

# Future Courses

- Attend “Course fair” in January to learn about your 3<sup>rd</sup> and 4<sup>th</sup> year course options.
- If you liked ECE241...
  - ECE243: Digital and Computer Systems
  - ECE334: Digital Electronics
    - Transistor-level design, simulation.
  - ECE342: Computer Hardware
    - Direct extension of ECE241. More gate-level.
  - ECE451: VLSI Systems, ECE452: Computer Architecture, ECE532: Digital Systems Design.

# Professional Experience Year (PEY)

- Work between your 3<sup>rd</sup> and 4<sup>th</sup> years (16 mos).
  - AMD, Actel, IBM, Altera, ...
- Most (~2/3) of our undergrads do PEY.
- +: Get to know a company; they get to know you.
  - Employment opportunities later on.
- +: Get a leg up on grads with no experience.
- +: Earn a salary.
- -: Delays your graduation by a year.

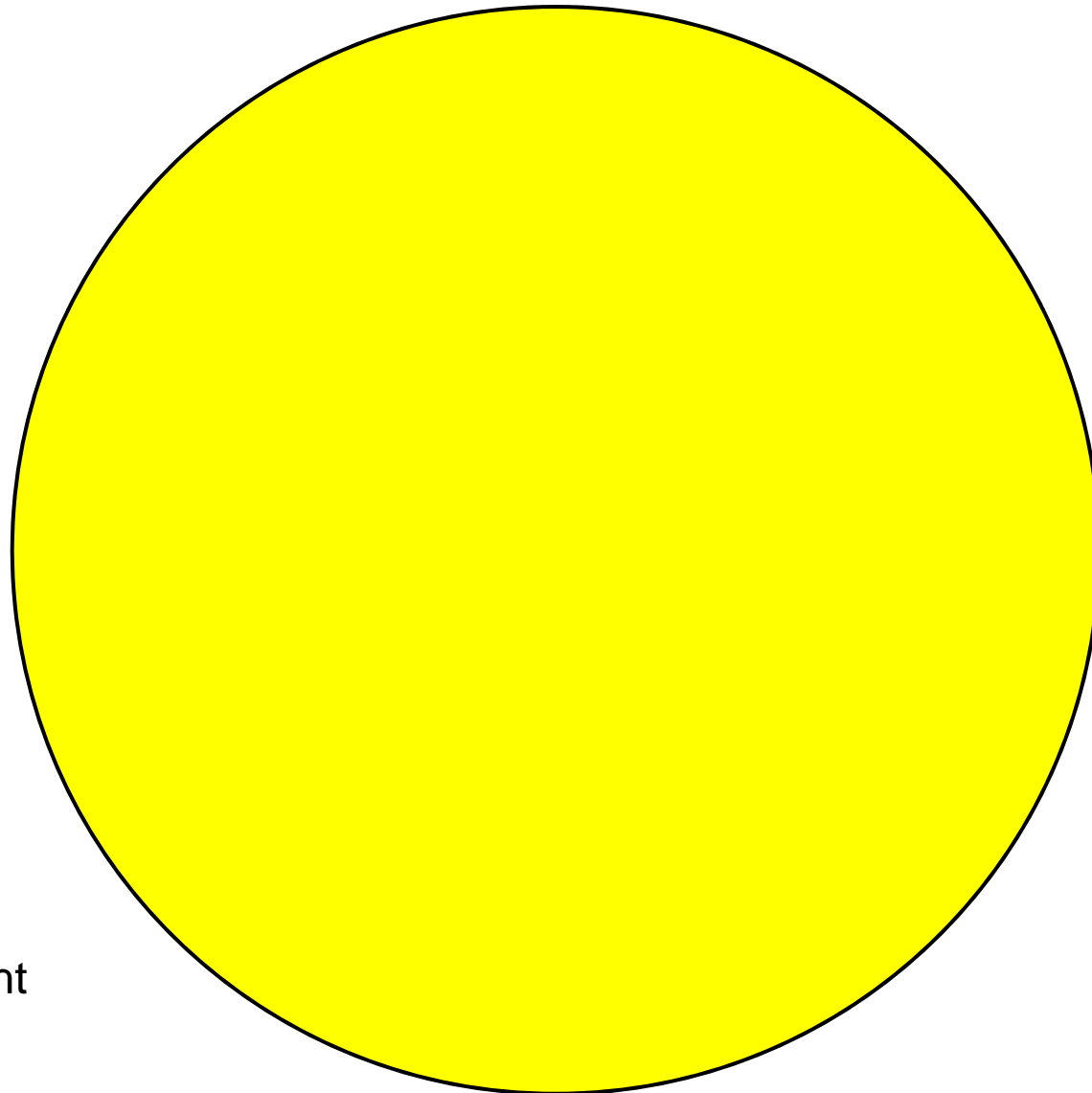
# What is Research?

- Advances human knowledge.
  - “Create” knowledge.
- Shedding light on unknown.
  - Transforming the unknown → known.
- Innovation:

Creativity brought to a useful purpose.

