

# Edsger Dijkstra and the shortest-path algorithm

## David Gries

You probably have all used an app to find a route from one point to another. Here's a map produce by Google Maps to find a route from Cornell University's Day Hall to Gates Hall, where Computer Science lives. Somehow, although I didn't tell it to do this, Google Maps inferred that I wanted walking routes, not driving routes.

That shortest-path algorithm is quite likely based on one developed by Edsger W. Dijkstra in 1956. At that time, Edsger had no high-level language in which to think. He knew machine languages and corresponding assembly languages, of course, but he wasn't about to develop the shortest-path algorithm in them!

Here's what Edsger said about developing the algorithm<sup>1</sup>.

... One morning I was shopping in Amsterdam with my young fiance, and, tired, we sat down on the cafe terrace to drink a cup of coffee. I was just thinking about whether I could do this, and I then designed the algorithm for the shortest path. As I said, it was a 20-minute invention.

Imagine that! He developed it in his head in 20 minutes. No paper and pencil. With no language support except Dutch. Further, Edsger didn't bother publishing it until someone told him he should —2–3 years later<sup>2</sup>.

One could ask: Why wasn't Edsger talking to his fiancé instead of thinking about an algorithm? Ha!

Well, his fiancé, Ria Debets, knew him well, and she was also a programmer. She was one of a dozen women who had completed high school with exceptionally high grades in mathematics and were hired to work in the new computing department at the Mathematical Center in Amsterdam by Director Van Wijngaarden<sup>3</sup>. Edsger had taught Ria and the other women programming. He was working on his PhD, which he got in 1959.

They were married about a year later, and they were close companions until he died in 2002. She passed away 10 years later.

To set some context, in 1956, when Edsger developed the shortest path algorithm, I, Gries, was a sophomore in Queens College in New York City. I didn't learn anything about computers until fall 1959. By happenstance, we taught together in a week-long summer school in Maryland in 1972, and we became friends and colleagues. His work and friendship have influenced me greatly.

In 1956, Edsger didn't have a formal concept of a loop invariant —that wasn't developed until about 1968. Yet, his description of the algorithm (see footnote 2 below) is remarkably close to our development and description of the algorithm, which you will shortly see.

Edsger's was one of the most deep and prolific thinkers in the history of computing, and his contributions to computer science are vast and profound. His influential contributions range from compilers to concurrent programming to operating systems to formal programming methodology to mathematical methodology and more. The easiest way to learn something about him is to look at his Wikipedia page, [https://en.wikipedia.org/wiki/Edsger\\_W.\\_Dijkstra](https://en.wikipedia.org/wiki/Edsger_W._Dijkstra). Also, look at the archive of his work at: [www.cs.utexas.edu/users/EWD/](http://www.cs.utexas.edu/users/EWD/).



<sup>1</sup> Taken from an interview published in the Communications of the ACM in 2010

<sup>2</sup> Dijkstra, E.W. A note on two problems in Connexion with graphs. Numerische Mathematik 1, 269–271 (1959).

<sup>3</sup> See <http://www-set.win.tue.nl/UnsungHeroes/heroes/computing-girls.html>.

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Ria Debets and Edsger Wybe Dijkstra,  
around 1956

Edsger, a friend and colleague, and Ria,  
about 1956

Edsger, a few years  
before his death.