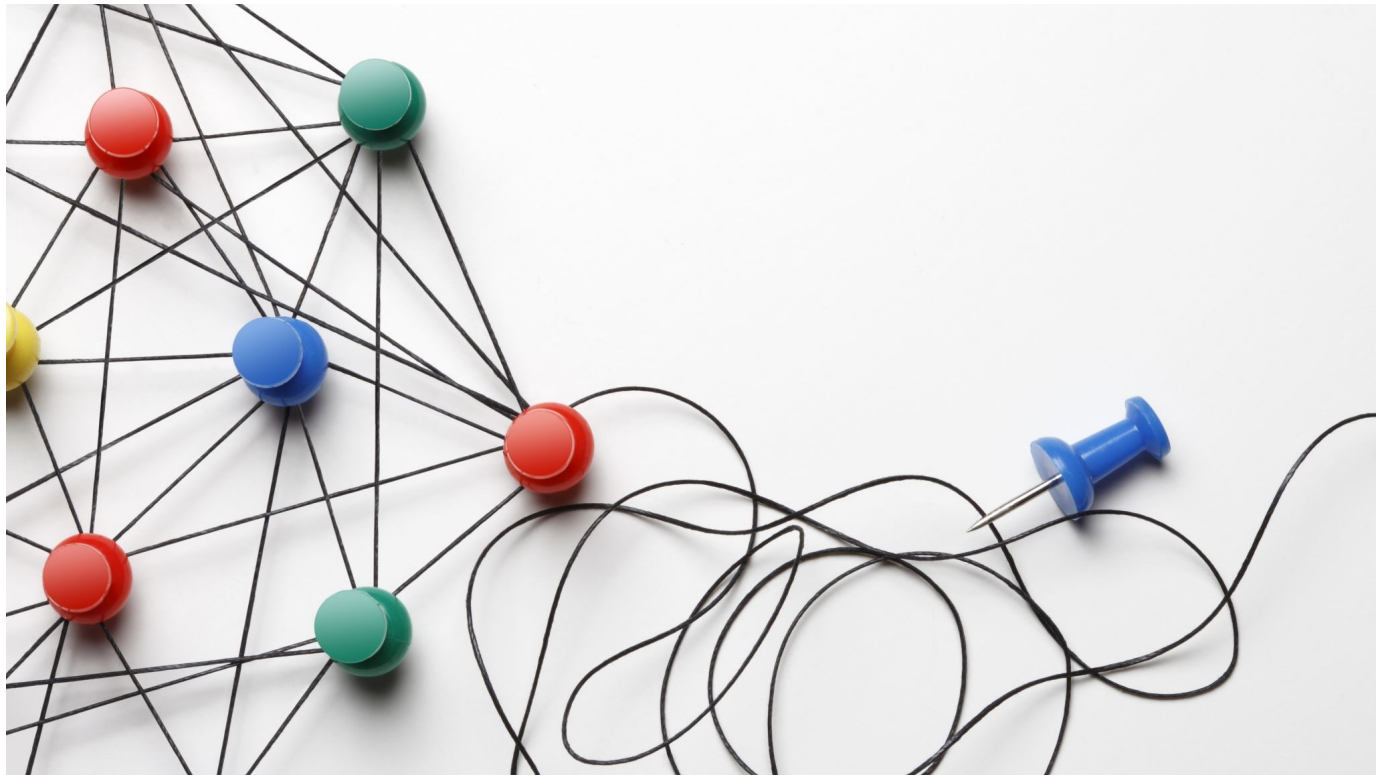
Tribute to David S. Johnson

Mauricio G.C. Resende

Amazon & U. of Washington

12th DIMACS Implementation Challenge: VRP

April 5-8, 2022



David S. Johnson (DSJ)

- Born on December 9, 1945
- Died on March 8, 2016

Thanks for the help in preparation of this talk

– Cathy McGeoch

– Luciana Buriol

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Cathy at WEA 2004 in Angra dos Reis, Brazil

Thanks for the help in preparation of this talk

– Cathy McGeoch

– Luciana Buriol

Luciana at Shannon Lab, Florham Park, NJ (2002)

Why am I giving this talk?

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DSJ was my manager at the labs for 25 years (1988–2013):

- 1988–1996: AT&T Bell Laboratories in Murray Hill, New Jersey
- 1996–2013: AT&T Labs Research in Florham Park, New Jersey
- At both locations my office and his were next to each other

AT&T Bell Laboratories, Murray Hill, NJ

October 1995

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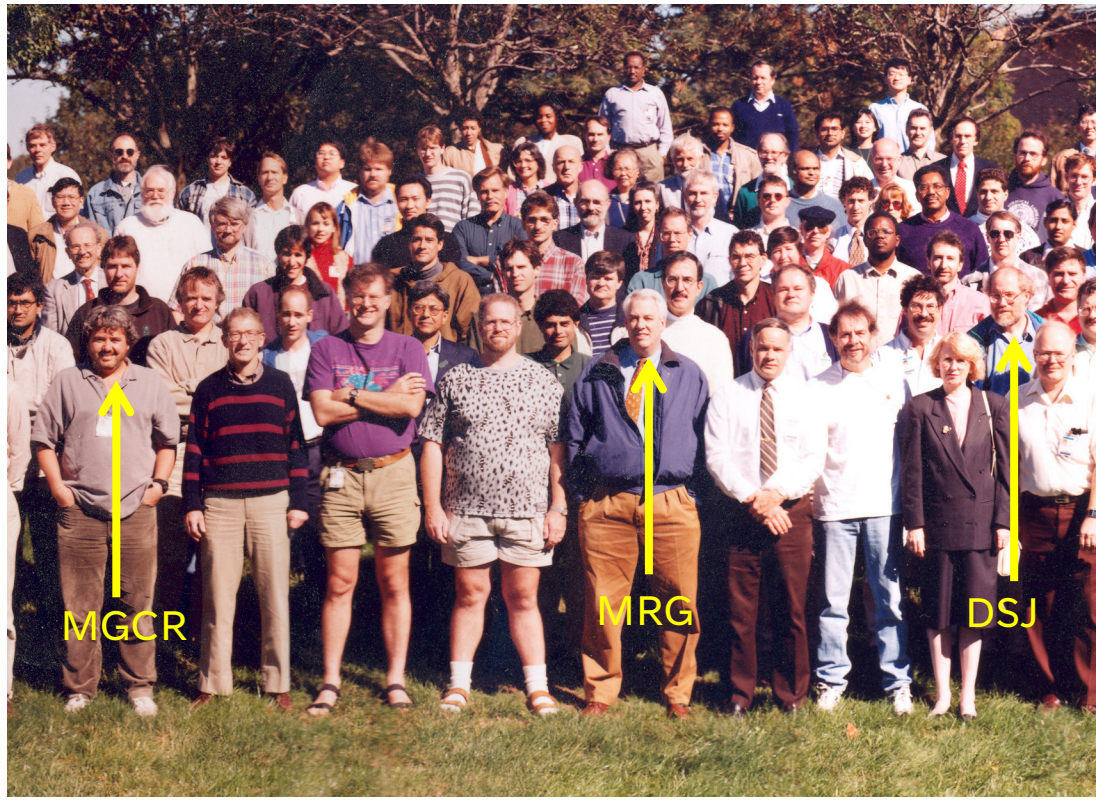
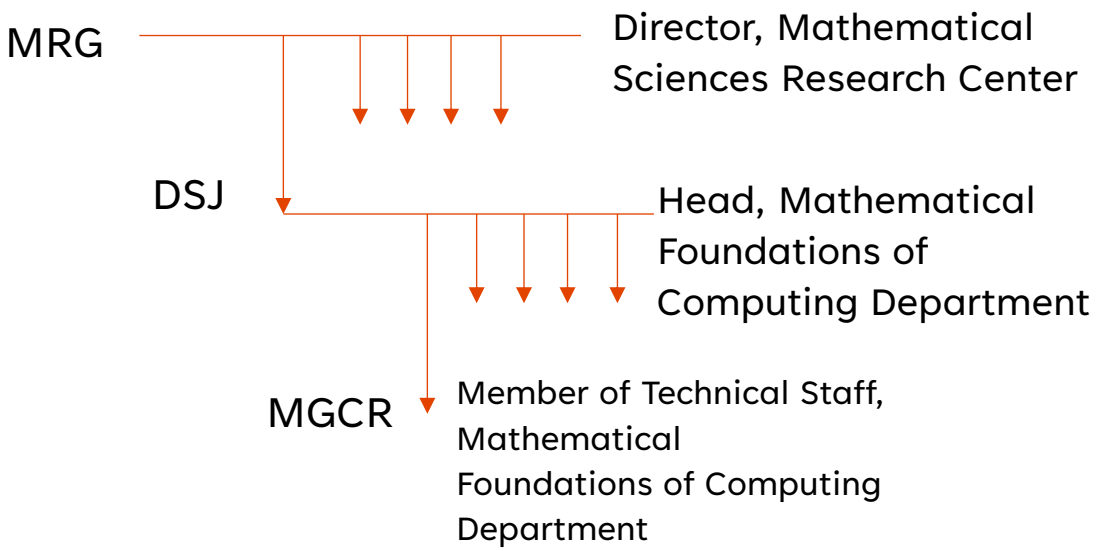
AT&T Bell Laboratories, Murray Hill, NJ



October 1995



DSJ's research interests

- Computational complexity and theory of NP-completeness
- Worst-case, probabilistic, and experimental analysis of algorithms
- Approximation algorithms
- Bin packing
- The Traveling Salesman Problem
- Network Design
- Graph Partitioning and Coloring

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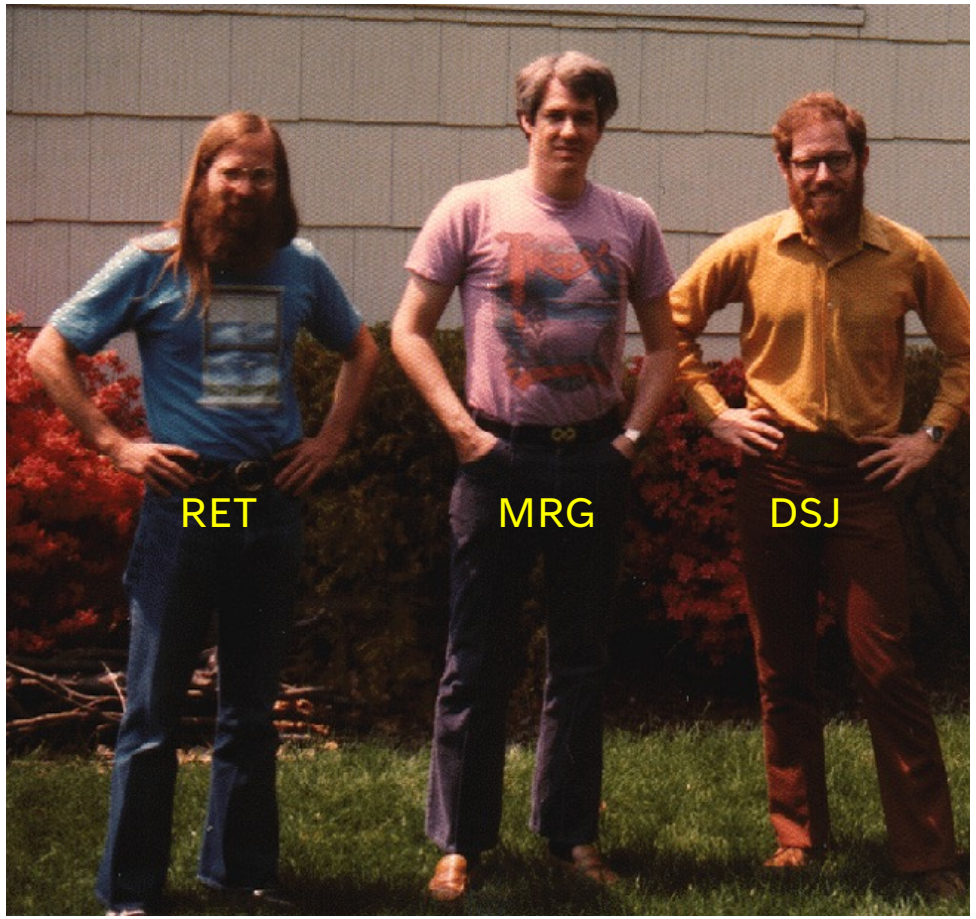


