Why do research?

Arka



What does "Research" mean to you?

Typical study/degrees

- Consumer of knowledge
- Expectation is that you follow what is taught to you
- A lot more mugging things up
- Research
 - Producer of knowledge
 - Expectation is that you will figure out a way to advance the state-of-art
 - A lot of self learning and deep thinking

Indian Institute of Science (IISc), Bangalore, India

Jsefulness



Is Research for you?

- If you are passionate deeper/greater learning
 - Studying for exam is different than doing research
 - Those who do well in exam are *not* necessarily do well in research
- Are you comfortable in venturing in the territory of unknown?
 - By definition, you will explore things at the boundary of knowledge
 - A lot of unknown and uncertainty
 - Ability and perseverance to figure things out on your own
- Keep the option of joining academia in future
 - PhD opens up of becoming professor
 - Also necessary to get into top industrial research labs (e.g., Microsoft <u>Research</u>)



Typical concerns of getting into research

- Delay settling down...
 - But, think of longer term
 - Your research background (or lack of it) could determine type of work you would for rest of your life
- You will be financially poor
 - True, while you survive on govt. scholarship your friends gets corporate salary
 - But folks with research experience may climb career ladder faster
- Limited job opportunities after a PhD
 - Many academic options
 - Several industry R&D options too

Computer Systems Research

Core Computer Systems Research Areas:

Architecture, programming languages, compilers, operating system, computer security, network, distributed systems, etc.



Why Computer Systems Research?

- Architecture research is history!
 - (Boring) Moore's Law, which will be dead soon!
- Hardware-oriented, no scope in India!
- Compiler performance (skeptism!)
 - Proebsting's Law: Improvements to compiler technology double the performance every 18 years.
- XXX is more fashionable/COOL!!
- System research does not lead to jobs in Google, Facebook, ...

Why Computer Systems Research?

- Systems research is the enabler of all areas!
- Systems research is exciting!
- Systems research is everywhere!



Why Computer Systems Research?

- **Computer Systems research is interesting!**
- It is going through exciting times!
 - Innovations in processor architecture, memory, interconnect (NoC), heterogeneous systems, domain-specific processors, ...
- Programming languages, compilers, computer security, operating systems, network, and distributed systems are critical for performance!
- Enabler for computer science growth and research!



THERE IS PLENTY OF ROOM @BOTTOM

Biswabandan Panda

CASS '18 @CSE-IITK

July 5th, 2018

Who Said This?

"Why cannot we write the entire 24 volumes of the Encyclopedia Britannica on the head of a pin?"

CLUE?



Bongo Player ??

Physicist ??

Noble Laureate ??

There is Plenty of Room at the Bottom

RICHARD FEYNMAN

Talk delivered in 1959

The question: 1000\$ Challenge

Head of a pin 1/16th of an inch. Magnify it 25000 times and that is sufficient area for all the pages in the encyclopaedia.

Today's Talk – A Curtain Raiser

Room in Computer Systems: *Plenty* of it.

What is (in) Computer Systems ?

After the talk: Go and talk to people of interest to find out problems of interest.

What is Computer Systems

Systems starts where theory ends

Computer theorists propose algorithms that solve important problems and analyze their asymptotic behavior (e.g., O(NlogN), O(N)). Computer architects (applicable to computer systems) set the constant factors of these algorithms – Christos Kozyrakis, Stanford

CSE: Science (Theory) + Engineering (Systems)

Theory vs Systems



Was ML there in 1960s?



Courtesy: Wikipedia

The Computing Stack



Computing to Communication

Computer Networks

Distributed Systems

Cloud based Systems

What about Security? Functionality?

Abstraction? Is it Good?

It is good if you don't care about the performance of underlying entities.



How many of you can drive a bike?

How many of you know how a bike works?

Systems: How bike works?



So break your abstraction barriers

There is Plenty of Room at the Bottom

Can you break the abstraction barriers?



How Can You Help?

Understand the layers/barriers of abstraction

Know the **HOW** and question the **WHY**?

Can you make it better? Think Big: by thinking about <mark>small</mark> things

Build systems for future

Be the producer:!consumer

Mantra That I follow [Courtesy Y. Patt]

Look Backward: Examine Old Code

Look Forward: New domains and new challenges

Look Up: Nature of Problems in the stack

Look **Down:** Technology (have EE friends)

Famous Quotes 🙂

"I don't think there will ever be a market for more than **five** computers in this world"

"640 KB of memory ought to be

enough for anybody"





There is Plenty of Room at the Bottom

Reality !!



There is Plenty of Room at the Bottom

Key Takeaways

Understand/break/re(develop) <u>the abstraction barriers</u>

Do not forget the **bottom of the stack** (ground floor of RM building) ③

Have a Good Time @CASS '18

"It takes two to speak the truth - one to speak and another to hear" - Henry David Thoreau

Thank You

Reach me: biswap@cse.iitk.ac.in



Academia → Industry → Academia

Two different perspectives on Computer System's research

My journey

- HRI (Circa 2003)
- UNSW (Circa 2004)
- Utah (Grad School)
- Micron
- Samsung
- IIT Gandhinagar
- ??





SAMSUNG



What You Know vs How much you know about it















What research teaches you?

- How to read
- How to write
- How to think clearly, communicate and present
- Perseverance and tenacity
- Have a *very thick* skin
- The sheer joy of solving a problem!
 - (hopefully something that others care about as well)

To:	JoeAverage@e	example.email.con	m / X
Subject:	HEY GUIZ!		
Insert:	Attachments	Sea Office docs	🔄 Photos 🔻 🔁 From Bing 🔻 🤓 Emoticons
🔏 🖻 📋	Tahoma	• 10 •	B / U ≡ ≡ ≡ ⊟ ⊞ ∰ ∰ 🔒 🚝 🔺 🖉
HI Joe			

thnx 4 emailing me da importent werd documint. i rlly needed it 2 finish da work task ive got

THANKS AGAIN BEN

How NOT to write an email!

HOW TO WRITE AN E-MAIL TO YOUR INSTRUCTOR OR T.A.



WWW. PHDCOMICS. COM

What is the Industry good for?

- Contribute to a real product! Build something real
- Bachelor's, Master's are sometime done in an academic bubble; its good to get out
- Gives you a sense of what's possible and feasible
- Execution! Execution! Execution!
 - Well defined executable tasks
 - Sense of responsibility
 - Timely delivery of products
- Mantra : Under-promise and over-deliver!



HOW PROFESSORS SPEND THEIR TIME



WWW.PHDCOMICS.COM

Why a career in research: Industry perspective

• Why should you care (career opportunities):

- Industrial research labs
- Advanced development groups (next gen prod groups)
- Be at the <u>forefront</u> of innovation
- Academia / industry collaboration long way to go.

• Why do we (industry) care?

- Product execution & schedules can take up 100% of an organization's resources
- Look to research community for ideas, PoCs
- Adapt ideas into products / design flows
- Academic and Industrial research has greatly influenced CPU design
 - Uarch features
 - Simulation methodology
- Push the envelope, real world solutions required