

# DONALD KNUTH

## EARLY LIFE

Donald Knuth was born in Milwaukee, Wisconsin on the 10<sup>th</sup> January 1938. He attended the Milwaukee Lutheran High School where his father, Ervin Knuth, worked as a teacher. In the 8<sup>th</sup> grade Knuth entered a competition to find the number of words that could be created by rearranging the letters in “Ziegler’s Giant Bar”. He won the competition to win a television and candy bars for all his school peers as he produced 4,500 words with the judges only having 2,500 options. Knuth obtained his love of education, music and mathematics during his time at Milwaukee Lutheran High School. This is where his ingenious mind really manifested itself with him receiving many academic accolades, including the highest ever grade point average that anyone had achieved at his school.



## EDUCATION

Upon graduation from second level education, Knuth received a scholarship to read physics at the Case Institute of Technology in Cleveland, Ohio. As he tended more towards the study of mathematics, he began to grow his expertise at writing computer programs. He had to use the IBM 650 and after reading the computer manual he decided to rewrite the assembly and compiler code for the machine used in the school as he believed that he could improve it. During his third year at the Case Institute of Technology, Knuth created a program to assist his school’s basketball team in winning their games. The program assigned values to the players in order to gauge their probability of obtaining points. In 1960, Knuth received his bachelor’s degree and quite uniquely, the school provided him with a master’s degree in addition due to the brilliance of his academic performance. Knuth continued with his further education and obtained his PhD in mathematics from the California Institute of Technology in 1963.

## EARLY WORK

Upon graduation from the California Institute of Technology, Knuth took a job as a software development consultant for the Burroughs Corporation. In addition, he accepted a role as Assistant Professor within the mathematics department at the California Institute of Technology and was promoted to Associate Professor in 1966. Knuth left in 1969 to become a professor of computer science at Stanford University.

## THE ART OF COMPUTER PROGRAMMING

In 1962, Knuth was still yet to complete his PhD in mathematics but Addison-Wesley approached him and asked him to write a text on compilers. Originally conceived as a single book, Knuth produced over 3,000 handwritten pages and after discussions it was agreed that Knuth should produce a 7-volume series covering much more than just compilers. To date, the first 3 volumes and part of the 4<sup>th</sup> volume of The Art of Computer Programming have been released. Knuth's aim is to *'organise and summarize what is known about the fast subject of computer methods and to give it firm mathematical and historical foundations.'* Knuth mentioned in a recent interview that he hopes that he will be alive to complete the remainder of The Art of Computer Programming series but nonetheless it has been the focal point of his career with the book regarded as a Bible in its respective field. His contributions through his writings in the volumes of The Art of Computer Programming were a considerable factor in Knuth being awarded the Turing Award in 1974 which is informally regarded as the Nobel Prize of computer science.

## TEX & MENTAFONT

In 1977, Knuth wrote a memo to himself describing the basic features of TeX and he had planned to complete it in 1978 but as it happened, the language was not completely ready until 1989, more than 10 years later. TeX is a popular means of typesetting complex mathematical formulae and is commonly used in mathematics, computer science, economics, statistics and many other fields within academia. MentaFont is a description language used to define raster fonts. Nowadays, LaTeX is a widely used macro package based on TeX. Both TeX and MentaFont were devised, designed and mostly written by Knuth.

# ALGORITHMS

Knuth is regarded as '*the father of the analysis of algorithms*' and has had an immense impact on a variety of different algorithms both directly and indirectly by forming a basis on which fellow academics have built upon. Two of his most well-known algorithms include The Knuth-Bendix Completion Algorithm and The Knuth-Morris-Pratt Algorithm. The former is a semi-decision algorithm for transforming a set of equations into a confluent term rewriting system and the latter is a substring-search algorithm that is much more efficient than previous substring-search algorithms established at the time. Knuth was the supervisor of Robert Sedgewick's PhD from Stanford University in 1975 which is regarded as a key milestone in the study of the QuickSort algorithm as he resolved many problems related to the analysis of various pivot selection schemes.

# CONCLUSION

There can be no denying that Donald Knuth is an extremely influential software engineer who has had a monumental impact on the field of computer science and mathematics. I became aware of Knuth having studied algorithms in-depth during my Senior Freshman year at university and found his ingenious, problem-solving mind to be inspirational. His academic achievements speak for themselves but what I was unaware of before engaging in the research for Knuth's biography was his exceptional work ethic and determination to achieve all the goals he sets for his day every day. His title of '*the father of the analysis of algorithms*' is most definitely justified because of his work and influence on computer science having written the Bible for all software engineers, The Art of Computer Programming. Donald Knuth has firmly established his legacy as a visionary of software engineering.

# BIBLIOGRAPHY

The following resources were used in the research for my essay:

- Article on 'The Yoda of Silicon Valley':

*<https://www.nytimes.com/2018/12/17/science/donald-knuth-computers-algorithms-programming.html>*

- Biographies of Donald Knuth:

*[https://amturing.acm.org/award\\_winners/knuth\\_1013846.cfm](https://amturing.acm.org/award_winners/knuth_1013846.cfm)*

*<http://www-history.mcs.st-andrews.ac.uk/Biographies/Knuth.html>*

- Biography of Robert Sedgewick:

*<https://www.cs.princeton.edu/people/profile/rs>*

- Detailed History of Donald Knuth (Interview):

*<https://www.youtube.com/watch?v=Wp7GAKLSGnI>*

- Knuth-Bendix Completion Algorithm:

*<http://mathworld.wolfram.com/Knuth-BendixCompletionAlgorithm.html>*

*Biography of Donald Knuth by Oran McVeigh-Keeling*