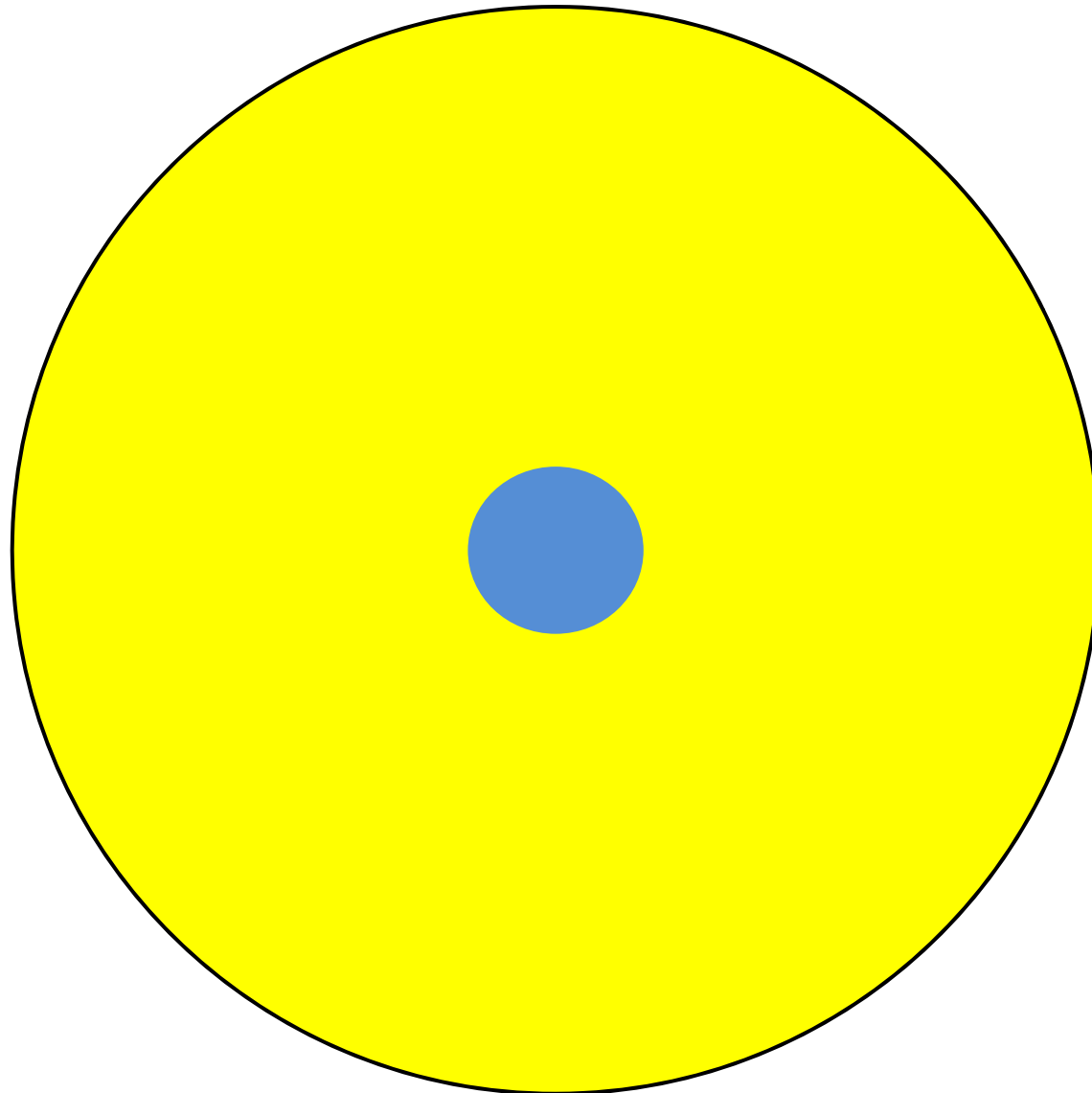


# All of Human Knowledge

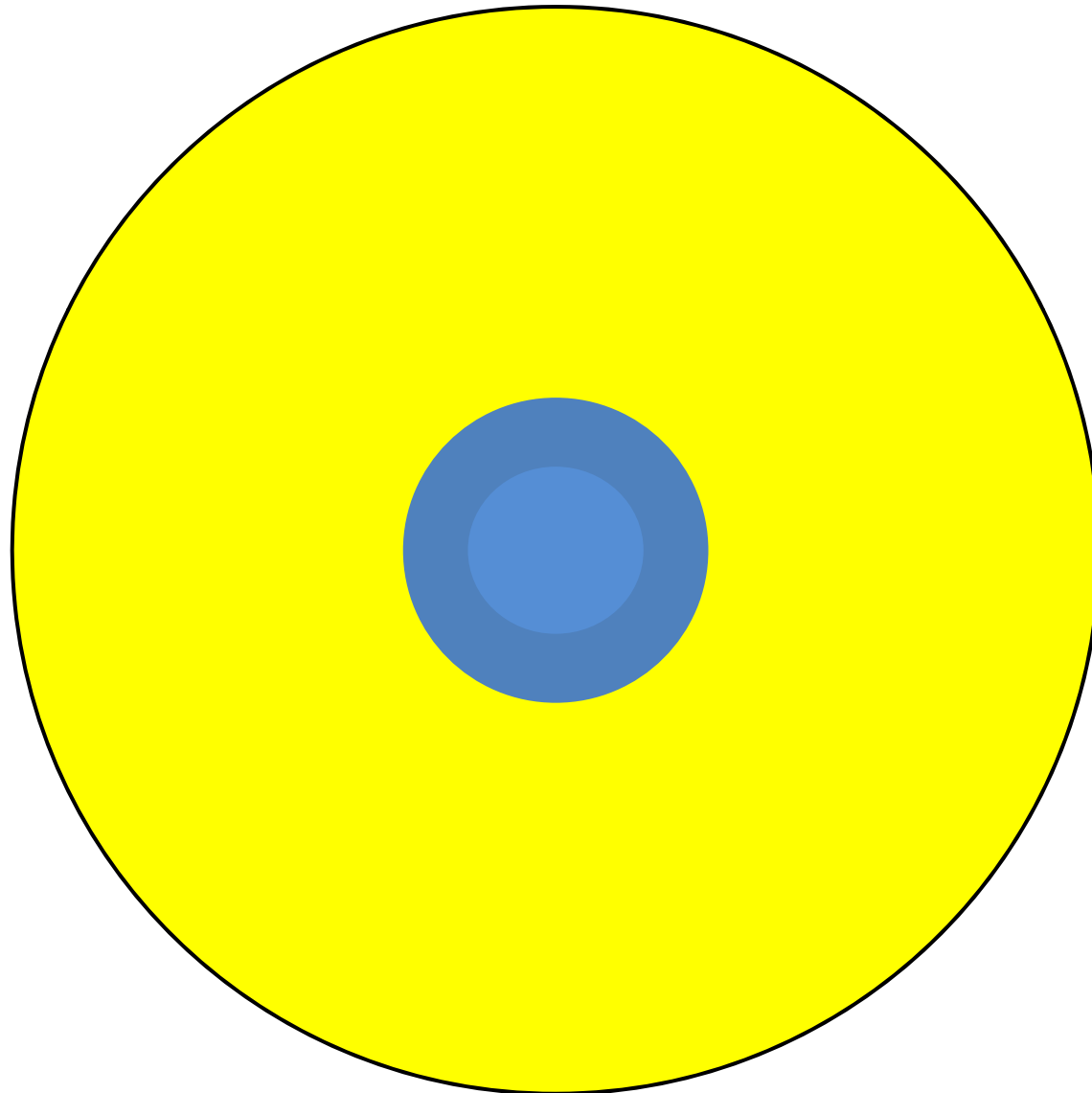


Source: Matt Might  
Univ. of Utah

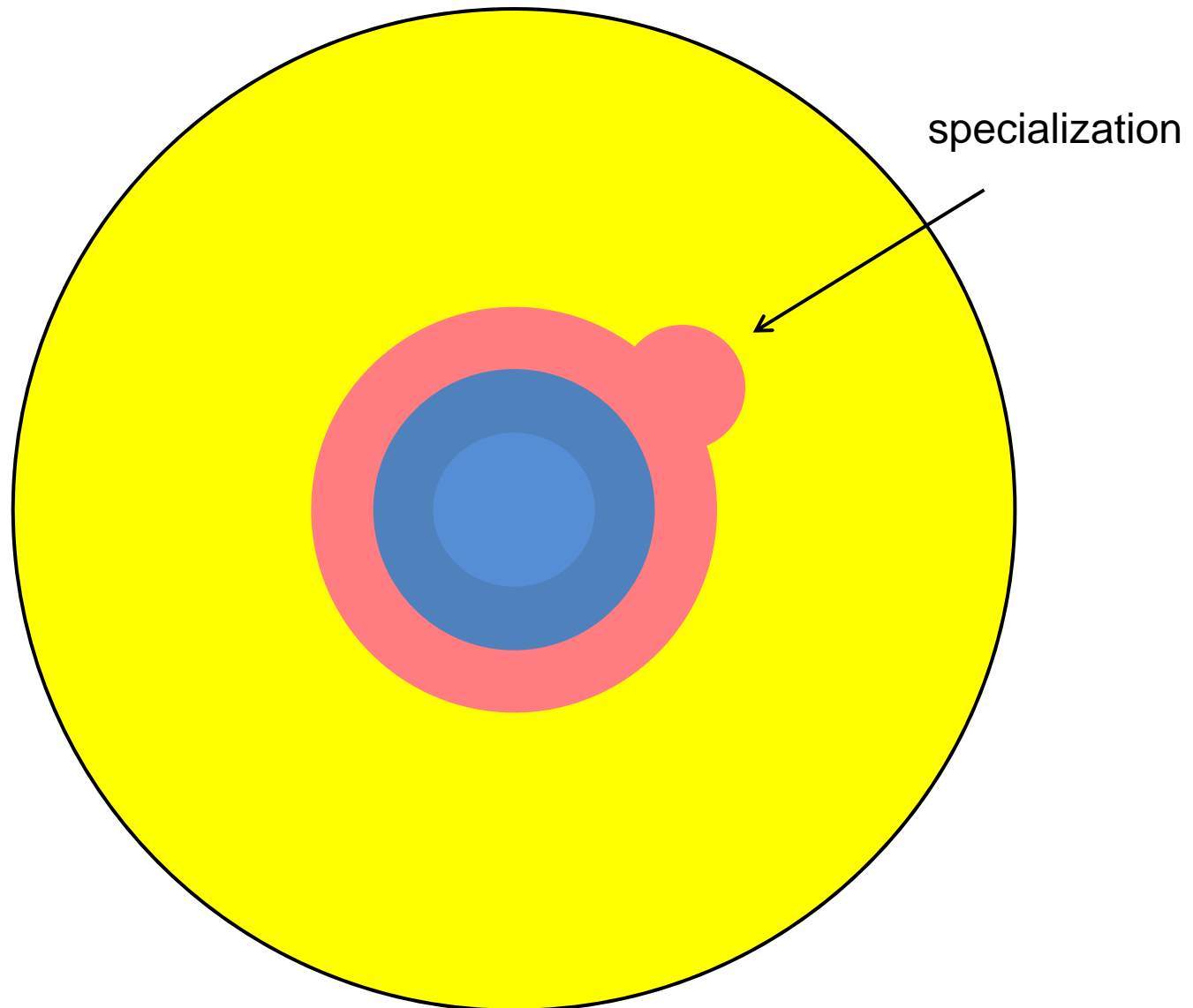
# Elementary School Education



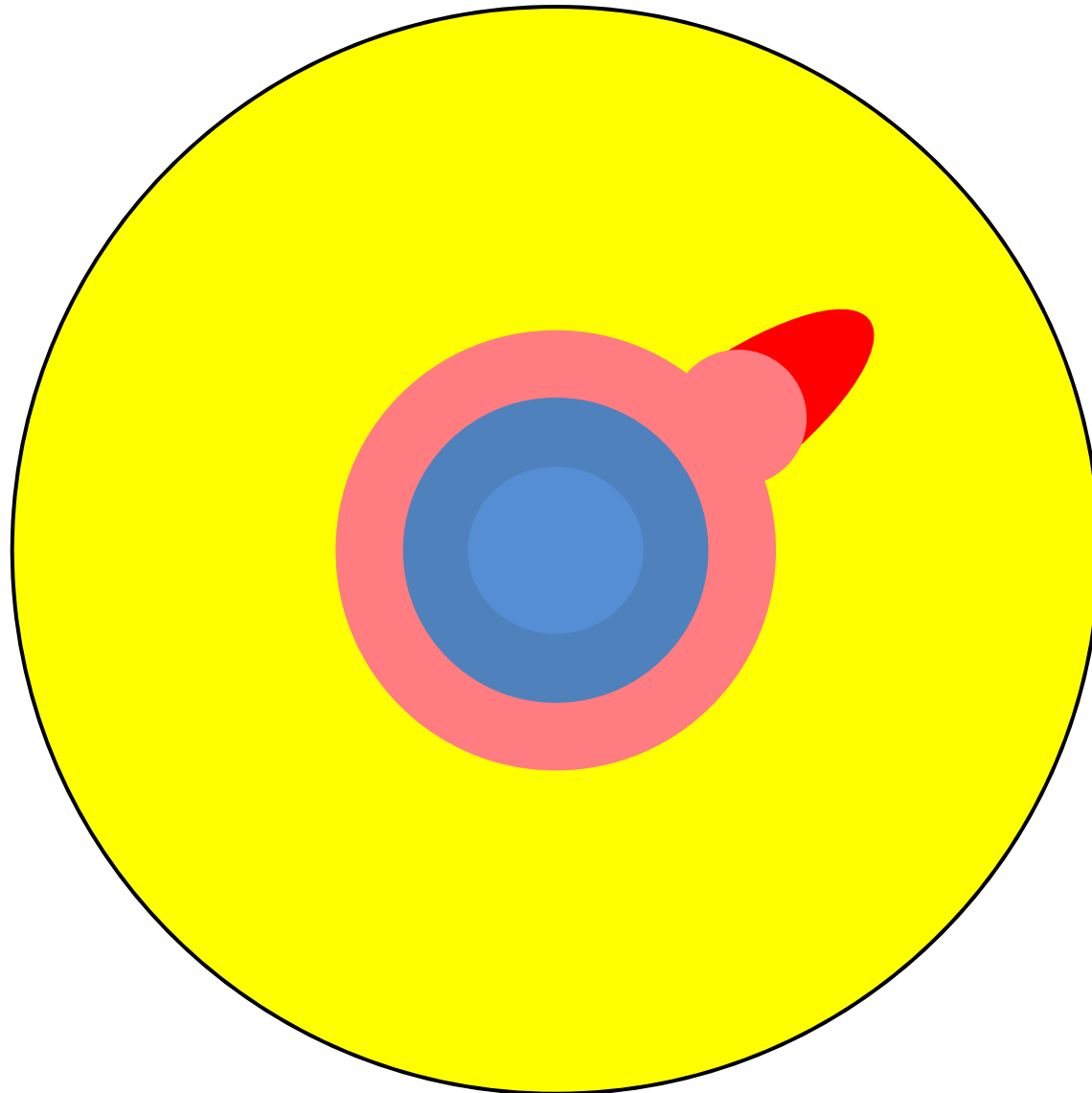
High School



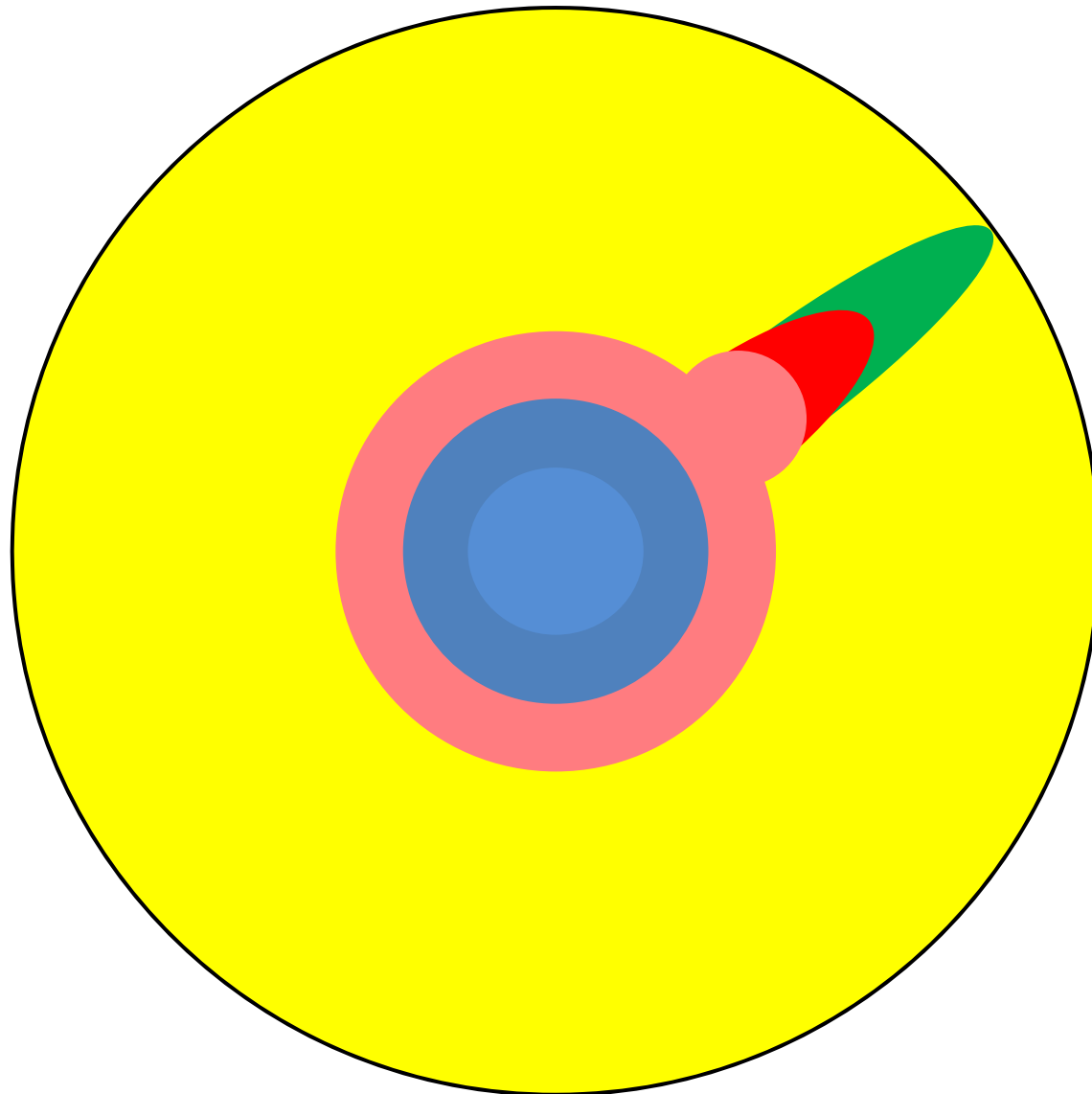
# Bachelor's Degree



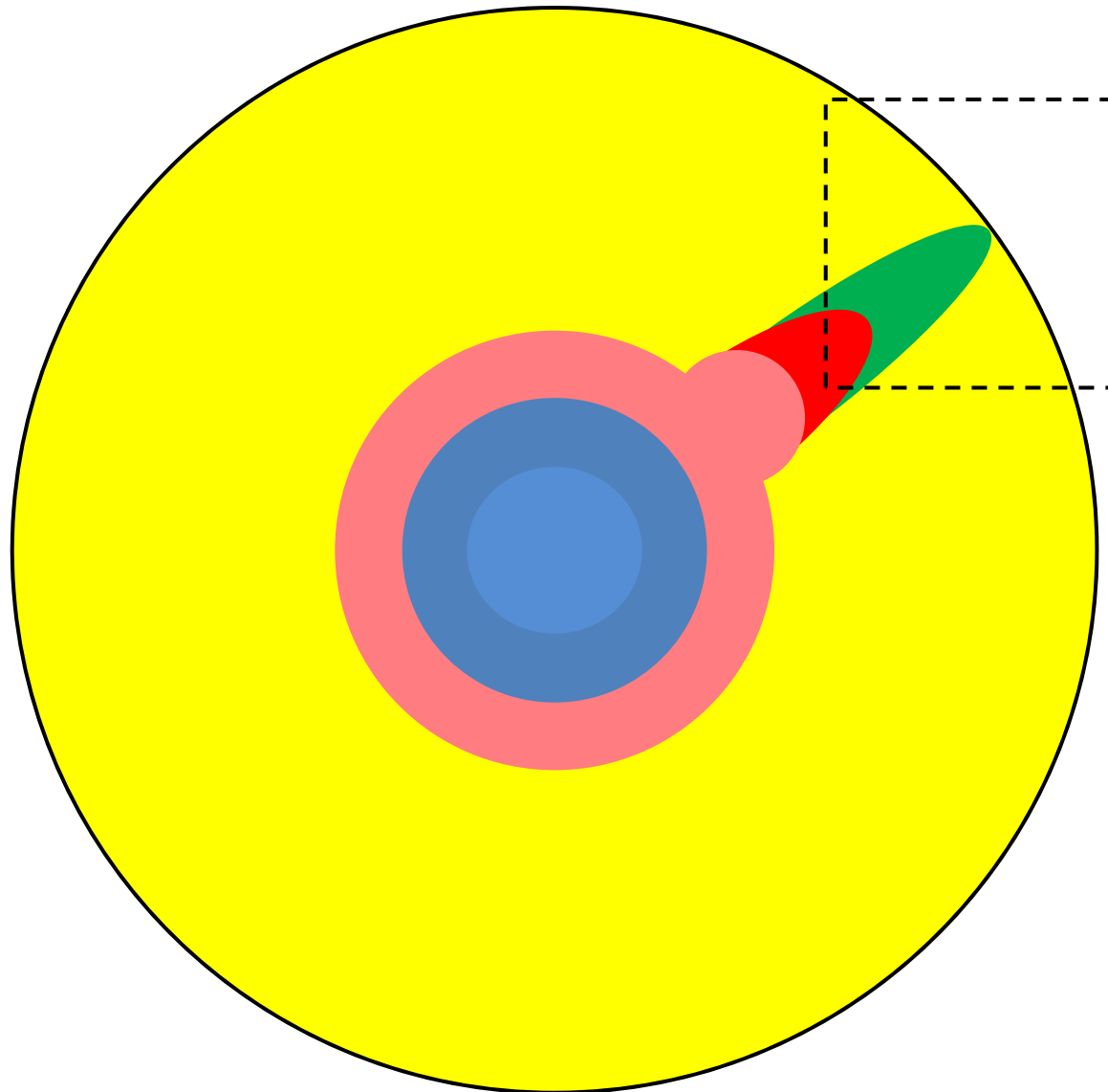
