REU-CAAR: You’re Here!
Credit where Credit is Due

Origin of this talk


Bill G modified this boring handbook into a fascinating ∼380-slide talk!

Auguste: Why are you telling them all that?
Bill: In academia it's very important to credit past work!
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Purpose of This Talk

1. Who are the mentors?
2. What are the projects?
3. What is expected of you?
4. What should you expect of us?
5. Nuts and bolts of how the program works.
6. Advice on how to get the most out of this summer!
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**REU:** Research Experience for Undergradutes.
**CAAR:** Combinatorics, Algorithms, and AI for Real Problems.

Discuss
Find a topic within CS that this title
does not cover?
Systems, HCI, Software Engineering, anything else?
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REU-CAAR: TEAM!
Projects and Mentors: Algorithms Projects

Parallel Algorithms for Nearest Neighbor Search
Mentored by Laxman and Tobias.
Laxman: mentored for us in 2023

2023:
Parallel Algorithms for High Dimensional Clustering
He seems to like Parallelism.

Tobias: first-timer, but has helped out REU-BRIDGE.

Exploring the Hilbert Geometry
Auguste and Dave.

2022:
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Only project that is Applying Theory to Practice
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BILL: I did one on Ramsey Theory. Auguste did Comp Geom. We have a few quantum.

AVIVA: I want to use Math to help farmers in India.

BILL: So you want to help people?

AVIVA: Yes!

BILL: What's that like? I mean, what is wanting to help people like?
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Projects and Mentors: Quantum Projects

Classical and Quantum Error Correction
Mentored by Victor and Nat.

2023: Classical and Quantum Error Correction
He must be error-prone to need that much correction.
Nat is a first-timer.

Quantum Graph Games
Mentored by Seyed and Jon
Seyed: first-timer but mentored a HS students on QC!
Jon is a first-timer.
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Andrew: mentored for us before
Projects and Mentors: Quantum Projects (cont)

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Computing Error Bounds for Quantum Simulation Algorithms
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2022: Verification of Quantum Simulation
2021: Fast Routing Using Teleportation Primitives
Computing Error Bounds for Quantum Simulation Algorithms
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2022: Verification of Quantum Simulation
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Projects and Mentors: Quantum Projects (cont)

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2022: Verification of Quantum Simulation
2021: Fast Routing Using Teleportation Primitives
2020: Sorting by Reversals
2019: QC: Practical Synthesis of Q Signal Processing Circuits
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2017: Quantum Computing
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Five times mentoring is a lot!
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**Bill Out Loud** That’s a great idea!
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**Bill Out Loud** Thats a great idea!

**Point:** The set of Quantum Projects is a wave function.
Admin

- **REU-CAAR Director:** William Gasarch.

- **Housing:** Allison Panila

- **Your Salary:** Jodie Grey

- **Lots of Stuff:** Sharron McElroy

- **Arrange REU Lunches:** Sharron McElroy

- **Lots of other Stuff:** Auguste Gezalyan

- **Airport, Amtrak Pickups:** Clyde, Darling, Auguste, Emily

- **Help with Final Presentations:** Clyde
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- **Help with Final Presentations:** Clyde.
REU-CAAR: Very Brief History
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- Applied Algorithmic Graph Theory
- Algorithmic Game Theory
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AI-NLP
AI-Image Processings

The AI projects all had a mathematical component.

We changed the name to:

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2. Bill has been the PI (Principle Investigator) 2013-2024.

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Other REU Programs We Will Interact With

1. Mihai Pop is running REU-BRIDGE: Bioinformatics Research in Data science for Economics for 2022-23-24. Housing lists this as BIRD. B is for biocomp. This REU program is at Univ of MD at College Park.

2. Wojciech Czaja is running REU-MATH: Modern Topics in Applied and Pure Mathematics for 2023-24-25. Housing lists this as PAM-Pure and Applied Math. This REU program is at Univ of MD at College Park.


4. We will share some activities with these REU programs.
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   - This REU program is at Salisbury University.

