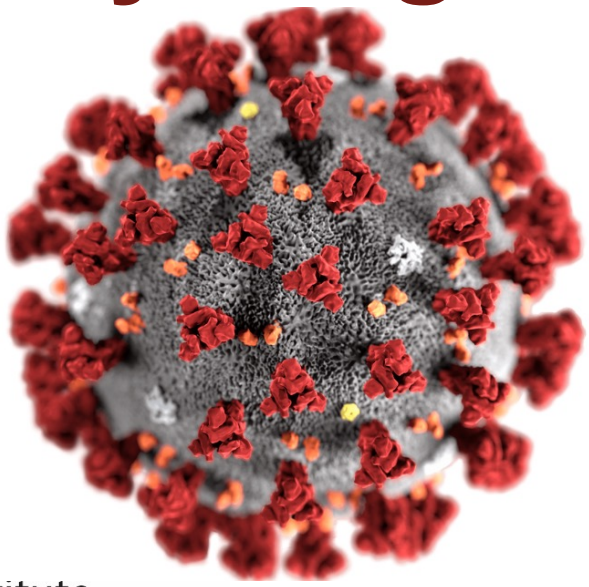


- How do we go from 18% to 2% in 1 year?
- Pandemic had an outsized impact, but we failed to support our in-progress undergraduates.

How do we create real change?

We need to change the culture of the geosciences. Change will not come from simply "intervening" with underrepresented populations.

Did the Pandemic Change Everything?



Student Culture has Abruptly Changed

Comments for COVID-19 Study and the News

"The reading, writing, arithmetic, all the discipline skills, the book skills were all there, but putting those to good use and the things that they don't teach you in college that you need to know when you get in the real world, we're missing." – *department head*

"They have extraordinarily poor social skills right now. And I think that can be seen at all levels of the institution. And I'm not just talking about students. I'm talking about staff and coworkers. It's everybody, right? We need to learn how to talk again to others … especially in large groups, because when you're in large groups, you're working off of other people's facial cues of when to stop and went to go. And when cameras are off, you don't have those social cues to work with." – *geoscience faculty*


The New York Times

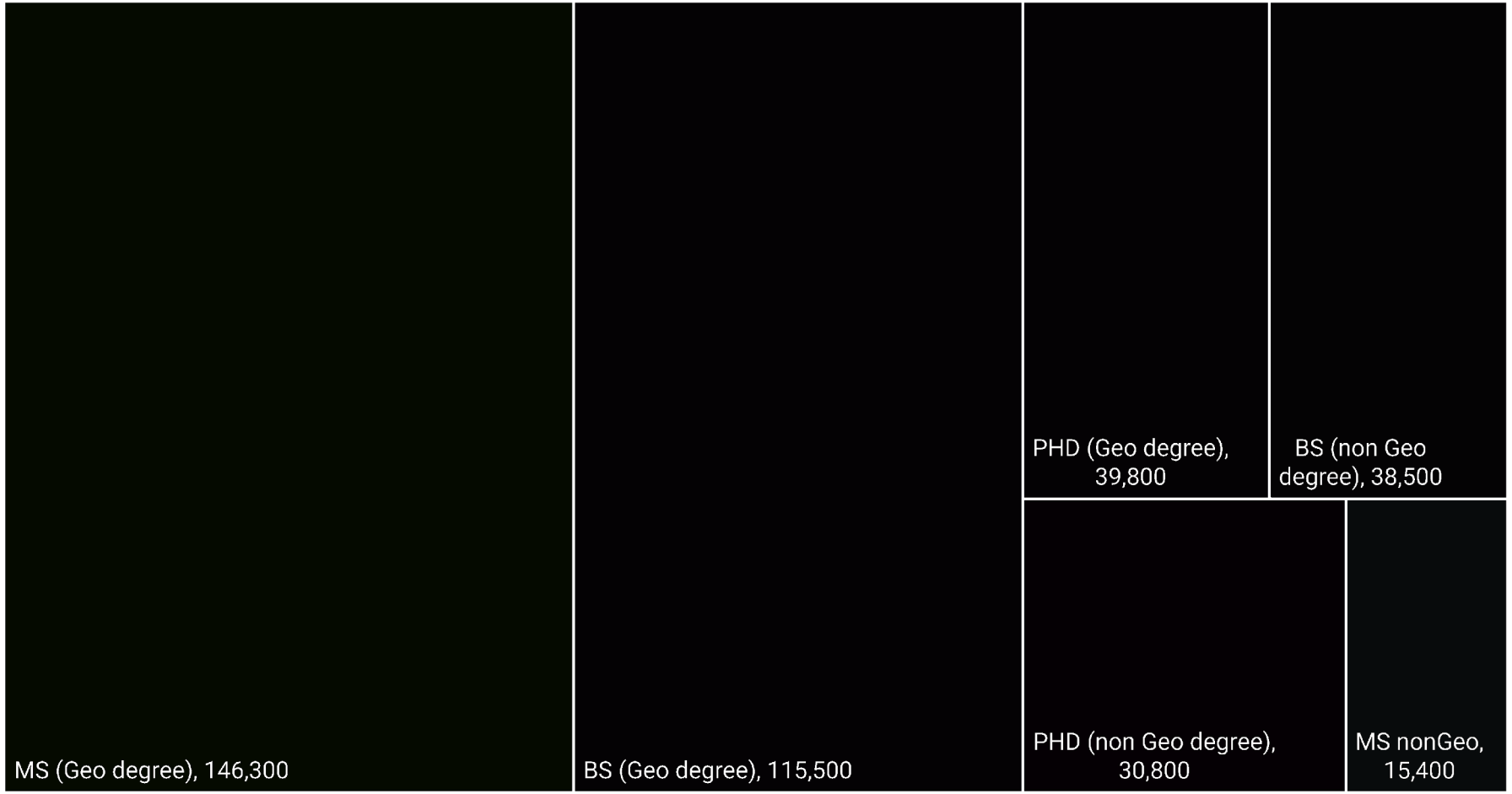
At N.Y.U., Students Were Failing Organic Chemistry. Who Was to Blame?

