

Making It in Academia with Aspects

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The Technion

Academia can be great!

- Pick your own research, and change whenever you want (in “US” model, less in “European”)
- Try out revolutionary ideas
- Interact with smart grad students
- Consult for industry on your terms
- Relative job security (after tenure)
- Influence future generations of practitioners

Academia can be Problematic

- Less money than industry (in general)
- May be disconnected from actual practice
- May be hard to influence future practice
- Publish or perish (tenure problem)
- Departmental or University politics
- Too many diversions
 - Grant proposals
 - Departmental committees
 - Teaching

Decision points

- After BSc: Do I want grad school?
- After MSc: Do I want to do research/advanced development, plus teaching?
- After PhD: Do I want to keep the academic option open?
- After “Postdoc”: Do I want academia?

For each, if “no”, go to industry.

A PhD Topic

- Usually suggested by the advisor
- A significant problem never solved (or at least never as well as you will) that still can be solved in 3-4 years
- “Equals” ~3 conference/journal papers (with variability)

My example

- Zohar Manna asked me how we can find inductive assertions to make Hoare logic proofs work automatically
- An undecidable problem!!
- Still, we found heuristics that used difference equations, and reasoning backwards from the output assertion and loop condition, to suggest candidate loop invariants
- Techniques were “reinvented” and refined 15 years later using model checking

What is important?

- Research accomplishments
- Teaching ability and investment
 - Nice but not crucial, not enough without R
- Administrative contributions (committees, curriculum development, admissions, ...)
 - As above, but even more so....

General Principles for Research

- Find a significant problem area where you can make an impact over time
 - Scattering small efforts over many subjects is less successful
- Develop and extend your “bag of tricks”
 - How you solve problems/challenges
 - How others have treated their problems
- Synthesize: apply old solutions to new problems in a different context, and invent entirely new approach when truly inspired

A few examples

- C.A.R. Hoare: “Hoare logic”, Communicating Sequential Processes
- Ed Clarke: Symbolic model checking, CTL
- Amir Pnueli: linear temporal logic for program specification and verification, reactive systems
- Gregor Kiczales: AspectJ
- Gary Leavens: algebraic spec., Java Modeling Language

All have done other things, but...

My Bag of Tricks Includes

- Super(im)positions (Dijkstra, Chandy-Misra, Back, Sere,...) in distributed systems
- Assume-Guarantee specs, inductive verification (Hoare,.....)
- Temporal Logic (Pnueli, Lamport,...)
- Model Checking (Clarke,Emerson, Grumberg)
- Interference freedom among parallel processes with shared memory (Gries-Owicki)

My Experience

- Heuristics for generating invariants
- Using those for debugging and optimization
- Multiparty Interaction communication
- Self-stabilizing fault tolerance
- Superimpositions for distributed systems
- Convenient Executions for reasoning about serializability or cache consistency, using equivalence classes of traces from partial orders
- Translating among verification notations and properties (VeriTech)

Using my “bag of tricks” for Aspects

- How can we apply known and proven techniques of formal methods to aspects?
- Examples of problems to be treated
 - Specification of aspects
 - Modular proof of aspects with model checking
 - Interference among multiple aspects

A trade-off!!

- Combining distinct areas can be productive
 - For me: Formal Methods and Aspects
- Relatively few understand both areas
 - Spend a lot of time explaining formal methods to aspects people, and aspects to formal methods people
- Can fall between the chairs
 - Expert in A thinks A part is straightforward, and doesn't understand B part, and vice versa

An Example

- Defined new specifications for **aspects** based on **temporal logic assumptions** about **underlying system**, and **guarantee** of **woven system**
- Use **tableau of LTL assumption** with **aspect woven in** to **model check guarantee**, and provide a once-and-for-all proof of aspect correctness for a library of aspects

How are we evaluated?

- Publications....journal >> conference >> demo>>> workshop
- Recommendations
 - By leaders in your research area
 - Your advisor is not enough
- Grants and External Support
- Contribution to academic community (organize workshops)
- Local contributions (“good citizen” in department)

Implications

- Need well-defined research contribution
- Postdoc and visibility with known leaders in your field are important
- Must extend research beyond PhD
- Must work with others
- Must publish in prestigious venues
- Good teaching spreads your message, attracts good students, and is laudable, but that's it....

Is it worth it?

- Possible advantage: keep reinventing what you do, as long and as often as you want
 - Intellectually stimulating environment
 - After tenure, if you want less intensive research, can turn to teaching and administration (or go to industry...)
- or you can continue working on new areas of research

Thanks and Good Luck!

Questions?