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1. Darren Cambridge and Hal Duame are running TRAILS

This is the program's first year. This program only has 5 people. They will join most of our lunches.

2. Bill Gasarch is running a Ramsey Gang. Every Tuesday June 17-July 30 Bill will be meeting with ∼12 students: mostly HS, some ugrads, and an obnoxious third grader. He (Bill, not the third grader) will talk about Ramsey Theory and toss out mini-projects. They will meet in our room, IRB 2207. You are free to join us.
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Program Goals and Expectations
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1. **Research!** What is Research? Discuss!

   - Work on problems where the answers are not already known.
   - Expose you to a variety of career paths: Grad School, Industry, Government, Writer for the Simpsons, Hobo, Other.
   - Build skills: Team Work, Communication, Project Management.
   - Build a network with faculty and students. Useful for the future!
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1. This program should not be seen as a job where you put in your 8 hours a day and then you’re free to to what you want.
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3. So you should want to keep working on your projects, perhaps on a lower level, after you go back to the dorms.
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4. Talk to each other in the dorms about your projects!
What the Program Expects of You: Restart

1. **Show up every weekday.**
What the Program Expects of You: Restart

1. **Show** up every weekday. On time AND sober.
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2. **P**articipate in assessments such as surveys.
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2. **P**articipate in assessments such as surveys.
3. **A**ctively contribute to your research project and your team.
4. **C**heck e-mail. Reminders, notices, requests will be emailed.

(I hyphenated email? Why? The original handbook did this and I wanted you to see an interesting piece of history. X-ray and T-shirt kept the hyphen but email did not. Why?)

5. **E**nthusiasm!
6. **A**ttend lunches, talks, and other activities.
7. **G**ive talks: Last week you will give a talk about your project. (Joint with REU-BRIDGE, REU-MATH, TRAILS.)
8. **E**njoy yourselves!

First letters spell **S**PACE **A**GE. Better for an astronomy REU.
What the Program Expects of You: Restart

1. Show up every weekday. On time AND sober. 10AM-4PM. You should want to work longer, but prob back in the dorms.
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4. Check e-mail. Reminders, notices, requests will be emailed.
5. Enthusiasm!
6. Attend lunches, talks, and other activities.
7. Give talks: Last week you will give a talk about your project. (Joint with REU-BRIDGE, REU-MATH, TRAILS.)
8. Enjoy yourselves!

First letters spell SPACE AGE. Better for an astronomy REU.
What the Program Expects of You: Restart

1. **S**how up every weekday. On time AND sober. 10AM-4PM. You should want to work longer, but prob back in the dorms.

2. **P**articipate in assessments such as surveys.

3. **A**ctively contribute to your research project and your team.

4. **C**heck e-mail. Reminders, notices, requests will be emailed. (I hyphenated email? Why? The original handbook did this and I wanted you to see an interesting piece of history. X-ray and T-shirt kept the hyphen but email did not. Why?)

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1. **Show** up every weekday. On time AND sober. 10AM-4PM. You should want to work longer, but prob back in the dorms.

2. **Participate** in assessments such as surveys.

3. **Actively** contribute to your research project and your team.

4. **Check** e-mail. Reminders, notices, requests will be emailed. (I hyphenated *email*? Why? The original handbook did this and I wanted you to see an interesting piece of history. X-ray and T-shirt kept the hyphen but email did not. Why?)

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Your Mentor’s Role

1. **Role modeling**: Their experiences offer clues for your own professional success story.
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2. **Communication:** Explain the project, answer questions, listen to your concerns and ideas, etc.
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1. **Role modeling:** Their experiences offer clues for your own professional success story.

2. **Communication:** Explain the project, answer questions, listen to your concerns and ideas, etc.

3. **Background:** Explain *why* the research is important! How it fits into other things!

4. **Connection:** Help connect you to their colleagues, graduate assistants, others.
What Faculty Mentors Expect from You

1. **Communication:**
   - Be clear in verbal & written comm.
   - Seek clarification, ask questions, provide suggestions.

