

# IGE: Integrating Data Science into the Applied Mathematics PhD: Generalized Skills for Non-Academic Careers

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## Crossing Domains of Science through Triads

To equip students with versatile skills that bridge traditional AM and contemporary AI, the program cultivates collaboration among academic, industrial, and governmental sectors. Key initiatives include:

- Establishing new pathways for students across various scientific domains.
- Inviting IL and NL scientists to co-develop and teach university courses.
- Recruiting students from diverse STEM domains.
- Organizing workshops promoting knowledge sharing.

The cornerstone of these efforts is the triadic collaboration model, which pairs each student with mentors from the university, industry, and government to enhance their development.

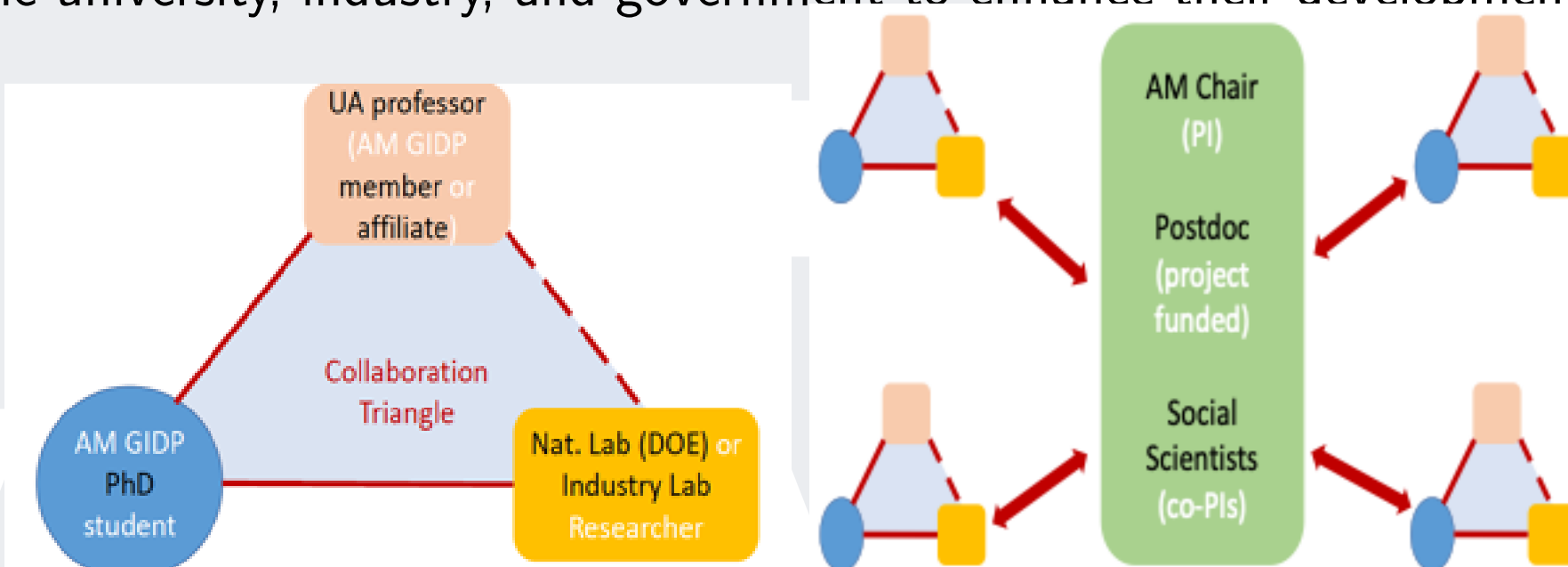


Figure 1: Multiple “triadic collaborations” are monitored interactively by the PI, co-PIs, resulting in new special topic courses, invited lectures, and new topics for joint workshops.

The triadic model aims to serve as a blueprint for integrating AM Ph.D. programs with NLs and ILs, drawing inspiration from successful implementations in other advanced economies.

## Implementation of Mentoring Triads

- Establishing triadic collaborations (see Figure) providing comprehensive mentorship and experience.
- Tailoring triads to student interests and career aspirations.
- Offering flexible arrangements, including part-time employment at partner labs.
- Courses and workshops linked to current industry and lab needs.
- Monitoring the triads' success to inform broader edu practices.

## Recruitment and Retention of Students

- Partnering with IL and NL for recruiting employees interested in AM Ph.D. programs.
- Integrating IGE program information in the AM Ph.D. application process.
- Developing a professional development seminar to introduce undergraduate STEM students to AM and IGE career pathways.
- Revising recruitment and support strategies based on feedback, aiming to improve diversity and inclusion.
- IGE Program Coordinator for outreach and recruitment efforts was hired.