# Master's Degree



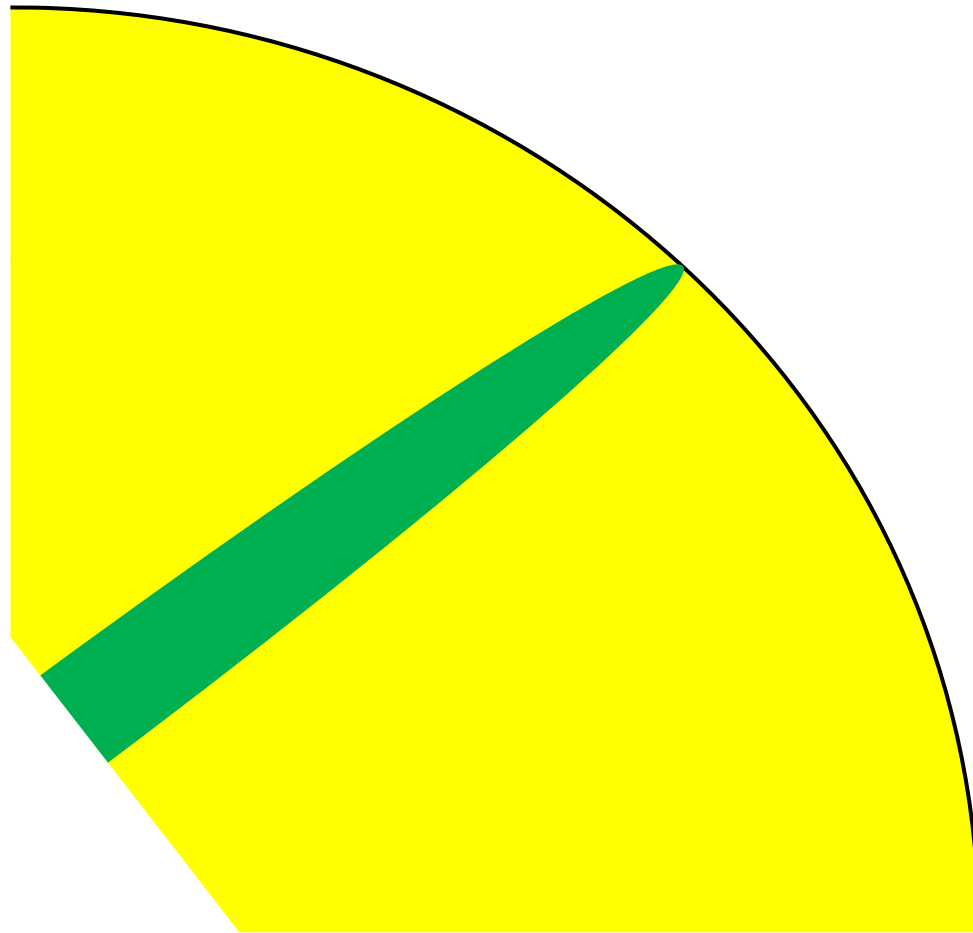
# Reading Research Papers



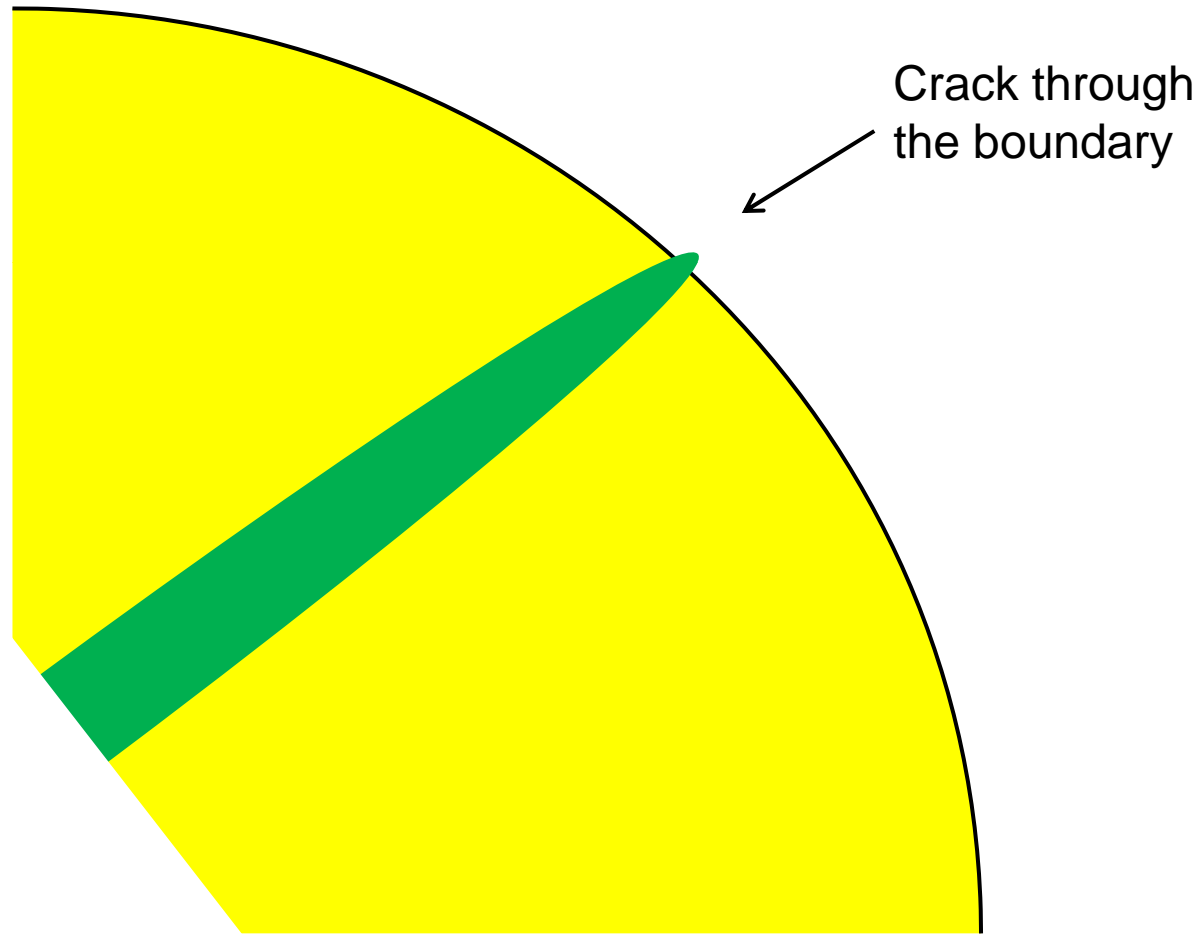
# Zoom in at the Boundary



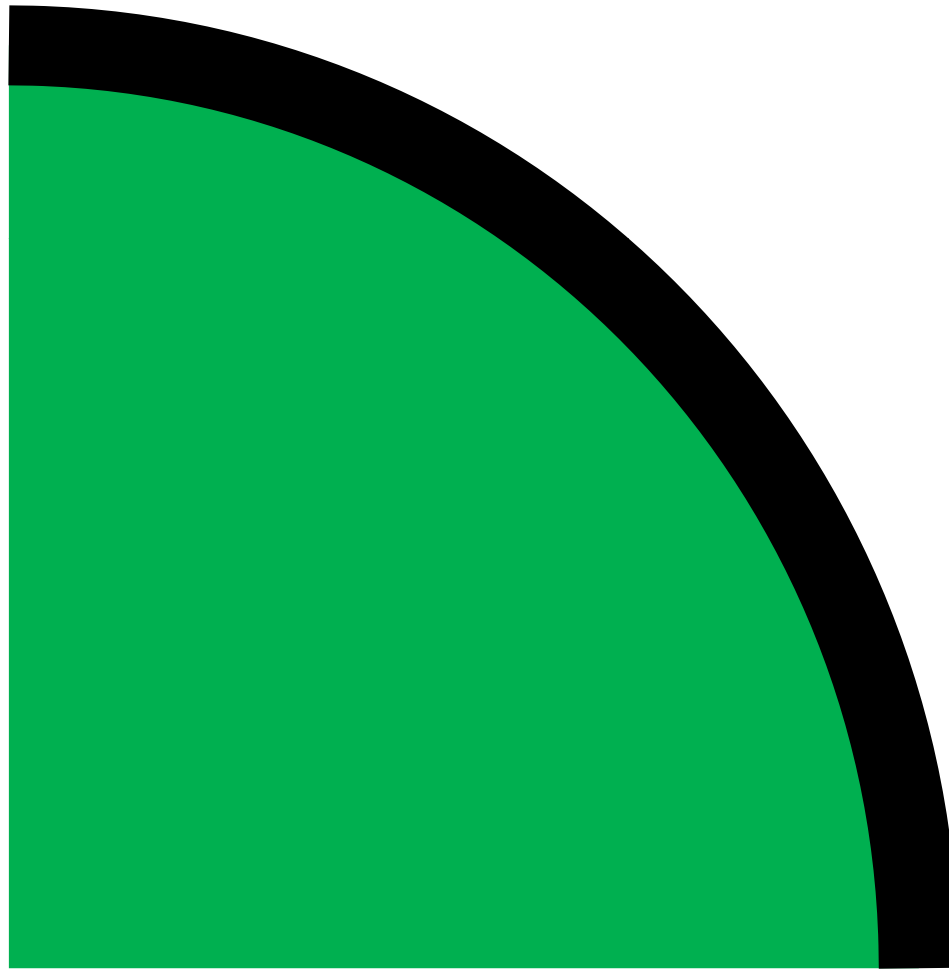
# At the Boundary



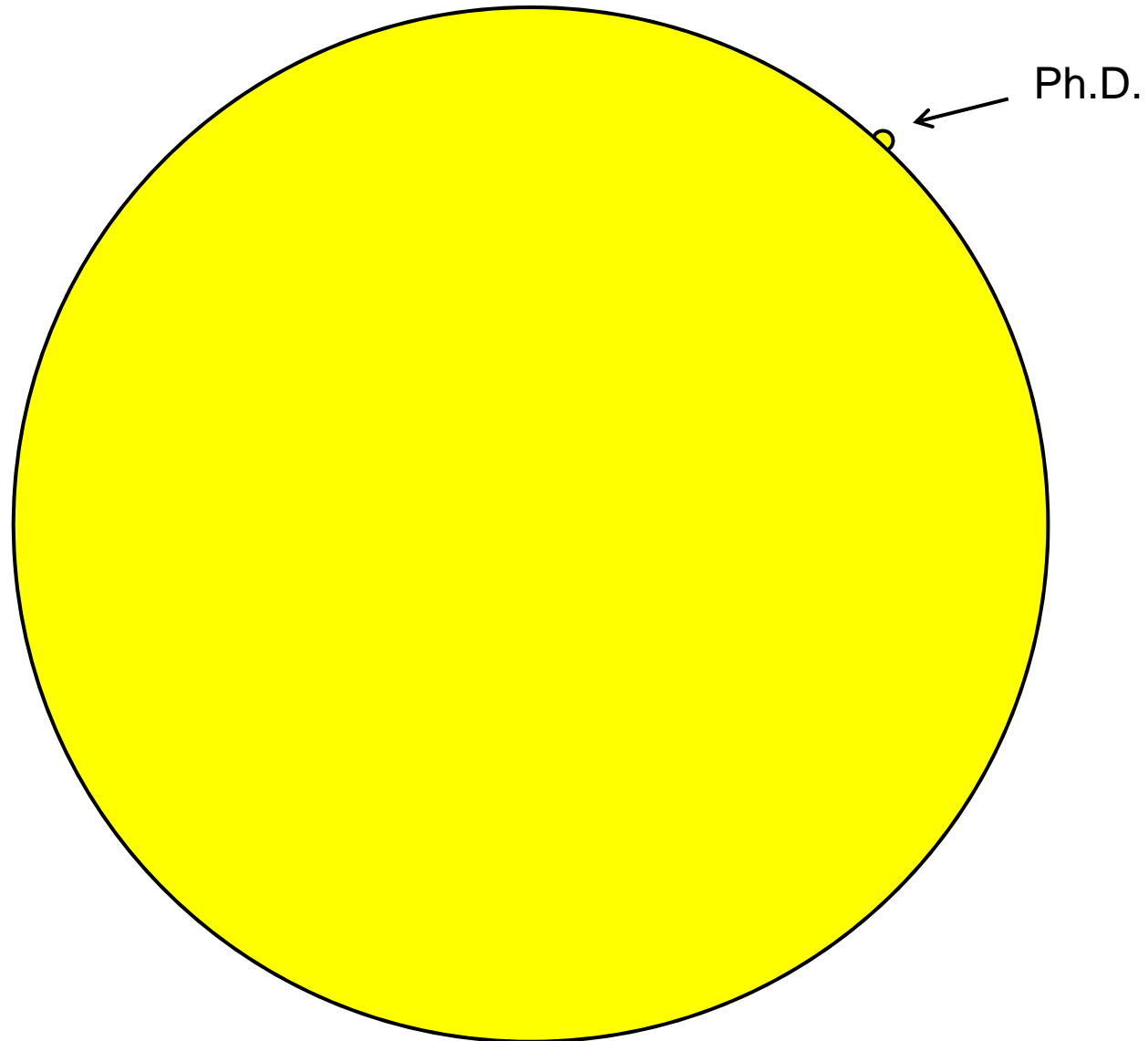
# Ph.D. Degree



# Knowledge Expansion



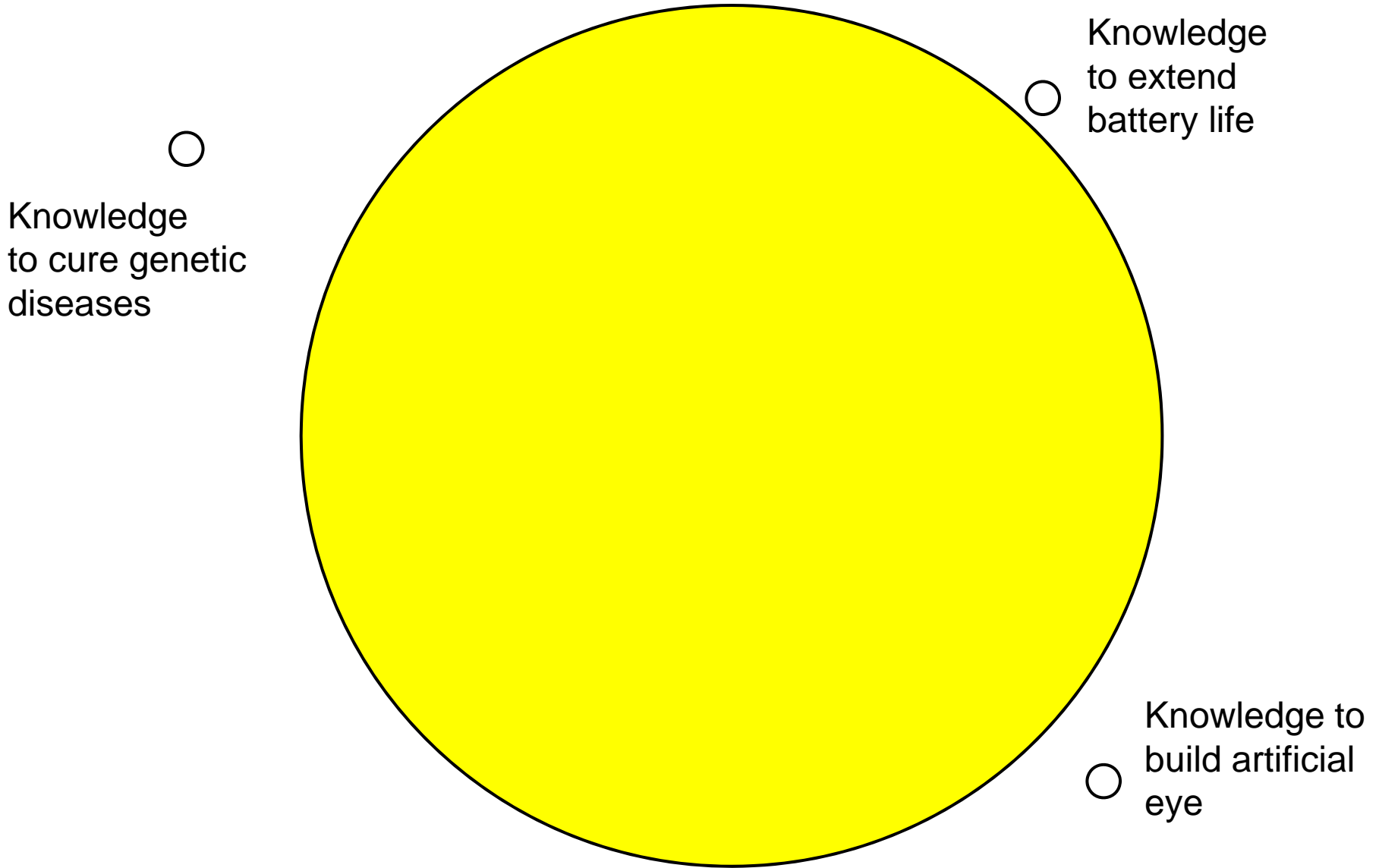
# Grand Scheme of Things



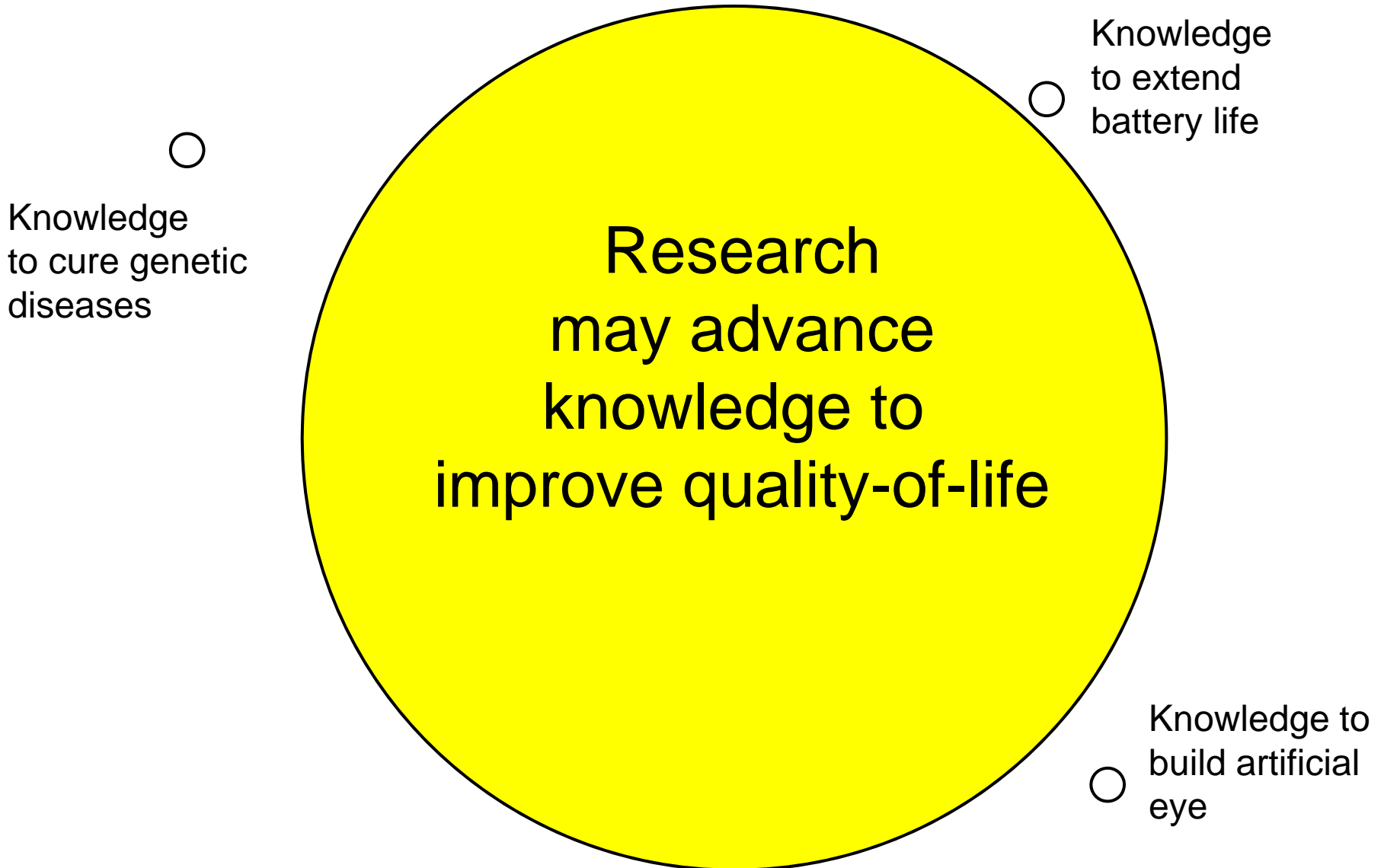
# Research

- A noble pursuit:
  - Extends human knowledge in a specific area.
  - A great service.
- A good master's degree can also extend human knowledge.
  - Though less so than a Ph.D.
- Years of work for a tiny “bump” in human knowledge?

# Outside the Circle



# Outside the Circle



# USRA

- NSERC Undergrad Student Research Award.
- Do summer research with a prof.
  - Find if you're cut out for doing research!
- Pays ~\$1400/month for 4 months (May-Aug).
  - 80% comes from the federal gov't.
- ECE dept has an allocation of 30 USRAs.
- Must be Canadian or PR to apply.
- Deadline is end of January.

# Considering a Master's Degree?

- Take advanced courses and thesis.
- Specialize in an area that interests YOU.
- Do a teaching assistantship.
  
- **Stretch yourself and find out whether research and teaching energizes you!**
  
- Good “return on investment”:
  - About 2 years.
  - Improved career options.
  - External visibility through your research .

# LegUp: A Self-Accelerating Adaptive Processor

Students: Andrew Canis, Mark Aldham, Jongsok Choi, Stefan Hadjis, Kevin Nam,  
Victor Zhang, Ahmed Kammoona