2. **Assertiveness:**
   - Think for yourself and support your own ideas.

3. **Maturity:**
   - Be reliable for what your mentor asks you to do.

4. **Enthusiasm:**
   - Be interested in the project, field, and topic.

5. **Responsible:**
   - Tell your team changes that affect your participation.

6. **Adaptability:**
   - Be flexible and open-minded.

First letters spell out **CAMERA**.

Better for a Vision REU.

Credit Auguste thought of making the first letters spell words.
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Issues that Probably Won’t Arise But Need to be Discussed
Sexual Harassment and Discrimination

1. If you feel uncomfortable, seek advice and guidance from others. Bill, Auguste, or Aviva can offer assistance and direct you to campus resources for help. Note that in the United States there is Mandatory Reporting: if a mentor or director hears about a case of sexual harassment, they must report it.

2. While this slide is about Sexual Harassment and Discrimination, feel free to talk to Bill, Auguste, or Aviva about any issue, even if it is uncomfortable.
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2. While this slide is about Sexual Harassment and Discrimination, feel free to talk to Bill, Auguste, or Aviva about any issue, even if it is uncomfortable.
Good News That You Know:
1. You get a stipend.
2. You get free room and some meal money.

If you do not do your part, you could be asked to leave, which will mean you get less of your stipend. This is RARE! (once in 2014 and once in 2016).

What is 'your part':
SPACE AGE and CAMERA
My Least Favorite Topic

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My Least Favorite Topic

Good News That You Know:

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You could be asked to leave, which will mean you get less of your stipend. This is RARE! (once in 2014 and once in 2016).

What is ‘your part’:
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What is ‘your part’:
SPACE AGE and CAMERA
Complain SOONER Rather than Later

Better to get a problem resolved EARLY, whatever they are.
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Key to a good relationship:
Complain SOONER Rather than Later

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Key to a good relationship:

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its finding whose to Blame :-)

Most Common Complaints

1. Most common complaint from students: My Advisor is Ghosting Me

2. Most common complaint from mentors: My Students are Ghosting Me

Upshot: Communication!
Most Common Complaints

1. Most common complaint from students:

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Upshot

Communication!
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1. Most common complaint from students: **My Advisor is Ghosting Me**
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1. Most common complaint from students:
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**Upshot** Communication!
Schedule and Activities
First Week++ Talks

You should all know about each others projects:
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For all projects $p$
First Week++ Talks

You should all know about each others projects:

For all projects $p$

there exists a mentor $m$ for project $p$ and a day $d$ such that
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You should all know about each others projects:

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there exists a mentor $m$ for project $p$ and a day $d$ such that

mentor $m$ gives a talk on project $p$ on day $d$. 
First Week++ Talks

You should all know about each others projects:

For all projects $p$
there exists a mentor $m$ for project $p$ and a day $d$ such that
mentor $m$ gives a talk on project $p$ on day $d$.

In symbols

$$(\forall p)(\exists m, d)[\text{MENTOR}(p, m) \land \text{TALK}(p, m, d)].$$
First Week - Lunch

1. Monday 12:00-1:30 lunch in IRB.
2. This lunch you will play telepictionary!
3. Tu, We, Th, Fr - Lunch in the union or IRB from your meal card.
4. Bill will join you for lunch some of the first week.
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First Week

1. Red Tape stuff (hopefully ends Tues).
2. Every day of the first week, at 4:00, a talk by a mentor on their project.
3. Research—Every day.
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Most Weeks

1. Get here by 10:00AM go to your projects room.
2. Research 10:00-12:00 (approx)
3. Lunch 12:00-1:30 (approx). MONDAY lunch IRB
4. Research 1:30-4:00.
5. Talks on Wednesday afternoons at 4:00.
6. Every other Friday you get your paycheck! Don't blow it all on supercomputer time!
7. At night talk about Applying Quantum error correction, ML, and Geometry to Crop Decisions
8. Weekends— Explore Washington DC! or College Park! (Check the metro website—lots of trains are not running at times.)
9. Some of these items may change (e.g., lunches, talks may be a diff day).
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Explore Washington DC On Your Own AND

1. Those of you that are locals please help the out-of-towners.
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U. of Del ugrad Joe Biden did his honors thesis on Parallel Algorithms for Nearest Neighbor Search
There is a Metro Stop in College Park.
College Park Metro Station

There is a Metro Stop in College Park.