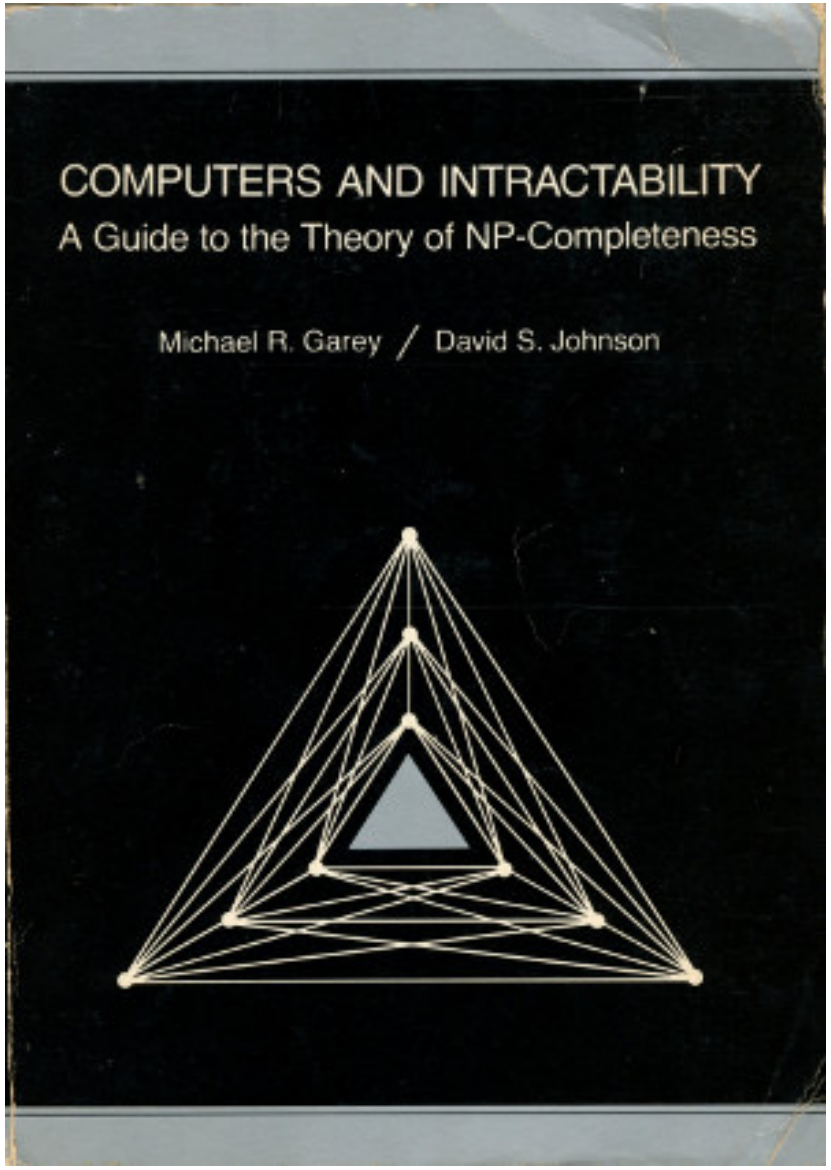
DSJ with Mike Garey and Bob Tarjan (1970s)

Timeline

- 1945-12-09: Born in Washington, DC
- 1967: B.A. from Amherst College, summa cum laude, mathematics
- 1968: S.M. from MIT, mathematics
- 1973: Ph.D. from MIT, mathematics, “*Near-optimal bin packing algorithms*”
- 1973: Joins Bell Laboratories

Timeline

- 1979: Publishes "*Computers and Intractability: A Guide to the Theory of NP-Completeness*" with Mike Garey (72,890 citations to date). Wins Lancaster Prize of the OR Society of America (today INFORMS)
- 1982: Started writing the "Ongoing Guide" on NP-completeness
- 1988: Head, Mathematical Foundations of Computing Department at AT&T Bell Labs
- 1990: Founded SODA (Committee chair for 25 years) and the DIMACS Implementation Challenges
- 1992: AT&T Bell Laboratories Research Affirmative Action Award



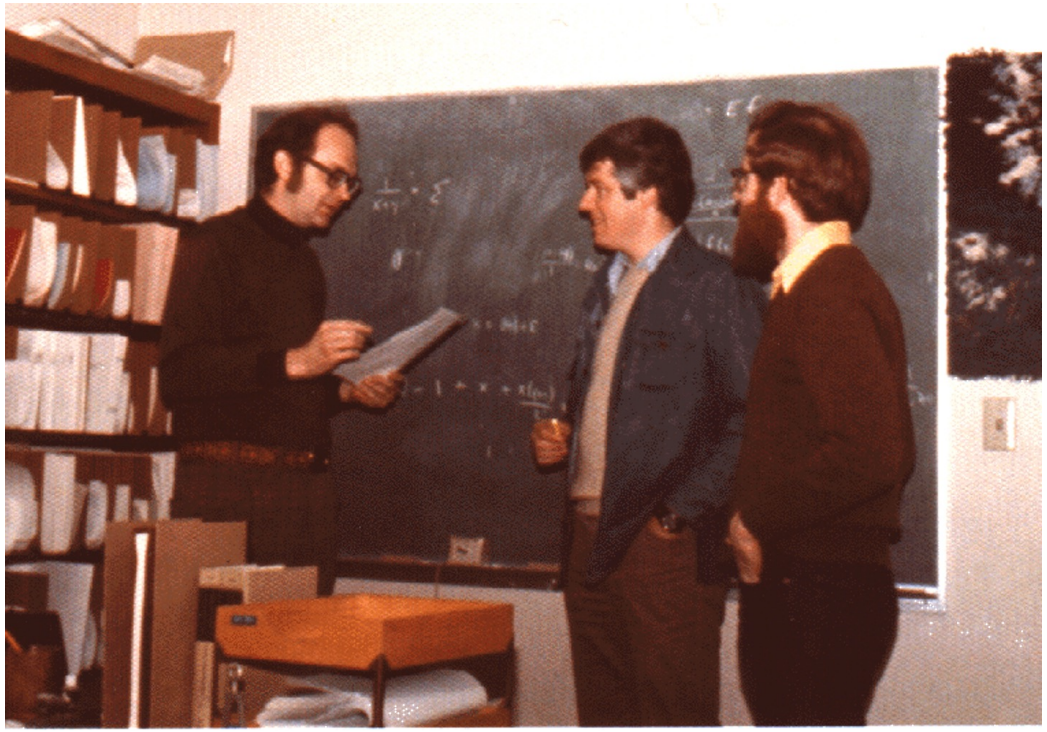
This book currently (2022-04-02) has over 72,000 citations on Google Scholar.

DSJ at WEA 2008 in Provincetown, MA

Timeline

- 1994: ACM Fellow for "fundamental contributions to the theories of approximation algorithms and computational complexity, and for outstanding service to ACM"
- 1996: Head, Algorithms & Optimization Research Department at AT&T Labs Research
- 2005: AT&T Fellow
- 2007: INFORMS Computing Society Prize for Research Excellence in the Interface Between OR and CS for the paper *On the Sum-of-Squares Algorithm for Bin Packing*
- 2009: SIAM Fellow for “contributions to algorithms and complexity theory”

Timeline

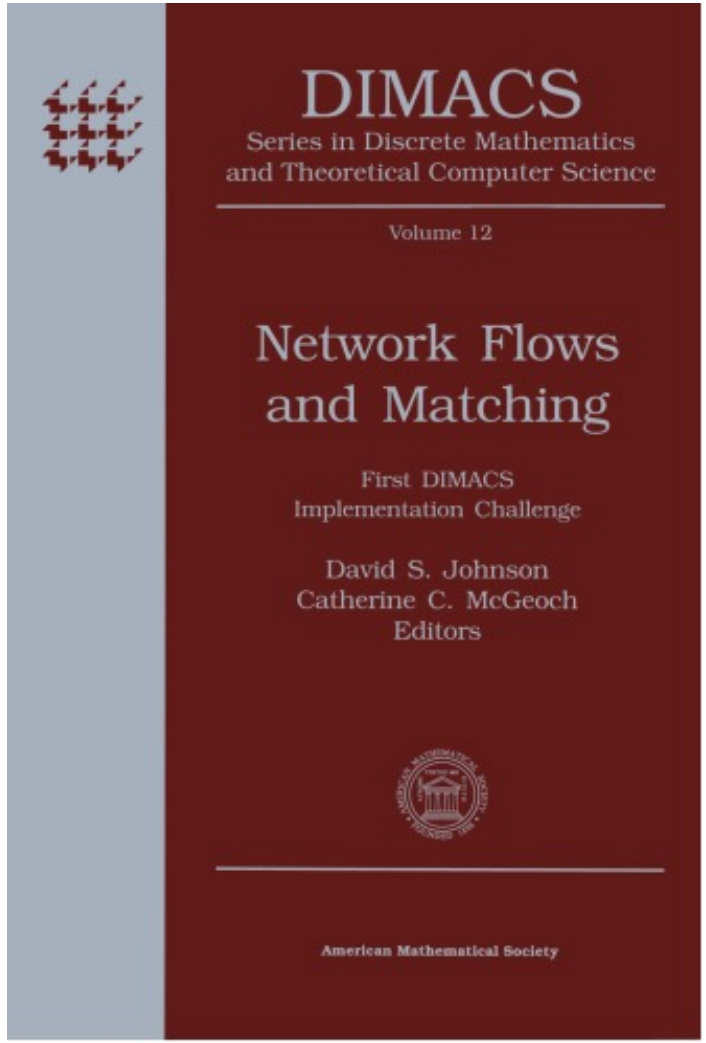


DSJ and MRG with Knuth in 1975

- 2010: *Donald E. Knuth Prize* for contributions to theoretical and experimental analysis of algorithms
- 2013: Retires from AT&T Labs Research and joins Columbia University as Visiting Professor
- 2016: Elected to National Academy of Engineering for his "contributions to the theory and practice of optimization and approximation algorithms”
- 2016-03-08: Died in New Jersey, age 70.
- 2020: David’s final paper, “Near-optimal disjoint-path facility location through set cover by pairs,” was published in Operations Research, vol. 68, pp. 896-926, 2020.

