



IEEE Signal Processing Society Princeton/Central Jersey Chapter and Princeton University

Presents

IEEE Signal Processing Society 2009 Distinguished Lecture

A Sparse Transform Theory for Time Varying and Non-stationary Signals and Systems

Prof. Charles A. Bouman

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*4:30-5:30 pm
Thursday, April 2, 2009
Friend Center, Room 008
Princeton University*

Abstract

The objective of this talk is to introduce a framework for the analysis of linear space varying systems and nonstationary random processes that is based on the use of fast sparse transformations. The approach centers around a family of fast orthonormal transformations, which we call sparse matrix transforms (SMT). The SMT is formed by a product of pair-wise coordinate rotations known as Givens rotations, and it can be viewed as a generalization of the Fast Fourier Transform (FFT) and the paraunitary wavelet transform. However, unlike the FFT, the SMT is appropriate for the analysis of time-varying systems and nonstationary random processes. In particular, the SMT is a fast transform that can be used to decorrelate or estimate the spectrum of a non-stationary random process, and it can also be used to dramatically reduce the computation of space-varying convolution.

The talk starts with a quick overview of research in model based image processing. Then we introduce the SMT and show how it can be used to estimate the covariance of high dimensional data with limited training data. Next we show how this same approach can be used to sparsify general matrix-vector operations through the introduction of a rate-distortion based approach to the lossy coding of linear transformations. The use of these methods is illustrated with examples from hyperspectral covariance estimation and scatter reduction in digital photography.

About the speaker

Charles A. Bouman received a B.S.E.E. degree from the University of Pennsylvania in 1981 and a MS degree from the University of California at Berkeley in 1982. From 1982 to 1985, he was a full staff member at MIT Lincoln Laboratory and in 1989 he received a Ph.D. in electrical engineering from Princeton University. In 1989, he joined the faculty of Purdue University where he is the Michael J. and Katherine R. Birck Professor of Electrical and Computer Engineering. He also holds a courtesy appointment in the School of Biomedical Engineering and is co-director of Purdue's Magnetic Resonance Imaging Facility located in Purdue's Research Park.

Professor Bouman's research focuses on the use of statistical image models, multiscale techniques, and fast algorithms in applications including tomographic reconstruction, medical imaging, and document rendering and acquisition. Professor Bouman is a Fellow of the IEEE, a Fellow of the American Institute for Medical and Biological Engineering (AIMBE), a Fellow of the society for Imaging Science and Technology (IS&T), a Fellow of the SPIE professional society. He is also a recipient of IS&T's Raymond C. Bowman Award for outstanding contributions to digital imaging education and research, has been a Purdue University Faculty Scholar, and received the College of Engineering Engagement/Service Award, and Team Award. He is currently the Editor-in-Chief for the IEEE Transactions on Image Processing, a member of the Board of Governors and a Distinguished Lecturer for the IEEE Signal Processing Society. He has been an associate editor for the IEEE Transactions on Image Processing and the IEEE Transactions on Pattern Analysis and Machine Intelligence. He has also been Co-Chair of the 2006 SPIE/IS&T Symposium on Electronic Imaging, Co-Chair of the SPIE/IS&T conferences on Visual Communications and Image Processing 2000 (VCIP), a Vice President of Publications and a member of the Board of Directors for the IS&T Society, and he is the founder and Co-Chair of the SPIE/IS&T conference on Computational Imaging.

Directions

Please visit <http://www.princeton.edu> or <http://www.princeton.edu/%7Epumap/>

From the NORTH/NEW YORK CITY

Take the New Jersey Turnpike south to Exit 9 (New Brunswick). After the toll booths, take the first right turn onto the ramp for Route 18 north. Soon after you enter Route 18, take the left side of a fork in the road, staying in the right lane. Immediately bear right for an exit to U.S. Route 1 south/Trenton. Drive south on Route 1 for about 18 miles to the Washington Road exit, which is a traffic circle. Take the first right off the circle (between the gas stations) toward Princeton. The campus is located approximately a mile straight ahead. From Washington Road, turn right onto Faculty Road (first stoplight after Route 1, just after crossing the lake). After passing Jadwin Gym, turn left on FitzRandolph Road (first street on left after turning onto Faculty Rd, about 600 meters from Washington Rd) and then take the first left turn into Parking Lot 21. Take the "[Blue Line](#)" shuttle bus transportation to the Friend Center. There are small shelters in parking lot 21 where the bus stops.

From the WEST

Drive east on Interstate 78 into New Jersey. Exit onto southbound Interstate 287 (toward Somerville). Follow signs for Routes 202/206 south. Go south on 202 for a short distance and

then follow signs to 206 south, which will take you around a traffic circle. Go south on 206 for about 18 miles to Nassau Street (Route 27) in the center of Princeton. Turn left onto Nassau Street, and follow it to the third traffic light. Turn right onto Washington Road. Continue down Washington Road. Turn left onto Faculty Road (the 4th light on Washington). After passing Jadwin Gym, turn left on FitzRandolph Road (first street on left after turning onto Faculty Rd, about 600 meters from Washington Rd) and then take the first left turn into Parking Lot 21. Take the [“Blue Line”](#) shuttle bus transportation to the Friend Center. There are small shelters in parking lot 21 where the bus stops.

From the SOUTH

If you are coming from southern New Jersey, we recommend that you take Interstate 295 north (instead of the New Jersey Turnpike). Take Exit 67 to Route 1 north. Travel about three miles north on Route 1 to the Washington Road exit, which is a traffic circle. Go three quarters of the way around the circle and turn right (between the gas stations) toward Princeton. The campus is located approximately a mile straight ahead. From Washington Road, turn right onto Faculty Road (first stoplight after Route 1, just after crossing the lake). After passing Jadwin Gym, turn left on FitzRandolph Road (first street on left after turning onto Faculty Rd, about 600 meters from Washington Rd) and then take the first left turn into Parking Lot 21. Take the [“Blue Line”](#) shuttle bus transportation to the Friend Center. There are small shelters in parking lot 21 where the bus stops.

From the EAST

Take Interstate 195 west (toward Trenton) to the exit for Interstate 295 north. Drive seven miles to the exit for Route 1 north (exit 67). Travel about three miles north on Route 1 to the Washington Road exit, which is a traffic circle. Go three quarters of the way around the circle and turn right (between the gas stations) toward Princeton. The campus is located approximately a mile straight ahead. From Washington Road, turn right onto Faculty Road (first stoplight after Route 1, just after crossing the lake). After passing Jadwin Gym, turn left on FitzRandolph Road (first street on left after turning onto Faculty Rd, about 600 meters from Washington Rd) and then take the first left turn into Parking Lot 21. Take the [“Blue Line”](#) shuttle bus transportation to the Friend Center. There are small shelters in parking lot 21 where the bus stops.

From the PHILADELPHIA AREA

Take Interstate 95 north into New Jersey and exit at Route 1 north (exit 67). Travel about three miles north on Route 1 to the Washington Road exit, which is a traffic circle. Go three quarters of the way around the circle and turn right (between the gas stations) toward Princeton. The campus is located approximately a mile straight ahead. From Washington Road, turn right onto Faculty Road (first stoplight after Route 1, just after crossing the lake). After passing Jadwin Gym, turn left on FitzRandolph Road (first street on left after turning onto Faculty Rd, about 600 meters from Washington Rd) and then take the first left turn into Parking Lot 21. Take the [“Blue Line”](#) shuttle bus transportation to the Friend Center. There are small shelters in parking lot 21 where the bus stops.