**Check**: There are websites that have metro information- check them before any excursion.
Other Things We Will Do

1. Discussion of Ethics of Research.
2. Discussion of graduate school (with other programs).
3. Game Nights with Pizza!
4. Final presentation the last week (with other programs).
5. Unexpected things will happen! Always expect the unexpected! (Is that a paradox? A project for Summer 2025 REU.)
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4. **Final presentation** the last week (with other programs).
5. **Unexpected things** will happen! Always expect the unexpected!
   (Is that a paradox? A project for Summer 2025 REU.)
Summary of Projects and People
Parallelism for Nearest Neighbor Search

Elevator Pitch

Design a Data structure for a large set of points in $A \subseteq \mathbb{R}^n$ such that the following query can be answered quickly:

Given a point $p \in \mathbb{R}^n$ find the point in $A$ that is closest to $p$.

Main concern is usually that we want the DS to use a small amount of space.

We change the problem in two ways at the same time:

1. We will settle for Approximate NN
2. The algorithm to find the NN is parallel.

Mentors

Laxman and Tobias

Students

Arushi, Atharva, Dinesh, Pranav.
Elevator Pitch

Parallelism for Nearest Neighbor Search

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Mentors: Laxman and Tobias

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**Given a point** $p \in \mathbb{R}^n$ **find the point in** $A$ **that is closest to** $p$. Main concern is usually that we want the DS to use a small amount of space.
Parallelism for Nearest Neighbor Search

**Elevator Pitch NN** Design a Data structure for a large set of points in \( A \subseteq \mathbb{R}^n \) such that the following query can be answered quickly:

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Exploring Hilbert Geometry

Elevator Pitch
Computational Geom asks comp questions about subsets of \( \mathbb{R}^n \).

One topic is to look at \( \{ (p_1, \ldots, p_n) : 0 \leq p_i \leq 1 \land \sum_{i=1}^{n} p_i = 1 \} \) which is called the probability simplex.

What if you are in another space? A curved space? What can you do?
You can do This project!

Mentors Auguste and Dave.
Students Carmen, Hridhaan, Lucy, Megan, Nithin, Olga, Megan, Sarah
Exploring Hilbert Geometry

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Crop Planning Decisions Support With Multi-Agent Reinforcement Learning
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Elevator Pitch

Farmers in India need your help!

Small changes in climate ⇒ big changes in planning crops.

They need to predict the weather AND make plans.

But if they all do the same thing, that's bad also.

Game Theory!

Mentor: Aviva

Students: Anubah, Daniel, Ethan, Shreya
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What Makes Multimodal Question Answering Difficult?

Elevator Pitch

AI is good at answering questions from text.

Yeah!

AI is bad at answering questions from sound or images.

Why?

Bad Models?  
Bad Data?  
Bad Researchers?  
Not anymore, now that REU-CAAR is on it!

Mentor  
Jordan

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Ahmed, Dmytro, Liam
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**Mentor** Jordan
**Students** Ahmed, Dmytro, Liam
Classical and Quantum Error Correcting Codes

Elevator Pitch

Alice wants to send Bob \( x \in \{0, 1\}^n \), but the channel is noisy! Can send \( x \) so that some errors will be detected and corrected, e.g., to send \( xxx \).

There are better ways CLASSICALLY.

What if you had QUANTUM methods! Can you do better?

Those who are doing this project will find out!

Mentor

Victor and Nat.

