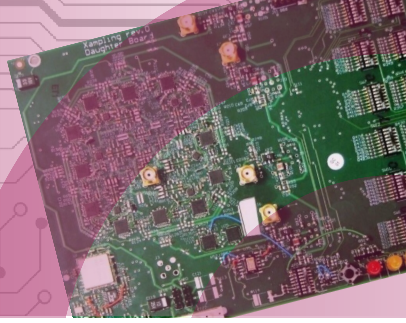
SAMPLLAB
Signal Acquisition Modeling Processing and Learning



Pushing the frontiers of signal-processing and machine learning to advance human lives and wellbeing

WHO WE ARE

SAMPL Lab

The Signal Acquisition Modeling Processing and Learning (SAMPL) Lab at the Weizmann Institute of Science, headed by Prof. Yonina Eldar, focuses on developing new technologies that more efficiently extract and process signals and information across a wide range of tasks, including medical imaging, radar, communication, scientific and optical imaging and biological inference. The lab also develops model-based methods for artificial intelligence (AI) that aid in obtaining increased information using minimal resources.

What is Signal Processing

Signal processing is the area of science and engineering concerned with the generation, acquisition, representation, transmission and analysis of signals and information using mathematical theory and methods. Digital signal processing enables conversion of physical signals to a digital representation for communication and processing by computers and digital devices. Signal processing is the power behind our modern lives, enhancing our ability to communicate and share information. The technology in our everyday lives – from computers, cell phones and autonomous vehicles to medical and defense systems – is enabled by signal processing.

The performance and effectiveness of these systems depend on the quality and efficiency of signal sampling and processing. In many cases, such as medical applications, automotive and aviation, these capabilities are critical to human health, life and wellbeing.

The Challenges We Are Facing

In coming years, new and increasingly complex challenges will arise as we become even more dependent on signal-processing in our everyday lives. As countless additional tasks and functions are replaced by smart and automated applications, they will require increasingly faster and more powerful technologies. As these new technologies sweep across the planet to billions across the emerging markets, they will need to become increasingly more efficient and less costly.

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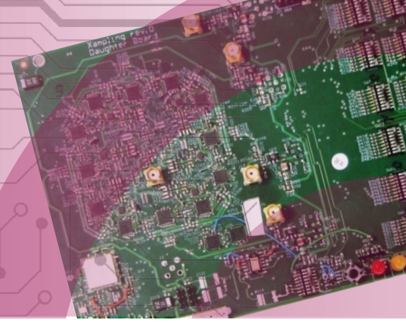

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OUR MISSION

Revolutionizing Signal Acquisition and Processing

SAMPL lab introduces a paradigm shift in signal sampling and processing, enabling the reduction of sampling, quantization and processing rates well below the Nyquist rate, which is considered the fundamental limit for signal sampling. By enabling the extraction of more information using fewer resources we can make machines think faster, make devices smaller and less costly and enhance their quality, helping doctors diagnose better, enabling more people around the world access to better services, and provide more powerful tools to enable scientific discoveries.

From Theory to Application

We facilitate the transition from pure theoretical research to the development, design, and implementation of prototype systems and clinical studies. We believe that theory and practice, when intertwined, help advance scientific discovery and human needs.

Striving to Make Real-World Impact

We strive to harness our technologies to impact medicine, technology, and basic science, and to drive progress for the benefit of society and human welfare:

Medicine We work in close collaboration with physicians and engage in clinical studies in order to improve medical imaging and to enhance early detection of diseases, reduce diagnostic errors, support physicians in their decision-making, and develop more accessible and higher quality imaging tools.

Industry We work with our industry partners to impact next-generation technologies, such as more efficient communication systems, high-resolution radar, joint radar and communication systems for automotive and IoT applications, and more.

Science We provide more powerful and higher-quality tools to enable scientific discoveries, e.g., super resolution microscopy and live cell imaging, and advanced AI and signal processing tools for biological and physical inference.

Inter-disciplinary Research

By encouraging and striving for collaborations between researchers from different disciplines, we promote diversity of thought and advance cutting-edge theoretical research and breakthroughs, and enrich various application domains by guiding scientific discovery toward real-world needs.

Education

We provide tools and methodologies for excellence in scientific research by teaching and mentoring of students, post-docs and resident physicians at their basic science research, with the purpose of shaping a future generation of researchers who will be as passionate as we are for cutting-edge scientific research that impacts society.

