A B C of an Academic Research Career

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An Academic Career?

- What's involved in an academic career?
- Jump through a number of hurdles:
  - Get a Ph.D.
    - Take courses; pass the qualifying exam
    - Come up with a thesis topic; conduct research
    - Write dissertation; publish research; Defend
  - Find an academic job
    - Apply to various Universities/research labs
    - Interview; negotiate; accept an offer
- Next step: tenure/promotion
  - Apply for grants; recruit students; publish research

Issues in Research

- What is involved in doing research?
  - Understand your area so well that you are practically "living" inside it. (Lots of reading)
  - Internalize existing knowledge;
  - Build abstractions; develop ability to reason at a high level
    Read "Surely you must be joking Mr. Feynman"
  - Know enough to fill in low level details
- The process of invention involves high level, abstract thinking.

Issues in Research

- Can anyone do research?
  - Brain vs perseverence
  - Do good grades mean research aptitude?
- Research requires creativity
  Imagination is more important than knowledge! -Einstein
- Creativity is god given (Mozart), but can be cultivated
  Heuristic search vs Brute force search
- Can one's research ability (creativity) be improved:
  - Atheletes can practice and improve
  - Can "intellectual atheletes" do the same?

Creativity & Perseverence

- Can ability to do research be acquired?
  - Only to an extent; creativity is largely innate
  - However, hard work & perseverence go a long way
- Success = Insights + Hard-work + Perseverence
  - `Genius is one percent inspiration, ninety-nine percent perspiration (Edison)`
  - `Big shots are little shots who keep shooting.`
  - `Genius is only the power of making continuous effort.`

How is Research Done?

- Research is generating new ideas.
- New ideas are generated from old one; so know prior research (read a lot)
  - I could see further because I stood on the shoulder of giants - Newton
- However, do not fall into the trap of reading all the literature first (know where to stop)
- Write a survey paper early in your research
  - Make this the second chapter of your thesis

Research in CS/Engg

- In Sciences, novelty is *per se* a contribution
- In engineering a novelty is not; to prove a new constribution one must show:
  - It is better than the state of the art
    - Better by sheer novelty (e.g., the WWW)
    - Shown by independent, impartial evaluation
    - Established by measurement
  - It is a fruitful general method of design/construction
    - Must have one instance of the fruit
    - Must demonstrate generalizability
- Not enough to have an idea, must demonstrate that they work and advance state-of-the-art

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Too much knowledge considered harmful

The difficulty lies, not in the new ideas, but in escaping the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds.

-- **John Maynard Keynes**

I have often pondered over the roles of knowledge or experience, on the one hand, and imagination or intuition, on the other, in the process of discovery. I believe that there is a certain fundamental conflict between the two, and knowledge, by advocating caution, tends to inhibit the flight of imagination. Therefore, a certain naiveté, unburdened by conventional wisdom, can sometimes be a positive asset. -- **Harish Chandra (Mathematician)**

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Research in CS/Engg

- Types of research topics:
  - Solve an open problem (theory area)
  - Build an artifact (a system)
  - Develop a general methodology
  - Performance Evaluation

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The Art of Generating New Ideas

- Can this art be learned?:
  - Study an idea, find its deficiencies and fix them
  - Jump into a completely new field; the most obvious ideas are novel
  - When reading a paper, pay attention to what is not said.
  - All else fails; seek faculty's help
- Doing a Ph.d. is about learning to create new ideas/knowledge
- Finding a thesis topic is your first introduction

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Generating new ideas

- This leads to the paradox that the more original a discovery the more obvious it seems afterwords. The creative act is not an act of creation in the sense of the Old Testament. It does not create something out of nothing; it uncovers, selects, re-shuffles, combines, synthesizes already existing facts, faculties, skills. The more familiar the parts, the more striking the whole.

  - Koestler.

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Generating New Ideas

- Consequence: Almost always the same idea is discovered by a number of people simultaneously
- We could produce new ideas in an algorithmic fashion; generate new ideas by:
  - Taking union/intersection of older ideas
  - Taking complement of an older idea
  - Taking a general idea and considering its instances
  - Dual of the idea

One man's theory is another man's practice

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Theses & Dissertations: Finding a Topic

- Do a reading program/course in your area of interest
- Keep a research idea wish-book
- Discuss ideas with your advisor/faculty members
- Choose a topic that you like; you should be genuinely interested; you may spend your next 10 yrs on it.
- Keep it narrow and doable (should be able to finish in 1yr)
- Don't go by popularity of the area; it may be out of fashion
  - If you can see the bandwagon, it's already too late. -Buffet
- Choose an area in which the world is also interested; else no job; however, if genuinely interested, go for it:
  - It is more important to paint than to eat. -- Van Gogh

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Building the Dissertation

- Build the dissertation around the thesis
- Assert a clear thesis in plain language
  "Such and such is true"
- Clearly state the "insight" driving your research
- Write a thesis proposal as soon as possible
- Design the arguments, then seek the facts
- If the facts are not there, rebuild the argument
- Identify your proposed "contribution to knowledge" explicitly

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Thesis Proposal

- Pay careful attention to thesis proposal (perhaps the most critical component of your success)
  - State precisely what the problem is
  - State outline of your solution
  - State milestones and how they will be achieved
  - Plan to finish research in 1 yr
    (finishing vs wowing the world)
  - Contract between you and your committee
  - The problem needs to be defined before it can be solved.

