a one-day symposium
bringing our research
to the public

Saturday, November 17, 2007
Friend Center
Princeton University

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Schedule

8:30–9a.m.	Breakfast
9–9:30a.m.	Opening talk: Kerry Walk Director of the Princeton Writing Program
9:30–11:30a.m.	Talk session I
11:30a.m.–2:15p.m.	Poster session and Lunch
2:15–3:45p.m.	Talk session II
3:45–4p.m.	Break
4–5p.m.	Keynote faculty talk: Ed Felten Professor of Computer Science and Public Affairs and Director of the Center of Information Technology Policy "Electronic Voting: Danger and Opportunity"
5–6p.m.	Awards/reception

Talk session I

The first talk session will take place from 9:30–11:30a.m. in Friend Center 4.

Bribery in Classical Athens
Kellam Conover (Classics)

This talk will be a synopsis of the first half of my dissertation, which looks at changing conceptions of bribery in classical Athens (ca.510–322BCE) and Athens' legal and institutional responses to it. Here I will make three interrelated claims: politics in classical Athens was commonly conducted through exchanging gifts or money; political office itself was viewed as an obligation owed by a citizen; and taking gifts or money while in office was thought problematic only when it interfered with a magistrate's political obligations to the city. Because these obligations were viewed through an ever changing light, bribery was thus blamed as the root cause of different bad outcomes at different times. To illustrate this, I contrast Athenian conceptions of bribery in two different time periods, showing how in one bribery was thought the cause of a magistrate's failure to obey the people's authority, while in the other bribery was thought the reason for an improper financial return. In this light, Athens' laws against bribery were not so much an attempt to curb the taking of gifts while in public office as a legal means to make public officials perform their job correctly.

Having earned his BA in Greek and Latin at Swarthmore College, Kellam Conover is a fifth year PhD candidate in the Department of Classics. He is always eager to bring Classics to a wider audience, even if that means bribing them (for research purposes, of course). He is looking forward to completing a draft of his dissertation this year under the generous grant of a Porter Ogden Jacobus Fellowship.

The Valuation of Employee Stock Options and Their Effects on Financial Accounting

Tim Siu-Tang Leung (Operations Research and Financial Engineering)

Many companies issue employee stock options (ESOs) to motivate, reward and retain employees. An ESO is a contract that entitles the employee to buy some shares of the company's stock at a specified fixed price within a certain period of time. Therefore, if the firm's stock price rises above the specified price, then the employee can profit from exercising the ESO, and this would incur a cost to the firm.

Since the mid-1980s, stock options have become an important component of compensation in the US. ESOs are now the norm in high-technology companies, and are becoming popular in other industries. For instance, large corporations such as Pepsico, Starbucks, and Cisco now give stock options to most or all of their employees. The cost of these options could be very burdensome to the shareholders, but it has been omitted from the firms' financial statements until recent years.

In 2004, the Financial Accounting Standards Board (FASB) passed regulations to mandate firms to estimate and report the ESO cost. The main difficulty of ESO valuation lies in the uncertain timing of ESO exercises while the special features and restrictions of ESOs further complicate the problem. In technical terms, this involves solving a stochastic control problem with optimal stopping, which leads to a free-boundary problem of reaction-diffusion type. In this talk, I will discuss how to estimate the employees' exercise time, and illustrate the impact of several ESO features on the cost.

Tim Siu-Tang Leung is a fourth-year graduate student in the Department of Operations Research and Financial Engineering. His thesis advisor is Professor Ronnie Sircar. He is currently supported by the Charlotte Elizabeth Procter Honorific Fellowship.

