

# Bill Cook, the TSP, Quantum Computing, and a New World Record

*Toast proposed by Martin Grötschel at Bill Cook's birthday dinner on October 18, 2022.*

MARTIN GRÖTSCHEL, BERLIN

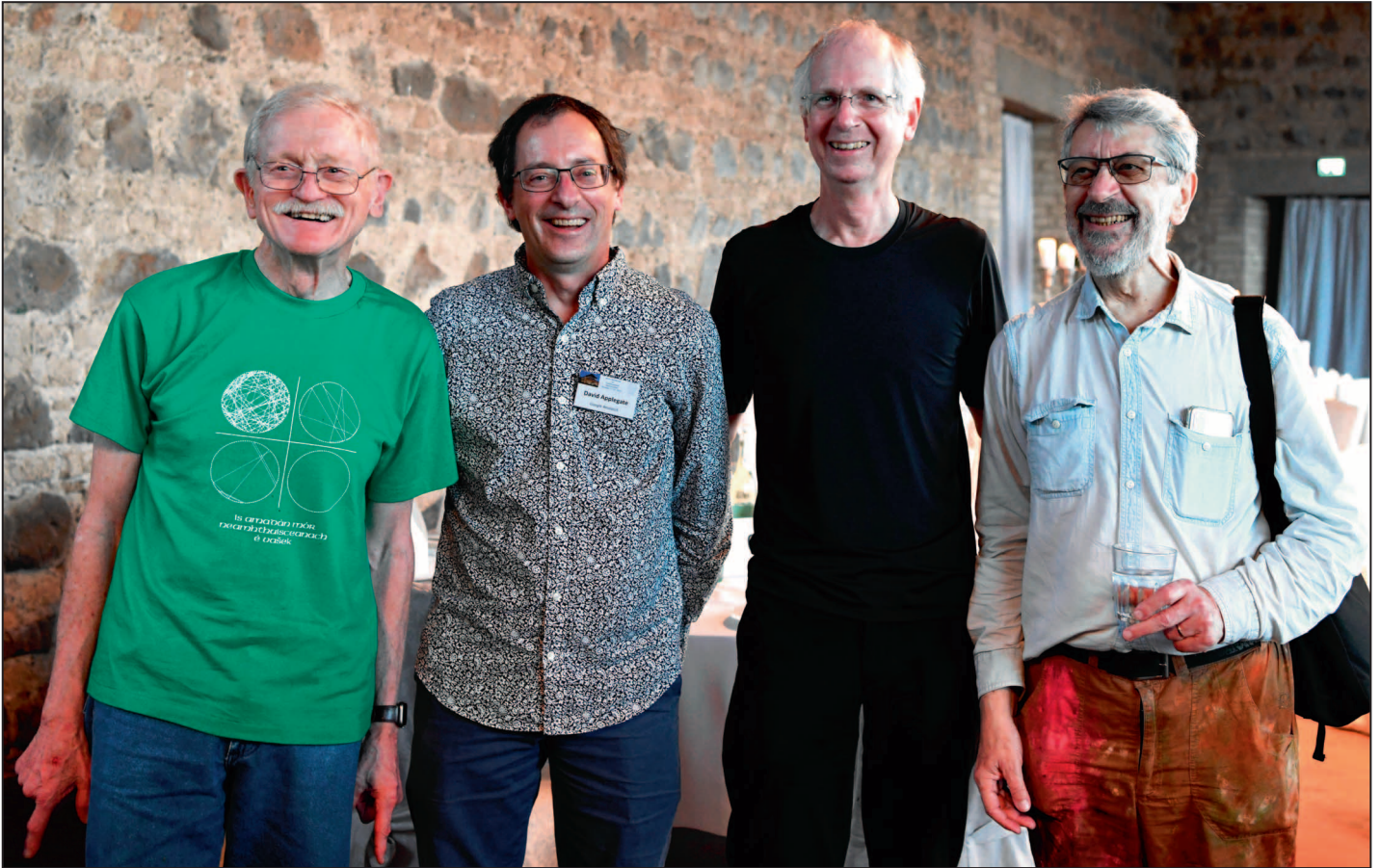
On April 2, 1992, the group of four mathematicians shown on the photo below, including Bill Cook, computed an optimum solution of a 3.038 city traveling salesman problem (TSP). Ever since this day, Bill Cook together with various coauthors, many of which are here tonight, has been holding all TSP world records. The currently largest problem was solved 2017 to optimality and has 109.399 cities<sup>1</sup>. Even more striking, for a 2.079.471-point instance, Bill and coauthors have found a tour for which they can prove that it is no more than a factor of 0.0000074 longer than an optimal tour. Considering that this computational effort includes solving linear programs with 2.162.098.780.185 variables, this achievement is simply breathtaking<sup>2</sup>. I feel honored to have been invited to the dinner tonight here in Bonn celebrating Bill's 65<sup>th</sup> birthday and his outstanding work: This is optimization at its best.

In my brief toast I want to tell you about another world record that Bill holds and most of you probably are not aware of.