Maitland Jones Jr., a respected professor, defended his standards. But students started a petition, and the university dismissed him.



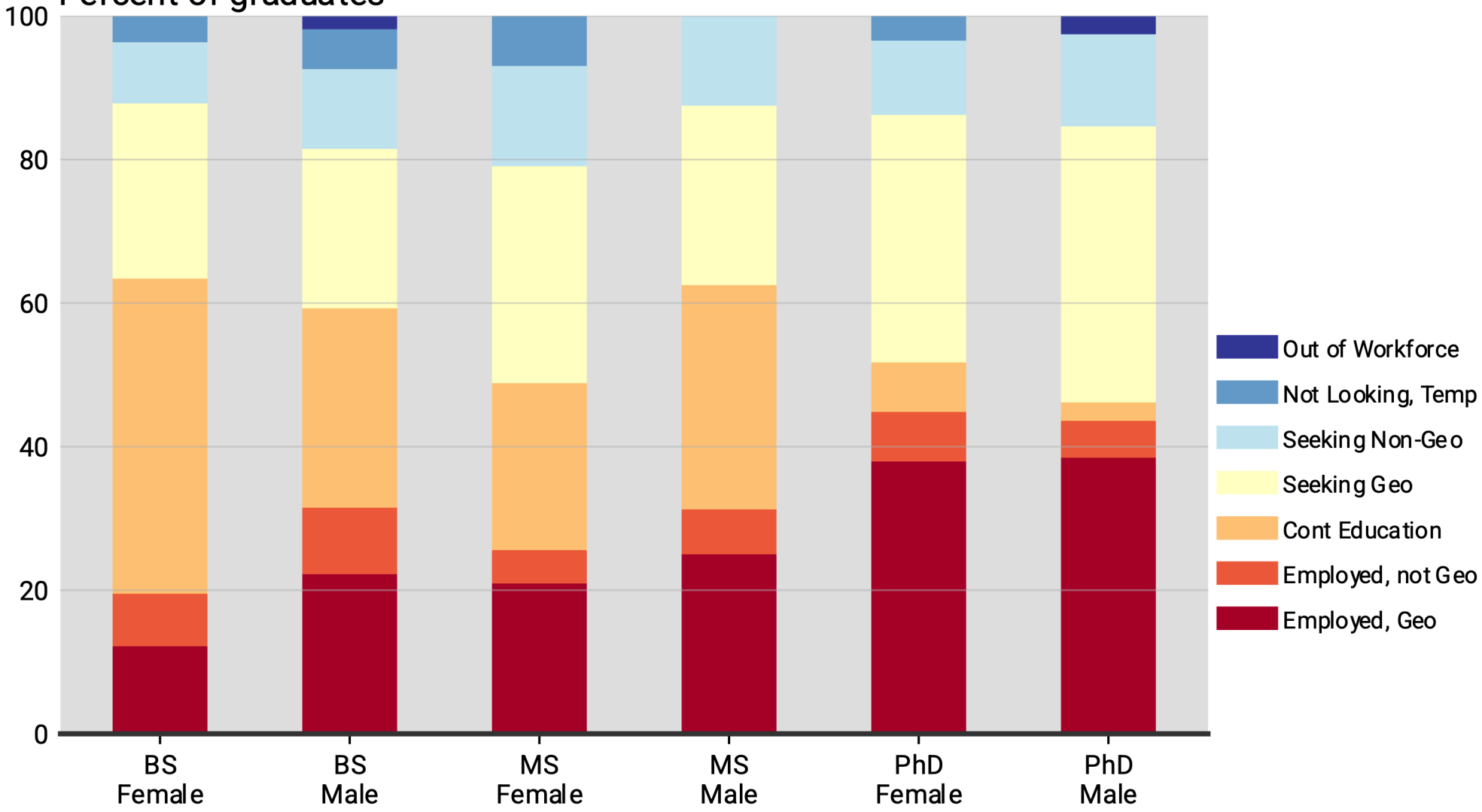
Motivations for Higher Ed Reflect Economics

