SOLOMON FEFERMAN

INSPIRATION, MENTOR
COLLEAGUE & FRIEND
IN APPRECIATION THEN AND NOW

“

I would like to thank Professor Solomon Feferman for agreeing to undertake the task of being my thesis advisor, and for his interest, encouragement, and support. I am grateful to him for many helpful discussions which have provided a deeper understanding of relations and distinctions between foundational work in logic and computer science. These discussions have been fundamental in clarifying the ideas, motivations, and goals of my work and in relating it to logic.

“

— Carolyn Talcott, Essence of Rum, acknowledgements
A LITTLE BACKGROUND

• As a PhD student, my interest was in foundations for reasoning about programs

• This lead to an interest in logic
  
  • reading Curry over the summer
  
  • attending Feferman’s logic classes
  
  • studying his papers on formal theories

• I needed a thesis advisor (I had funding from the AI Lab)
  
  • I invited Sol to my office and showed him my ideas
  
  • I asked if he would be my thesis advisor
  
  • I think he was surprised, but happily he agreed
FEFERMAN AS MENTOR

SOME STORIES

• On the way to the Forum*

  • Sol introduced my Stanford Computer Forum presentation

  • He spent > 5 minutes describing my background and work!
    • How did Sol find out all that stuff about me?
    • There was no Google in those days

• The ultimate challenge: getting my thesis read.

  • Sol was very busy with Volume I of the Godel collected works

  • There were typesetting issues -- need for special fonts/characters.

  • We made a deal: I would make fonts while he read the thesis.

* The Stanford Computer Forum is provides CS&EE industry with access to recruiting, faculty liasons, students interns, workshops/courses ... in return for many $$$.s
FEFERMAN AS INSPIRATION

1971 Tarski Symposium
Feferman honoring his mentor
FOUNDATIONAL GOALS

MATHEMATICS

• Goals for foundations of mathematics
  • to account for practice -- to provide precise definitions of informal concepts so that formal proofs can be carried out
  • to isolate underlying principles for definition and proof and to determine what principles are needed for what parts of mathematics
  • to isolate the proof theoretic strength of various fragments of mathematics
FOUNDATIONAL GOALS

COMPUTING

• Goals for foundations of computing
  • to account for practice -- to provide precise definitions of informal concepts so that formal proofs can be carried out
  • to improve practice — an understanding of
    • the mathematical properties of computation and of operations combining various mechanisms is a valuable tool for writing, debugging, and verifying programs
    • the mathematical consequences of combinations of computation mechanisms and of choice of computation structures and their representation is important for the design and implementation of programming systems

Constructive theories of functions and classes, in: Logic colloquium 78, edited by M. Boffa, D. van Dalen and K. McAloon (North Holland, Amsterdam) pp. 159–224. 1979 (not shown)

VARIABLE TYPE SYSTEMS IN A NUTSHELL

• Feferman's variable type systems [1975, 1975, 1979] are two sorted theories of operations and classes initially developed for formalization of (constructive) mathematics. Feferman continued development and application of these systems to study purely functional languages.

• In fact, these systems form the cornerstone for study of a much broader class of computation models and languages.

• Main ideas for computing
  • Natural representation of mathematics
  • Explicit representation of operations and classes
  • Intensionality
  • Partiality
  • Essentially First Order
So what is missing?

- ‘Real programs have effects’
  - From a paper in the Journal of *Functional Programming* by Agha, Mason, Smith & Talcott.

- Real programs don’t just compute functions, they
  - read and write memory
  - manipulate their own control structure (computable goto's)
  - describe distributed processes that interact with each other and with the physical world (including humans).

- Question: What does equivalence mean in this case?
  - Want substitution of equals for equals
  - Intuition: ‘not distinguishable by any context of use'
BUILDING ON FEFERMAN'S FOUNDATIONAL WORK

SEMANTIC MODELS

- Essence of Rum (Talcott thesis)
  - developed a theory of control primitives
  - defined combinators for computations
  - studied notions of program equivalence

- The Semantics of Destructive LISP (Mason thesis)
  - introduced memory structures to model destructive operations,
  - studied of equivalence relations
  - intentionality v extensionality
VTLoE (Variable type Logic of Effects)
- a first-order theory of individuals built on equality and contextual assertions (updatable memory)
- a theory of classes and class membership (semantic types) -- supports construction of inductively defined sets and derivation of the corresponding induction principles.

Feferman Landin Logic (presented at the Feferfest, 1998)
- generalizes VTLoE to a wide collection of languages meeting simple conditions on rules defining the primitives, inspired by Landin’s Next 700 Programming Languages)
- includes axioms and reasoning principles adequate for treating existing reasoning bench marks and more.
- Restricted to programs that are sequential / non-reactive

Actors and Logical Analysis of Interactive Systems
- Towards a foundational understanding of distributed interactive systems
  - language and principles for specification of and reasoning about such systems.
  - elucidation of the distinction between sequential (turing equivalent) computation and interactive computation
- Result: the set theoretic models of the formal interaction theory have greater recursion theoretic complexity than analogous models of theories of sequential computation.
Rick asked me to talk about Sol’s work in Biology.

I only learned he was working on formal Biology when we were both invited to speak at a workshop at the AMS meeting in January 2016 (Applications of Logic, Model Theory, and Theoretical Computer Science (LMT&TCS) to Systems Biology.)

Sol discussed ideas for modeling biological systems continuing the ideas of Variable Type Theories:

- top down -- systems view
- many-sorted first-order structures with nested (sub)sorts and substructure
- heterogeneity: multiple levels of abstraction with a model
- sorts indexed by time to model dynamics
- application of recursion theory to model homeostasis

With further development, these ideas could result in a framework for integrating diverse models of specific aspects of a system. Currently an unsolved problem.
COLLEAGUE & FRIEND

• Joint student (Ian Mason)
  • Documented in "Two PhD Students for the Price of One" (a paper contributed to the 2011 Festschrift in my honor.)
  • A joint NSF grant -- looking a data types from an operations and classes perspective.
  • I had the honor to be a local organizer of the Feferfest (70th birthday, organized by Jon Barwise and Wilfried Sieg).
  • As usual Sol says it better than I can: In 2 for 1 he says: "I have maintained warm personal relations with both of them over the years since they completed their respective doctoral theses."
Thank you Sol for being you. Even though you are not physically here, you remain a guiding light.