For quite some time, I have been annoyed by hilarious statements that some quantum scientists, many representatives of quantum computer companies, and several supporters of these make publicly. Some media jump on these. They seem to prefer hyping the announcement of new self-declared world records or unproved quantum supremacy statements to making solid investigations of facts and reporting these.

On November 25, 2021, I read the article »Die Chancen der Quantenrevolution«<sup>3</sup> by Ann-Kristin Achleitner<sup>4</sup> which was published simultaneously in the Berlin based newspaper Tagesspiegel and the widely read German business newspaper Handelsblatt. Ms. Achleitner is a German economist, currently a professor at Technische Universität München, a vice president of acatech, and member of many corporate boards. Her list of distinctions is impressive<sup>5</sup>. Ms. Achleitner also chairs an ethics committee.





From left to right: Bob Bixby, David Applegate, Bill Cook, Vašek Chvátal.  
Photo taken by Patrick Rocca on October 18, 2022 at Cook's birthday dinner in Bonn-Bad Godesberg.

Ann-Katrin Achleitner wrote correctly in her article that the TSP is NP-complete and demonstrated that an  $n$ -city TSP has many solutions, concluding: »Aber schon bei 20 Stopps müsste das Programm viele hundert Jahre laufen, um zu einer Lösung zu kommen. Abhilfe könnte eine neue Schlüsseltechnologie schaffen: der Quantencomputer«. She then mentions that quantum computers reach in special cases an enormous speed advantage compared to classical computers and praises a Japanese research team that, employing a special quantum chip, has solved a 22-city problem for which a supercomputer would have needed more than thousand years.

Having, this way, »convincingly established« the supremacy of quantum computing, Ms. Achleitner indicates that the TSP and its variants have uncountably many important practical applications (I fully agree) and presents the usual quantum computer lobbyist's catalogue for administrative measures and financial support to make Germany one of the winners of the quantum revolution.

I wrote to Tagesspiegel and Prof. Achleitner indicating, see above, the state of art of TSP problem solving. I suggested to consult Bill Cook's homepage<sup>6</sup> where one can find an excellent

lecture on this topic and Bill's wonderful TSP-book »In Pursuit of the Traveling Salesman: Mathematics at the Limits of Computation«<sup>7</sup> – hoping that the statements in the Achleitner article would be corrected. I did not receive a reply, no correction appeared in the newspapers. I also informed Bill about Achleitner's outrageously wrong statements.

Bill Cook replied that the Washington Post published, on February 5, 2018, a similar article<sup>8</sup> containing the following statement: »It would take a laptop computer 1,000 years to compute the most efficient route between 22 cities, for example. A quantum computer could do this within minutes, possibly seconds.«

Vivek Wadhwa, the author of this article, appears to have obtained this running time information from Michelle Simmons, who is a director at the Centre for Quantum Computation and Communications Technology and the 2018 Australian of the Year for her work and dedication to quantum information science<sup>9</sup>. Contemplating the striking similarities of the statements it is not inconceivable that Achleitner was influenced by the Wadhwa article. I would call this: »Propagation of fake news«.

Bill Cook reacted to the Washington Post article through a twitter post<sup>10</sup> as follows: »To clarify, computing an optimal TSP route on 22 points takes 0.005 seconds on my iMac, not the 1000 years reported in @washingtonpost An error factor of 6 trillion. Like reporting the US National Debt is \$4.«

Thomas Lumley took Bill's clarification of the real running times up in a post<sup>11</sup> on Stats Chat entitled »Most inaccurate media number ever?« and stated: »In 2012, the Telegraph and other UK papers were off by five orders of magnitude when they said there were only 100 adult cod in the North Sea. The Washington Post beats that easily.« I like the title of Lumley's post pointing out that a multiplicative error in a magnitude of about  $10^{13}$  between claim and reality is the biggest error ever made in a newspaper.

Bill Cook proved this discrepancy and thus holds the world record in discovering the biggest numerical error ever reported in public media.

*Congratulations, Bill!*

1. <https://www.math.uwaterloo.ca/tsp/star/hyg.html>
2. <https://www.math.uwaterloo.ca/tsp/star/gaia1.html>
3. <https://www.handelsblatt.com/meinung/gastbeitraege/gastkommentar-die-chancen-der-quantenrevolution-/27825902.html>
4. [https://en.wikipedia.org/wiki/Ann-Kristin\\_Achleitner](https://en.wikipedia.org/wiki/Ann-Kristin_Achleitner)
5. [https://de.wikipedia.org/wiki/Ann-Kristin\\_Achleitner#Auszeichnungen](https://de.wikipedia.org/wiki/Ann-Kristin_Achleitner#Auszeichnungen)
6. <http://www.math.uwaterloo.ca/tsp/>
7. <https://press.princeton.edu/books/paperback/9780691163529/in-pursuit-of-the-traveling-salesman>
8. <https://www.washingtonpost.com/news/innovations/wp/2018/02/05/quantum-computers-may-be-more-of-an-imminent-threat-than-ai/>
9. <https://youtu.be/cugu4iW4W54?t=264>
10. <https://twitter.com/wjcook/status/963146847186444289>
11. <https://www.statschat.org.nz/2018/02/14/most-inaccurate-media-number-ever/>