US Geoscience Employment by Highest Degree Level, 2017



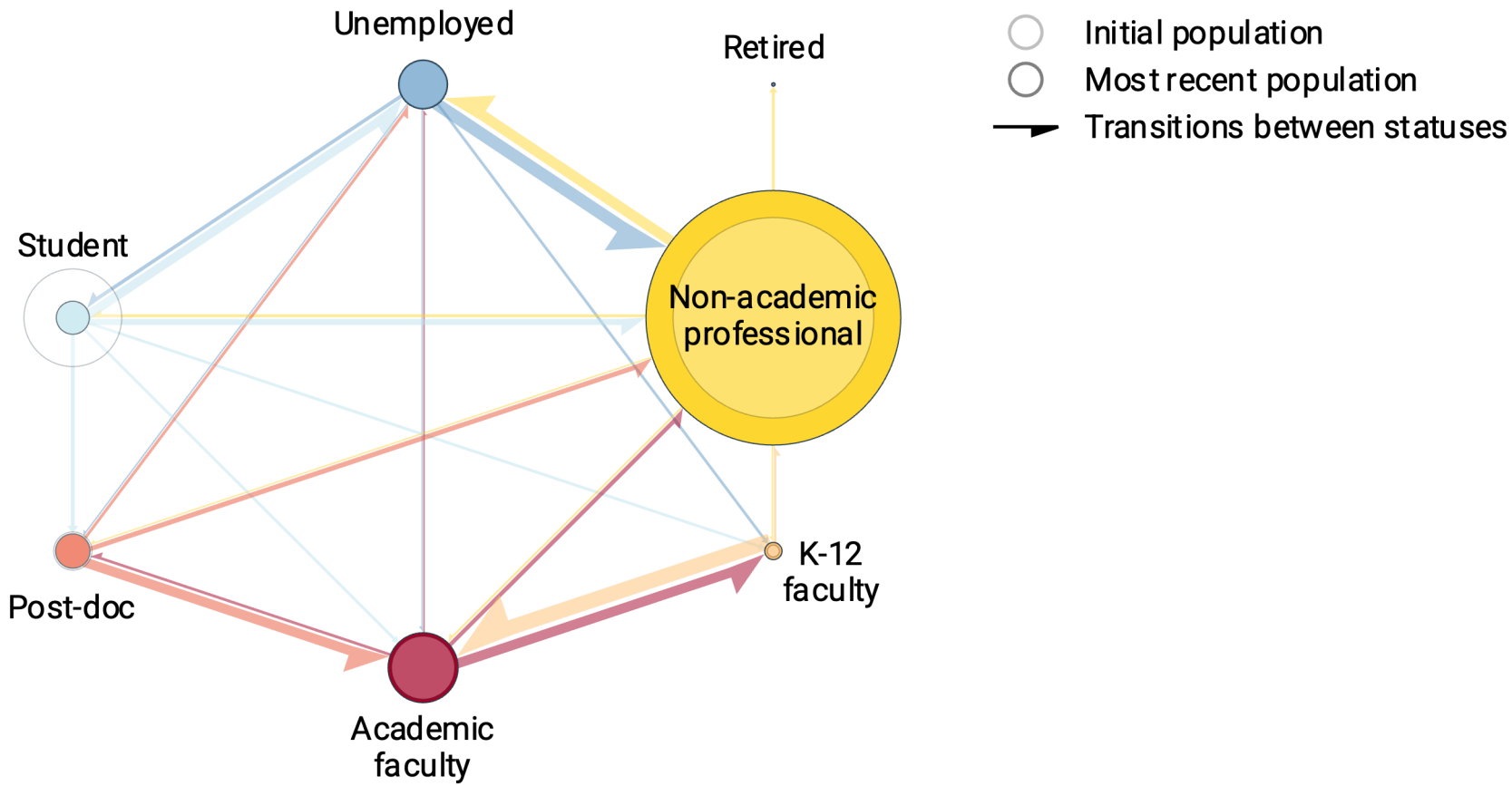
Employment Status at Graduation by Degree Level and Gender, 2020-21

