REU-CAAR: Research Experience for Undergraduates in Combinatorics and AI for Applied Research

William Gasarch-Director
John Dickerson-Co Director
Many Mentors!
Many Students!
Time and Money

1. June 5- August 11 (10 weeks)  
   (If on campus then arrive on June 5)
2. $6000 stipend
3. Housing and some Meal Money
4. Excellent student-to-teacher ratio.
5. For more info
   https://www.cs.umd.edu/projects/reucaar/
Activities

1. Research

2. Learning more discrete math and algorithms.

3. Research

4. Lunches

5. Research

6. Sight Seeing in Washington DC (weekend)

7. Research

8. Presentation on How to do Ethics of Research

9. Research

10. Making friends for life! (now possibly with Facebook). (When I first ran the program in 2013 this was novel!)
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1. At the website is a tab to click for descriptions of the Projects.
2. When you apply you will write a statement. That statement should list which projects you are happy to work on, and for each one (a) why you are interested, and (b) why you are qualified. Advice: Keep it SHORT and pick 3 or 4 projects.
3. Next slides describe THE PROJECTS!
4. The projects range from THEORY to PRACTICAL WITH A THEORY BEND.
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Classical and Quantum Error Correction

**Mentors** Victor Albert and Phillipe Faist
Classical and Quantum Error Correction

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Prereq  Linear Algebra, Quantum Mechanics, Quantum Computing, Quantum Error Correction (two of the three Quantum Prereqs will suffice)
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**Description**
Classic communication uses error correction so that even if a message flips some bits, the original message can be recovered. There are many ways schemes for this.
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Much more recently there is Quantum Communication which also needs error correction.
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Much more recently there is Quantum Communication which also needs error correction.

The project will study both classical and quantum error correction and help build the ErrorCorrectionZoo, a website of classical and quantum error correction schemes.
Improving Machine Translation for Wikipedia

**Mentors** Marine Carpuat and Eleftheria Briakou.
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**Prereq** Python, Pytorch, Some Deep Learning.

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There are cases where **Human** translators do better than **Machine Translators**. What to do?
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**Description**
There are cases where **Human** translators do better than **Machine Translators**. What to do?

We will use Wikipedia pages as a test bed for understanding and evaluating the use of popular Machine Translation Services (e.g., Google Translate, Meta AI) in a real world translation context. We will use what we learn to have Machine Translators that detect and correct errors.
Parallel Algorithms for High-Dimensional Clustering

**Mentors** Laxman Dhulipala
Parallel Algorithms for High-Dimensional Clustering

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**Prereq** Algorithms, Systems Programming, C and C++ (no knowledge of parallelism required)
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**Description**

*Clustering* is taking a dataset and grouping together objects that are similar. This is useful in Machine Learning. Current algorithms can be slow. How to speed them up?
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Parallelism!

We will design and implement Parallel algorithms for this problem. We will then apply them to known benchmarks and see how they do.
I want ANOTHER Solution!

Mentor William Gasarch
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Prereq P and NP and Reductions.
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**Description**
The following problem is thought to be hard (formally NP-complete):
Given a Boolean Formula $\phi(x_1, \ldots, x_n)$ does there exist an assignment of TRUE and FALSE that make it TRUE? (called a **satisfying assignment**). We will study many variants of this:
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Find a partial assignment such that there is only one way to extend it to a satisfying assignment.
Given $\phi$ and a satisfying assignment, find if there is another. We will study these problems and the analogs for other NP-complete problems.
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Fair Decision Making

**Mentor** Furong Huang
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**Prereq** ML, Fairness, Probability, Linear Algebra, Calculus, Reinforcement learning a plus but not required.
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**Description**
Machine Learning is being used in healthcare, finance, hiring, and education. The hope was that this would eliminate bias, but unfortunately it often reinforces it.
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Computational Hilbert Geometry

Mentor  David Mount and Auguste Gezalyan
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**Prereq** Discrete Math, Algorithms, Programming Skills (no knowledge of computational geometry or Hilbert geometry needed)
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**Description** The distance you are used to working with is the **Euclidean Distance**. But there are other distances one can use. These other distances may be useful in Genetics, Probability, Physics, and other fields.
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Description  The distance you are used to working with is the Euclidean Distance. But there are other distances one can use. These other distances may be useful in Genetics, Probability, Physics, and other fields.

