Research Practices
and
Atmospheres in World-Class Research Laboratories

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Have you done any research before?

RE ... SEARCH

to look for (new) solutions
to selected problem
... again and again
to improve upon existing ones

Searching in RESEARCH
- Need of progressive searches
  with rewarding advancement towards successful ends
- Need of recursive searches
  with aim at improvement or refinement or corrections

Searching in RESEARCH
- Need of regressive searches
  to trace back to causes of failures and learn from them
- Need of self searches
  to sustain inspiration and spirit throughout research period

Steps in ‘research’
**First SEARCH**

**search for problem**

*How to select good research problem?*

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**Problem Selection Criteria**

- **Good** research problem must be
  - Worth investigating – to you, to others
  - Not too wide – very specific objective
  - Not too crowded – with rooms for improvement
  - Not too old – originality, novelty
  - Not implausible -- possible & reasonable

- **Best** research problem is that one you feel **obsessed** of solving

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**Second SEARCH**

**search for data relevant to problem**

*(literature survey)*

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**Literature Review**

- Who are main authorities in the selected problem?
- What are proposed, existing solutions?
- How these existing solutions work?
  - Key logical idea = ?
  - Where they work? (applicable range)
  - Where they don’t? (known limitations)
  - Where they won’t? (unknown limitations)
- Why them? (pros and cons)
- Why not others? (creativity)

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**Third SEARCH**

**search for new solutions to solve problem**

*(proposed methodology)*

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**Methodology**

- **Analytical**:
  - mathematical analysis
- **Experimental**:
  - implementation of idea on lab-scale/real-scale systems with evaluation by actual measurement
- **Simulation**:
  - emulate system dynamics in computer program
Methodology Comparison

<table>
<thead>
<tr>
<th></th>
<th>analytical</th>
<th>experimental</th>
<th>Simulation</th>
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<tbody>
<tr>
<td>Interpretability</td>
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<td>Cost</td>
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<td>Skill</td>
<td>math</td>
<td>lab</td>
<td>programming</td>
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Fourth SEARCH

search for results that support new solutions
(applicability range)

Results

- MUST specify both pros and cons of the proposed methodology
- MUST be compared with existing methodologies
- SHOULD be based on practical ranges of parameter settings

Fifth SEARCH

search for reasons to explain obtained results (discussion)

Discussion

- Common Pitfall: After getting results, students often think that they have finished their investigations.
- Remember: results without explanation are meaningless
- Need to ask why to every result
- If you cannot find sound reason for a result, then you need more results
- Discussion is typically much time consuming

Sixth SEARCH

search for conclusion (conclusive evidence)
Conclusive Evidence

*From all obtained results ... can you ‘conclude’ anything non-trivial (cannot be deduced from initial intuition before obtaining results)?*

Seventh SEARCH

*search for places where you can announce research outcomes (publication)*

Publication

*Be prepared well ahead of submission deadline

Typesetting program (LaTeX) is academically standard

Conference .. Then journal*

Eighth SEARCH

*search for next problems (recommended future work)*

Recommendation for Future Work

*Good research work must open new directions for further research

“Step over other giant’s shoulder”

Research community – fruitful for newcomers*

Welcome to research world

*I hope you would gain much more than just knowledge*
Imperial College London (institution)
- Number 1 in engineering of UK
- Science/math departments are very strong -- a few Nobel prize winners
- Large research budget from both state agencies and industries
- Faculty staff being real experts

Imperial College London (student)
- Top students from best of every country
- Multi-cultural environment (Greek, Indian, Singaporean, Chinese, UK and Europe Continent)
- Extremely hard-working

Imperial College London (MSc study)
- Lots of classes, assignments and labs
- One comprehensive exam
- Plus 3-4 months to do a small research and write a thesis
- Study all the time (day/night/holiday)
- 1 year

Imperial College London (PhD study)
- No classes, no grade
- Only two exams: Thesis Proposal and Viva
- Time is all yours to manage
- Students must be independent and self-disciplined
- Up to 8 years

Difference IC & CU
- IC classes, every student is very active in asking/commenting/arguing
- CU classes, every student is quiet
- At IC, time is taken seriously ... deadline and schedule and plan are commitment
- CU time is 15 minutes late and you feel not guilty!

H. M. Principles of Working
- Systematic study of all data
- Holistic view of problem
- Start tackling the easiest
- Continue in progressive steps
- Think out(side) of textbooks
H. M. Principles of Working

- Inspiration - burst from within
- Simplicity
- Profitable failures
- Self-dependence
- Honesty
- Perseverance

H.M. King Rama IX

best role model in research

- เราจะกระทำเพื่อด้วย <what to do>
- 做什么 <how to do>
- เพื่อประโยชน์สุข <why to do>
- แหล่งทรัพยากรวิจัย <for whom>

หลักการทรงงานของในหลวง

- ระเบิดจากข้างใน
- ทำให้ง่าย
- ขาดทุนคือการสูญเปล่า
- พึ่งตนเอง
- ซื่อสัตย์สุจริต
- ความเพียร

หลักการทรงงานของในหลวง

- ศึกษาข้อมูลอย่างเป็นระบบ
- มององค์รวมของปัญหา
- เริ่มแก้ปัญหาที่จุดเล็ก
- ทักษะเล็กตั้งขึ้น
- ไม่ติดต่ารา