Percent of graduates



Changes in occupational status, Feb 2020 - Mar 2022

Recent geoscience graduates, Classes of 2014-2021

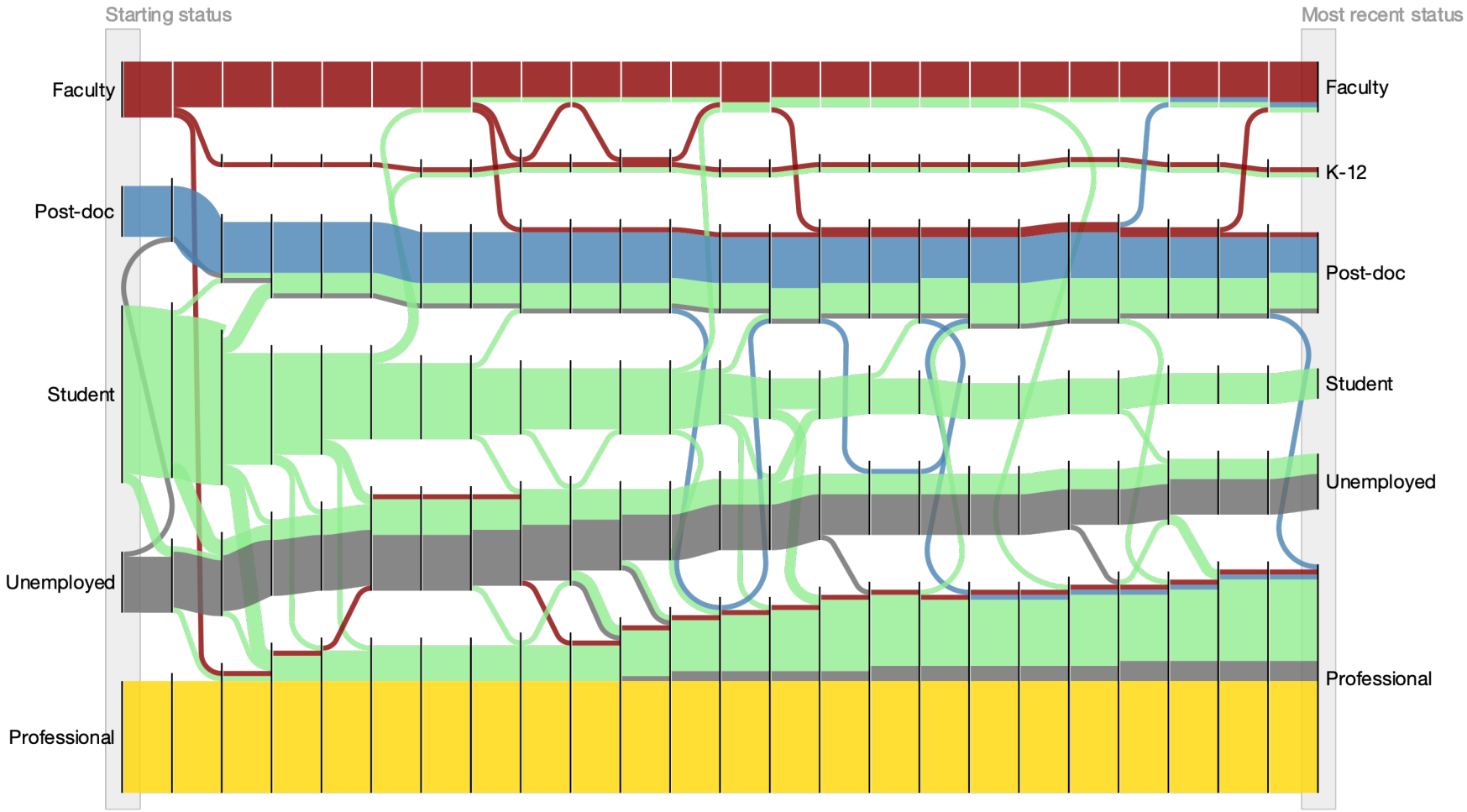


Career trajectories

Growth in post-doc and non-academic professions.

Some increase in unemployed graduates.