We will explore what happens to Computational Geometry problems when you use a different distance. You will learn Comp Geom and combine Comb Geom with programming.
Using Markov Decision Processes to Mitigate Climate Risk

Mentor Aviva Prins
Using Markov Decision Processes to Mitigate Climate Risk

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**Prereq** Discrete Math, Probability, Algorithms, ML, Numerical Analysis, Mechanism Design, Reinforcement Learning, Fairness. (Thats a long list so its okay if you don’t know all of them.)
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**Mentor** Aviva Prins

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In India the farmers are vulnerable to climate risk. Giving them crop advice is crucial.
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In India the farmers are vulnerable to climate risk. Giving them crop advice is crucial.

This project will develop tools to actually help them plan. It is in conjunction with a non-profit organization.
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Activities

1. First week - BEGIN your projects PRONTO!
2. First week - Talks from all the mentors on all the projects.
3. Every Monday - REU lunch. Discussion topics:
   - Grad School
   - Work on Math problems together!
   - Professional Talks
4. Every Wednesday - REU talks
   - From mentors on topics of interest
   - From others that happen to be in around
5. Every weekday - Work on Project.
6. Field Trip to Washington DC.
7. There will be presentations of the projects.
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2. Knowing how to program.
3. See website for prerequisites for some projects.
4. US Citizenship for NSF funding. But see next point.
5. We have some (not alot!) money for non-citizens.
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How to apply: Goto the website!
Will need:

1. Transcript (including Fall 2022)
2. Statement of Purpose (say which 3 or 4 projects you want to work on, WHY you are interested and WHY you are qualified)
3. Letters of recommendation. (Your letter writers will submit those)
4. Other stuff that is on form
Logistics

1. YOU apply by March 7. Apply EARLIER as we will begin accepting students earlier.
2. WE accept or reject you. Final decisions made by the Middle of April (or sooner).
3. If we reject you then...
   Oh well. (Apply to several programs.)
4. If we accept then you can
   ▶ Reject us! This is perfectly fine.
   ▶ Accept us! And come!
   ▶ Accept and then NOT come. DO NOT DO THIS!
   If you ACCEPT then we look forward to seeing you in June!
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Advice for ANY REU-app, Grad School App

1. Apply Early.
2. Get your personal statement done ASAP.
3. Personal Statement should elaborate on what you want to work on, why you are qualified, and why you’re interested.
4. Apply to many places (REU programs—Google NSF REU to find more programs).
REU-CAAR was a fantastic program. I had a great experience with my group and my mentor, and I learned a ton across many different areas from working on our project even in a few short weeks. Even though we were remote this year, Prof. Gasarch and my mentor were incredibly accessible throughout which made the program go so much more smoothly. In addition, we were still able to get to know everybody in weekly activities and game nights (done virtually because of COVID). I would absolutely recommend REU-CAAR to anyone interested in computer science research!
This REU experience was greatly beneficial in expanding my knowledge and experience with machine learning. Dr. Gasarch, the mentors, my team, and the professors were all very supportive and encouraging, and I learned so much from them over the course of the program. The program was a perfect way to explore different research aspects and allow me to get a better idea of how research is conducted. I am very thankful for this experience.
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Though auction design as a topic was not familiar to me before, I learned it by reading several papers. Our program includes both mathematical and computer science components. That is nice as I am interested in both, and our group members divided the work so we all worked on stuff we cared about.
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Aside from the research, the lunches and talks were interesting. Thanks to Professor Gasarch, his helper Auguste, and all the mentors. I would recommend it to anyone interested in computer science or mathematics.
Another REU Program at Univ of MD

REU-BRIDGE

1. Most of what I said about REU-CAAR also apply to REU-BRIDGE.
2. REU-BRIDGE website is: https://www.cbcb.umd.edu/summer-internships
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Summary

If you want to

1. Get a research experience
2. Bond with fellow students
3. Get a taste of graduate school
4. Have a great time!

then **APPLY** for REU-CAAR!