## GOR – Beirat

Prof. Dr. Stefan Pickl (Vorsitz)  
Universität der Bundeswehr München  
Institut für Theoretische Informatik,  
Mathematik und OR  
Werner-Heisenberg-Weg 39  
85577 Neubiberg  
Tel.: 089 6004-2400  
Fax: 089 6004-3561  
E-Mail: beirat\_vorsitz@gor-ev.de

Prof. Dr. Brigitte Werners (stellv. Vorsitz)  
Ruhr-Universität Bochum  
Fakultät für Wirtschaftswissenschaft  
Universitätsstr. 150  
44780 Bochum  
Tel.: 0234 32-28311  
Fax: 0234 32-14267  
E-Mail: or@ruhr-uni-bochum.de

Dr. Michael Bussieck  
GAMS Software GmbH  
Postfach 4059  
50216 Frechen  
Tel.: 0221 949-9170  
Fax: 0221 949-9171  
E-Mail: mbussieck@gams.com

Dr. Ulrich Dordorf  
INFORM Institut f. Operations Research  
und Management GmbH  
Pascalstr. 35, 52076 Aachen  
Tel.: 02408 9456 1160  
E-Mail:  
Ulrich.Dordorf@inform-software.com

Dr. Ralph Grothmann  
Siemens AG, Siemens Deutschland  
Digital Industries, Data Analytics  
RC-DE DI CS SD5 2  
Universitätsallee 16  
28359 Bremen  
E-Mail: ralph.grothmann@siemens.com

Prof. Dr. Richard Hartl  
Universität Wien  
Department of Business Administration  
Lehrstuhl für Produktion und Logistik  
Oskar-Morgenstern-Platz 1  
1090 Wien, Österreich  
Tel.: +43-1-4277-38091  
Fax: +43-1-4277-8 38091  
E-Mail: richard.hartl@univie.ac.at

Prof. Dr. Robert Klein  
Universität Augsburg  
Lehrstuhl für Analytics & Optimization  
Universitätsstraße 16  
86159 Augsburg  
Tel.: 0821 589-4150  
Fax: 0821 589-4226  
E-Mail: robert.klein@wiwi.uni-augsburg.de

Prof. Dr. Natalia Kliewer  
Freie Universität Berlin  
Fachbereich Wirtschaftswissenschaft  
Lehrstuhl für Wirtschaftsinformatik  
Garystr. 21, 14195 Berlin  
Tel.: 030 838-55009, Fax: 030 838-52027  
E-Mail: natalia.kliewer@fu-berlin.de

Dr. Steffen Klosterhalfen  
BASF SE,  
AI Solutions - Services & Core Systems -  
0230  
Pfalzgrafenstr. 1, 67056 Ludwigshafen  
Tel.: 0621 6097920  
E-Mail: steffen.klosterhalfen@basf.com

Prof. Dr. Marco Lübbecke  
RWTH Aachen Universität  
Fakultät für Wirtschaftswissenschaften  
Lehrstuhl für Operations Research  
Kackerstraße 7  
52072 Aachen  
Tel.: 0241 80-93362  
Fax: 0241 80-92369  
E-Mail: marco.luebbecke@rwth-aachen.de

Dr. Marie Schmidt  
Erasmus University Rotterdam,  
Department of Technology and Operations  
Management  
Postbus 1738, Burgemeester Oudlaan 50  
3000 DR Rotterdam, Niederlande  
Tel.: +31 10 4082199  
E-Mail: schmidt2@rsm.nl

Prof. Dr. Oliver Stein  
Karlsruher Institut für Technologie (KIT)  
Institut für Operations Research  
Schlossbezirk 13, 76131 Karlsruhe  
Tel.: 0721 608-46782  
Fax: 0721 608-45440  
E-Mail: stein@kit.edu

Prof. Dr. Kevin Tierney  
Universität Bielefeld  
Lehrstuhl für BWL,  
Decision and Operation Technologies  
Postfach 10 01 31, 33501 Bielefeld  
Tel.: 0521 106-3940  
E-Mail: kevin.tierney@uni-bielefeld.de

Prof. Dr. Norbert Trautmann  
Universität Bern  
Ordinariat für Quantitative Methoden  
der BWL  
Schützenmattstraße. 14  
3012 Bern, Schweiz  
Tel.: +41 31 631-5325  
E-Mail: norbert.trautmann@pqm.unibe.ch

Prof. Dr. Guido Voigt  
Universität Hamburg  
Fakultät für Betriebswirtschaft, Institut für  
Logistik und Supply Chain Management  
Moorweidenstraße 18, 20148 Hamburg  
Tel.: 040 42838 1549  
E-Mail: guido.voigt@uni-hamburg.de