Occupational status of graduate degree recipients, classes 2019-2022



An Unforced Fumble in Valuing College



Bad Marketing with Loan Forgiveness

- Loan forgiveness signals higher education is not worthwhile – requiring a federal bailout to “customers”
  - Terrible way to attract first-gen students
- Did nothing to address the cost of attending college
- Coupled with high inflation and interest rates
  - Less cash for tuition
  - Potentially more difficult loan terms in the future
  - Easy loans fueled higher ed inflation

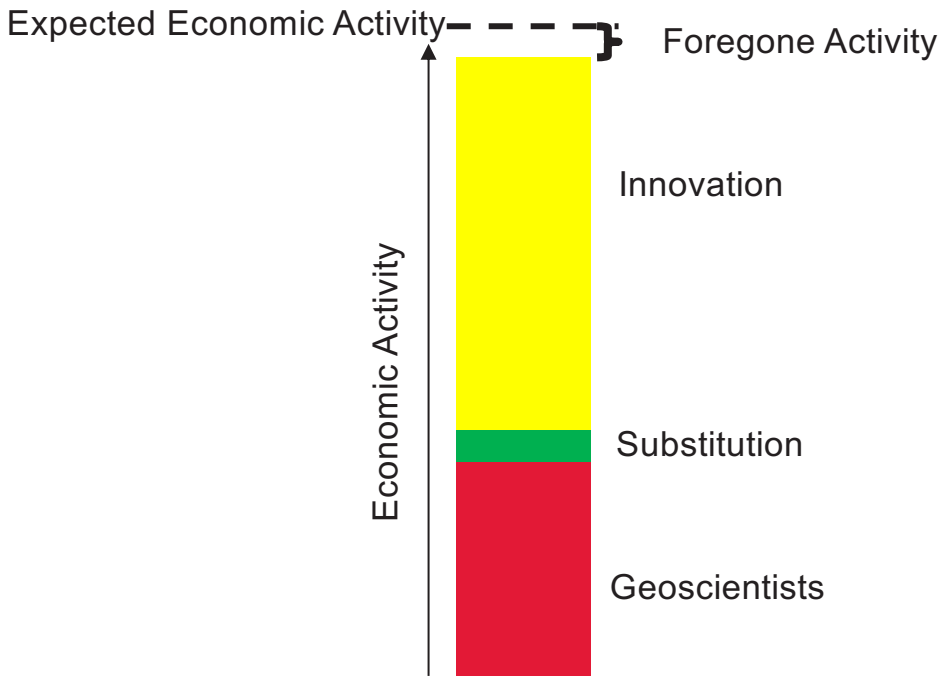
The Nature of Science Work is Changing

Solution Pathways to Strong Enrollment



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Rise of Machine Learning in Geoscience



D = Total Labor Demand (FTE)

X = Economic Activity Per Person

n = Total Workers

X' = New Economic Activity Per Person

If X' = 5X, then n drops substantially, while D remains the same.

Mining Industry and Machine Learning

- Mining companies determined 80-82% of their geoscientists time was in searching, cleaning, and prepping data
- Energy Companies reported 79% in data effort
- GoldCorp collaborated with IBM to develop Watson for Natural Resources

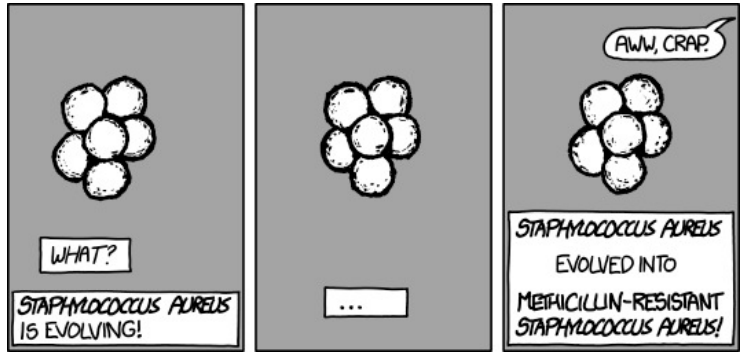


Is Machine Learning Effective in Geoscience?

- Contrived problems had a 35x decrease in solution time using Watson than a senior geoscientist team
- First real-world problem:
  - Senior geoscientist team: 1080 person-hours to solve the problem
    - Nearly all of the time was in data management and processing.
  - Watson for Natural Resources: 14 minutes

Is Machine Learning a Threat?