Communication and Group Living in the Social World of Bacteria
Carey Nadell (Ecology and Evolutionary Biology)

Bacteria are often thought to be simple, solitary organisms that interact very little with each other. However, recent research has demonstrated just the opposite: bacteria are highly social and frequently grow in large, diverse groups called biofilms. These microbial collectives are ubiquitous in nature and play an important role in both beneficial and pathogenic interactions between bacteria and people. Social life in the microbial world is even more intricate: by way of a process known as quorum sensing, many bacteria are capable of detecting and responding to the local population density of other cells. Quorum sensing entails the secretion and detection of signaling molecules, which accumulate in a cell density-dependent manner. When these signaling molecules reach a critical concentration—that is, when a quorum occurs—bacteria rapidly alter their gene expression patterns so as to coordinate group behavior. Not surprisingly, traits associated with biofilm formation, such as the secretion of sticky extracellular polymers, are often under quorum sensing control. This phenomenon presents many challenging questions for biologists, and in this study we aim to characterize how quorum sensing evolves in the context of biofilm formation. Specifically, we use individual-based simulations to explore the evolutionary dynamics of quorum sensing control over extracellular polymer production. We find that the selective advantage of quorum sensing, and the pattern with which polymer production falls under quorum sensing control, ultimately rests upon a balance of competition within biofilms, and competition between biofilms.

Carey Nadell is a graduate student in the Department of Ecology & Evolutionary Biology.

Wireless Ad Hoc Podcasting

Vincent Lenders (Electrical Engineering)

Podcasting has become popular for dissemination of streaming contents over the Internet. It is based on software clients that query servers for updates of subscribed content feeds. Podcasting may be used for any media content, but it is most commonly associated with audio streams. It provides a simple, no-frills broadcasting system for delay tolerant contents. A main limitation with this system is the inflexible separation of downloading to a docked media player and expending of the data when on the move. We herein present how podcast could be supported by our proposed delay-tolerant broadcasting system in order to reduce the expected times between updates and to provide a new ad hoc podcasting mode among mobile nodes. Our system substitutes the client-server paradigm inherent in present podcasting by a peer-to-peer paradigm where mobile nodes provide each other with content. We present the protocol for this, and an evaluation of solicitation and caching strategies that greatly affect the application-level throughput. Our design aims at simplicity in order to enable implementation in mobile phones with media players and other devices that communicate over short ranges by means of Bluetooth or wireless LAN.

Vincent Lenders has worked as a postdoctoral research fellow in the electrical engineering department at Princeton University since January 2007. He holds a Master's and a Ph.D. in electrical engineering from ETH Zurich obtained in 2001 and 2006, respectively. His current research interests cover various aspects related to wireless and mobile communication networks.

Reconstructing the Pantano Longarini Ship
Sarah Kampbell (History)

In the 40 years that have passed since the excavation of the seventh-century CE Pantano Longarini shipwreck in Southeastern Sicily, many additional ships have been located, including at least five from the same century. Due to the accumulation of so much data, it is necessary to revisit the original conclusions and make changes in light of new information.

There has been debate over the date, origin, type and purpose of the Pantano Longarini ship since its discovery. Despite its excellent preservation, the circumstances surrounding its excavation and publication have resulted in scholars ignoring or misinterpreting it. In order to correct the historical record about the Pantano Longarini ship, one must examine the details of the design of the vessel.

This analysis points not to a seagoing merchantman as originally reported, but to a coastal lighter. The unusual assembly of timbers at the stern presents an innovative and unique structural solution for a vessel that carried extremely heavy cargo in shallow water. The Pantano Longarini ship demonstrates adaptive strategies for local naval needs as well as broader maritime technological designs utilized in the seventh century CE Mediterranean.

Sarah M. Kampbell is a first-year graduate student in the department of History studying Late Antique trade and economy through archaeological and textual methods.

Posters

The poster session will be held from 11:30a.m.–2:15p.m. in the Friend Convocation Center.

1) Spectral Visions: Poetic Renditions of History in Contemporary Iberian Novel, Theater, and Documentary Film
Miguel Balsa (Comparative Literature)

Whenever we think, speak, or write about the past, the word "history" comes to mind almost immediately. On closer examination, however, the term reveals an intriguing ambiguity: it refers, on the one hand, to past events and actions (what our ancestors did), and, on the other, to material renditions of those past occurrences (texts meant to represent what our ancestors did). In other words, by virtue of the term "history" we articulate two altogether different forms of human activity—doing vs. making, or performing actions vs. fabricating objects, or praxis vs. poiesis.