Student

Alexander
Elevator Pitch

Alice wants to send Bob $x \in \{0, 1\}^n$, but channel is noisy! Can send $x$ so that some errors will be detected and corrected, e.g., to send $xxx$. There are better ways CLASSICALLY. What if you had QUANTUM methods! Can you do better? Those who are doing this project will find out! Mentor Victor and Nat. Student Alexander
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**Mentor** Victor and Nat.

**Student** Alexander
Quantum Games

Elevator Pitch
Consider the following game. Alice and Bob are cooperating. There are two graphs $G$ and $H$ that Alice and Bob can both see. Alice is given a vertex $v_a$ in $G$ at random. Bob is given a vertex $v_b$ in $G$ at random. They don't see each others vertices. Alice then picks $w_a$ in $H$, and Bob picks $w_b$ in $H$. They win if $(v_a, v_b)$ and $(w_a, w_b)$ are either both edges or both non-edges. Known Alice and Bob can win iff there is a homomorphism between $G$ and $H$.

If you thought that was fun, wait until you see the quantum version! Alice and Bob share an entangled quantum state!

Mentor Seyed and Jon
Students Bushra (Bea) and Jakin.
Quantum Games

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**Mentor** Seyed and Jon

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Quantum Simulation

One of the motivations for QC is that a QC can simulate QM. There has been some success here but how can we tell? We need to compute error bounds on the simulation to see how well it is doing.
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Quantum Simulation

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Mentors Andrew and John
Quantum Simulation

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**Mentors** Andrew and John

**Students** Andrew (diff Andrew) and David (diff David)
Funding
Who is Funding This?

1. National Science Foundation (NSF).
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2. Google/An Zhu (An Zhu was an undergrad at UMCP who worked in Theory). Great!


4. Other Schools mini-grants pay stipends. Great!

5. The UMCP CS dept kicks in some money. Great!

6. Some unpaid local students. Great!

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Irwin Winkler

Bill Gasarch’s Mother is Pearl (Nee Winkler) Gasarch

1. Produced over 50 movies
2. Directed 7 movies
3. David Selznick Lifetime achievement award for producing
4. Produced *Rocky*, *Goodfellas*, *Creed 1,2,3*
5. For more about him: [https://www.imdb.com/name/nm0005563/?ref_=fn_al_nm_1](https://www.imdb.com/name/nm0005563/?ref_=fn_al_nm_1)

Why am I telling you this?
Bill Gasarch’s Mother is Pearl (Nee Winkler) Gasarch

Pearl Gasarch’s Brother is Irwin Winkler
Irwin Winkler

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Irwin Winkler is a producer in Hollywood.
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Why am I telling you this?
Irwin Winkler has established a charitable foundation that gives money to
Irwin Winkler has established a charitable foundation that gives money to (a) many worth causes and
Irwin Winkler has established a charitable foundation that gives money to (a) many worth causes and (b) our REU!
Adam Winkler is Irwin’s son who administers the foundation.

Adam Winkler is a law professor so he understands academia. (The other sons: Charles—a director; David—a screenwriter.)

Adam has written two books: *Gunfight: The Battle over the Right to Bear Arms in America* and *We the Corporations: How American Businesses won their civil rights*. The last book got this review: “It is deeply shocking that *We the Corporations* is not boring. Also, the last book was a nominee for the National Book Award.”
Adam Winkler

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Show me the Money!

Where Does the Winkler Money Go?
Things the NSF won’t pay for:

▶ Money for housing for non-citizens.
▶ The REU Lunches.
▶ Misc.
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Does Where You Got Your Funding Matter? NO

1. Some of you are NSF funded.
2. Some of you are Iribe funded.
3. Some of you are Google/Zhu funded.
4. Some of you are funded by your own school/Winkler/UMCP.
5. Some of you are not funded.

The first draft of the Declaration of Independence had the following:

All REU students are created equal.

None of this will matter except:

1. Google/Zhu & Iribe students will write letters of thanks.
2. Unpaid students: less forms to fill out.
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Joe Biden's Senior Thesis was not on Parallel Algorithms for Nearest Neighbor Search. It was on Classical and Quantum Error Correction.
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Questions from You?

I welcome questions now and anytime!