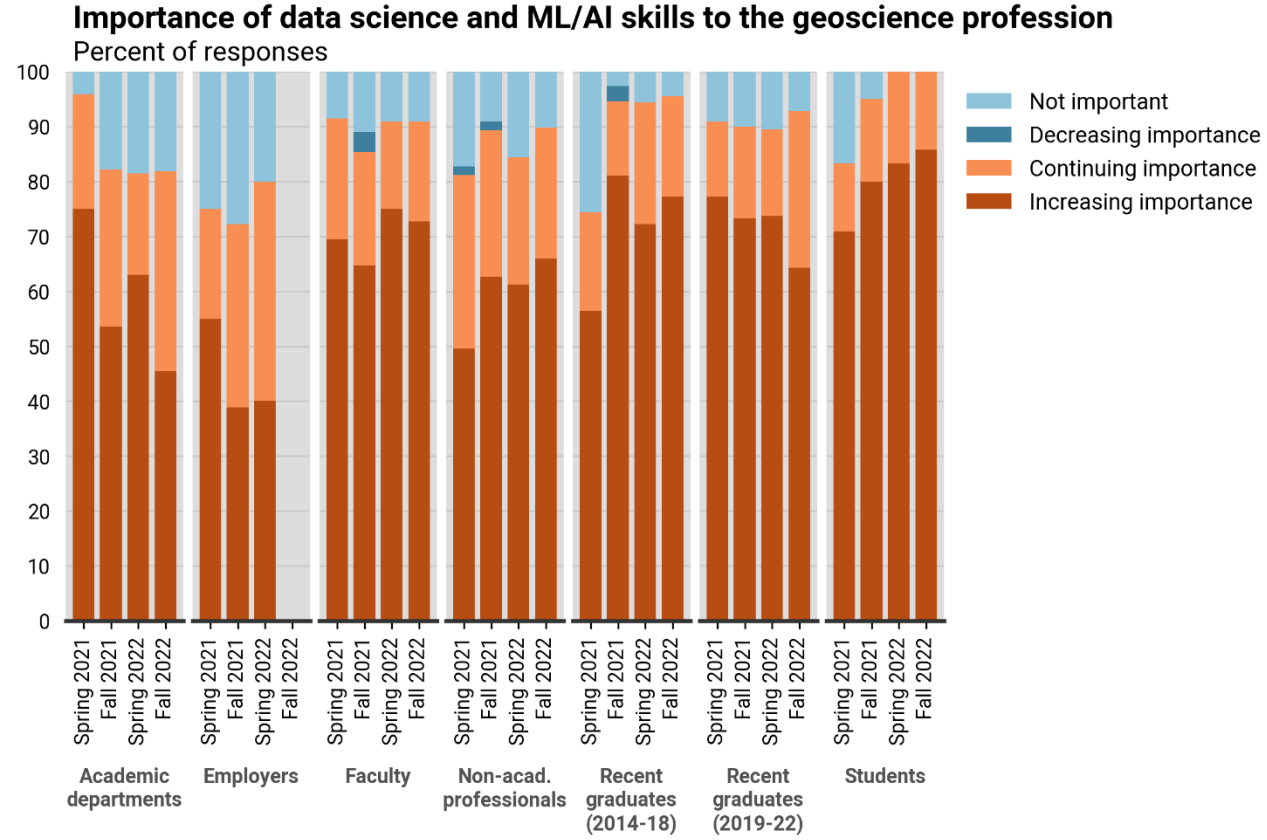
- Only if we do not evolve!