The purpose of my project is to explore how works by some Iberian artists, such as playwright Jose Sanchis Sinisterra, novelist Antonio Lobo Antunes, and filmmaker Mercedes Alvarez, interrogate the paradoxical movement of art akin to that of history between doing and making.

Interrogating the spectral space between doing and making entails reflecting on the relationship between the past and the present. Common sense tells us that little space is left for human agency in the realm of history if we represent it exclusively as a set of accomplished facts. As I show, certain artworks strive to represent historical events in ways that enable human beings to experience the past anew. These representations allow us to see history spectrally: as present as well as past, as poiesis as well as praxis. And such spectral visions of history, in turn, enable us to envision ourselves as subjects of history, rather than as subjected to the past.

Miguel A. Balsa was born in Spain, and he is currently a Ph.D. student in the Department of Comparative Literature. He comes to his doctoral studies from a background in Theater, Journalism, and International Relations. His interests include history, political theory, and the history of theater.

2) To be announced
Silvia Bulow (Geosciences)

3) The Roles of *chalice* and *quit* in Drosophila Oogenesis
Lesley Chuang (Molecular Biology)

Cell migration is vital. Without it, there would be no embryonic development. However, if we can inhibit cell migration, tumor metastasis could be better treated. My thesis project is focused on cell migration during oogenesis in *Drosophila melanogaster*. At stage 10B, a group of 50 follicle cells migrate from the periphery of the egg chamber toward the center. As the centripetally migrating cells move between the nurse cells and the oocyte, they form the anterior aspect of the maturing egg. Very little is known about the molecular control of centripetal cell specification and migration. Therefore, I propose to analyze two mutants with failed centripetal cell migration. *chalice (chal)* and *quit (qui)* were first isolated from a genetic screen for female sterile mutations. In the egg chambers of these mutants, centripetal cells remain on the outside of the nurse cell-oocyte complex. Consequently, open-ended eggshells form. I hypothesize that chal and qui are involved in the migration of centripetal cells. By mapping and characterizing both mutations, I aim to provide insights into the complex interactions among migrating cells and with other cells in their environment.

Lesley Chuang is a second-year Ph.D. student in the Department of Molecular Biology. She is an Adult Third Culture Kid (ATCK)—she grew up in Taiwan and New Zealand, and spent time in Australia before attending college in the US. When she is not working in the lab, she enjoys traveling, reading and listening to "This American Life."

4) Getting a handle on cell motility
Robert Cooper (Molec4ular Biology)

Dictyostelium, "the social amoeba," is a fascinating model organism (biologist speak for easy-to-work-with) used to study many processes in higher animals. For example, when starved, the normally solitary cells signal to each other and spontaneously group together. This process can teach us much about multi-cellular development, as well as cooperation, since some cells survive to find a better place while others sacrifice themselves for the greater good. Perhaps even more interesting is how the individual cells detect each other or food (bacteria), and move in the correct direction. Human white blood cells behave in much the same manner when chasing invaders in your own blood stream. I aim to study the motion of these cells using quantitative techniques and precision that has thus far been lacking in the field. This has required developing image processing algorithms to follow cells in live-action movies and learning how to manipulate DNA to make different parts of the cells glow fluorescently. The stories these amoebas have to tell, if one asks the right questions and knows how to listen for the answers, should tell us a lot about how cells decide where to go and put their decisions into action.

I am a second-year student in Molecular Biology, and did my undergraduate work at Williams College in Massachusetts. My major there was Physics, so when talking to biologists I say I am defecting, when talking to physicists I say I am infiltrating, and when talking to people who do both I say I am integrating. Really, my goal is just to apply the analytical and quantitative skills and mindset that I learned from physics to the myriad questions in biology.

