

STYLES OF RESEARCH

William Gasarch- U. of MD at College Park

FOUR STYLES

1. Question Driven
2. Field Driven
3. Vision Driven
4. Hired Gun

Note: This is oversimplification.

QUESTION DRIVEN

1. **Question Driven**
2. Field Driven
3. Vision Driven
4. Hired Gun

QUESTION DRIVEN

You have a question that just **grabs** you! You **need** to answer it! Or get it answered!

QUESTIONS COME FROM

1. Things you **read** (Conf. proc., Journals)
2. Things you **hear**.
3. Inspired by **practical problems**.
4. **GOTO Confs and Workshops**.
5. **Variants** of other questions.
6. Your **advisor**.
7. **Curiosities**.

DO

1. **Read** all you can about the problem.
2. **Think** all you can about the problem.
3. **See** if it has been looked at before.

DO NOTs

- **Ponder** what journal you will publish in.
- **Assume** it has already been worked on.

DO and DO NOT

Ask an expert

EXAMPLE

A **problem** from the 1983 Math Olympiad:

“Is there a subset of $\{1, \dots, 10^5\}$ of size 1983 that has no arithmetic progression of length 3?”

Answer: Yes, there is a subset of size 2^{11} .

My Question: How big can it be?

WHAT NEXT?

1. **Asked** Joel Spencer (an expert).
2. **Read** the literature on 3-free sets.
3. Proofs were **nonconstructive**.
4. Proofs were **asymptotic**.
5. Apps to **Comm. Comp.**

THEN WHAT?

1. **Wrote** a survey of the constructions.
2. J. Glenn found **algorithms**.
3. C. Kruskal did work on small n .
4. I found apps to Comm. Comp.- R. Beigel helped.

UPSHOT

By taking this Math Olympiad Curiosity **seriously** I got

- An empirical paper on 3-free sets (with James Glenn and Clyde Kruskal)
- A theory paper on Comm. Comp. (with James Glenn and Richard Beigel)
- Knowledge of interest to me

ANSWER...

I found a website by someone else who studies this problem (who'd have thought!) and YES, there is a 3-free subset of $\{1, \dots, 10^5\}$ of size larger than 2048. STILL happy with the papers I wrote and the knowledge I gained.

FIELD DRIVEN

1. Question Driven
2. **Field Driven**
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II: FIELD DRIVEN

A **field** peaks your interest!

You begin **reading** up in it!

You have **no particular question** in mind!

EXAMPLE

1. I got interested in Private Information Retrieval (PIR).
2. I wrote a survey.
3. I maintain a website.

BENEFITS

1. Survey is well **cited**.
2. Got out another paper.
3. Got **invited** to panel at SECURECOM.
4. **Talked** to experts.
5. Got **ideas** of things to work on!

STUDENT BENEFITS

1. Arkady got a Master's Paper, went to week-long workshop on PIR, and got a summer job at APL (indirectly) from this.
2. Andy got a summer job at APL from this (paper pending).

UPSHOT

1. Curiosity lead to Survey.
2. Survey lead to Website.
3. Website lead to Fame.
4. Fame lead to Invite.
5. Invite lead to Insight.
6. Insight lead to research for grad and ugrad.

VISION DRIVEN

1. Question Driven
2. Field Driven
3. **Vision Driven**
4. Hired Gun

III: VISION DRIVEN

I can solve **important problem XXX** if I can get **YYY** and **ZZZ** in place!!!

EXAMPLE

Joel Spencer: “Infinite Combinatorics is easier than finite combinatorics since messy constants go away. E.g., $\text{RAMSEY}(\infty, \infty) = \infty$ but we do not know $\text{RAMSEY}(5, 5)$.”

MY PLAN: Devise a complexity theory for infinite objects, get a version of P vs NP, solve that version, and then solve normal P vs NP.

BOUNDED QUERIES IN COMPUTABILITY THEORY

1. Time has **no meaning** in computability.
2. Count the **Number of Queries** used.
3. Do more queries help?
4. Given problem, how many queries?

WHAT DID I GET OUT OF IT

1. Last chapter of my PhD thesis
2. 19 papers
3. Tenure
4. A Book

ORIGINAL PROBLEM SOLVED?

1. Did not solve P vs NP :-(
2. “Proved” limits on Greedy for graph coloring.
3. “ReProved” Binary Search Optimal.
4. David Harel got **limits of approximation.**

HIRED GUN

1. Question Driven
2. Field Driven
3. Vision Driven
4. **Hired Gun**

IV: HIRED GUN

Someone asks **you** to help them on something which is not your field. Could be a small project in some other field.

PROS

1. Learn a new field.
2. Might find new problems.
3. Might even switch fields.
4. Meet new people.
5. Get new trains of thought.

CONS

1. Not as emotionally tied to the area.
2. Might be in a fog.
3. Might fumble during talks.

EXAMPLE

Carl Smith to Bill Gasarch:

“Hey Bill, you know **Computability Theory**,
can you help us with these problems in
inductive inference?”

FOCS/JACM paper!

“Learning via Queries” by Gasarch and Smith:

1. FOCS 1988 and JACM 1992.
2. Ushered in a new era of really hard techniques in inductive inference.

WHAT I GOT OUT OF IT

1. 14 papers.
2. 4 times on program committee.
3. 2 grants (really!)
4. Invited to give a series of talks in Spain.

UPSHOT

1. My abilities and knowledge fit **well**.
2. I learned **some** things of interest.
3. But **never cared** that much.

CONCLUSIONS

All of these styles share the following:

1. Get ideas from **talks! papers! courses! advisors!**
2. Get yourself out there!
3. There are **many** styles, a blend of them will fit **you!**

CONCLUSIONS