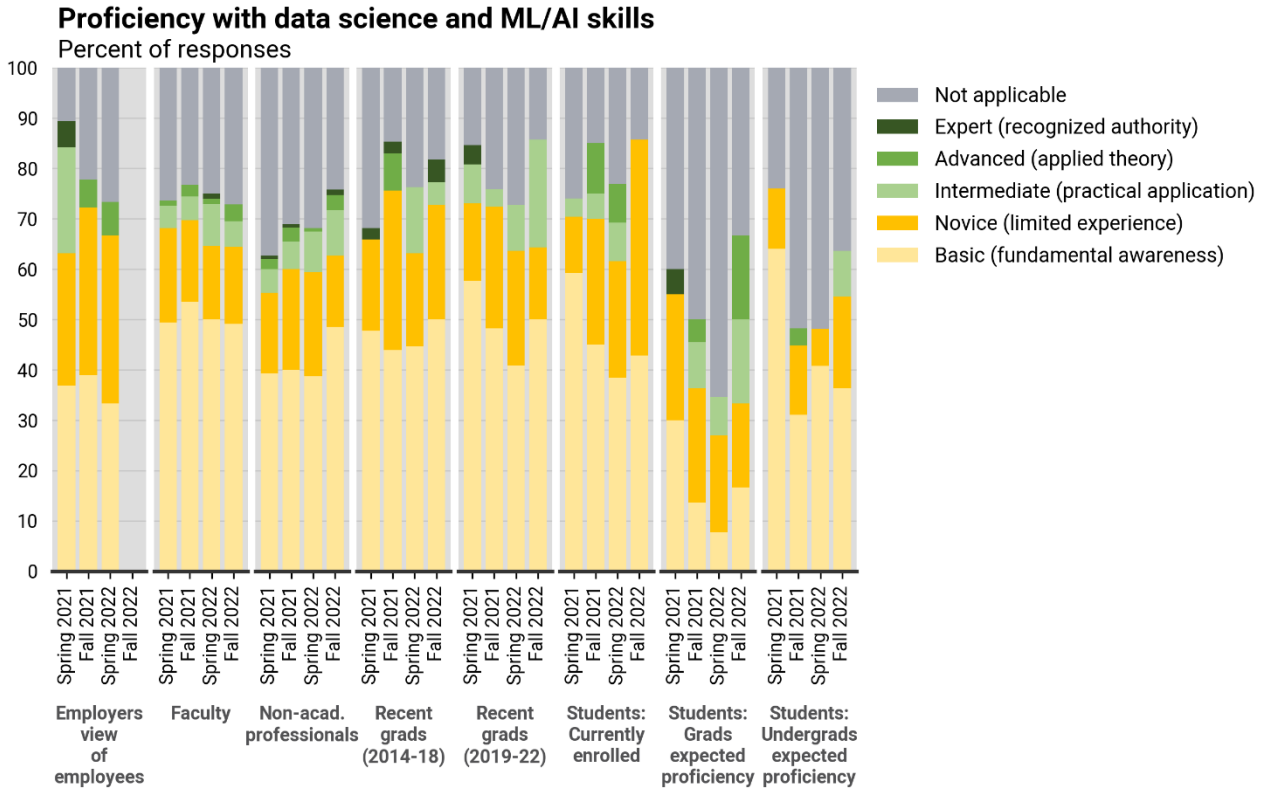


- Traditional occupations are disappearing (loggers, interpreters, etc)
- Move towards the "**augmented geoscientist**" – who focuses on domain problem solving with robust tools at their disposal.

Data science / ML / AI

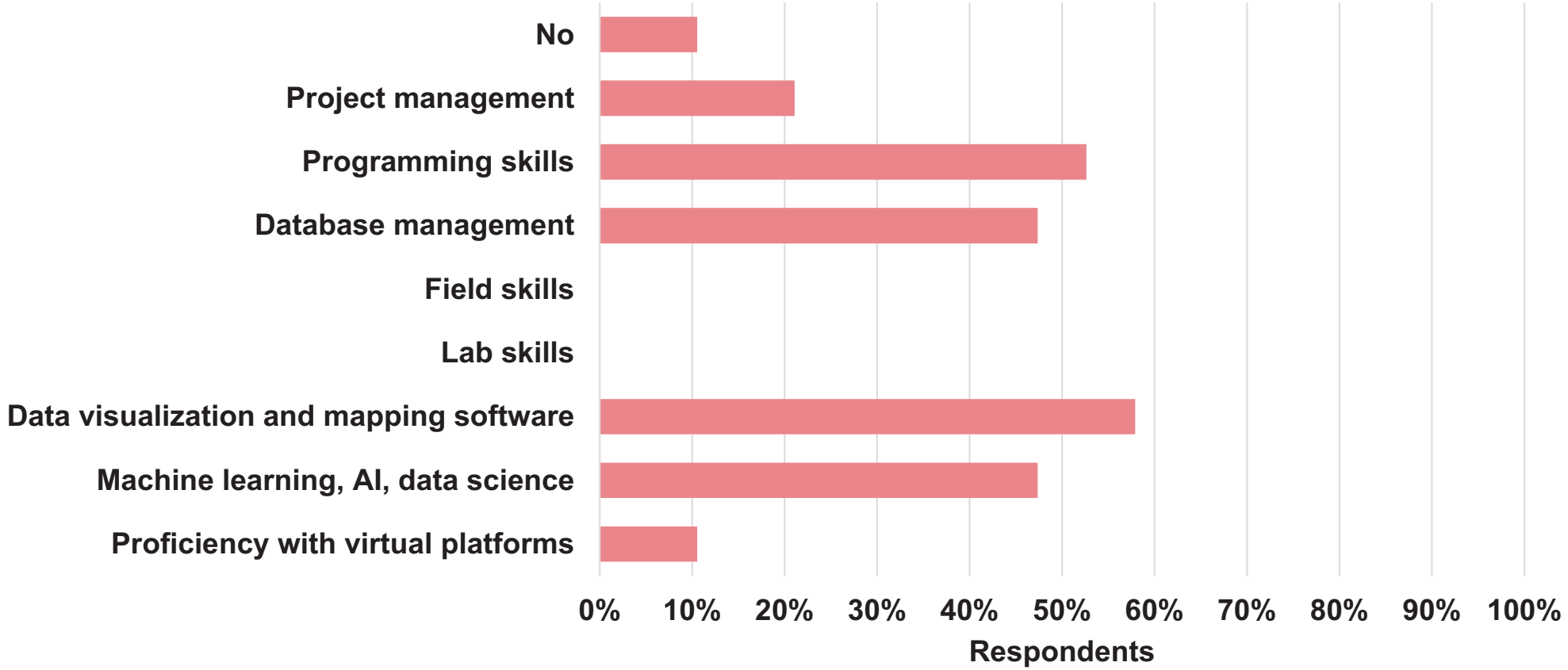
A fast rising skill with emerging proficiency in the community