5) Self-Consistent Axisymmetric Plasma Equilibria
Nathaniel Ferraro (Plasma Physics)

Determining the equilibrium state of a magnetically confined plasma is a difficult task due to the complicated nonlinear behavior of plasma in a magnetic field. We obtain axisymmetric steadystates of the full extended-magnetohydrodynamic (X-MHD) fluid model of plasma in toroidal geometry, including two-fluid effects, flow, and gyroviscosity, by evolving the X-MHD equations from an initial ideal-MHD equilibrium. Self-consistent flows are observed, and spontaneous spin-up is found to develop even when a simple resistive single-fluid model is used, in agreement with previous theoretical and numerical results. In the steady-state, resistive and thermal losses are offset by inductive current drive. These accurate and self-consistent steady-states may be used as the initial equilibrium for non-axisymmetric linear stability calculations to determine stability limits for fusion plasmas, for example. The steady-states are obtained using M3D-C1, a parallel, implicit, nonlinear, high-order finite element code. Cylindrical coordinates are used instead of magnetic coordinates, eliminating difficulties arising from the coordinate singularity at the magnetic x-point in diverted plasmas. The vacuum region between the fusion plasma and the vacuum vessel is modeled as a high-resistivity plasma, allowing the same physical equations to be applied throughout the simulation domain. An unstructured, adaptive triangular mesh is used to maximize computational efficiency without degrading spatial resolution.

Nathaniel Ferraro is a fifth-year graduate student in the Program in Plasma Physics. His advisor is Stephen Jardin.

6) Aspects of interaction between the Meridional Overturning Circulation and the Antarctic Circumpolar Current

Neven-Stjepan Fuckar (Atmospheric and Oceanic Sciences)

The critical role of the oceans in the Earth's climate system stems from their enormous capacity to absorb heat, freshwater and biogeochemical substances (i.e., tracers) and the global redistribution of these tracers on decadal to centennial and millennial time scales. A long duration, from the water mass formation at the surface (in the contact with the atmosphere) and sinking to ventilation (i.e., rising back to the surface), particularly of the deep and abyssal waters, generates a mechanism for moderation of global climate variability and change.

A change of the Meridional Overturning Circulation (MOC) has a potential to significantly modify the intensity of the Antarctic Circumpolar Current (ACC) and the Southern Ocean overturning circulation with a substantial climate impact. Using a hierarchy of idealized ocean general circulation models we demonstrate that ocean dynamics can convey to the Southern Ocean a perturbation induced by surface density change restricted to the Northern Hemisphere. Specifically, while keeping the surface conditions in the Southern Hemisphere fixed, a hypothetical northern hemisphere surface warming induces the weakening of the deep MOC; this causes an increase of the ACC transport and the Southern Ocean overturning south of the ACC. This interhemispheric MOC-ACC interaction can substantially alter interbasin exchange and ventilation rates in the Southern Ocean, therefore modifying the ocean's role in climate dynamics by reducing the time that deep and abyssal waters spend away from the surface.

Neven S. Fuckar is a Ph.D. candidate in Atmospheric and Oceanic Sciences Program with a research interest in climate and ocean dynamics. He has a B.Sc. in Physics from University of Zagreb (Croatia) and a M.Sc. in Oceanography from Texas AM University (College Station, TX).

7) Hadronic energy reconstruction with the CMS experiment
Davide Gerbaudo (Physics)

The Compact Muon Solenoid (CMS) project is a major experiment in particle physics which will start this summer at the European Center for Nuclear Research (CERN) in Geneva, Switzerland, after about a decade of preparatory work carried out by thousands of scientists worldwide. This experiment aims at collecting data that has never been accessible before. It will notably consist in measuring the particles generated by the collision of protons at unprecedentedly high energies.