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Communication Skills

- Reading, writing, speaking well are very important for success in any career
- More so in an academic career; writing well is particularly important
- Learn to read: Reach a point where you can:
  - Glance over a paper and say what it is about
  - Read the abstract and say what the paper is about
  - Read the title and guess what the paper is about

Requires broad knowledge of CS and good understanding of the research

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Communication Skills (Writing)

- Learn to write well: good writing is a must for any career; You'll write theses, papers, proposals, books
- Writing is also a good way to reify your thinking
- Learn to get ideas across;
- Write to inform, not to impress
- Read books on writing (Strunk and White)
- Practice; Observe other people's writing
- While writing, be prepared to revise several times;
- Writing is like programming: changes introduce bugs

Excellent work is the product of excessive revision

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Communication Skills (Speaking)

- Learn to speak effectively:
  - Learn to get the main ideas across
  - Practice; practice; practice

    Excellent work is the product of excessive revision
  - Make sure that at least part of the talk is accessible to everybody
    - What is the one thing that you want them to take back
    - Organize your talk around "what", "why", and "how" questions
  - It's all about confidence, which comes from practice.

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Publishing Papers

- In today's world publishing papers is critical
  - Critical for job after your ph.d.
  - Critical for tenure/promotion when you get a job
  - Critical for research funding
- "Publish or perish"
- Papers communicate our research
- Peer reviewed venues; non-reviewed venues
  - Journals vs conferences vs magazines

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Publishing Papers

- Is publishing papers the means or the end?
  1. Is research your goal and papers are side-effects?
  2. Or is writing papers your goal, and you do research so as to write papers?
- Both approaches are reasonable (as long as you do not lose your perspective)
  - I like to think along the lines of 2; it gives you a short term goal that you can try to achieve
- The publish or perish syndrome has lead to lots of inconsequential conferences being organized and lots of inconsequential papers being written.

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Publishing Papers

- Quantity vs Quality: quality is what matters; though, large quantities can be superficially impressive.
- Least publishable units; Should you publish 1 large paper or mutltiple papers each with one LPU
- Don't publish mediocre research in order to boost numbers; keep your conscience clean

  For every paper, no matter how bad, there is always a journal that is of low enough quality that will publish the paper. –Frank Harary
- Don't publish for the sake of publishing; bad research is recognized and will have negative impact on your career.

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The Game of Publishing

- When you submit a paper, it is reviewed by referees, the editor has the final say.
- You can view this as an adversarial game between the referee and the author, with the editor as the umpire; author's goal is to get junk published, referees goal is to reject the best paper.
- A number of strategies that both the referee and author can use to win the game.
- Publishing involves human psychology heavily;
- Recognition/Fame is a psychological entity

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Other Ethical Questions

- Should you submit the paper simultaneously to 2 venues?
- Should you publish by LPUs?
- How much should two papers overlap?
- Can an already published paper be submitted elsewhere
  - Exception: Conference papers can appear in journals

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The Game of Publishing

- Author's move: submit; Referee's move: reject; Game terminates when one player gives up
- Tactics for authors:
  - Obscure journal tactics (support to make a point)
  - Wrong reference tactic (make ref check all references)
  - Prestige tactic (cite someone well known)
  - Barrage tactic (send lots of submissions)
  - Flattery tactic (thank reviewer in the revised paper)
  - Anticipation tactic (cite potential reviewers or choose your references carefully to avoid certain reviewers)
  - Precedent tactic (cite a low quality paper)
  - Deliberate mistake tactic (insert a mistake deliberately)

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The Game of Publishing

- Tactics for referee:
  - Obscure journal tactics (suggest work is not original)
  - Wrong level tactic (author trades rigor for clarity; not rigorous)
  - Unsuitable-for-this-journal tactic (suggest an insulting journal)
  - Shorten paper tactic (ask author to shorten the paper)
  - Deliberate misunderstanding tactic (pretend to not understand)
  - Personal knowledge tactic (question something the referee knows the author knows nothing about)
  - Standardized notation tactic (author uses non-standard notation)
  - Scare tactic (cite own paper suggesting work already done there)
  - Frustration tactic (simply ignore the paper)
- The Game of refereeing. J. of App. Behavior analysis. 1968.

