Edsger Wybe Dijkstra

“You probably know that arrogance, in computer science, is measured in nanodijkstras.”

– Alan Kay
The Child
Born May 11<sup>th</sup> 1930
Rotterdam, Netherlands
Parents

- Father: Douwe Wybe Dijkstra
  - Chemistry Teacher, and later Superintendent
  - “He would rather be the first among the counts than the last among the dukes.”

- Mother:
  - Mathematician
  - “She had a great agility in manipulating formulae and a wonderful gift for finding very elegant solutions.”
The Student

Universiteit Leiden 1948-1956
Universiteit van Amsterdam 1956-1959
September 1951

- Dijkstra attends a three-week course in Cambridge on programming for an electronic computer because it “might come in handy” for his career in theoretical physics.

- This electronic computer was the EDSAC (Electronic Delay Storage Automatic Calculator)

“It is no exaggeration to say that those three weeks in Cambridge changed my life!”
March 1952 – Mathematisch Centrum

• Dijkstra accepts a job offer from Adriaan van Wijngaarden to become the first in the Netherlands with the paid qualification ‘programmer’.
• “A programmer? But was that a respectable profession?”
The Programmer
Mathematisch Centrum  1952-1962
1956 - Dijkstra’s Algorithm

- Shortest Path Algorithm, finds the shortest path between two nodes
- Designed as a demonstration program for the ARMAC computer
- Developed in 20mins without pen or paper on a café terrace in Amsterdam
1959 – PhD Thesis

- Focused on the development of the Assembly language for the Electrologica X1
- Was the first machine to use real-time interrupts, & the asynchronous I/O handling was written by Dijkstra
- Hardware designed by Bran J. Loopstra and Carel S. Scholten
1960
The Stack

- ALGOL-60 Compiler created by Dijkstra and Jaap Zonneveld in eight months
- The concept of the *Stack* introduced in the paper ‘Recursive Programming’ in order to describe the way that the ALGOL-60 Compiler functioned.
The Teacher
Technische Universiteit Eindhoven 1962-1973
This famous parable describing *Deadlock* was created as a student exam question.

Dijkstra’s original solution is the *Resource Hierarchy Solution* which uses a partial order to force a resource order that can be considered “fair”.
1968 – GOTO Debate

“Since a number of years I am familiar with the observations that the quality of programmers is a decreasing function of the density of go to statements in the programs they produce.”

“...it is too much an invitation to make a mess of one’s program.”
1968 – THE OS for X8

- THE Multiprogramming System
- Built with Cor Ligthmans, Piet Voorhoeve, Nico Habermann and Frits Hendriks, part-time over about four years.
- Designed for the Electrologica X8.
- Earliest example of software architecture, and many design principles.
- First OS of its kind:
  - Levels of abstraction
  - Programming in layers
  - Semaphore (Deadlock avoidance)
  - Cooperating sequential processes
1970 – Notes on Structured Programming

“When we now take the position that it is not only the programmer’s task to produce a correct program but also to demonstrate its correctness in a convincing manner, then the above remarks have a profound influence on the programmer’s activity: the object he has to produce must be usefully structured.”

“Program testing can be used to show the presence of bugs, but never to show their absence!”

“The art of programming is the art of organizing complexity, of mastering multitude and avoiding its bastard chaos as effectively as possible.”
1972 – AM Turing Award

“It took me by complete surprise for I had never considered myself as a potential recipient of that most prestigious award, and I could hardly believe it...When I realized that my six predecessors had all been native English speakers working at famous institutes in the USA or the UK, I got even a bit overwhelmed.”
The Researcher
Burroughs Corporation 1973 - 1984
1976 – A Discipline of Programming

“My original idea was to publish a number of beautiful algorithms in such a way that the reader could appreciate their beauty.”

A focus on formal verification to streamline the mathematical arguments of programming algorithms, with exploration into the semantics and constructs of programming languages.
Notable Contributions

- 1973: Predicate Transformer Semantics – based on Hoare Logic
- 1974: Separation of Concerns (SoC) – basic principle of Software Engineering
- 1976: Guarded Command Language (GCL) and Nondeterminacy
- 1978: On-the-fly Garbage Collection (et al)
- 1980: Dijkstra-Scholten Algorithm (termination in distributed systems) (et al)
- 1981: Smoothsort
The EWD Manuscripts

- Collection of notes, trip reports, observations, and commentaries spanning almost 40 years.
- Almost 500 written while working for Burroughs
- Number in total: 1318
- Mainly handwritten
- Online Database: http://www.cs.utexas.edu/~EWD/

Twenty-eight years ago I wrote EWD0.