Faculty: Jason Anderson, Stephen Brown

Industrial Liaisons: Tom Czajkowski, Desh Singh

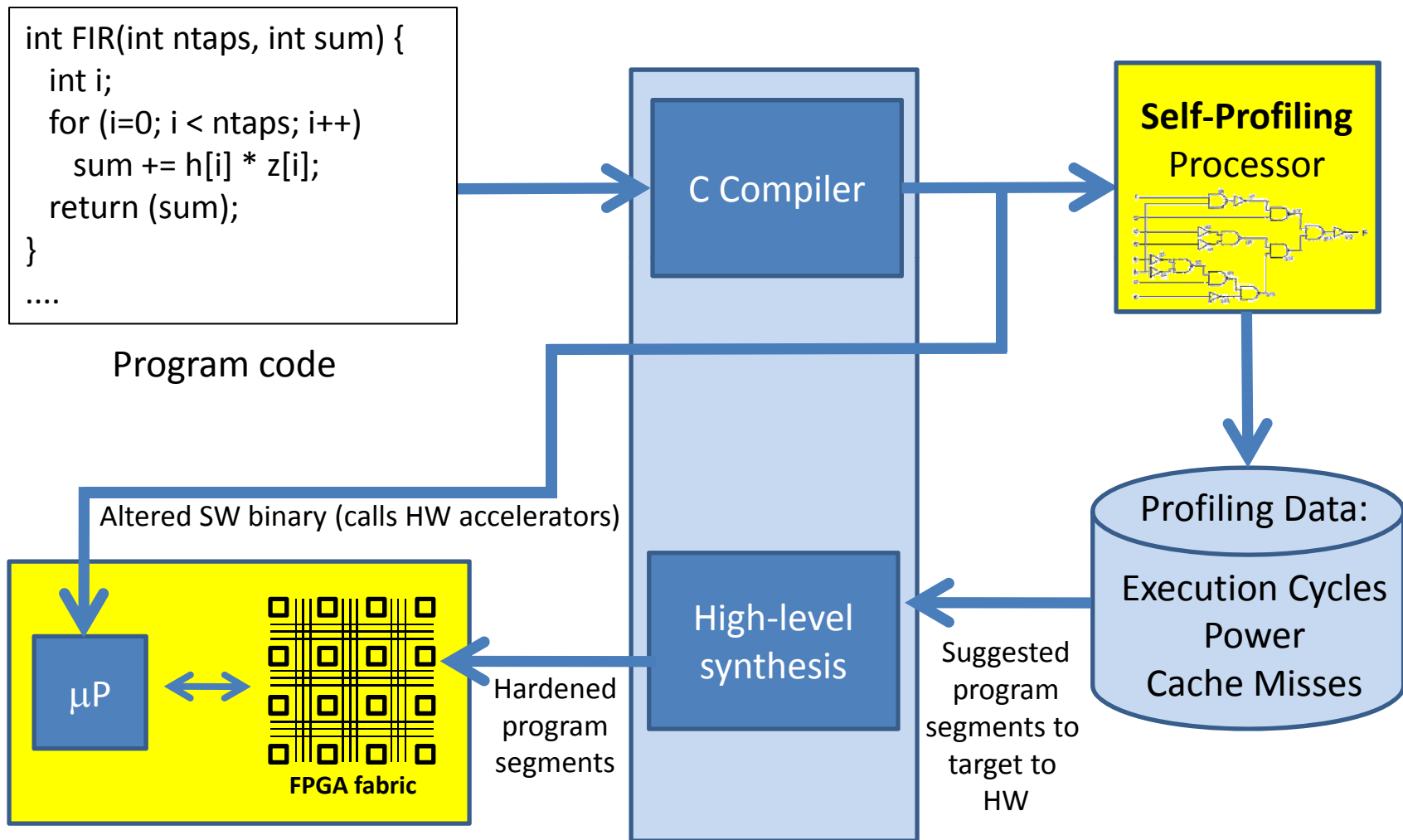
Appears in ACM FPGA 2011, FPGA 2012

# Motivation

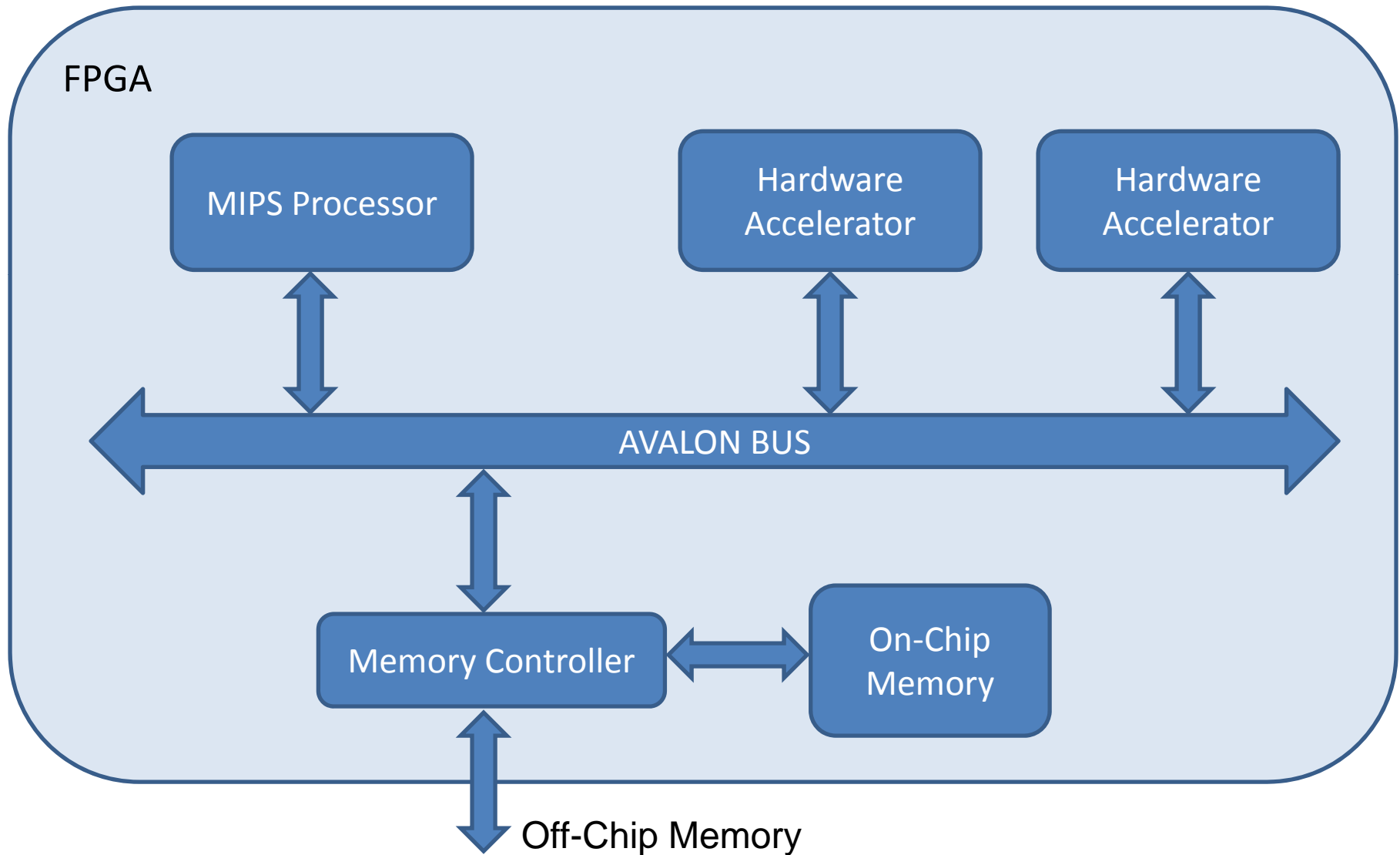
- Hardware design has advantages over software:
  - Performance: lower latency, higher throughput
  - Energy-efficiency
- Hardware design is difficult and skills are rare:
  - 10 software engineers for every hardware engineer\*
- We need a CAD flow that simplifies hardware design for software engineers

\*US Bureau of Labour Statistics '08

# Top-Level Vision



# System Architecture

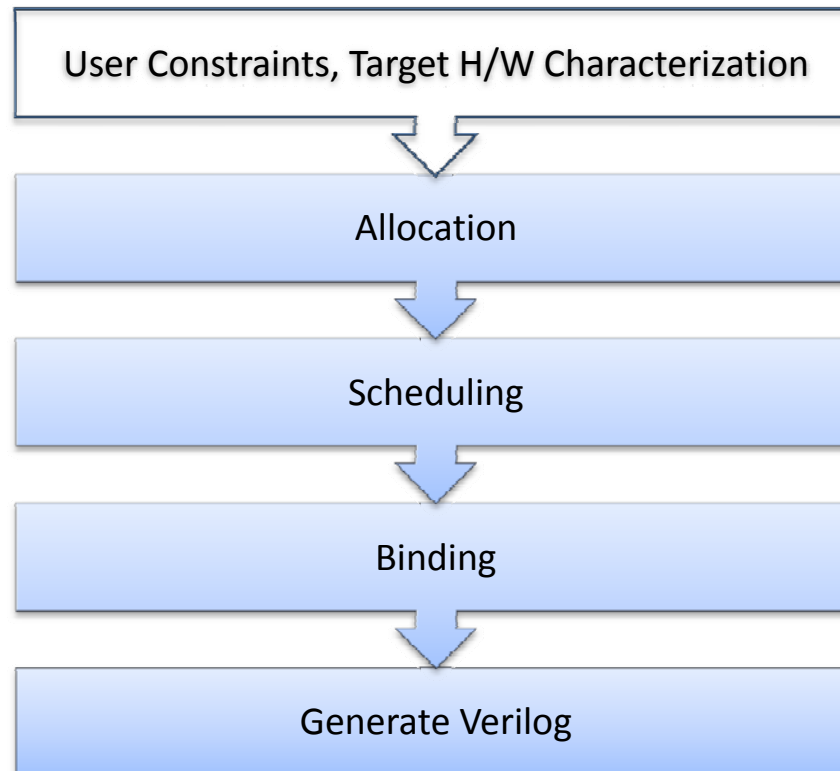


# High-Level Synthesis Framework

- Leverage LLVM compiler infrastructure:
  - Language support: C/C++
  - Standard compiler optimizations
- We support a large subset of ANSI C:

Supported	Unsupported
Functions	Dynamic Memory
Arrays, Structs	Floating Point
Global Variables	Recursion
Pointer Arithmetic	

# LLVM-Based High-Level Synthesis



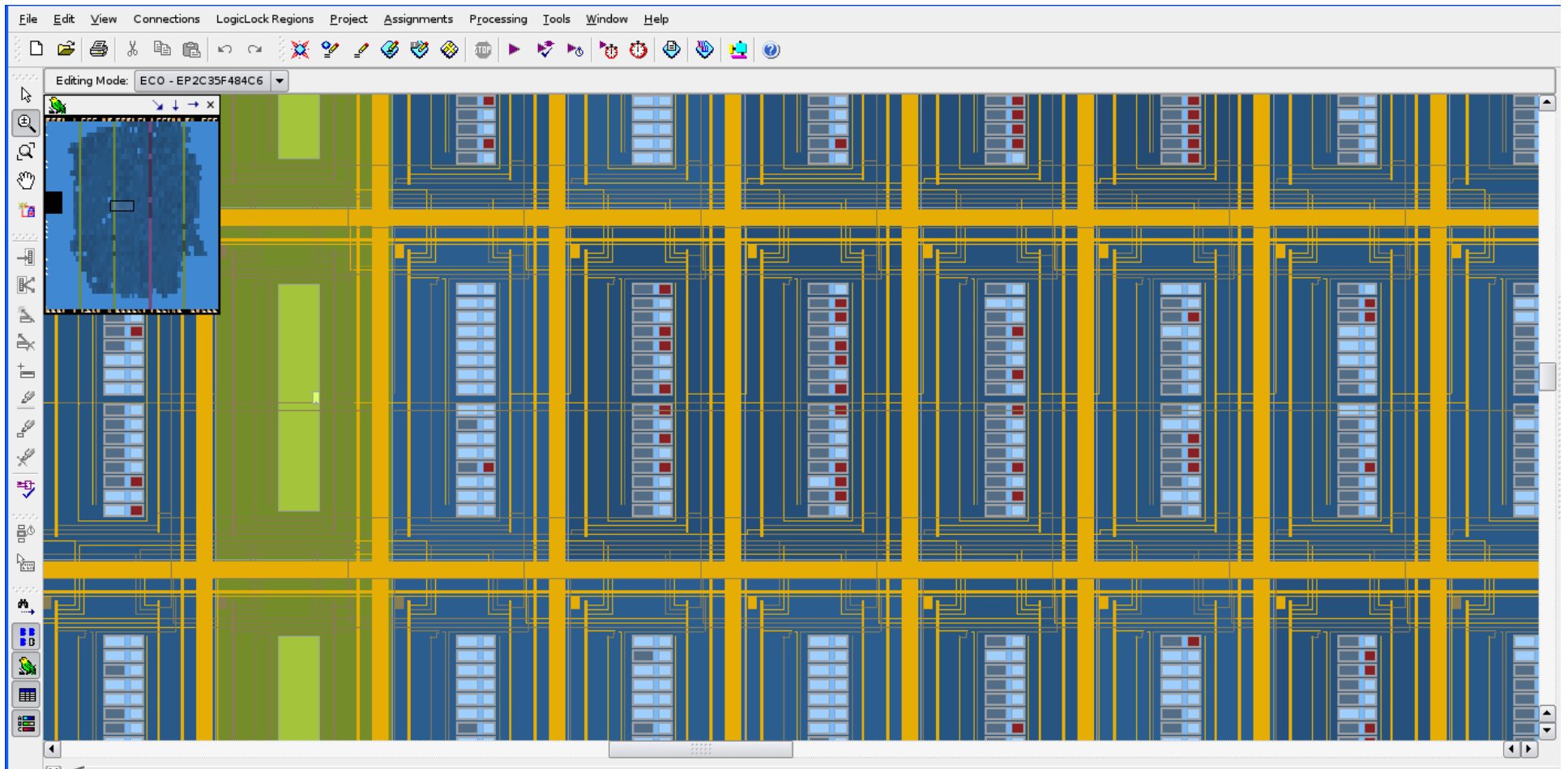
- Flexible compiler pass architecture
  - Passes can be swapped for alternate algorithms