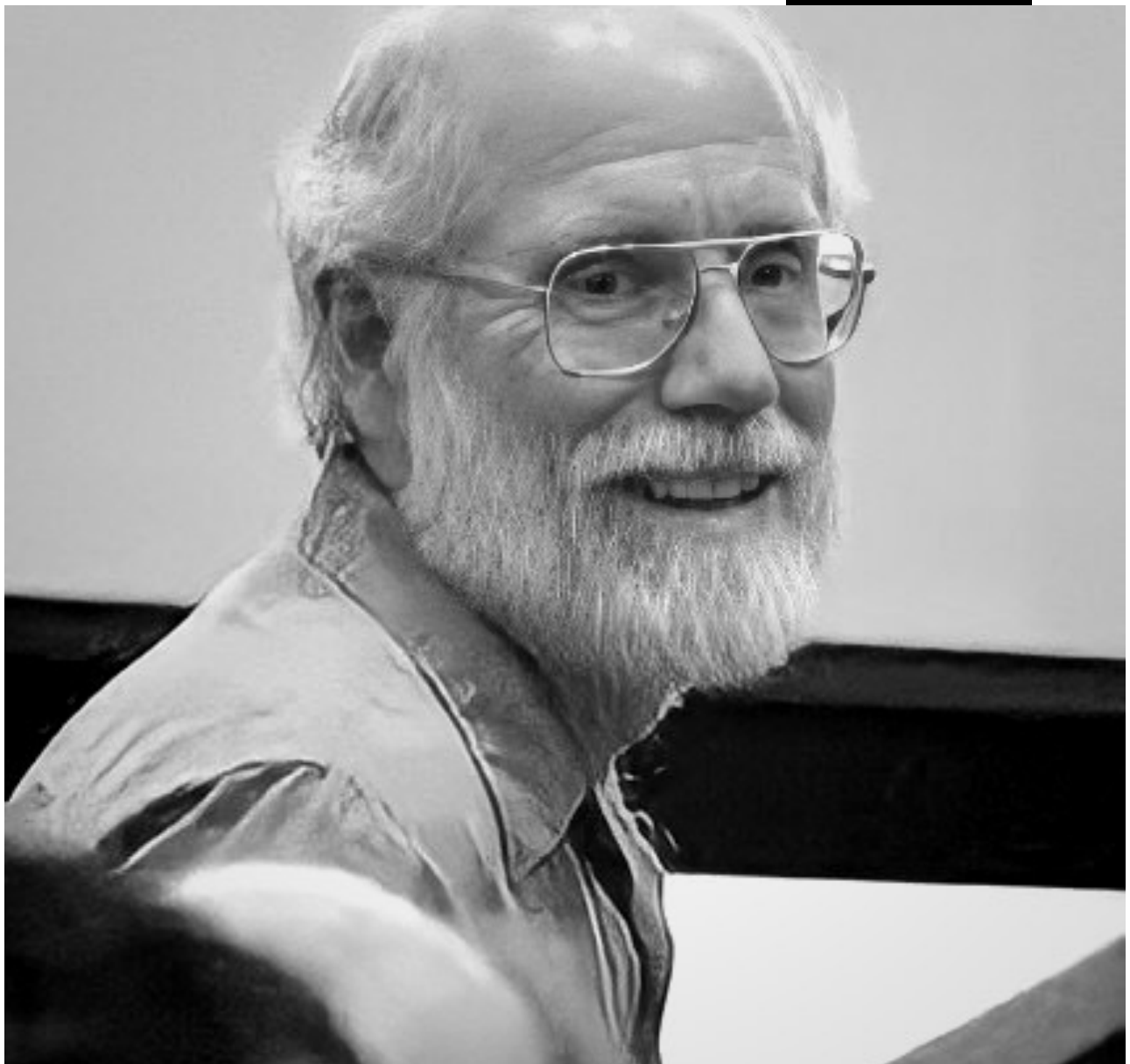
In 1990, David created the DIMACS *Implementation Challenges*

- “to address questions of determining realistic algorithm performance”
- where “worst-case analysis is overly pessimistic”
- and “probabilistic models are too unrealistic.”
- “Experimentation can provide guides to realistic algorithm performance where analysis fails."