The protons will be accelerated by the Large Hadron Collider (LHC), which is probably the biggest and the most complex scientific instrument ever built, located underground in a tunnel 17 miles in circumference. Two proton beams will circulate in opposite directions, reaching a center of mass energy of 14 TeV (that is the protons will travel at 0.999999991 times the speed of light), and collide head-on at four points in the ring, each of these being the site of a different experiment. Located at one these four points is the CMS detector, a general-purpose detector whose main goal is to give us a better understanding of the fundamental forces and of the elementary constituents of matter—probably by discovering new particles such as the most sought after "Higgs boson."

One of the most important and challenging tasks for a collider experiment is to measure the energy carried by hadrons (composite particles held together by "the strong force"). These particles are one of the outcomes of the performed collisions, and their energy is detected by different types of calorimeters and reconstruction techniques. My poster will describe the CMS detector, with emphasis on its hadronic calorimeter, and on the adopted strategy for hadronic energy reconstruction.

Davide Gerbaudo started working on the Compact Muon Solenoid experiment as an undergraduate and as a Master's student at the university of Torino, Italy, where he was initially working on the CMS tracking detector. In 2005 he moved to the USA, where he started his PhD in experimental particle physics. Here at Princeton, he has kept working on the CMS experiment, and he is looking forward to analyzing the upcoming Large Hadron Collider data next year.

8) Magnetic resonance reversals in optically pumped alkali-metal vapor
Fei Gong (Physics)

Ground-state magnetic resonances of optically pumped alkali-metal atomic vapors have been widely used in atomic clocks and magnetometers. Here I report an unusual phenomenon, peculiar sign reversals of the ground-state magnetic resonances, which means that the vapor becomes more transparent when the applied oscillating magnetic field is on resonance with some ground-state transition. It is in marked contrast to all previous observations that we know of, where pumping with circularly polarized D1 light increases the transparency of the vapor and when the externally applied oscillating magnetic field is on resonance, transparency of the vapor will be decreased and the pumping light will be absorbed more. These anomalies occur when a weak circularly polarized D1 laser light is tuned to pump atoms predominantly from the lower ground-state hyperfine multiplet. One can understand the signal reversals in a simple, semi-quantitative way with reference to the spin-temperature distribution of the alkali-metal atoms among the ground state sublevels. Quantitative computer simulations are in excellent agreement with the experimental results. I report an unusual phenomenon, peculiar sign reversals of the ground-state magnetic resonances of optically pumped alkali-metal atomic vapors, which occur when a weak circularly polarized D1 laser light is tuned to pump atoms predominantly from the lower ground-state hyperfine multiplet. These phenomena can be understood in a simple, semi-quantitative way with reference to the spintemperature distribution of the alkali-metal atoms among the ground state sublevels. Quantitative computer simulations are in excellent agreement with the experimental results.

Fei Gong is a graduate student in the Department of Physics.

9) Targeting Amacrine Cell Subpopulations through Pairwise Combinations of Genes

Praveena Joseph-de Saram (Molecular Biology)

The retina is made up of five main cell types: photoreceptors, horizontal cells, bipolar cells, amacrine cells and ganglion cells. Distributed within these are as many as 55 different cellular subtypes, which vary in morphology, biochemistry and function. The retina functions as an image processor with inputs arriving at the photoreceptors being compressed, filtered spatially and temporally, and finally transmitted to the brain via the retinal ganglion cells. The output of the ganglion cells is shaped greatly by the amacrine cells, which are the most diverse cell type, numbering over 20 subtypes. Though different subtypes are thought to perform distinct functions, studying them is often difficult since there are few ways to target individual groups of cells. While attempts have been made to characterize subtypes of amacrines by the expression of a single substance, this has been unsuccessful in all but the starburst amacrine cell. We wish to isolate subtypes of cells via coexpression patterns of neurotransmitters, neuropeptides and receptors. Double immunofluorescence staining will be performed to identify a suitable combination of markers. Under the control of a Cre/loxP system, the promoters for these genes will then be used to drive the expression of a novel receptor such as channel halorhodopsin or allatostatin. This will enable the inactivation of these cells selectively and reversibly through the use of light or the ligand for the receptor, allowing us to study the effect of specific subtypes of amacrine cells on the ganglion cell output.