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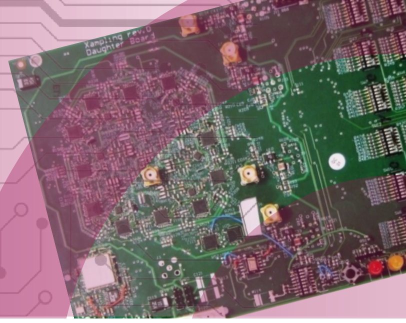
$$C=\int_0^B \log_2\left(1+\frac{S(f)}{N(f)}\right)df$$

$$\hat{x}=\arg\min_{x\in\mathbb{R}^n}\|x\|_1+\lambda\|y-Ax\|_2^2$$



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HOW WE DO IT

Our Approach

While traditional systems treat the sampling and processing stages separately and require sampling at the well-known Nyquist rate, SAMPL lab introduces a paradigm shift in which sampling and processing are designed jointly in order to exploit the signal properties and the task already in the sampling stage.

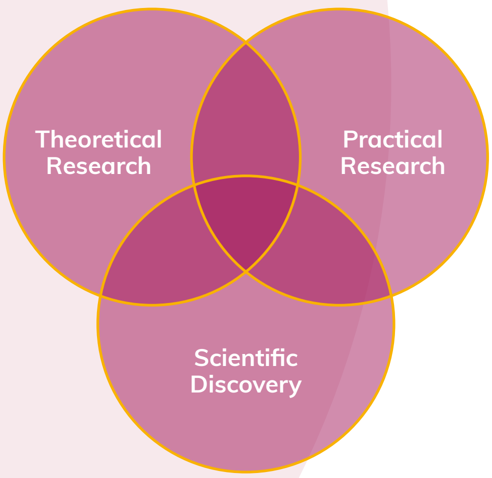
Thus, we can acquire and process only the information needed for the required task, reduce the sampling and processing rates well below the Nyquist rate, and greatly improve the resolution which can be obtained from a limited number of samples in time, space and frequency.

This approach paves the way to new technologies such as:

- Wireless Ultrasound
- Compact Portable Devices
- Fast and Quantitative MRI
- Super Resolution Microscopy
- Efficient Wideband Sensing
- High Resolution Radar
- Efficient Communication Systems
- Joint Radar and Communications Systems
- Super Resolution Ultrasound
- Model-based Efficient & Interpretable Deep Networks

Our Methodology

In coming years, new and increasingly complex challenges will arise as we become even more dependent on signal-processing in our everyday lives. As countless additional tasks and functions are replaced by smart and automated applications, they will require increasingly faster and more powerful technologies. As these new technologies sweep across the planet to billions across the emerging markets, they will need to become increasingly more efficient and less costly.



Medical collaboration
Via our Clinical Research arm, we collaborate with physicians across Israel and abroad, to advance healthcare, medical diagnostics and imaging.

Industry collaboration
Via our Technologies arm, we collaborate with industry partners to impact next-generation technologies.

Scientific collaboration
Via our collaboration with researchers in biology and physics, we promote technology for scientific discovery.

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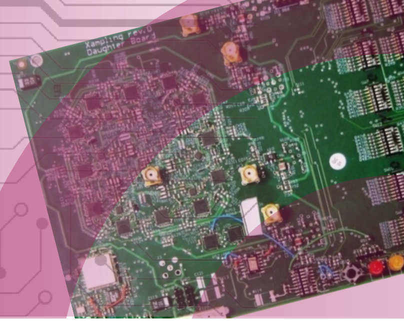

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Prof. Yonina Eldar

Yonina Eldar is a Professor in the Department of Math and Computer Science at the Weizmann Institute of Science, Rehovot, Israel, where she heads the center for Biomedical Engineering and Signal Processing.

She is also a Visiting Professor at MIT, a Visiting Scientist at the Broad Institute, an Adjunct Professor at Duke University, an Advisory Professor of Fudan University, and was a Visiting Professor at Stanford University. She is a member of the Israel Academy of Sciences and Humanities, an IEEE Fellow and a EURASIP Fellow.

Prof. Eldar has received many awards for excellence in research and teaching, including the IEEE Signal Processing Society Technical Achievement Award, the IEEE/AESS Fred Nathanson Memorial Radar Award, the IEEE Kiyo Tomiyasu Award, the Michael Bruno Memorial Award from the Rothschild Foundation, the Weizmann Prize for Exact Sciences, the Wolf Foundation Krill Prize for Excellence in Scientific Research, the Henry Taub Prize for Excellence in Research (twice), the Hershel Rich Innovation Award (three times), and the Award for Women with Distinguished Contributions.

She was a Horev Fellow of the Leaders in Science and Technology program at the Technion and an Alon Fellow. She was selected as one of the 50 most influential women in Israel and in Asia.

She is the Editor in Chief of Foundations and Trends in Signal Processing, and serves the IEEE on several technical and award committees. She Chairs the Committee for Promoting Gender Fairness in Higher Education Institutions, and was a member of the Young Israel Academy of Science and Humanities and the Israel Committee for Higher Education.

She is author of the book "Sampling Theory: Beyond Bandlimited Systems" and co-author of five books, all published by Cambridge University Press.

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