Department of Scientific Computing

Fall 2023

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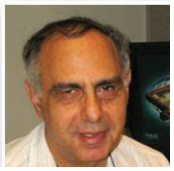

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Emeritus Professor continues high level research

Emeritus Professor I. Michael Navon, an international leading authority in reduced order modeling, optimal control for numerical weather prediction and fluid dynamics, large-scale minimization, non-smooth optimization and adaptive sensor location continues to make substantial contributions to Scientific Computing since his retirement in 2015. He is the highly cited author of over 400 peer reviewed publications who has enriched the intellectual life of the program, always eager to bring in new research ideas or advise in new research topics. He has served as an invaluable mentor for new faculty members and graduate students.

Professor Navon is a visionary scholar who introduced – long before Data Science Programs were established - the field of data assimilation as both a research and teaching component for Scientific Computing. He quickly developed new methods for hybrid data assimilation and became interested in image data assimilation, assimilation of lightning flashes in high impact weather events and adaptive sensor location for threat detection and pollution events. He was one of the first to develop new AI-based methods in nonlinear model order reduction methods in forward and inverse problems.

When offering coveted research advice to colleagues in and outside the department, Navon puts them in contact with renowned colleagues in his field, promotes publishing in high impact journals and introduces new and special issues in the latest research topics. He communicates on an individual basis with faculty and researchers to discuss their scholarly undertakings, giving productive feedback on drafts of important journal papers, grant applications, and advises in promotion issues.

Beyond FSU, Professor Navon regularly provides feedback as a reviewer for journal *continued on page 7*

SC Alum uses scientific tools for wide impact

Clayton Webster is Senior Research Fellow at the Center for Scientific Machine Learning, Oden Institute for Engineering & Computational Sciences, University of Texas at Austin, and a Distinguished Research Fellow at Lirio AI Research & Behavioral Reinforcement and Learning Lab at Lino, LLC in Knoxville. Webster earned his Ph.D. at Florida State University under the supervision of Max D. Gunzburger. During a recent visit to the Department of Scientific Computing, Webster presented a seminar entitled, *Smoothing-based gradient descent for high-dimensional nonconvex optimization* and sat down to express his thoughts on his resesarch and career.

Right: Clayton Webster, Ph.D.

Mathematics

My attraction to math was one thing that was always natural, because I enjoy solving problems and problem solving always pulled me back to mathematics. Originally, my undergraduate major was engineering physics which is essentially nuclear engineering. After the first year I remember saying to someone, "This is not mathematical enough." Around that time, I got some very good advice from people in other departments; they said if you love math, you should study math because your life will be easier if you're doing something you love. I decided to take that advice. That was in 1997 and I've never stopped. Since then, math and this university have been

excellent to me. I've gone far with my degree and I've done a lot of things. Anything is possible once you learn how to think logically like a mathematician thinks. You can work on Wall Street, or start a company or work in finance or healthcare. Lots of doors open up. I just managed to find really cool things to work on. There's so much you can do with a math degree.

Advising

During my studies, I had a famous Ph.D. advisor, a real rock star. I owe almost everything to him. He set me up for life. He taught me how to do a lot of things that are outside academia - things I needed to know how to do in this crazy research world that we live in.

Part of what I learned from Max [Gunzburger] is how to pick out areas that have a large overlap in application space so you can attack a problem and then have a very wide impact. I try to keep that legacy going. One of my students, Nick Dexter, is on the faculty here.

Problem analysis

I view many science subjects as applications of mathematics, so I spend a lot of time finding interesting areas where there is overlap – a way to combine math and science. My group focuses on the fundamental parts we know on these applications, and we spend a lot of time in advancing theory, algorithms, and all the underlying necessities to improve these applications.

We do applied work obviously but primarily we're focused on a larger question, namely, 'How can we advance that field?" To do that, we have to get down to the real core of everything - we invent new capability in settings where the applications of mathematics are not always obvious.

A good example is something that I started working on during graduate school - something called high dimensional approximation, or how do you build a numerical method that can approximate a function that's more than 3D – think about thousands of dimensions. Well, that problem happens to be widely applicable to finance, mortgages, large language models, neural networks, a host of different fields where there are lots of parameters. Guess what they are? Nothing more than high dimensional functions that we need to approximate.

Current project

One of the most exciting things I'm doing right now is I'm working with a company that is focused on a behavioral health project – their goal is to communicate with people to get them to do things that lead to improved health and better lives. This company is unique in that they are scientifically driven; they have a bank of scientists in various fields - behavioral science, neuroscience, mathematics, computer science - and they're trying

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Meyer-Baese named Trefftz Professor

Scientific Computing Professor Anke Meyer-Baese is a recent recipient of the Trefftz award. Named for German physicist Eleanor Trefftz, a TUD Dresden University of Technology graduate whose extensive groundbreaking work focused on theoretical questions in nuclear and molecular physics and spectroscopy, the award is given to women scholars, professors and advanced students to support and encourage research and teaching in the sciences.

