Doing Research in Software Analysis Lessons and Tips

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Tip #0

Your success in life must be earned with earnest efforts

Lesson #1 Get inspired!

Read & Reread Richard Hamming "You and Your Research"

Dijkstra's Three Golden Rules for Successful Scientific Research (The Idealist's View)

Dijkstra's Golden Rule #1

Raise your quality standards as high as you can live with, avoid wasting your time on routine problems, and always try to work as closely as possible at the boundary of your abilities. Do this, because it is the only way of discovering how that boundary should be moved forward.

Dijkstra's Golden Rule #2

We all like our work to be socially relevant and scientifically sound. If we can find a topic satisfying both desires, we are lucky; if the two targets are in conflict with each other, let the requirement of scientific soundness prevail.

Dijkstra's Golden Rule #3

Never tackle a problem of which you can be pretty sure that (now or in the near future) it will be tackled by others who are, in relation to that problem, at least as competent and well-equipped as you.

What is great research

- Two styles of great research
 - A longstanding hard nut, you cracked it
 - Seminal work that opens up a new area
- Great research should have
 - Given a new powerful solution / concept
 - The potential to change how
 - A community thinks about a particular problem
 - People approach things

Lesson #2 Pick a problem for you

Pick a good problem

- □ Very hard
 - Art
 - Taste
 - Luck
 - Pain killers vs. vitamins

- □ Bottom-line
 - You should care about its solution!
 - You are just excited about it!

Types of problems: established

- The easiest kind
- Examples: pointer analysis, race detection ...
- Incremental, but solid bricks
- Most good work falls here
- Most bad work falls here as well
 - Incremental, but not quite solid bricks

Types of problems: hard nuts

- Longstanding, well-known problems
- New techniques
- Breakthroughs
- ☐ The problem solver type

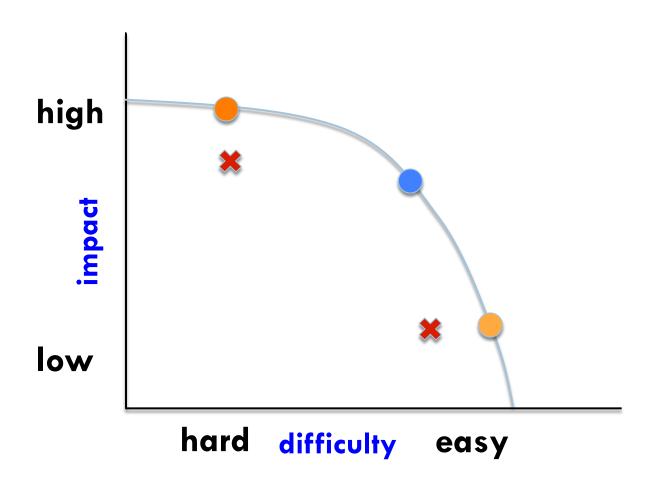
Types of problems: essence

- □ Take a real-world messy problem
- Understand its essence
- Formulate/conceptualize
 - Problem
 - Concept
 - Solution

Types of problems: the hardest

- Problems people don't even know they have
- The visionary, abstract thinker type
- Revolutions typically come out of here

The Pareto front



Heilmeier's Catechism

- What are you trying to do
 - Articulate your objectives using absolutely no jargon
- How's it done now, what are limits of current practice
- What's new in your approach, why you'll be successful
- Who cares (your audience)
- If you're successful, what difference will it make
- What are the risks and payoffs
- How much will it cost; How long will it take
- □ What are midterm & final "exams" to check for success

Lesson #3 Understand, justify, execute

How to solve a problem (1)

- □ Understand it
 - A well-chosen example for motivation & illustration
 - Never underestimate its importance
- □ Formalize if possible
 - □ Goal: obtain a **crisp description** of the problem
- What are the key difficulties
 - Conceptual, technical, and engineering
 - Extremely important to understand these well

How to solve a problem (2)

- How to approach the challenges
 - Key insights
 - Key technical novelties
 - Key engineering hurdles (i.e., feasibility)
- □ How to evaluate if you succeed doing the work
 - Ask this question early, don't delay
- What unique & impressive to show at the end
 - Vision, problem formulation, theory, technique, results?
 - Is it so evidently unique and impressive?
 - Any elements of intrigue & surprise

How to solve a problem (3)

- The process is full of decisions
 - Understand your options well
 - Don't rush to take the first option you think of
 - Can justify your choices
 - Also understand what's important, what's not
 - Avoid taking shortcuts
- Takeaways
 - Always mindful
 - Justify, justify, and justify
 - Convince yourself first, then others

Tip #1 Easy vs. difficult

Tip #2 Hammer vs. nail

Tip #3 Release tools

Tip #4 Excitement vs. despair

Tip #5 Results vs. the process

Final Remarks

- Everybody can do fun & great work
 - When you believe so
 - Why not, we all should!
 - When you put your heart to it
- □ Great things will happen, just
 - Dream big, think big
 - Be a mindful & flexible thinker
 - Work hard, never give up