# 13 C Benchmarks

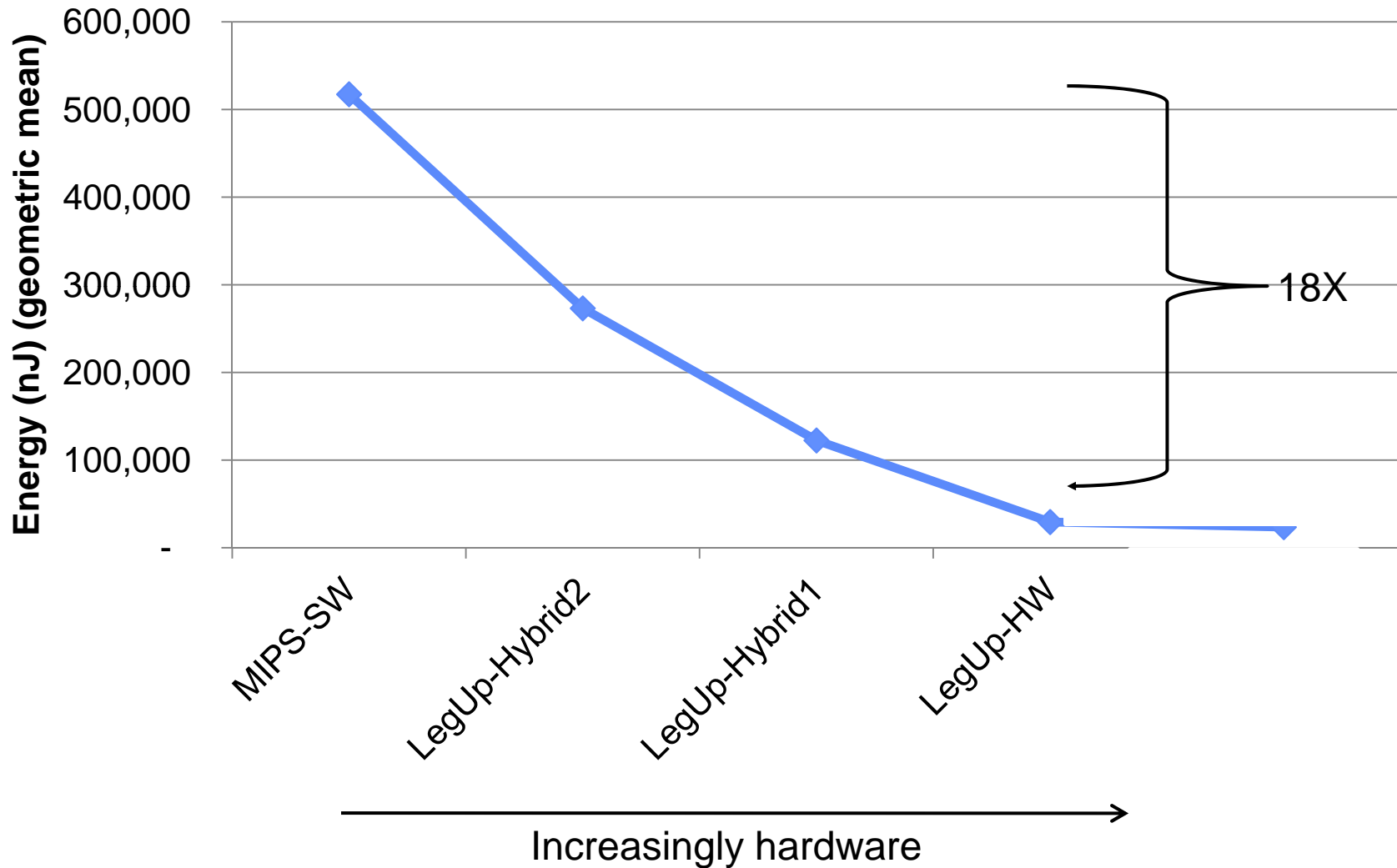
- 12 CHStone Benchmarks (*JIP'09*) and Dhrystone
  - Too large/complex for academic HLS tools
- Include golden input/output test vectors

Category	Benchmarks	Lines of C code
Arithmetic	64-bit double precision: add, mult, div, sin	376 – 755
Encryption	AES, Blowfish, SHA	716 – 1,406
Processor	MIPS processor	232
Media	JPEG decoder, Motion, GSM, ADPCM	393 – 1,692
General	Dhrystone	491

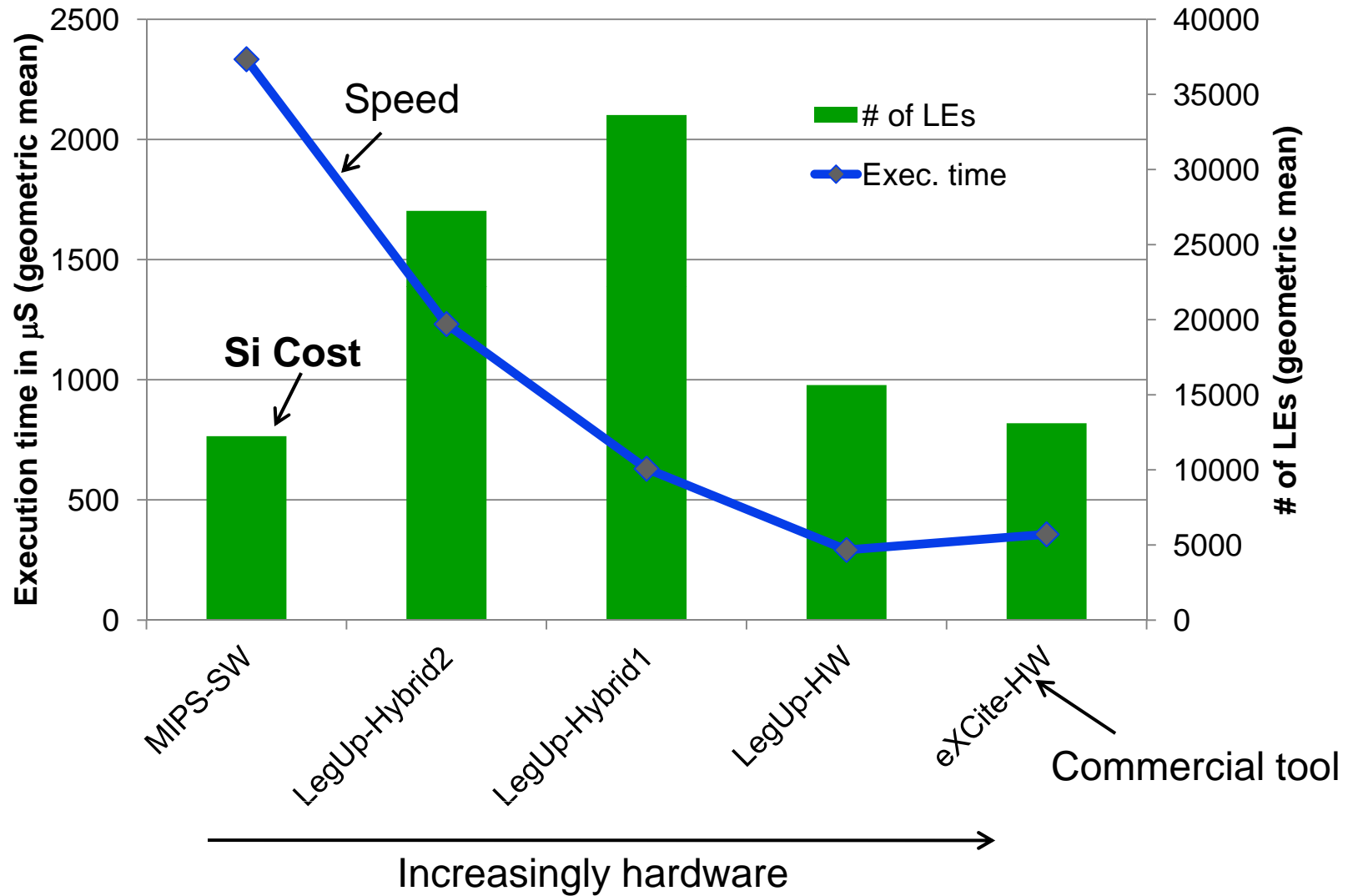
# Example FPGA Implementation of a Program



# Results: Energy Consumption



# Speed and Silicon Area



# Our Research Objectives

- Trying to change the way people design hardware digital circuits.
  - Make hardware design **much** easier and less costly.
  - Improve the energy-efficiency and speed of computations.
  - Lofty and **hard**.
- 3 M.A.Sc. students involved +  
2 summer undergraduate researchers.
- Industrial funding.

Questions?