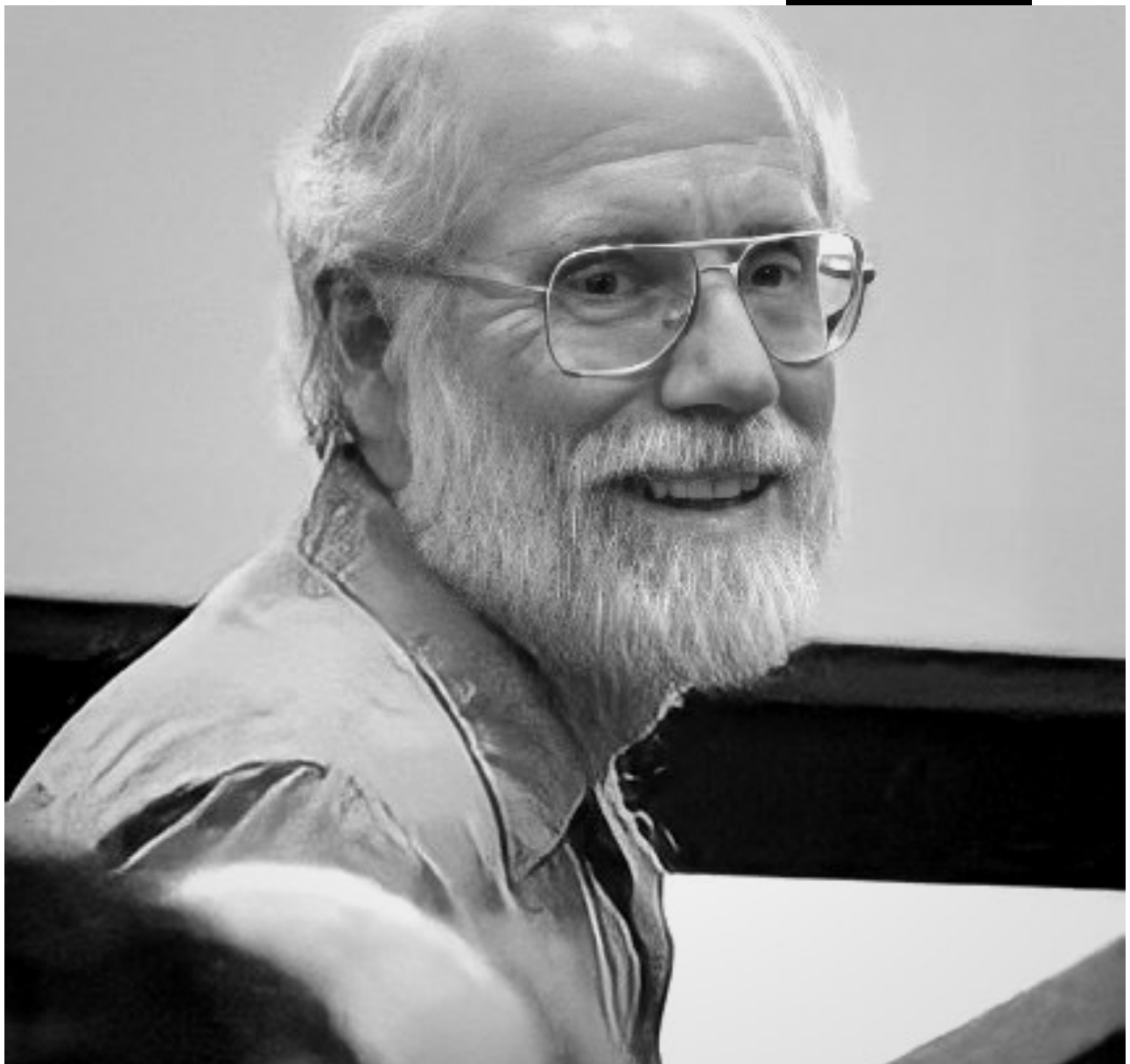
1990-91: First Challenge

Network Flows and Matching



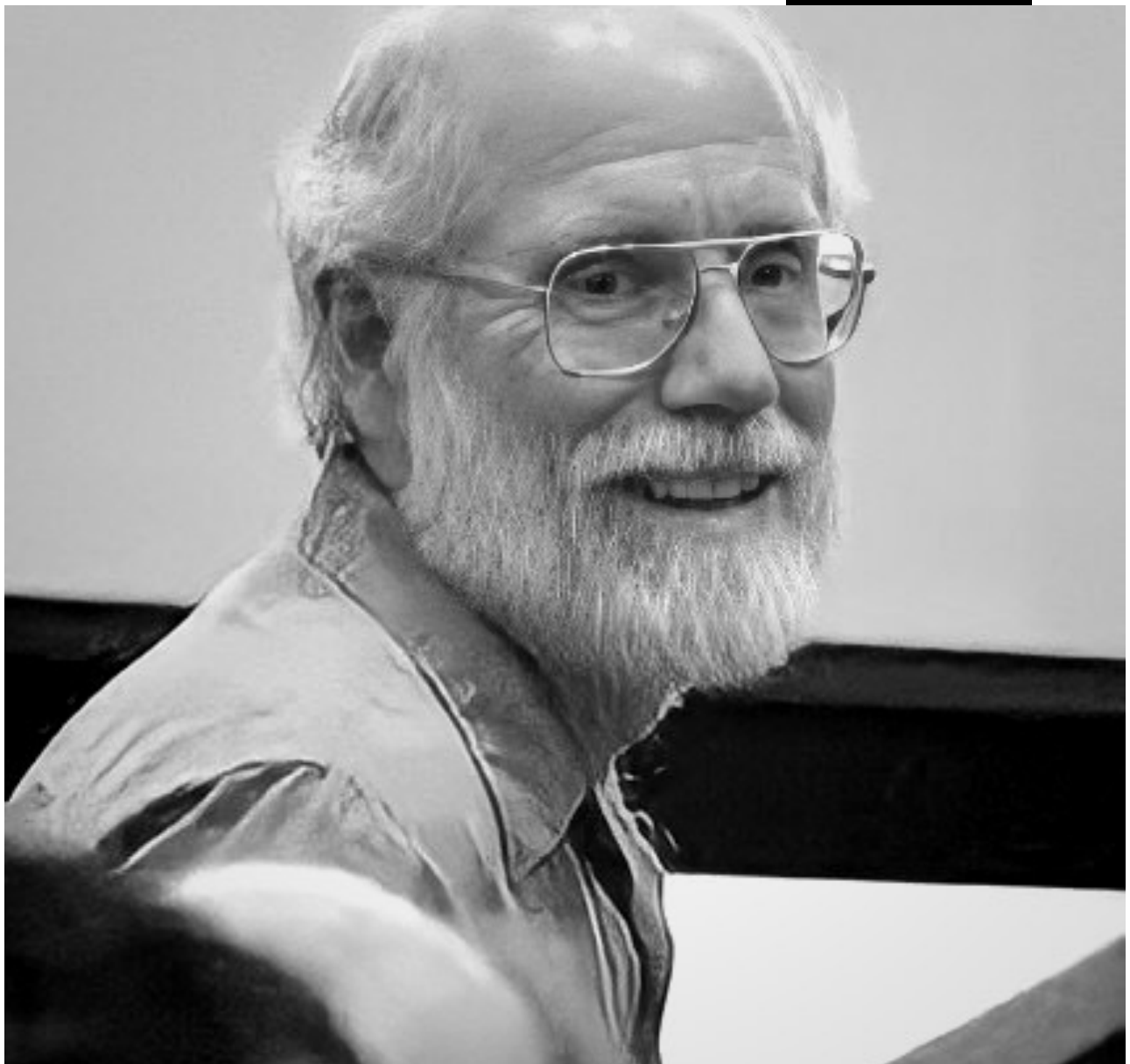
1992-93: Second Challenge

NP Hard Problems: Maximum Clique, Graph Coloring, and Satisfiability



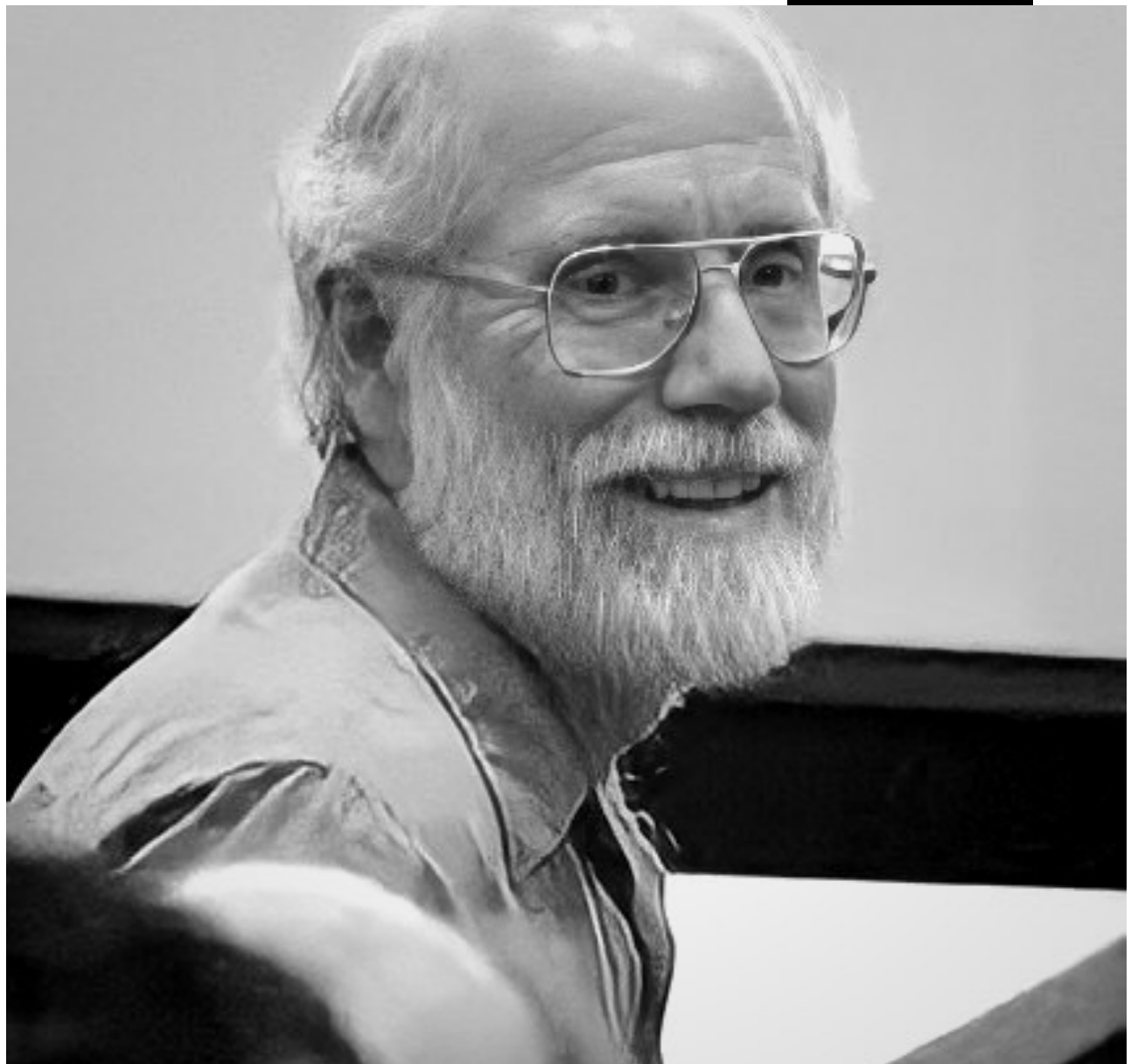
1993-94: Third Challenge

Effective Parallel Algorithms
for Combinatorial Problems



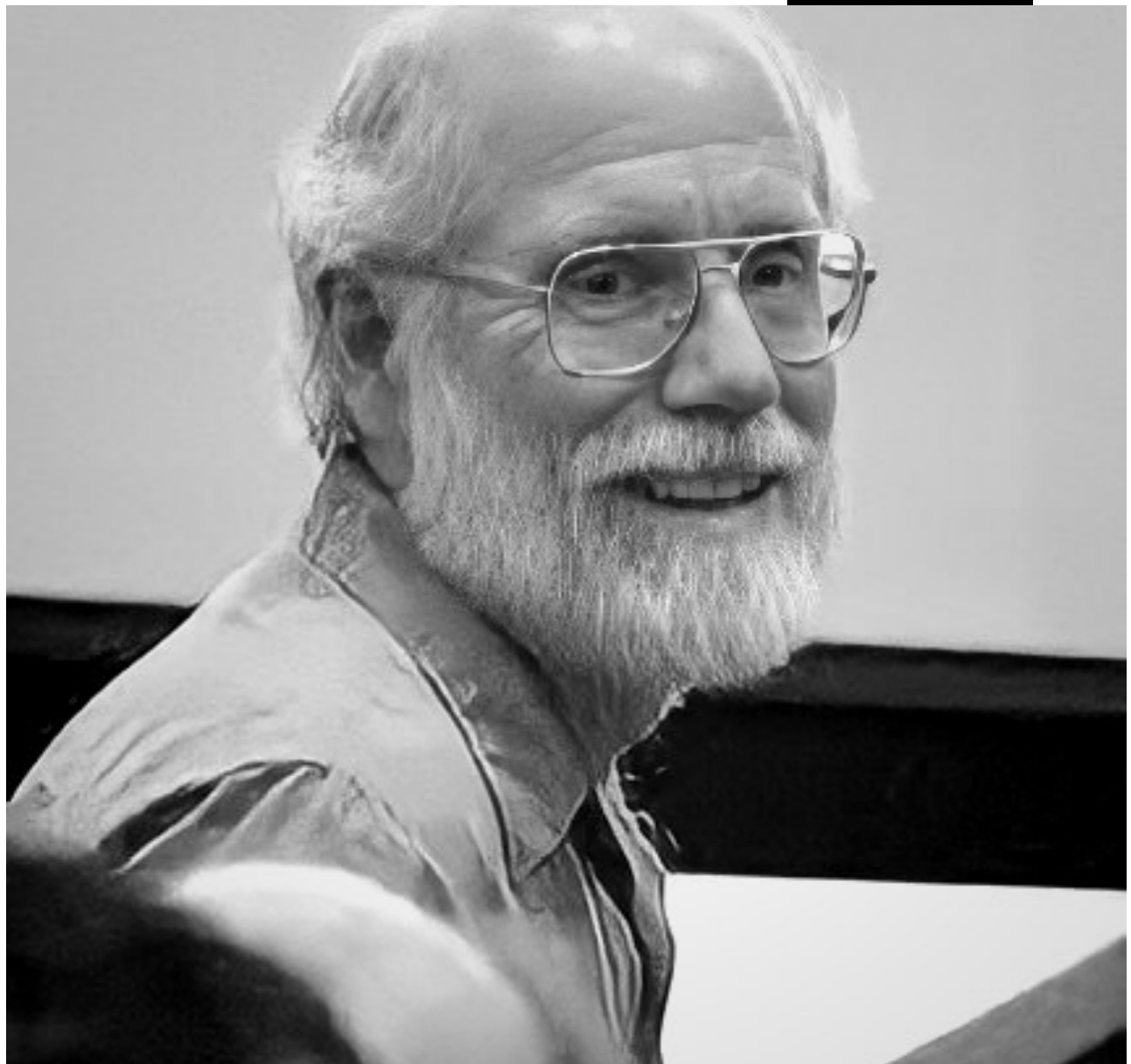
1994-95: Fourth Challenge

Two Problems in Computational Biology: Fragment Assembly and Genome Rearrangements