Praveena Joseph-de Saram is a second-year graduate student in the Department of Molecular Biology Neuroscience Program. She is a member of Michael Berry's lab, which studies neural computation in the retina. Praveena received her undergraduate degree in Physics from the University of Oxford.

10) Effects of Sex Ratio on Marriage Rate
Weicheng Lian (Economics)

Imbalanced sex ratios in the marriage market are predicted to influence marriage behaviors. In this paper, we study the effects of sex ratio on the marriage rates of young people at the city level. China's household registration system, which divides people into the urban *hukou* and the rural *hukou*, creates marriage segmentations between people with different *hukou*-types. Then we estimate sex ratio effects on urban women, rural women, urban men and rural men separately. We find that sex ratio has positive effects on the marriage rates of rural women, rural men and urban women, and its effects on the marriage rate of urban men are insignificant. To identify the source of the positive sex ratio effect, we estimate it on different age groups and find that the sex ratio effect in age exhibits an inverse U-shaped curve, i.e., the effects are large and significant around the middle ages and small and insignificant at younger and older ages. The implication of this finding is that people will marry earlier when the sex ratio increases.

Weicheng Lian got a bachelor degree of science in physics and a Master's degree of economics in Peking University in China. He is currently a first-year Ph.D. student in the Department of Economics at Princeton University. His research interests include econometrics, economic theory and development economics.

11) First-principles calculations of iron oxides—towards an understanding of steel corrosion

Peilin Liao (Chemistry)

Steel has played a very important role throughout human civilization. It is robust, and easy to process. Unfortunately, this useful material suffers from corrosion when exposed to air and moisture, causing the material to fail. The corrosion products of steel consist of iron oxides (FeO, Fe_2O_3, Fe_3O_4), commonly referred to as rust. Understanding the formation and properties of rust will help design ways to protect steel surfaces from corrosion. Atomic-level insights regarding these materials can be gained through Density Functional Theory (DFT), a standard first-principles electronic structure method. However, DFT does not properly describe the interactions between 3d electrons found in materials including iron oxides. Finding ways to treat 3d electrons is a critical first step in simulating iron oxides.

Since last decade, a modified scheme of DFT in the local density approximation (LDA), commonly referred to as LDA+U, has been developed by physicists. LDA+U calculations correctly treat the interactions between 3d electrons and have been shown to improve on LDA. However, these calculations require two parameters called U and J. Conventionally, they were either chosen empirically or calculated from some scheme that has some intrinsic defects. In our work, we developed a method to derive these parameters from *ab initio* Hartree-Fock (HF) calculations. Our calculated U and J parameters provide the correct physics, and also fall into the range that gives results in good agreement with experiments. This work forms a solid basis for further investigating properties of iron oxides through first-principles calculations.

Peilin Liao is a second-year graduate student in the Department of Chemistry. Her advisor is Professor Emily A. Carter.

12) High Performance Quantum Cascade Lasers for Mid-infrared Sensing Applications

Zhijun Liu (Electrical Engineering)

Quantum Cascade (QC) lasers are new type of semiconductor laser with wavelengths that can be engineered to be anywhere in the mid-infrared and far-infrared. This spectral range contains the strongest fingerprint absorption features of many gaseous pollutants and some human disease—related trace gases, thus enabling the possibility of building extremely sensitive gas sensors using QC lasers as light sources. For many of the practical gas sensing applications, high-temperature (room temperature and above), high-power, continuous-wave operation of QC lasers is desirable in order to simplify the system and increase the sensitivity. In this abstract, I will present our effort in developing high-performance QC lasers through advanced laser design, crystal growth and device packaging. Above room temperature operation in continuous-wave is demonstrated at various wavelengths covering the first and second atmospherical windows. In addition, examples of sensing applications based on these lasers will also be presented.

