Reflections on Early AI and CS at Stanford 1963 – 1969 and Beyond

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1960s: The Golden Age of SAIL

- Robotics
- Computer Vision
- Knowledge Engineering
- Speech
- Language Understanding
- Computer Music
- Chess, Symbolic Mathematics, Correctness of Programs, Theorem Proving, Logical AI, Common Sense
- Time Sharing
- LISP
- DEC Clones: Foonly, Graphical Editors, Pieces of Glass, Theory of Computation

The Hand Eye Project

- Interaction with the Physical World
  - Early work by
    - Karl Pingle, Bill Wichman, Don Pieper and Vic Scheinman
  - Main Project Team
    - Jerry Feldman, R. Lou Paul, Marty Tenenbaum, Gerry Agin, Irwin Sobel, etc.
  - Started in 1965
  - Using the PDP1 and later the PDP6
- Led Machine Vision and Robotics Industry
  - Via SRI and Vic Scheinman

Image Analysis and Understanding

- Image Analysis
  - Manfred Hueckel, Ruzena Bajcsy, and Tom Binford
- Led to Vision and Robotics at UPenn

- Image Understanding
  - Natural Scenes and Face Recognition
    - Mike Kelly and Raj Reddy
- Led to Vision and Robotics at CMU

Mobile Robotics

- Mars Rover and Stanford Cart
  - Marvin Minsky (visiting)
    - Mars Explorer project 1964
  - Les Earnest
  - Bruce Baumgart
  - Lynn Quam
  - Hans Moravec
  - Rod Brooks (later in the seventies)
- Influenced direction of programs at SRI and MIT

Capturing Expertise

- Heuristic Dendral: Representation, acquisition and use of knowledge in chemical inference
  - Project Team
    - Ed Feigenbaum, Josh Lederberg, Bruce Buchanan, Georgia Sutherland et al.
  - Started in 1965
- Led to
  - Expert Systems, Knowledge Engineering
  - Knowledge Based Systems Industry
  - Early Applications of AI

Speech

- Speech Input to Computers
  - Started in 1964 as a class project
  - Using a PDP1 with drum memory and a display
  - By the end of 1964 we had a vowel recognizer running
  - Project team in the sixties
    - Raj Reddy, Pierre Vicens, Lee Erman, Gary Goodman, Richard Neely
- Led to the DARPA Speech Understanding Project during the years 1971-76
- Most influential branch of Speech Recognition Industry: Dragon Systems, Apple, Microsoft
  - Indirectly IBM and Bell Labs

Language Understanding

- Parsing and Understanding of Natural Language: Question Asking and Dialog Modeling
  - Computer Simulation of Belief systems
    - Ken Colby, Lawrence Tesler, Horace Enea et al
  - Parsing of Non-Grammatical Sentences
    - Colby, Enea et al
  - Conceptual Parsing
    - Roger Shank
- Led to Language Processing Industry
  - via Shank and associates
- Led to other Language Processing groups at Yale and UCLA
  - CMU, UMass, Berkeley, etc.
- Influential strand of Language research

Computer Music

- Computer Synthesis of Music
  - Started in 1964 on PDP1
    - John Chowning
    - Leland Smith
    - Andy Moorer
- Impact
  - Led to Yamaha adopting digital synthesis for consumer products
  - Establishment of a Center in Computer Music in Paris

Other AI Projects

- Chess and other game playing programs
  - Kalah: R. Russell
  - Chess: McCarthy, Barbara Huberman (Liskov)
  - Checkers: Art Samuels
- Symbolic Mathematics
  - Algebraic Simplification: Wooldridge and Enea
  - Reduce: Tony Hearn
- Proving Correctness of Programs
  - Correctness of Programs: McCarthy and Painter
  - Equivalence of Programs: Kaplan and Ito
  - Properties of Programs: Zohar Manna
- Theorem Proving
  - David Luckham and John Allen
- Use of Predicate Calculus as a Representation for AI
  - McCarthy, Cordell Green et al
- AI and Philosophy
  - McCarthy and Pat Hayes
- Programs with Common Sense
  - McCarthy, later by Doug Lenat

Non-AI Research at SAIL

- Programming Languages
  - LISP
    - Symbolic Computation
    - Dynamic Storage Allocation and Garbage Collection
    - Forerunner of Functional Programming
  - SAIL
    - LEAP Associative Data Structure
      - Feldman and Rovner
- Time Sharing and Real Time Systems
- Graphics
  - scan line graphics!
- User Interfaces
  - Graphics text editors and Graphical debugging
- Systems: Foonly and other clones
- Team: Earnest, Russell, Weiher, Poole, Panofsky, Sauter, Baumgart, Quam, Swinehart et al

Non-AI Research at SAIL (Cont)

- Theory of Computation (SAIL Memo No 28, 1965)
  - Semantics of Programming Languages
    - What do strings of symbols representing programs … denote!
  - Data Spaces (aka Data Structures)
  - Representation of Time Dependent and Simultaneous Processes
  - Speed of Computation (aka Computational Complexity)
  - Storage of Information (aka Databases)
  - Syntax directed computation such as computations described by productions and rule based systems
  - Equivalence of programs
  - Halting problem for practical cases

Other Innovations

- Film Reports
  - Ellis D. Kropotechev and Zeus, his Marvelous TSS, Gary Feldman
  - Butterfinger, Gary Feldman
  - Hear Here, Raj Reddy, Dave Espar, and Art Eisenson
  - Avoid, Gary Feldman and Don Peiper
  - #?+@, Anon
- Use of displays and video terminals
- Early use of Laser Printing

Looking back: What we missed!

- Personal Computers!
  - Alan Kay's dynabook vs Apple and PCs
- Internet and the WWW
  - ARPAnet in 1968 with Stanford as one of the initial nodes
- Moore's Law and VLSI
- Graphics
- Human Computer Interaction
  - UI design

Looking back: off in timing!

- Speech
- Vision
- Robotics
- Natural Language

Recent Trends in AI

- Learning Systems
  - Learn from examples
  - Learn from experience
  - Dynamic Learning
  - Learning from Sparse data
- Architecture of Intelligence
  - Integrated Intelligence
    - Learn from Experience
    - Use Knowledge
    - Communicate using Speech and Language
    - Operate in real time
    - etc

Recent Trends in CS

- Lisp → Functional Languages
- Timesharing → Thin Clients
- Algorithm Design → Scalable Dependable
- Systems → beyond OS
- Graphics → 2D to 3D
- UI → Illiterate users?
- Hardware → Low power mobile

Whither AI?

- Arthur Clarke's The Songs of the Distant Earth
- Ray Kurzweil's Immortality

Whither CS?

- Computers are for Entertainment and Communication
  - Not for Computing
  - “People are the Killer App” from Parc
- Software as Service
  - Death of Software Product Market
  - Net 2.0 and Web Services
- Cell Phone as the Dominant Computing Platform
  - Embedded Body Computers

In Conclusion…

- Much of what transpired in AI and CS in the last 40 years can be seen to have roots in the Stanford AI Labs activities of the 60s!
  - We now have a million times more computing power!
  - May be we do need 1.7 Einsteins, 3 Maxwells and 0.7 Manhattan project (McCarthy, 1980s) to get there