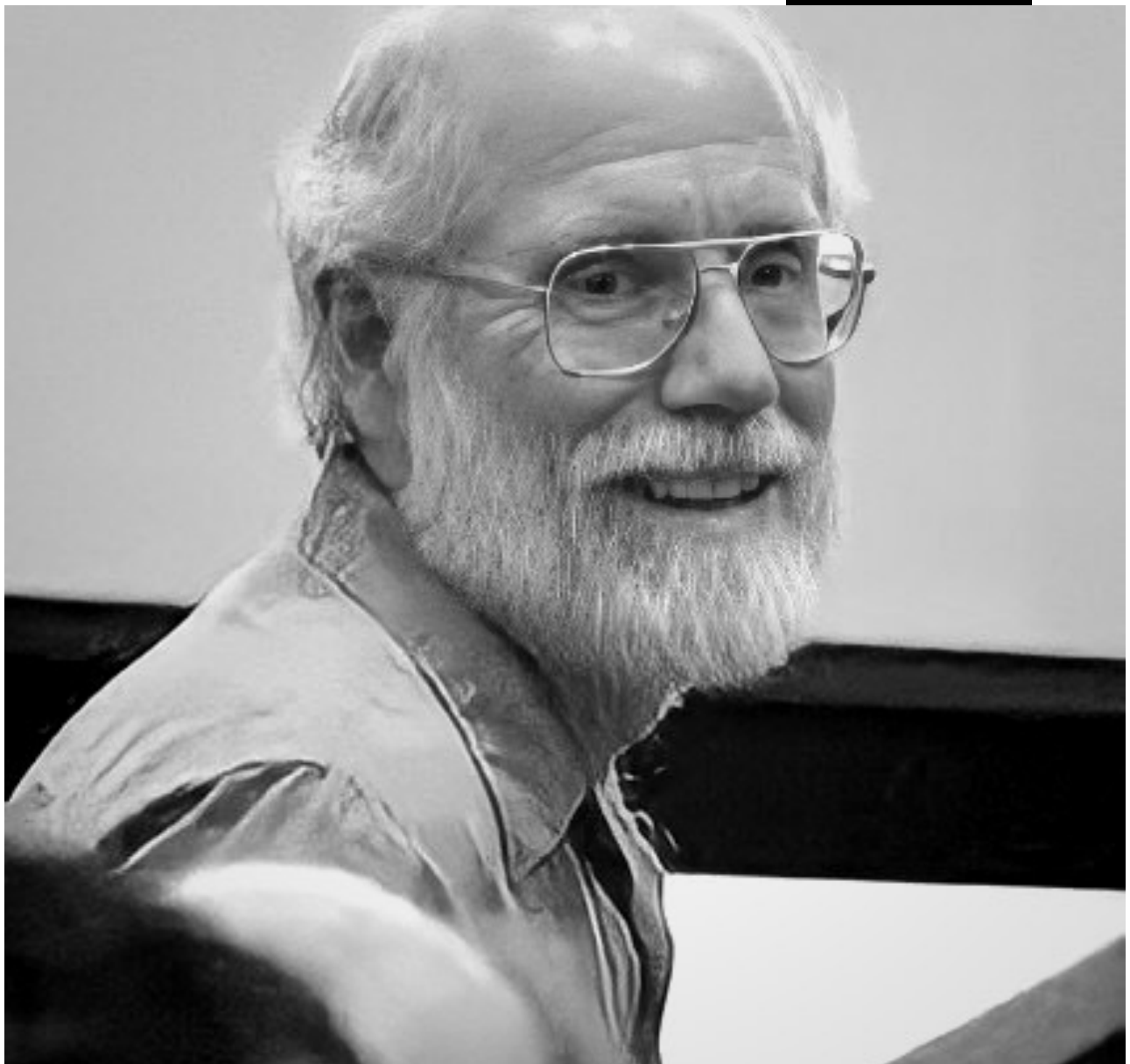
1995-96: Fifth Challenge

Priority Queues, Dictionaries, and Multi-Dimensional Point Sets



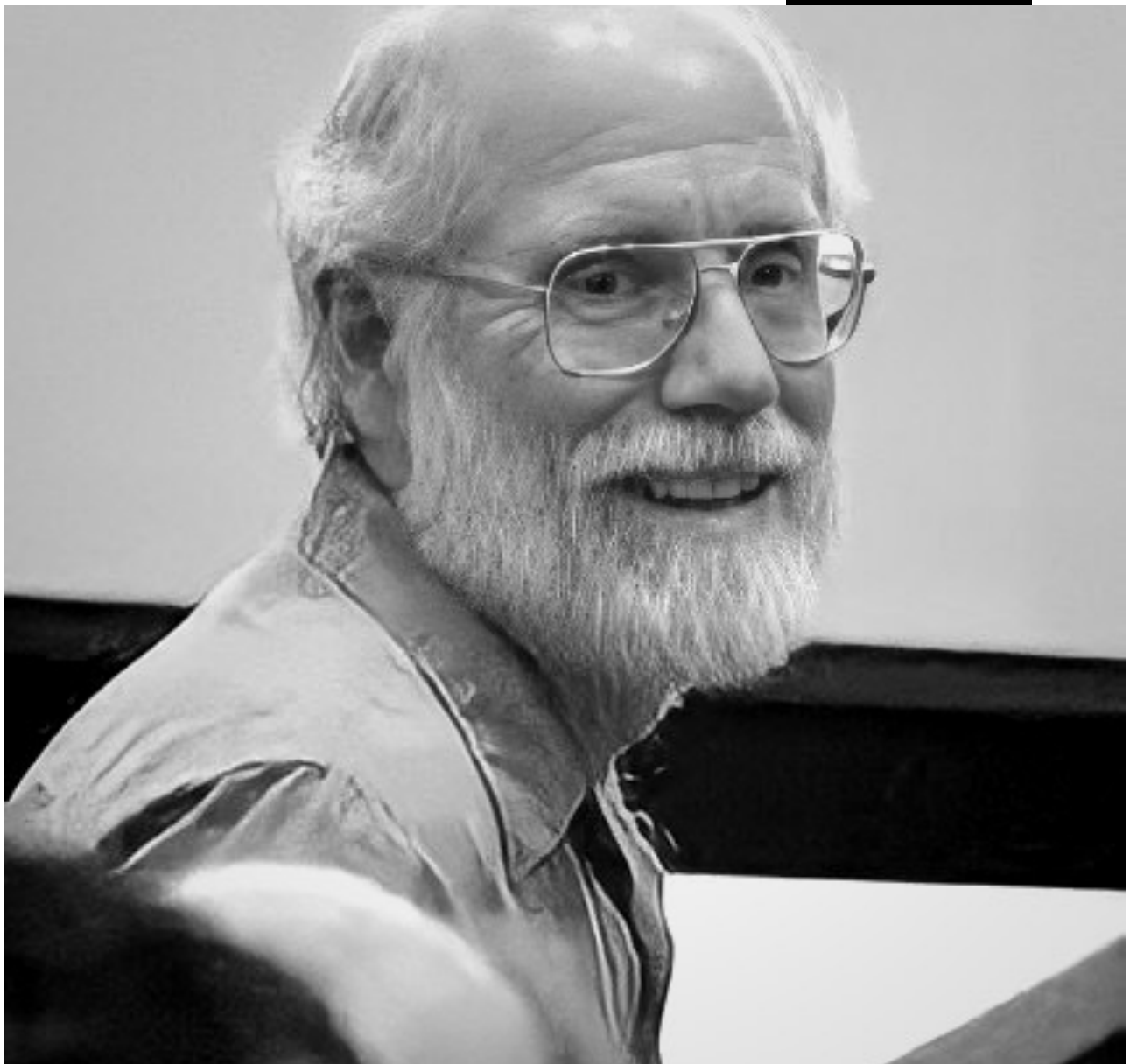
1998: Sixth Challenge

Near Neighbor Searches



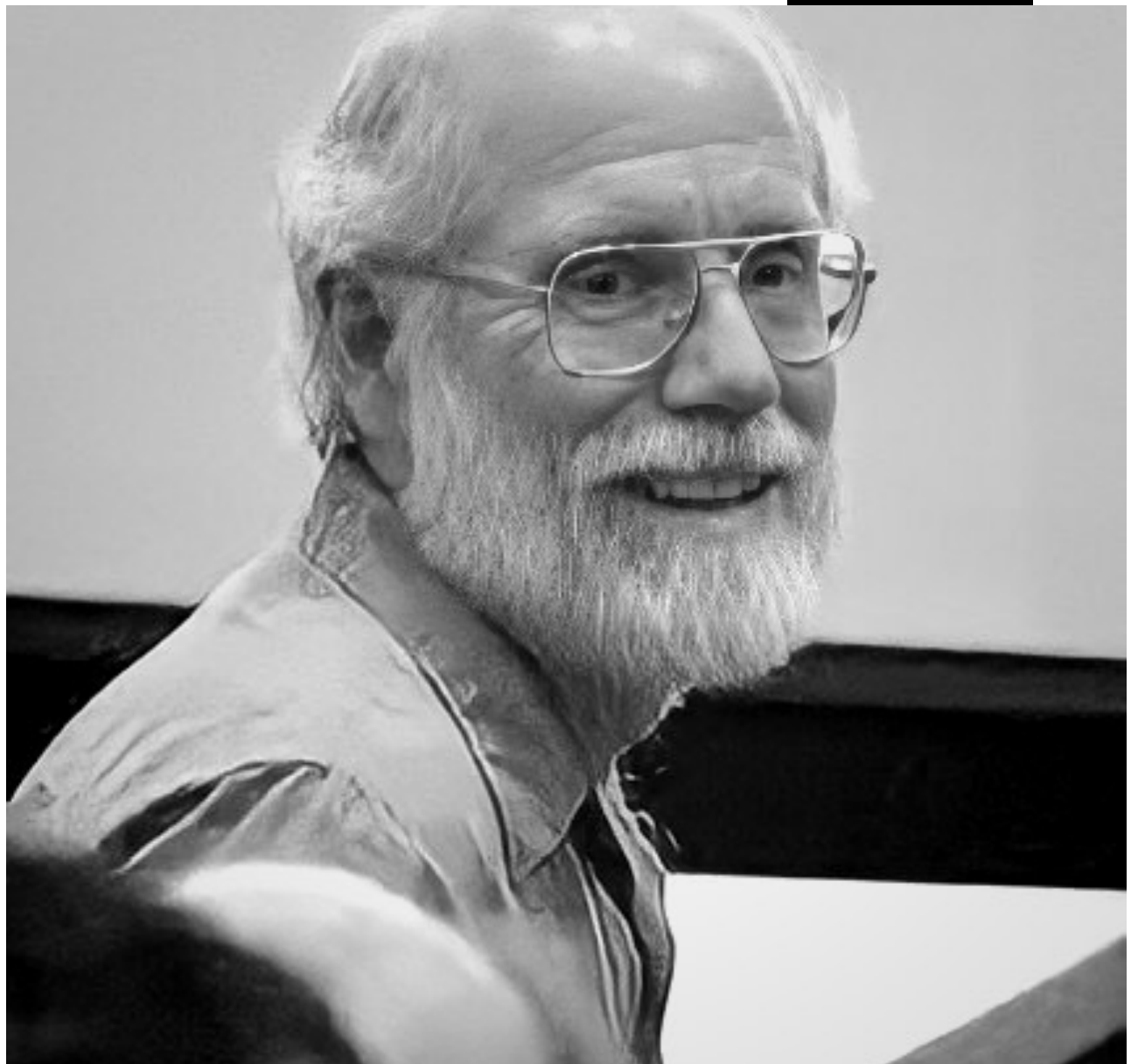
2000: Seventh Challenge

Semidefinite and Related Optimization Problems



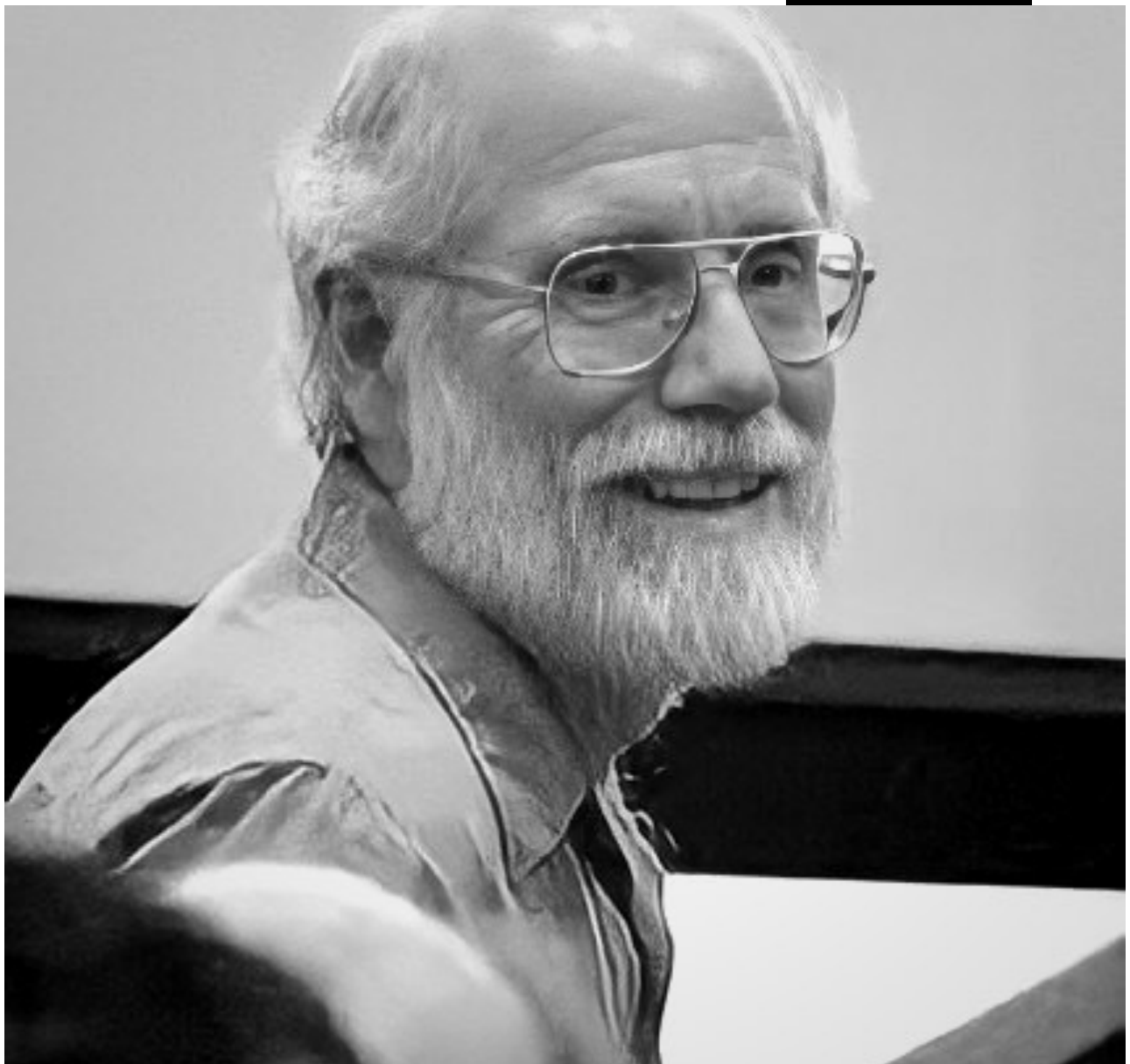
2001: Eighth Challenge

The Traveling Salesman Problem



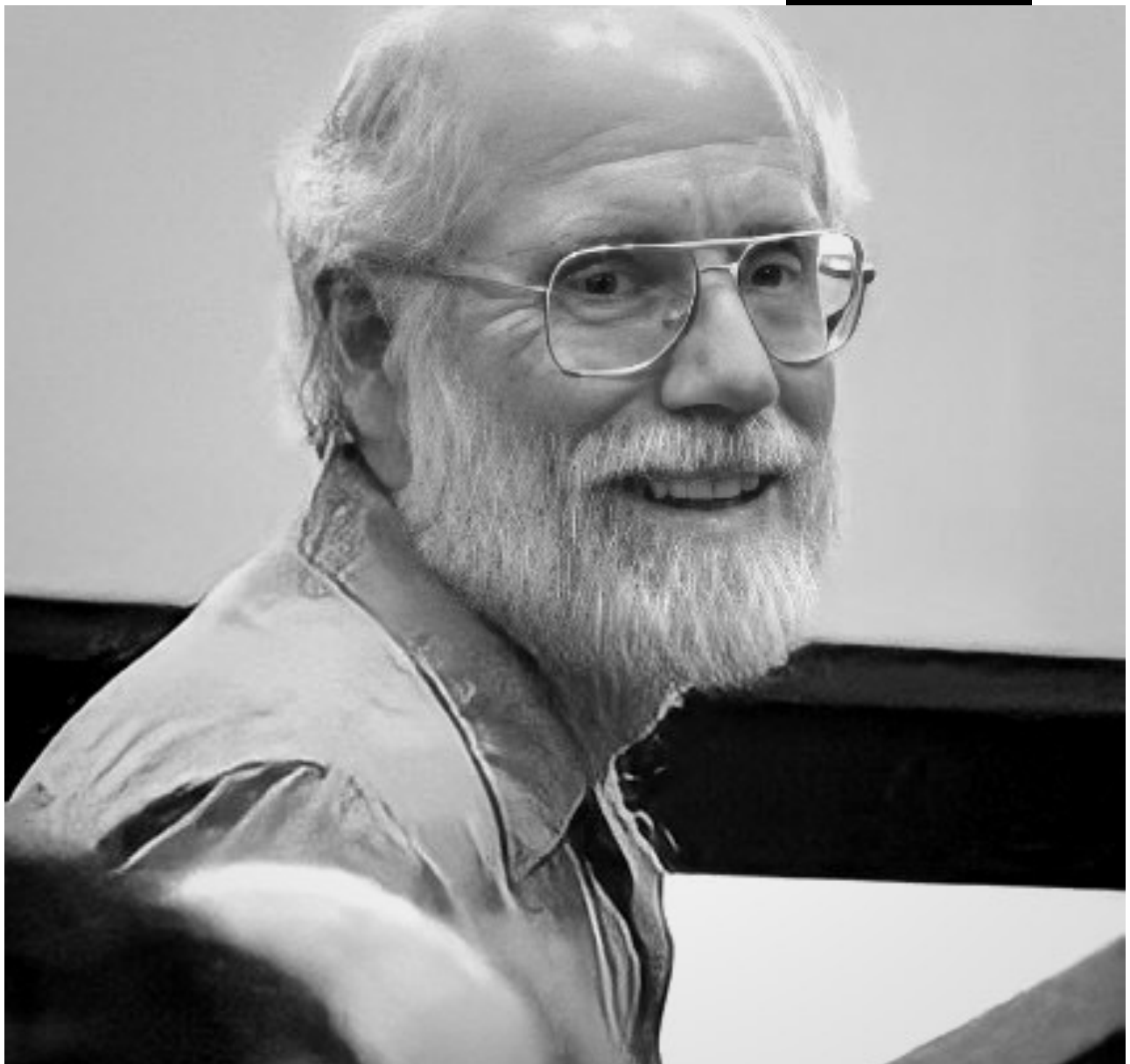
2005-6: Ninth Challenge

The Shortest Path Problem



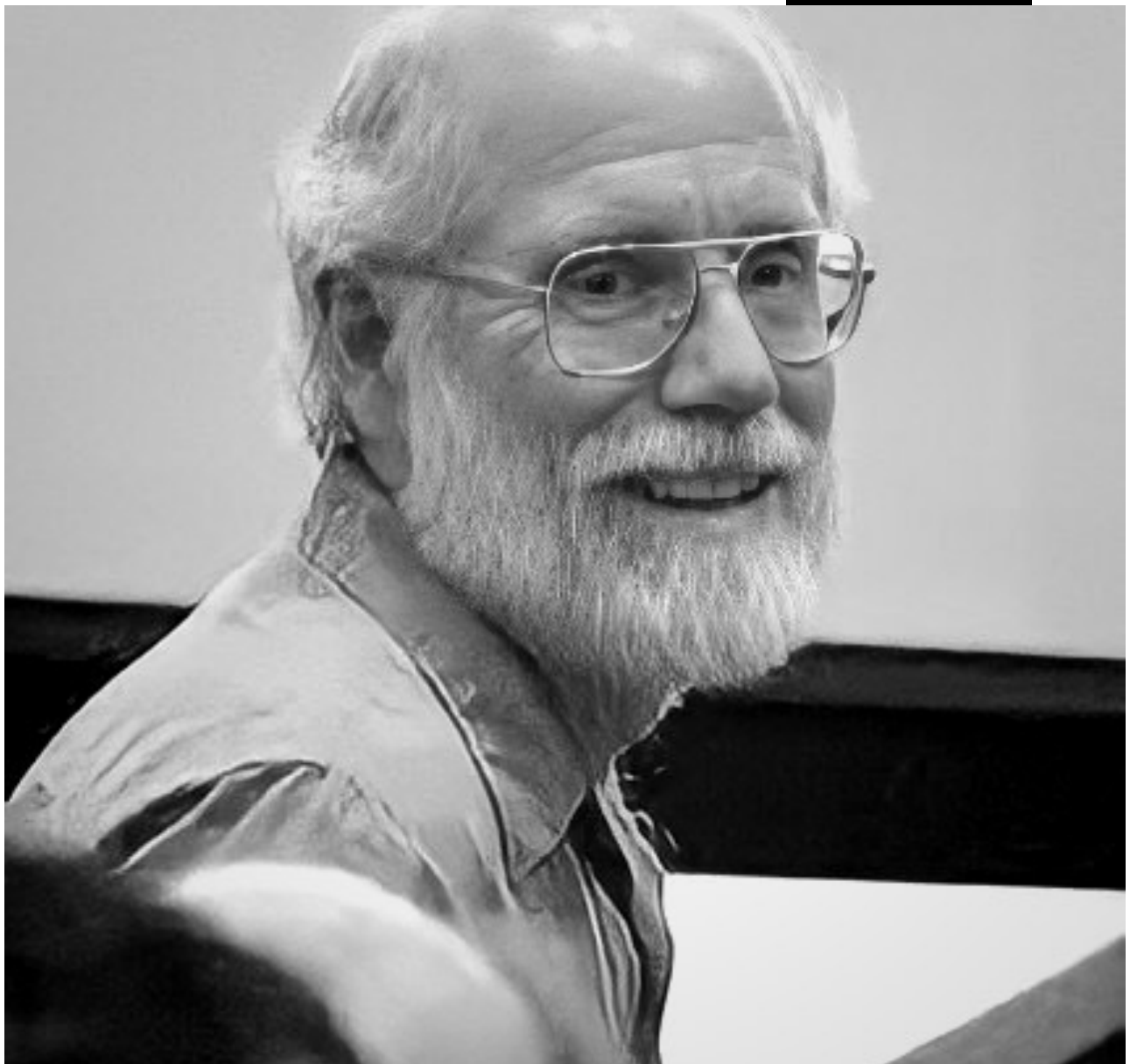
2012: Tenth Challenge

Graph Partitioning and Graph Clustering



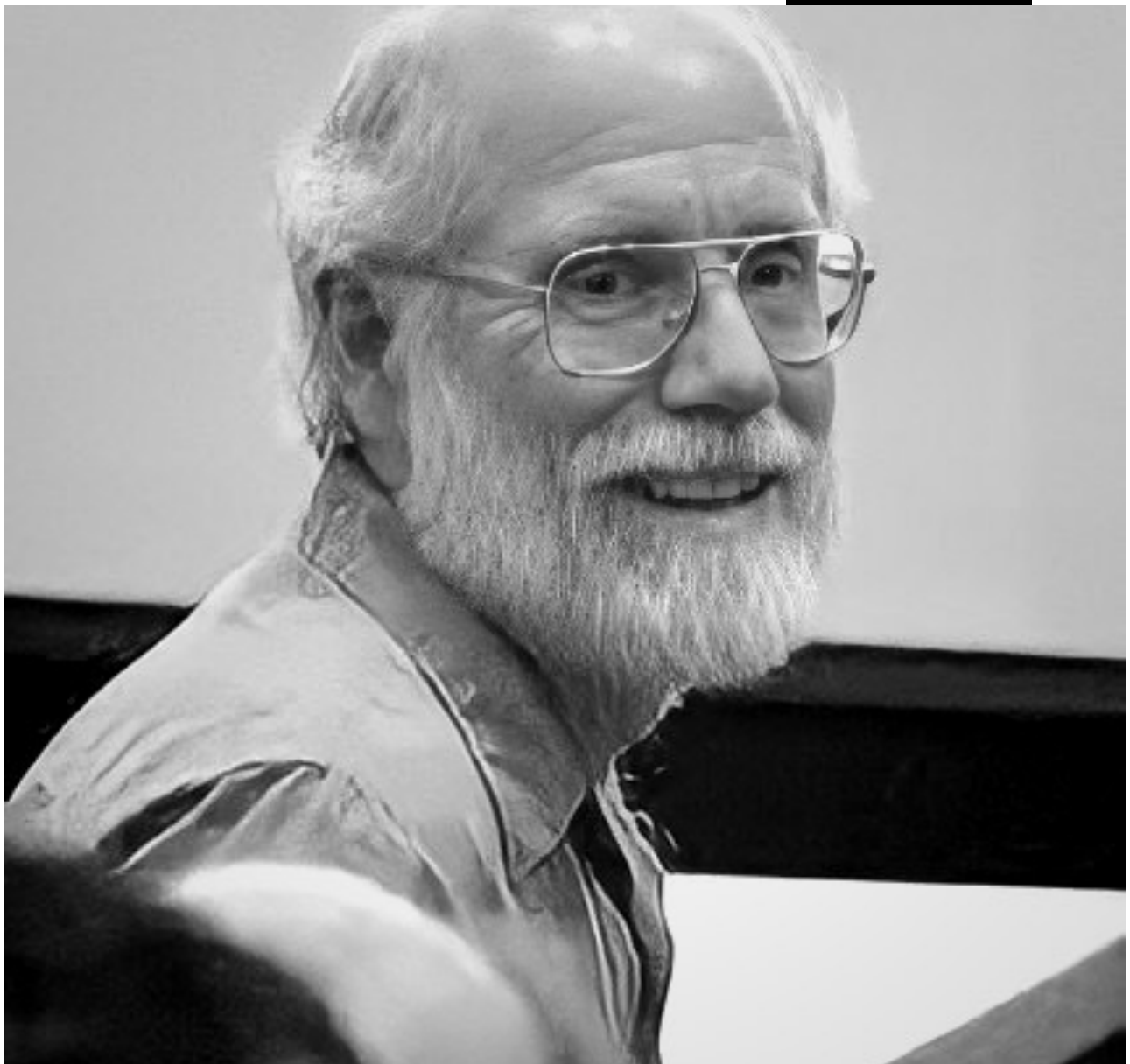
2014: Eleventh Challenge

Steiner Tree Problems



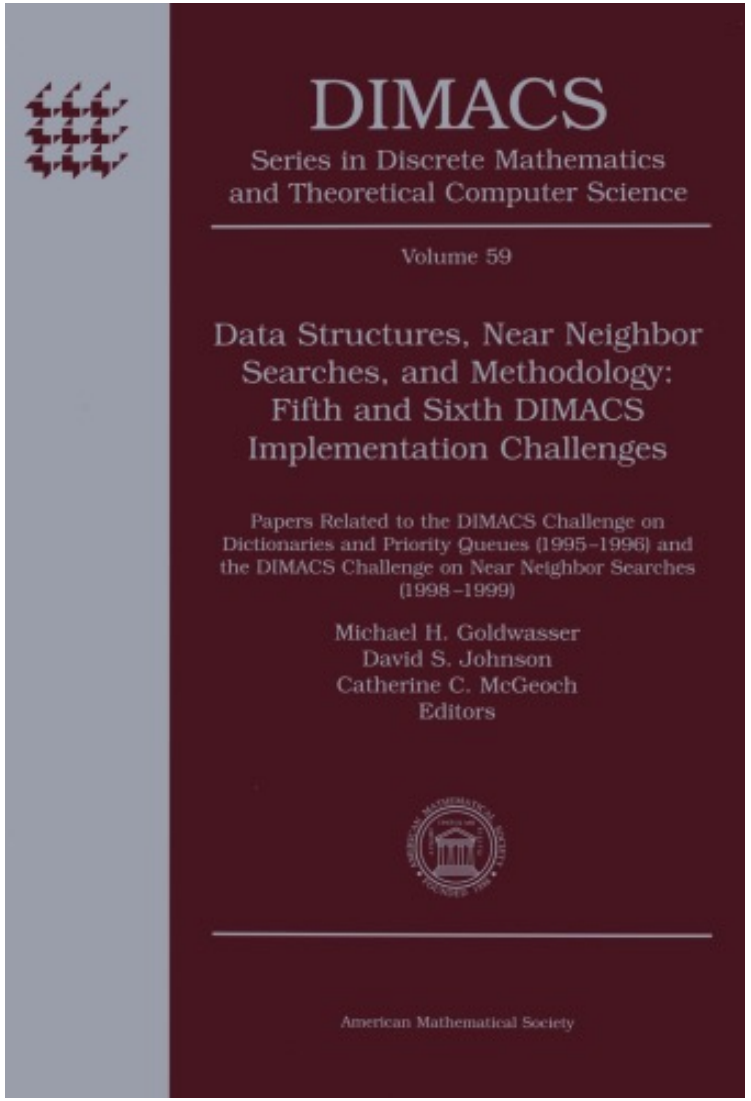
2021-22: Twelfth Challenge

Vehicle Routing Problems



In 2002, David published his influential experimental analysis of algorithms paper

D.S. Johnson, “A Theoretician’s Guide to the Experimental Analysis of Algorithms” in *Data Structures, Near Neighbor Searches, and Methodology: Fifth and Sixth DIMACS Implementation Challenges*, M.H. Goldwasser, D.S. Johnson, and C.C. McGeoch, Editors, DIMACS Series in DM and TCS, vol. 59, pp. 215-250, American Mathematical Society, Providence, 2002. Expanded version of a 7-page 1996 draft.



Theoretician's Guide to the Experimental Analysis of Algorithms

