Impact Analysis of Software Technologies

Tao Xie

University of Illinois
at Urbana-Champaign, USA

taoxie@illinois.edu
http://www.cs.illinois.edu/homes/taoxie/

Main Types of Impact

- **Practice** impact: Practice adoption of tools/systems/technologies… for **practitioners**
  - Some examples discussed in this talk
- **Research** impact: inspiring/impactful ideas/directions/subareas… for **researchers**
  - Example: model checking
- **Societal** impact: inspiring/impactful ideas/thinking/awareness… for **general public**
  - Example: privacy, medical-device security, MOOCs, …

ACM Software System Award

30 Awardees

http://awards.acm.org/software_system/

ACM Software System Awardees

30 Awardees

- 2012: LLVM
- 2011: Eclipse
- 2010: GroupLens Collaborative Filtering Recommender Systems
- 2009: VMware Workstation for Linux 1.0
- 2008: The Gamma Parallel Database System
- 2007: Statemate
  - 1996 Turing Award: Amir Pnueli
- 2006: Eiffel
- 2005: The Boyer-Moore Theorem Prover (ACL2)

ACM Software System Awardees

- 2004: Secure Network Programming
- 2003: MAKE
- 2002: Java
- 2001: SPIN
- 1999: Apache
- 1998: The S System (R)
- 1997: Tcl/Tk
- 1995: NCSA Mosaic, World-Wide Web
- 1994: Remote Procedure Call
- 1993: Sketchpad
  - 1988 Turing Award: **Ivan Sutherland**
- 1992: Interlisp

ACM Software System Awardees

- 1991: TCP/IP
  - 2004 Turing Award: **Vinton Cerf & Robert Kahn**
- 1990: NLS
  - 1997 Turing Award: **Douglas Engelbart**
- 1989: PostScript
- 1988: System R, INGRES
  - 1998 Turing Award: **Jim Gray**
- 1987: SMALLTALK
  - 2003 Turing Award: **Alan Kay**
- 1986: TeX
  - 1974 Turing Award: **Donald Knuth**
- 1985: VisiCalc
- 1984: Xerox Alto System
  - 2009 Turing Award: **Charles P. Thacker**
  - 1992 Turing Award: **Butler Lampson**
- 1983: UNIX
  - 1983 Turing Award: **Dennis Ritchie, Ken Thompson**

Categorized Awardees

- **Development Environments/Tools**
  - 2012: LLVM
  - 2011: Eclipse
  - 2007: Statemate
  - 2006: Eiffel
  - 2005: The Boyer-Moore Theorem Prover (ACL2)
  - 2003: MAKE
  - 2001: SPIN
  - 1992: Interlisp
- **Languages**
  - 2002: Java
  - 1998: The S System (R statistical analysis)
  - 1997: Tcl/Tk
  - 1987: SMALLTALK

Categorized Awardees

- **Operating/Runtime/DB Systems**
  - 2009: VMware Workstation for Linux 1.0
  - 2008: The Gamma Parallel Database System
  - 1999: Apache
  - 1988: System R, INGRES
  - 1983: UNIX
- **Construction Paradigms**
  - 2004: Secure Network Programming
  - 1995: World-Wide Web
  - 1994: Remote Procedure Call
  - 1991: TCP/IP

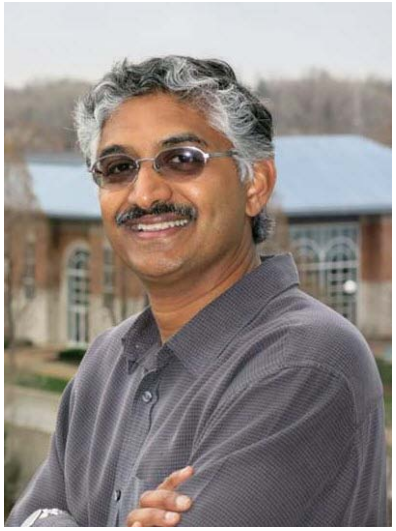
Categorized Awardees

- **Applications**
  - 2010: GroupLens Collaborative Filtering Recommender Systems
  - 1995: NCSA Mosaic
  - 1993: Sketchpad
  - 1990: NLS
  - 1989: PostScript
  - 1986: TeX
  - 1985: VisiCalc
  - 1984: Xerox Alto System

2012 LLVM (UIUC)

- The openness of the LLVM technology and the quality of its architecture and engineering design are key factors in understanding the success it has had both in academia and industry.

http://llvm.org/



Vikram Adve

Chris Lattner

Evan Cheng

Dev Env/Tools: University Origin vs. Company Origin

- University origin:
  - 2012: LLVM (UIUC) → Apple, etc.
  - 2007: Statemate (Weizmann Inst. Science) → I-Logix
  - 2005: Boyer-Moore Theorem Prover (ACL2) (UT Austin) → Computational Logic Inc.
- Company origin:
  - 2011: Eclipse (IBM)
  - 2006: Eiffel (Eiffel Software) → ETH
  - 2003: MAKE (Bell Labs)
  - 2001: SPIN (Bell Labs)
  - 1992: Interlisp (BBN)

Dev Env/Tools: Open Source vs. Commercialization

- Open source/community contribution:
  - 2012: LLVM
  - 2011: Eclipse
  - 2005: Boyer-Moore Theorem Prover (ACL2)
  - 2003: MAKE (part of Unix)
  - 2001: SPIN
- Company commercialization
  - 2007: Statemate
  - 2006: Eiffel
  - 1992: Interlisp