Anke Meyer-Baese, Ph.D.

Professor Meyer-Baese is an expert in the fields of medical image processing, computational biology, and computational neuroscience. Her research over the past 30 years has included the development of theoretical machine learning methods such as learning in graphical models, biosignal processing, artificial intelligence and applications of these methods in medical imaging, e.g. for the diagnosis of dementia and tumors. Prof. Meyer-Baese discovered the potential of computational intelligence as a key element for the design of integrated systems in biomedicine. She subsequently created the framework for applying theoretical artificial intelligence tools to biomedical imaging and collaborated across disciplines, among others with the Lee Moffitt Cancer Center in breast cancer research and with the MD Anderson Cancer Center and the National High Magnetic Field Laboratory in brain cancer research.

Meyer-Baese has published four monographs in her main research area and over 250 peer-reviewed publications. In recognition of her research, she has received numerous international and national research awards.

During her stay at TUD, Meyer-Baese was able to contribute her expertise in an interdisciplinary way, for example in cooperation between the Institute of Biomedical Engineering and the Department of Neurology at Dresden University Hospital, where joint research took place in the fields of sleep medicine and neurodegenerative diseases. She also offered lectures on topics such as data mining for medical data and computational neuroscience.

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Alum Receives Prestigious Research Award

Brandon Gusto, a 2022 Scientific Computing Ph.D. graduate, has been awarded a SMART Scholar SEED Grant by the Department of Defense. SEED Grants are reserved for Department of Defense SMART Scholars, a highly selective and prestigious award that provides full tuition, annual stipends and employment with DoD after graduation. Since graduation, Gusto has worked at the Naval Undersea Warfare Center, Newport Division, Advanced Computing and Software.

Gusto will use grant funding to develop a new computational optimization software, an exciting optimization tool that, at its follow on phases, could be virtually limitless and varied in its application. The software will be tailored for engineering design and prototyping applications and will be based on a technique that uses successive sampling to "learn" relationships between objective function and design variables. This functionality will drastically reduce the overall cost of solving problems by incorporating both computationally expensive high fidelity models and less costly low fidelity models.

Gusto was inspired to pursue this topic "because I felt that, given my background in computational science research and my interest in optimization applications, I was in a unique position to deliver something that could really have a positive impact for the Navy within a relatively short time frame."

The SMART Scholar SEED Grant Program develops future technical subject mater

Brandon Gusto, Ph.D.

experts within the DoD and provides up to $100,000 per year for up to three years. An additional $25,000 per year may be requested to support the mentor working directly with the grant principal investigator or to encourage other efforts that assist in the professional and technical development of the PI. Examples include participation in technical trainings, rapid innovation or prototypes, collaboration

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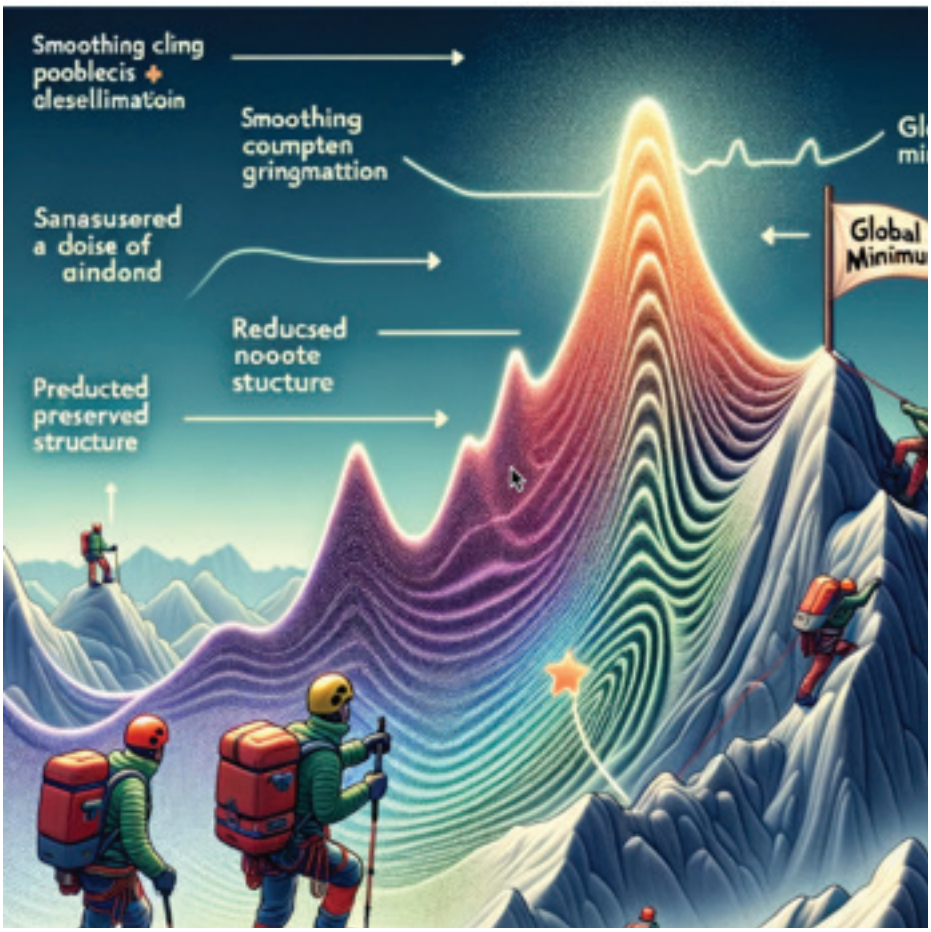
to develop communication capabilities that are personalized to an individual. What we're trying to do is learn how and what to communicate. For example, what t barriers does an individual have to going to get a vaccine? The goal is to build a system that can first learn what an individual person's barrier is and then learn how to communicate with them about that barrier. This approach is known as reinforcement learning or personalized communication with reinforcement learning.