- Theoretical results cannot tell the full story about real-world algorithmic performance.
- Experimentation provides a pathway from theory into practice.
- New forums for presenting results, e.g., ACM JEA, SODA, ESA, WEA (SEA), ALENEX.

Theoretician's Guide to the Experimental Analysis of Algorithms

- Field of experimental analysis is fraught with pitfalls.
- Implementation of an algorithm is the easy part. The hard part is successfully using that implementation to produce meaningful and valuable (and publishable!) research results.

Theoretician's Guide to the Experimental Analysis of Algorithms

Four types of experimental papers

1. *Application paper*: Describe the impact of an algorithm in an application.

Theoretician's Guide to the Experimental Analysis of Algorithms

Four types of experimental papers

2. *Horse race paper*: Provide evidence of the superiority of algorithmic ideas.

Theoretician's Guide to the Experimental Analysis of Algorithms

Four types of experimental papers

3. *Experimental analysis paper*: Better understand the strengths, weaknesses, and operation of interesting algorithmic ideas in practice.

Theoretician's Guide to the Experimental Analysis of Algorithms

Four types of experimental papers

4. *Experimental average-case paper*: Generate conjectures about the average-case behavior of algorithms under specific instance distributions where direct probabilistic analysis is too hard.

DSJ’s ten basic principles for writing experimental papers

1. Perform newsworthy experiments.

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DSJ's ten basic principles for writing experimental papers

1. Perform newsworthy experiments.
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3. Use instance testbeds that can support general conclusions.
4. Use efficient and effective experimental designs.

DSJ's ten basic principles for writing experimental papers

5. Use reasonably efficient implementations.

DSJ's ten basic principles for writing experimental papers

5. Use reasonably efficient implementations.
6. Ensure reproducibility.

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7. Ensure comparability.

DSJ's ten basic principles for writing experimental papers

5. Use reasonably efficient implementations.
6. Ensure reproducibility.
7. Ensure comparability.
8. Report the full story.

DSJ's ten basic principles for writing experimental papers

9. Draw well-justified conclusions and look for explanations.

DSJ's ten basic principles for writing experimental papers

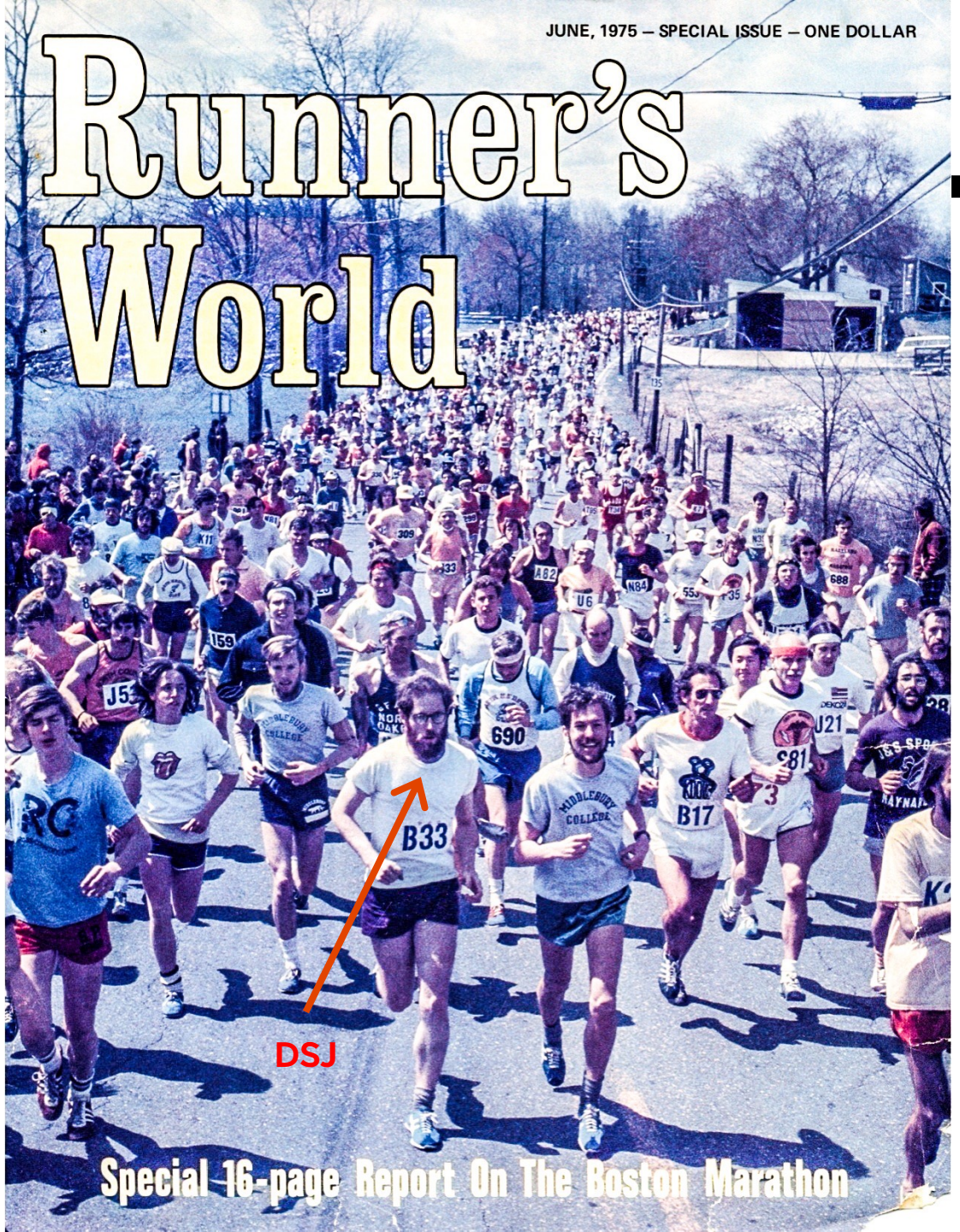
9. Draw well-justified conclusions and look for explanations.
10. Present your data in informative ways.