Zhijun Liu received the B.S. and M.S. degrees in Physics from Sichuan University, Chengdu, China in 2000 and 2003, respectively. He is currently working toward a Ph.D. degree at the Department of Electrical Engineering, Princeton University, NJ, USA . His research focuses on high performance quantum cascade lasers.

13) Spatial Ecology of Yellow Baboons

Christine Markham (Ecology and Evolutionary Biology)

Most primates live in discrete and stable social groups, and for many species these groups occupy partially overlapping homeranges rather than exclusive territories. Given the influence of habitat quality on distribution and fitness, this pattern of non-exclusivity raises fundamental questions about homerange partitioning (i.e. when and how groups temporally and spatially share the landscape). Here I provide an initial evaluation of the spatial ecology of wild primates as a critical step to understanding how the distribution of resources shapes space-use patterns on a temporal-spatial scale. To do so, I will use data from a 30-year longitudinal study of yellow baboons (*Papio cynocephalus*) in the Amboseli basin of East Africa. For the past three decades, each study group within this population has been regularly monitored several days a week and locational data were collected every 30 minutes on observation days. I will use GIS tools to characterize space-use patterns captured by this dataset, principally examining homerange size, overlap, and shift in the context of resource (sleeping and drinking sites) distribution and changes in population density. Spatial ecology investigations of this scope and scale are rare in wildlife studies, and virtually unprecedented in research on wild-living primates. Results will thus yield unique insight into landscape-level questions such as how groups sharing a recent social history interact in space and time, how group-level dominance patterns affect where and when groups move in relation to one another, and to what extent space-use patterns are dynamically influenced by within and between group competition for resources.

I am a second-year graduate student in the Department of Ecology and Evolutionary Biology. My research interests are focused on the socioecology of primates, specifically using GIS/GPS technology to examine spatial and temporal distribution patterns in wild-living yellow baboons.

14) Trait ascription and social comparison: linking self-perception, other-perceptions, and meta-perceptions

Kathleen Schmidt (Psychology)

The social self can be defined in several ways. Who you are, how you compare to others, and how you think others perceive you are all fundamental to your identity. The intersection between self-enhancement, social comparison, and social perception has potential to advance the study of social psychology. In my research, I sought to uncover how concepts of the self are created and changed by exploring the effects of three types of perception (self-perception, other-perception, and meta-perception) on trait ratings and ascription. Undergraduates were asked to rate themselves, their average peer, and how other people see them on a variety of traits. Within-subjects comparisons indicated high participant ratings for the average peer, lower ratings for the self, and the lowest ratings for the meta-perceived self on all traits regardless of valence. These results were moderated by individual difference variables including happiness and self-esteem. In between-subjects comparisons, the average student was rated higher in the context of self-ratings than when assessed alone. Because differences in trait ascription could reflect an asymmetry in perception, I also tested for actor-observer differences. Contrary to expectations, approximately the same number of traits was ascribed to the self, other, and meta-self. The results of these studies can be explained using an anchoring and adjustment model of trait perception. Continued exploration into the role of meta-perception in trait ascription, behavioral attribution, and self-other comparisons may lead to further insight regarding the social self.

Originally from Tennessee, Kathleen is a recent graduate of Swarthmore College. She is currently working as a research assistant in Princeton's Psychology Department.