COVID-Era Graduates Skills Reflection

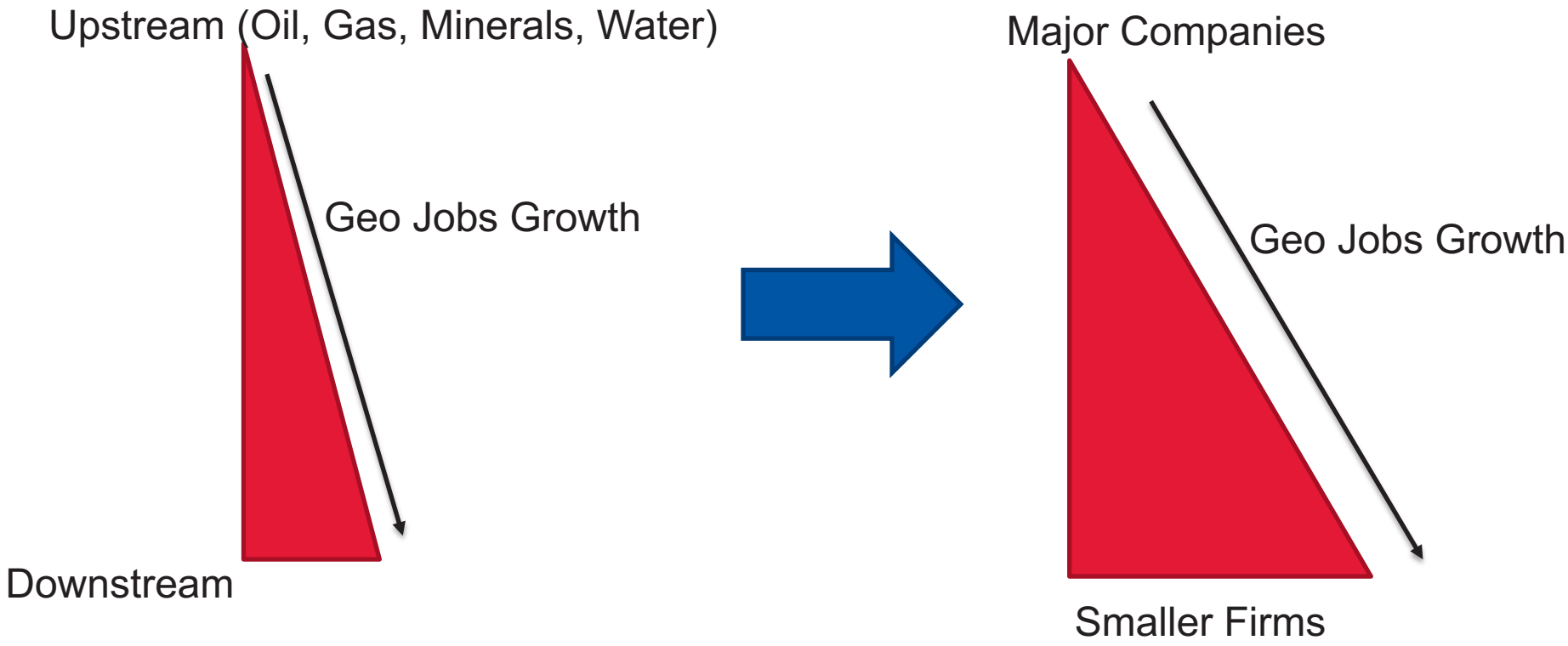
Skills Wished had Gained



What is the “today” skill portfolio?

- Core geoscience understandings
- Core scientific understandings in physics, chemistry, biology
- Ability to work quantitatively
- Licensure keeps ALL doors open
- Think of co-curricular skills or requirements:
  - HAZWOPER certification
  - FAA Drone Pilots License
  - Python/R programming
  - GIS/visualization

Geoscience Goes Gig-lite



Other Apparent Factors

- AI/ML greatly reducing middle-skill geo jobs
  - Seismic/Strat Interpreters
  - Loggers
- Spread of fixed-price contracts
  - Shifting risk to smaller firms
  - Demanding higher skills/agility for increasing margin
- Increase in the singleton geoscientist
- Geosciences need to become solution providers
  - Skillfulness and innovative thinking are winning traits

For more information

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www.americangeosciences.org/workforce