What I learned from DSJ

- Hit one or more home runs during your PhD
- Attend as many conferences as possible in the first ten years after your PhD (David never missed a single STOC (the annual ACM Symposium on Theory of Computing)
- Implement local search as efficiently as possible
- Think through computational experiments
- Do things in a reproducible way
- Work hard. Go the extra mile to perfect your work.
- Be humble.

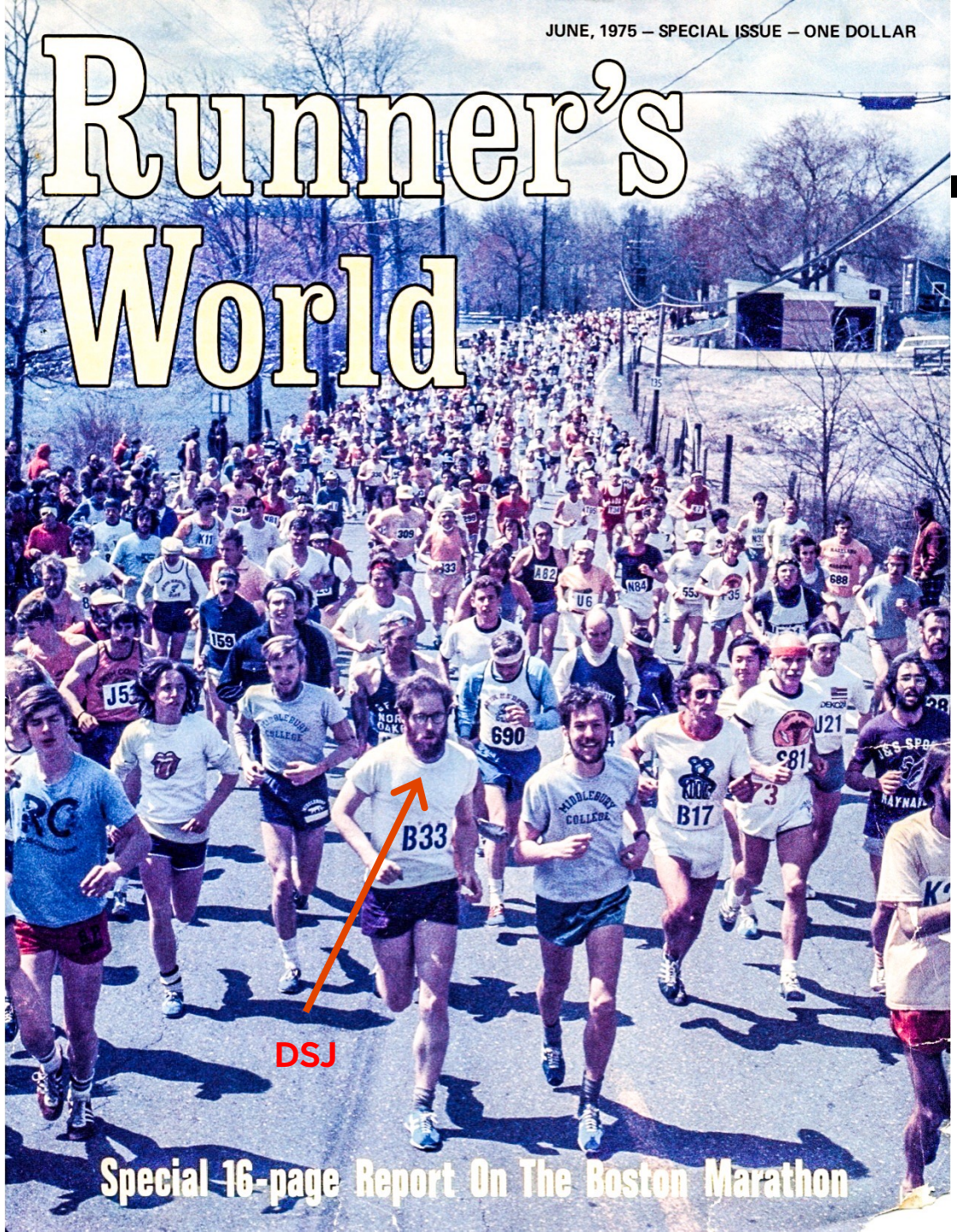
The person

- David served in the U.S. Army from 1969 to 1971. He was 1LT.
- David was a runner.
- David was married to Dorothy Wilson. Jack Johnson is their son.
- David lived in Madison, NJ, for over 25 years, 5 miles away from Bell Labs (Murray Hill) and 3 miles away from AT&T Labs (Florham Park).
- When possible, David would bike to work.



The person

- When he drove to work, David would always park in the same spot.
- David loved to have lunch with his colleagues in what he called the “theory lunch table.” Every day at exactly noon, he would go by each office in our corridor and say “lunch?”
- Every day he would eat the same *salad (dressing on the side) with a Coke* for lunch. He did not like the “stinky” cheese David Applegate would sometimes bring to share with the theory lunch folks.
- At 1 PM everyone would take a cue from David and get up to go back to work.
- At 4 PM every day, David would have his second Coke. He did not drink coffee.



The person

- David loved theory lunch so much that even when he was on vacation, he would bike into Shannon Lab just for lunch.
- David told me after he was ill that he was happy that he could make it to my “retirement” dinner on 11/18/2014.
- That was the last time we saw each other in person. We kept exchanging emails until 2/9/2016 when I congratulated him for his election to the NAE and he replied saying he got many emails about NAE and a “SEA subreferee request from Petra Mutzel for a bad TSP paper I couldn't resist.”

Annual Johnson-Wilson Picnics

From dsj Tue Jun 15 15:35:13 EDT 1993
To: alur, david, edith, mahaling, matias, mgcr, mischu, mkearns, ms, rjb,
    roche, schapire, shor
Subject: picnic
Status: RO
X-Status:
X-Keywords:
X-UID: 309476

You are invited to the 11th Annual Johnson-Wilson Picnic
for Friends, Summer Students, Mentors, Visitors, Families, et al.

Date: Thursday, June 24, 1993
Time: After work (starting 5:30 - 6:00 pm)
Place: [redacted] Prospect Street, Madison, NJ (maps provided free of charge)
Rain Date: None (it's a big house...)

We will be providing burritos, taco makings, etc., and some
salads, plus Coke, Pepsi, lemonade, sangria, and a limited selection of beer.
If you wish to bring something, a pint of your favorite
flavor of ice cream would be fine, plus your preferred beverage if
it's not on the above list. [If you are more ambitious, please contact
me; we can always use a little help.]

If possible, let me know by Monday 6/21 whether you plan to attend,
and how many will be coming with you. Children are welcome.

David Johnson
MH 2D-150

1993

Date: Sat, 10 Jul 2010 15:17:27 -0400
From: David Johnson <dsj@research.att.com>
Message-Id: <201007101917.o6AJHR2P015562@prim.research.att.com>
X-Mailer: mailx (AT&T/BSD) 9.9 2008-02-12
Mime-Version: 1.0
Content-Type: text/plain; charset=us-ascii
Content-Transfer-Encoding: 7bit
To: aarcher@research.att.com, david@research.att.com, dsj@research.att.com,
garay@research.att.com, hajiagha@research.att.com,
howard@research.att.com, mgcr@research.att.com, mip@alum.mit.edu,
mthorup@research.att.com, njas@research.att.com
Subject: Picnic 2010
Status: RO
X-Status: A
X-Keywords:
X-UID: 313075

You are invited to the 28th Annual* Johnson-Wilson Picnic
for Friends, Summer Students, Mentors, Visitors, Families, et al.

As a result of multiple divestitures, the invitation list now spans
both present and past employees of four companies (AT&T Labs, Bell Labs,
Telcordia Technologies, and Avaya Communication). Researchers receiving
this invitation are encouraged to bring along their summer students, and
summer students who receive the invitation are encouraged to pass it
along to their mentors.

Date: Thursday, July 22, 2010
Time: After work (starting 6:00 pm)
Place: [redacted] Prospect Street, Madison, NJ (directions on the web - see below)
Rain Date: None (it's a big house...)

We will be providing hamburgers, hot dogs, etc., and a salad or two,
plus Coke, Pepsi, lemonade, etc. However, this year we will
be counting more on contributions of salads and other dishes from the
non-students who are coming.

If you are able to help, please let me know what you would like to bring.
Salads of all types are especially welcome because of the many vegetarians
who typically attend.

*Note that this is likely to be the last of these affairs we will host.
Next year Dorothy and I will both be old enough to qualify for Medicare,
and its time to pass the torch on to younger and more energetic hands.

David Johnson
AT&T Labs: 973-360-8440, FP C239, dsj@research.att.com

28th Annual Picnic, 2010

*Note that this is likely to be the last of these affairs we will host. Next year Dorothy and I will both be old enough to qualify for Medicare, and its time to pass the torch on to younger and more energetic hands.

David Johnson
AT&T Labs: 973-360-8440, FP C239, dsj@research.att.com

Indeed, there was no picnic in 2011.

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David Johnson
AT&T Labs: 973-360-8440, FP C239, dsj@research.att.com

Indeed, there was no picnic in 2011.

But, … the 29th picnic was held in 2012.

Last Wishes

- More examples of impact (or lack thereof).
- Suggestions for future Kanellakis Prize nominees.
- Suggestions of new problem domains for future DIMACS Implementation Challenges.
- Questions?

Last slide of DSJ's Knuth Prize Lecture.

Last Wishes

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- Suggestions of new problem domains for future DIMACS Implementation Challenges.
- Questions?

Last slide of DSJ's Knuth Prize Lecture.

And so, … here we are at the 12th DIMACS Implementation Challenge – VRP.

Snapshot of David’s homepage in April 2013 (Internet Archive): https://bit.ly/35t7tDD

David S. Johnson

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AT&T; Labs - Research

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Phone: 973-360-8440
Fax: 973-360-8178
Email: dsj@research.att.com

http://www.research.att.com/~dsj

Research Interests:

Combinatorial Optimization, Approximation Algorithms, NP-Completeness, Network Design, Routing and Scheduling, Facilities Location, The Traveling Salesman Problem, Bin Packing, Graph Coloring

Additional Information:

Resume.
Publication List.
NP-Completeness Columns as .pdf files.
Other Papers that are available electronically.
Instructions on how to obtain the test instances discussed in my experimental papers.
Picture Wall: Algorithms and Theoretical Computer Science at AT&T; Labs - Research.
DIMACS Implementation Challenge on the TSP, which I organized.
Challenges for Theoretical Computer Sciences - A draft report I helped prepare for the NSF.

Site Meter

Thank you

mgcr@berkeley.edu