Above: Smoothing-based gradient descent for high-dimensional nonconvex optimization

Advancement

Somehow, I find these problems then I pull them apart and start to figure out what are all the problems we can improve right now. That's the only way to advance the field. What we have to do is answer the question, 'What are the things that halt the subject from moving forward?'

In general, when you're developing mathematical theory, there are lots of approximations along way. Theory building is what drives me. I like to find something new that's not there. It's both rewarding and very frustrating, and for all the successes there are many more failures. We come up with ideas all the time and most of them don't work out. We have to learn to accept that.

For more on Webster and his research, go to https://scholar.google.com/ to do a search.

For more on the Department, go to: https://www.sc.fsu.edu

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articles and research projects; he is highly sought as a chief editor for high-ranked journals and special issues. He continues to write and publish, both in applied mathematics and related interdisciplinary research. He has continued to be a regular scientific presence in the department, attending symposia, Departmental Colloquia, and presentations by guests, colleagues, and students in the program. He has generously contributed to inviting and hosting high-profile guest professors while at FSU. He gladly accepts invitations to write review papers in the modern field of Data Science and gives guest lectures as an invited speaker at many prestigious international conferences and symposia. He has responded to Imperial College London and other prestigious universities see Navon as an important resource and invite him to speak and collaborate.

zProfessor Navon has been a mentor for many colleagues at different career levels, and has helped postdocs and graduate students write high-impact publications, obtain grants and attain national and international prizes. He advises national and international faculty members on how to prepare for leadership roles and works actively with them on awarded grants. Many of his younger colleagues' publications and grant proposals have benefited from his feedback.

Besides his stellar academic contributions, Prof. Navon is a kind and generous colleague, whose advice and guidance have been invaluable over many years.

To see a presentation of Professor Navon's academic career, go to https://people.sc.fsu.edu/~inavon/pubs/Presentation_Navon_retirement1.pdf.
For more, go to the Department of Scientific Computing's website, https://www.sc.fsu.edu.

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The department's mission is to be the focal point of science and computation at Florida State University. Peter Beerli is Chair of the Department of Scientific Computing. He can be reached at 850.644.1010. Newsletters are issued three times each year. Subscriptions and single copies are available by calling 850.644.0196. This publication is available in an alternative format on request.

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with other DoD projects, mentorship and outreach.

The SEED grant is available only to recipients of the DoD's SMART Scholarship-in-Service who have completed the Ph.D.

For more information on the DoD Smart Scholarship and SMART Scholar SEED Grant, go to www.smartscholarship.org.
For more on Brandon Gusto, go to https://people.sc.fsu.edu/~blg13/bgusto.pdf.
For more on the Department of Scientific Computing, go to www.sc.fsu.edu.

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Meyer-Baese holds a Ph.D. in Electrical and Computer Engineering from the Technical University of Darmstadt. Currently, she is Professor of Scientific Computing at Florida State University.

This article originally appeared on the TUD Dresden University of Technology website at https://tu-dresden.de.

Fulbright Scholar and Humboldt award winner Anke Meyer-Baese teaches and does scholarly research at the Department of Scientific Computing. Find out more by going to sc.fsu.edu.

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