How To Conduct High-Quality Research and Manage A Research Group?

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Part I: How to Conduct High-Quality Research?

Motivation is the Key

- Why should I do MS or PhD?
  - Internal drive
    - Research interest (curiosity, sense of achievement/fulfillment)
    - Strong ambition (self-expectation)
  - External drive
    - Degree and diploma
    - Parents, teachers, friends
    - Peer pressure (sense of honor and responsibility)
    - Small success

Problem Selection

- Good research largely depends on the selected problem
  - A good problem is difficult to find
    - Not too easy or too difficult
- How to select a problem?
  - Is it an old problem or a new problem?
    - Usually, new problems have more opportunities
  - Is it a significant problem?
    - Practically important yet technically challenging

More about Ambition

- Principle of "aim high, accept low"
- Use problem selection as example
  - Aim high
    - Do not patch a small hole left by leading researchers
    - Find a more fundamental problem which may have a long impact
  - Accept low
    - If it is difficult to find a fundamental problem, then we need a compromise
    - Advice from professor is important

Literature Survey

- Use tools
  - Trace backward
    - Tutorial paper and reference list
  - Trace forward
    - Use Google scholar to find papers that cite the current work
- Proactive vs. passive reading
    - Reading with a critical attitude
    - Reading according to your own agenda
    - Reading between lines (not only what was said but what was not said)
- Form a study group

Nurturing Good Taste

- There are many mediocre papers published
  - Do not ruin your taste by poor-quality papers
- Read selectively
  - Highly cited papers and papers from first-tier journals and top-ranked conferences
- Classification of papers
  - Type A: 80% understanding (main idea, solution method and main results)
  - Type B: 50% understanding (idea & results)
  - Type C: 20% understanding (only introduction)
- Learn to appreciate good papers and criticize poor papers

Monitoring Activities of Leading Research Group in Your Field

- Identify leading research groups in your field
- Find out their recent research focus

Research Environment

- Large group can be a blessing
  - More resourceful in terms of interaction (now) and networking (future)
- Senior students can be very helpful to junior students
  - Experience sharing & encouragements
  - More tolerant to mistakes
  - More accessible
- Good versus bad environments
- Each group has its own culture
  - Building a nice group culture is rewarding

Guidance and Feedback

- Role of Advisor
  - Joint decision on problem selection
  - Set up the research standard
  - Help when students get stuck
    - Find out why
    - Re-directing
  - Feedback on research results
    - Positive and negative feedback
  - Help in oral presentation and written reports

Oral Presentation

- Preparation of the ppt file
- Logical flow of motivation/ideas/results
- Fluent English language capability
- Practice, practice and practice

Paper Writing

- Critical to the sale of your ideas/results
- Paper organization
  - Proper arrangement of texts, figures and tables
- Multi-pass writing style
  - 1st pass: Detailed outline
  - 2nd pass: Rapid writing
  - 3rd pass: Fine-tuning
  - 4th pass: cross-reading

Plagiarism

- A severe problem
- Intentionally and un-intentionally
  - Need to tell students a proper way to cite and paraphrase

Part II: How to Manage A Research Group

Big versus Small Groups

- Small groups
  - Pro: More opportunities to interact with advisor
  - Con: Limited peer interaction
- Large groups
  - Con: Fewer opportunities to interact with advisor
  - Pro:
    - More peer interaction (inter-personal skill)
    - Broader perspectives on research field (diversity)
    - More friends in future career development

My Experience in Early Years

- My experience at MIT
  - Little supervision from MS and PhD advisors
  - Little interaction with peers
  - Little management observed
- My early years at USC
  - First 5-6 years (ad hoc style)
  - When the no. of group members goes beyond 10
    - Seeking a better management system
  - How to reach today's status?
    - 20 PhD students
    - About 5 students graduating per year

Report and Feedback (1)

- Weekly report system
  - The origin of the weekly report system
  - The practice
    - Due every Thursday night
    - Read and returned on Friday afternoon during subgroup meetings
    - A synchronization and diagnosis tool

Report and Feedback (2)

- Weekly report format
  - Tasks achieved last week
  - Tasks to be done next week
  - Feedback and interaction
  - Reports
  - Milestones

Goal Set-up, Planning and Execution

- Long-term goals (6-12 months) are set up
  - Screening, qual, defense exams
  - Conference/journal papers due dates
  - Deliverables for sponsored projects
- Milestones are established and revised
  - Schedules are set according to the goals
  - Periodic review of progress towards to these goals
  - Milestones revision may be needed

Group Dynamics and Interaction (1)

- Group level
  - Group weekly seminar
    - Friday noon: 12:30-1 and 1-2
  - Group website
    - Internet and intranet
  - Thanksgiving luncheon and other events
- Subgroup level
  - Subgroup meetings
  - Informal discussions among special interest groups (SIGs)
  - Talk rehearsals

Group Dynamics and Interaction (2)

- Personal level
  - One-to-one professor-student meeting
  - Mentor system
    - Every junior student has a senior student as mentor
- Support from Alumni
  - Many graduates still contribute to the mentoring and research co-supervision of students

Role Modeling

- Building an atmosphere of a big family
- Building core values
  - Team spirit (accepting and giving help)
  - Hard-working spirit
  - Openness to diversified research topics
  - High standards
    - Both technical and ethical

External Collaboration

- Collaborators
  - Group Alumni
  - Faculty in other universities and USC
  - Industrial partners
  - Weekly report & conference calls
- Key driving force to different new research areas

Education That Goes Beyond Research

- An Educator role
  - Teacher, Friend, Senior (father or big brother) and Shepherd
- 40-minute sharing per week (before the group seminar) about various topics
  - How to do research
  - How to find a job
  - Technology trends
  - Observations from trips & conferences
  - How to handle stress and disappointment
- More than technology
  - From academic value to working attitude
  - From working attitude to perspectives on life

Example 1: Learning Management Skills Early

- Two skills not taught (but caught) in universities
  - Management
  - Sale and marketing
- About management skills
  - Resources management
    - Time, search tools, e-mails, faculty, student peers, etc.
  - Objectives management
    - Importance vs urgency
  - Planning is needed to match objectives and resources

Example 2: Sales and Marketing Skills

- Sales is essentially related to your presentation skills and networking
  - Paper writing
  - Oral presentation
  - Poster presentation
  - Proposal writing
  - Making friends and building networks
- Marketing skills
  - Finding new opportunities in funding and research directions
    - Blue ocean versus red ocean
  - Resource is limited -> seek the possible biggest impact

Conclusion

- Build a group culture
  - Consistency, transparency, fairness
  - Encouragement yet with discipline
- Demand an eco-system
  - Funding source
  - Job opportunities
- Demand determination and commitment
  - A system could be too demanding on the leader if implemented by mimicking
    - Local adaptation is needed
  - Where to get the energy to run the system
    - A genuine love to research and students

Two References

- H. T. Kung, “Useful things to know about PhD thesis research,” 1987 October.
- Ronald T. Azuma, “A graduate school survival guide” 1997 (original) and 2000 (revised)