Publishing Strategies

- Two types of papers have better chances:
  1. Those that prove theorems
  2. Those w/ performance numbers
- If you have both, even better
- Hard to publish papers that describe a process or a method; you can increase its chances by including a proof of correctness of the method
- Papers that are more formal, seem to do better
- People doing systems research are perceived to have a harder time publishing papers.
- Reviewers are wary of simulation papers

Academic Job Hunting

- Typically you start looking for a job in the last year of their Ph.D.
- If you plan to start in fall 2005, you'll apply around Nov/Dec 2004.
- Ads appear in CRA.org, ACM.org and IEEE.org and in journals/magazines (CACM, IEEE computer).
- Select the places you want to apply and send:
  - Detailed CV
  - Statement of teaching
  - Statement of research
  - References

Academic Job Hunting

- Job market can vary (cyclical); depends on:
  - State of economy
  - Supply and demand
- Once you apply wait for interview calls
- Things that matter:
  - Your area (s/w engg.; security)
  - Quality of your research (there's more competition)
  - Your publication record
  - Contacts may also get you an interview (they are convinced that you are a smart person)

Getting an Interview

- Important to have contacts (through advisor)
  - Tell people about your work in conferences; get to know people in your area; get them to know you.
  - Collaborate (through your advisor) with researchers in your area
  - Participate in organization of workshops & conferences
  - Project the image of a hard working, ambitious, congenial person
  - Contacts are needed in all stages of your life

The Interview

- Lasts 1-2 days and consists of:
  - A 1 hour talk (incl. Questions)
  - 30 min. meetings with faculty members
  - 30 min. meeting with the Dean
  - Tour of city and/or campus
- Interview talk the most important item: you will be judged as a teacher based on your talk.
- Exude confidence while giving the talk; you are the expert in the area.

The Interview

- Practice summarizing your research in 5 min.
  (people who couldn't go to your talk will ask about your research)
- Interview is for both parties to "discover" assess each other.
- Your goal is to convince them that you should be their #1 choice; their goal is to convince you that they should be your #1 choice.
- Your personality plays an important role; you've already been judged to fit academically.
- Salary is not negotiated during the interview. You negotiate when the offer is made later.

The Interview

- Ask lots of questions during meetings with individual faculty membes, department head and the dean.
  - How do they like this place?
  - Where do they see the dept. in 5 years
  - How much split between teaching/research
  - What are the general expectations for obtaining tenure
  - What's the cost of living;
  - What's the salary like (ball park figure) and benefits
  - Are their people you could collaborate with?
  - Do faculty members get along
  - What is the expectation w.r.t. research grants
  - Ask people about *their* research

The Academic Jungle

- Finally you get a job and you face more challenges:
  - Teaching (perhaps for the first time)
  - Defining your research agenda
  - Recruiting students in your research
  - Raising money for your research from funding agencies
    (national, state, private, or your Univ)
  - Performing departmental service (committees)
  - Continue to do cutting edge research; make yourself known in the research community; serve community
  - Balance a family

The Academic Jungle

- An academic job is quite challenging, and not for everyone
- However, there are many advantages:
  - Freedom to pursue your research
  - Flexible schedule
  - Teaching can be quite rewarding
  - You are around smart people
  - You meet smart people in conferences
  - You get to keep the glory (not your company)

The Academic Jungle

- W.r.t Disadvantages:
  - You have to be self-motivated to succeed
  - Have to juggle a lot of things (may work 60 hrs/wk)
  - Initially teaching may take a lot of time; some people get bogged down with teaching
  - Creative thinking is hard; can you keep producing cutting edge research forever (or until tenure ☺)
  - You are paid only for 9 months, you have to raise your 3 months' salary yourself
  - When you are teaching you are stuck; can't travel
  - May become lonely: others may not care about your research

Strategies that Work

- Dream big: embark on solving a very difficult problem; the first small step is your Ph.D., the rest can provide a life-time of research problems. This is also a recipe for becoming famous.
- Keep your conscience clean; don't get enmeshed in mediocre research; quality over quantity.
- Don't become complacent; especially true when doing a Ph.D.
- Be honest with yourself; set high standards; Anything you do should meet your own high standards. As long as you are happy with what you do, it may not matter what others think about your/your research.

Strategies that Work

- Work with a large team of researchers (another recipe for becoming famous);
  - If you can't beat'em, join'em
- Pick a role model (dead or alive) in your area; try to follow their example, emulate their career.
- Don't be swayed by flavor of the day (however, stay current).
  - The folks in the industry will tell you that they don't have any use for your abstruse academic goals; but once you achieve them, they'll say that that's what they wanted all along. -- C. A. R. Hoare
- Read biographies of famous researchers for inspiration as well as for realizing that they are just as human as any one else.
- Need 1 or 2 good ideas a year to produce papers/research
  - One needs only 1 or 2 good ideas a year to make a lot of money
    - Warren Buffet

Human Dimension

- It will serve you well if you understand human psychology:
- Clearly, competence is required to succeed, but that's a minimum requirement, it doesn't guarantee "success"
- Being able to deal well with human psychological issues as well as sociological issues is going to further improve your chances of success.

  Recommended reading: The Prince. – N. Machiavelli

Tenure

To be continued…