## Workshops for Students Already in the Program

Annual workshops strengthen ties between the AM program and ILs/NLs, utilizing successful formats like the Arizona-Los Alamos Days: <https://appliedmath.arizona.edu/> and the AM Raytheon days <https://appliedmath.arizona.edu/events/raytheon-day-fall-2023-symposium>

## New Student Paths and Opportunities

- The program pilots unique education and research opportunities, starting from admissions and early internships at partner facilities.
- Emphasizes the creation of mentor triads and the inclusion of NL/IL lectures to guide students in choosing their research focus.
- Diverse examples of student paths include:
  - A student with experience at a national lab now blending fluid mechanics with data mathematics at UA.
  - A retired naval officer and industry professional focusing on applied mathematical aspects of control systems in Ph.D. studies.
  - A student who explored machine learning methods for fluid dynamics through internships and is now employed in the industry.
  - Collaborations with a staff member at a national security site co-supervising a Ph.D. thesis on geophysical data analysis.
  - An intern focusing on advancing medical innovation and regulatory science at a non-profit, leading to full-time employment after graduation.
- The program is well-suited for cultivating new triadic interactions, with a significant portion of the projects related to national security and open to U.S. citizens or eligible international students.

## New Forms of Interaction and Collaboration

- Development of a triadic co-advising model involving a PhD student, a UA Professor, and a co-advisor from a national or industrial lab (NL/IL) to enhance early research engagement and career success.
- Junior-level scientists and postdocs play a critical role in guiding students across disciplinary divides, identifying educational and research opportunities.
- Strong collaborations with major national labs and industry partners are leveraged, aiming to cultivate new partnerships and innovative educational approaches.
- Each partner offers unique contributions to student development, from cutting-edge data science to the balance of classified work and open research.
- Collaborations range from co-developing student curricula to providing internships and practical research experience aligned with national security missions.
- The program aims to maintain a pipeline of PhD researchers skilled in modern applied mathematics (AM) and to foster cross-fertilization of educational ideas.

## New Courses Taught by Young IL/NL Researchers

- A survey of AM graduates and their advisors has highlighted gaps in AM education, particularly in data science and AI.
- New specialized courses are being developed in response, including topics like “Data Driven Computational Physics” and “Science Informed AI”.
- Young researchers from NLs and ILs are engaged in course creation, bringing fresh perspectives to traditional curricula.
- Partnerships with labs support the initiative through expert visits, co-teaching arrangements, and joint workshops.

## Project Timeline:

	Spr'24	Sum '24	Fall'24	Spr '25	Sum '25	Fall'25	Spr '26	Sum '26	Fall'26
#1 New Forms of Interaction and Collaboration	<ul style="list-style-type: none"> <li>Triad co-advising model = an interested new PhD student, a UArizona Professor, and a NL or IL co-advisor</li> <li>An assistant research scientist and young NL/Industry researchers will coordinate multiple triads</li> <li>The general model is calibrated via partnership with 4 National and 2 Industrial laboratories</li> </ul>								
#2 New Student Paths and Opportunities	4 active triads with our industrial and national lab partners			8 active triads with our industrial and national lab partners			12 active triads with our industrial and national lab partners, including 2 with new partners		
#3 New Courses Taught by young IL/NL Researchers	New AM course with a national laboratory partner		New AM course with an industrial partner	New AM course with a national laboratory partner		New AM course with an industrial partner	New AM course with a national laboratory partner		New AM course with an industrial partner
#4 Recruitment & Retention (Section IV)	<ul style="list-style-type: none"> <li>Through IL &amp; NL partners (Section IV A)</li> <li>Through undergraduate STEM programs (Section IV B)</li> <li>Regular fall visits (colloquia + student run “brown bag” seminars) by our industrial partners</li> <li>Continuous recruitment campaign at facilities of our NL &amp; IL partners. Many triads will start with internships</li> </ul>								
#5 Workshops (Section V)	<ul style="list-style-type: none"> <li>Los-Alamos Arizona days (annual events with 25 years of history, alternating between Tucson and Los Alamos) in May</li> <li>Testing Los-Alamos Arizona days model on other National and Industrial partners, rotating locations – one event a year</li> <li>Inviting to the workshop observers from other Applied Math PhD program across the Nation</li> </ul>								

## Please Spread the Word