It was during a kind of scientific interregnum: my thesis and the basic software for the Xi had been completed and I could not start on the ALGOL compiler because ALGOL 60 had not been defined yet. I did all sorts of unrelated things. It was, for instance, the year that I published - at last!- my algorithms for the shortest path and the shortest spanning tree. It was also a time of explorations. At a given moment I was working on four or five different manuscripts. Of course, the pages of each manuscript were numbered; after I had mixed up pages between manuscripts for the second time, I decided that I had better end that confusion, and numbered the manuscripts as well: EWD0, EWD1, EWD2, EWD4. And that is how it started.

I don’t remember their topics, nor whether they have been completed. The oldest EWD of which I remember the topic is EWD6, on which I worked in Peterswolde in the “Familiehotel”, where, in the early summer, I spent a holiday with my young family. It was on my discovery how to implement recursion. I vividly remember my conscious search for a good name for the device, good in the sense that it would yield both a noun and a verb.
From Home to the World

- Once a week the ‘Tuesday Afternoon Club’ at Eindhoven University would meet.
- Visited the US Burroughs office a few times a year.
- Lectured around the world.
- Kept in contact with scientific colleagues by regular mail and EWDs.
The Professor
University of Texas at Austin 1984 - 1999
Teaching Style

- Learned the names of all of his students
- Didn’t use any textbooks (except his own while he was still writing it)
- Preferred to write directly on the board with chalk
- Oral exams conducted one-on-one and followed with a chat over a beer
Teaching Style
Pursuing Formal Verification

- 1984/88 - Een Methode van Programmeren / A Method of Programming
- 1990 - Predicate Calculus and Program Semantics (with Scholten)
- Believed providing formal verification, and an understanding of the fundamentals, leads to correctly composed code.
State of Computing Science

1988 - On the Cruelty of Really Teaching Computer Science

“... the programmer's task is not just to write down a program, but that his main task is to give a formal proof that the program he proposes meets the equally formal functional specification.”

1993 - From my Life

“in computing, the excessive preoccupation with speed is, of course, a little bit vulgar.”

2000 – The end of Computing Science?

“I would therefore like to posit that computing's central challenge, viz. "How not to make a mess of it", has not been met. On the contrary, most of our systems are much more complicated than can be considered healthy, and are too messy and chaotic to be used in comfort and confidence.”
Awards & Honours

- 1971: Member of the Royal Netherlands Academy of Arts and Sciences
  Distinguished Fellow of the British Computer Society
- 1972: The Association for Computing Machinery's A.M. Turing Award
- 1974: Harry H. Goode Memorial Award from the IEEE Computer Society
- 1975: Foreign Honorary Member of the American Academy of Arts and Sciences
- 1976: Doctor of Science Honoris Causa from the Queen's University Belfast
- 1982: Computer Pioneer Charter Recipient from the IEEE Computer Society
- 1989: ACM/SIGCSE Award for Outstanding Contributions to Computer Science Education
- 1994: Fellow of the Association for Computing Machinery
Awards & Honours

- 2001: Honorary doctorate from the Athens University of Economics & Business, Greece
- 2002: Recognition Award from the C&C Foundation of Japan

The AMC PODC Influential-Paper Award in Distributed Computing

- Since 2003, the AMC PODC PODC Influential-Paper Award in Distributed Computing is known as the “Edsger W. Dijkstra Prize in Distributed Computing”

- Since 2005, the Department of Computer Science at Loyola University Chicago has presented The Dijkstra Award for Outstanding Academic Achievement in Computer Science.

- Since 2010, the University of Texas at Austin has held an annual Edsger W. Dijkstra Memorial Lecture.

- Dijkstra’s 60th birthday was celebrated with a two-day seminar at the University of Texas at Austin. His 70th with a symposium, with a farewell lecture from Dijkstra.
A Lifetime’s Legacy

- 9 books
- 12 book chapters
- 40 journal articles
- 34 contributions to conference proceedings, 22 miscellaneous publications
- 1318 EWDs

“I mean, if 10 years from now, when you are doing something quick and dirty, you suddenly visualize that I am looking over your shoulders and say to yourself "Dijkstra would not have liked this.", well, that would be enough immortality for me.”
Questions?

“Thank goodness we don't have only serious problems, but ridiculous ones as well.” – Dijkstra 1982