Dev Env/Tools: Building a Community

- 2012: LLVM
  - Yearly LLVM Developer s' Meeting
  - http://llvm.org/devmtg/
- 2011: Eclipse
  - Yearly EclipseCon Conference
  - https://www.eclipsecon.org/
- 2001: SPIN
  - Yearly SPIN Symposium on Model Checking of Software
  - http://spin2014.org/

No Necessary Strong Correlation with Top Venue Publications

- 2012: LLVM
  - Lattner and Adve. LLVM: A Compilation Framework for Lifelong Program Analysis & Transformation, *CGO 2004*
- 2005: Boyer-Moore Theorem Prover (ACL2)
  - Kaufmann and Boyer. The Boyer-Moore Theorem Prover and Its Interactive Enhancement, *Computers and Mathematics with Applications*, 1995
- 2001: SPIN
  - Holzmann. The SPIN Model Checker: Primer and Reference Manual. Addison-Wesley, 2004.

No Necessary Strong Correlation with Top Venue Publications

- 2007: Statemate
  - Harel. Statecharts: A Visual Formalism for Complex Systems", *Science of Computer Programming 1987*
  - Harel et al. Statemate: A Working Environment for the Development of Complex Reactive Systems, *ICSE 1988*.
- 2006: Eiffel
  - Meyer. Object-Oriented Software Construction, Prentice Hall, 1988

Statemate

Statecharts in the Making: A Personal Account

David Harel
The Weizmann Institute of Science

The process leading to the eventual publication of this paper is interesting in its own right. For almost two years, from early 1984 until late 1985, I repeatedly submitted it to what seemed to be the most appropriate widely read venues for such a topic. These were, in order, *Communications of the ACM*, *IEEE Computer* and *IEEE Software*. The paper was rejected from all three of these journals. In fact, from *IEEE Computer* it was rejected twice — once when submitted to a special issue on visual languages and once when submitted as a regular paper. My files contain quite an interesting collection of referee reports and editors' rejection letters. Here are some of the comments therein:

http://soeunix.ucsd.edu/GordonCenter/g_leadership/l_summer/docs/saase/papers/harel/Statecharts.History.pdf

Statemate

Statecharts in the Making: A Personal Account

"I find the concept of statecharts to be quite interesting, but unfortunately only to a small segment of our readership. I find the information presented to be somewhat innovative, but not wholly new. I feel that the use of the digital watch example to be useful, but somewhat simple in light of what our readership would be looking for."

"The basic problem [...] is that [...] the paper does not make a specific contribution in any area."

"A research contribution must contain 'new, novel, basic results'. A reviewer must certify its 'originality, significance, and accuracy'. It must contain 'all technical information required to convince other researchers in the area that the results are valid, verifiable and reproducible'. I believe that you have not satisfied these requirements."

1995 WWW

- "The paper that Tim Berners-Lee and Robert Cailliau submitted to the [**ACM Hypertext**] conference was rejected, and they had to set up shop with their NeXT machine on a table at the venue where they would demonstrate the world wide web to passing delegates. This web page was set up for offline demonstration purposes. The hypertext community were unimpressed with the web; it looked rather simple.

  After the conference, however, Tim went knocking on doors. One of those doors belonged to Paul Jones at the University of North Carolina. Paul had a NeXT and Tim demonstrated the world wide web on it using this page."

  http://first-website.web.cern.ch/blog/1991-web-page-found-password-lost

Aspect-Oriented Programming

ECOOP 1997 Keynote Paper

http://www.cs.ubc.ca/~gregor/papers/kiczales-ECOOP1997-AOP.pdf

Model Checking

- Edmund Clarke: "The birth of model checking was quite painful at times. Like most research on the boundary between theory and practice, theoreticians thought the idea was trivial, and system builders thought it was too theoretical. Researchers in formal methods were even less receptive. Research in the formal- methods community in the 1980s usually consisted of designing and verifying tricky programs with fewer than 50 lines using only pen and paper. If anyone asked how such a program worked in practice on a real computer, it would have been interpreted as an insult or perhaps simply as irrelevant."

Hoffman . Q&A Talking Model-Checking Technology. CACM 2008.

http://cacm.acm.org/magazines/2008/7/5378-qa-talking-model-checking-technology/fulltext

More …

- Open Source
  - 2012: LLVM
- Commercialization
  - 2009: VMware Workstation for Linux 1.0 (Stanford)
  - Yuanyuan Zhou et al. PatternInsight (UIUC/UCSD)
    - Li et al. CP-Miner: a tool for finding copy-paste and related bugs in operating system code. OSDI 2004
  - Dawson Engler et al. Coverity (Stanford)
    - Engler et al. Bugs as Deviant Behavior: A General Approach to Inferring Errors in Systems Code. SOSP 2001.
  - Gail Murphy et al. Tasktop (UBC)
    - Kersten and Murphy. Mylyn: a degree-of-interest model for IDEs. AOSD 2005.
  - Andreas Zeller et al. Testfabrik (Saarland)

Ideas Have Many Parents…

- Researchers
- Scientific and technical communities
- Technology transfer agents
- Students with new degrees
- New hires with different perspectives
- Early adopters
- Commercializers

http://www.sigsoft.org/impact/

Summary

http://awards.acm.org/software_system/

Thank you!

Questions ?

https://sites.google.com/site/asergrp/