15) Knowing more than you know you know: category discrimination without awareness

Aaron Schurger and Min-Soo Kim (Psychology)

What happens if a pale green square is presented to one eye and a pale orange square is presented to the other? With one eye closed one sees a green color; with the other eye closed one sees an orange color; but with both eyes open, the two colors mix in the brain and the square appears yellow. This phenomenon, called "dichoptic color fusion," was first studied more than 200 years ago. Now consider what might happen if one eye sees a green object on an orange background and the other eye sees the same object, but in orange on a green background. At moderate levels of color contrast, the object can vaguely be made out, but as the color contrast decreases the object quickly fades from view, and one sees only a uniform yellow field. We used dichoptic color fusion to render stimuli difficult to see, and asked subjects to discriminate faces from houses (simple line drawings). Subjects were asked to guess the category of the stimulus (face or house) and then, after each guess, to bet (real) on the accuracy of their own guesses. Within a certain range of color contrasts, subjects were quite good at guessing the category of the stimulus, and yet completely failed to make use of this information to maximize their earnings, suggesting that they did not consciously "see" the stimuli at these contrast levels. We are preparing to move this study into the MRI scanner to examine the way the brain processes information without awareness.

Aaron Schurger is a Ph.D. candidate in the department of Psychology, Program in Neuroscience. Min-Soo Kim is a graduate of Yonsei University (Republic of Korea), where she studied biochemistry. She is now working as a research assistant and planning to attend graduate school.

16) Evolutionary Algorithms
Ofer Shir (Chemistry)

An Evolutionary Algorithm is a mathematical approach to generic problem-solving that attempts to mimic the Darwinian model of natural evolution by means of computer simulation in order to arrive at optimal solutions. In principle, it works by encoding complex problems into an artificial biological environment by mapping the "genes," constructing a "fitness function," and defining the rules of inter-generational dynamics.

By instigating the "reproduction cycles" over dozens of pairs of "parents" and thousands of "generations," it is suggested that such simulation can yield an optimal solution for the given problem, much as organic evolution has continually produced the fittest creatures. Evolutionary Algorithms have been successful in solving search problems in a large variety of fields—theoretical as well as real-world—including engineering, medicine, physics, and economics.

While most search problems simply require the location of the global optimum (the one best solution), many real-world applications would prefer to locate multiple good solutions. Niching Methods extend evolutionary algorithms to incorporate the evolutionary speciation effect into the artificial biological environment. In doing so, Niching Methods can produce a number of best solutions, rather than allowing the generations to converge into a single optimal solution (or "species"). Additionally, by maintaining diversity amongst solutions, Niching Methods have the advantage of being able to provide a few good solutions of differing conceptual design to the given problem.

Ofer M. Shir is a Visiting Scholar Research Collaborator at Princeton University, Fall 2007. He is a Ph.D. Student in Computer Science in the Natural Computing Group at Leiden University (The Netherlands). He did his undergraduate studies in Physics and Computer Science at The Hebrew University of Jerusalem, Israel from 2000—2003.

17) Designing wireless network algorithms through the lens of convexity
Chee Wei Tan (Electrical Engineering)

Convexity is a simple and natural notion, which can be traced back to Archimedes (circa 250 B.C.), in connection with his famous estimate of Pi (π). Recently, the modern viewpoint on convexity has entailed a powerful and elegant interaction between theory and system design. Motivated by practical engineering problems in wireless networks, a new area of research pioneered by Princeton has emerged. This theory enables us to systematically understand dynamic algorithms, which have practical relevance to wireless network engineers. Specifically, we look at power control problems used in wireless networks to meet Quality-of-Service requirements with minimal energy consumption. The key problem is the lack of provisions in the transient for guaranteed received signal quality, especially in times of congestion. Therefore, it is necessary to control the transient behaviors of dynamic power control algorithms. We provide theoretical insights on how to design power control algorithms for interference management. Our approach also allows the system design trade-offs to be quantitatively understood through the mathematical language of convexity theory.

Chee Wei Tan is a Ph.D. student in Electrical Engineering at Princeton University. He obtained his M.A. in Electrical Engineering from Princeton University in 2006. He worked as a technical consultant for Fraser Research Lab, Princeton NJ, in 2005 on broadband access networks, and is a visiting student at the Coordinated Science Lab, UIUC during 2007. His research interests are in wireless communication theory, nonlinear optimization theory applied to communication systems and optimal resource allocation for wireless and high speed networks.

18) Design, Synthesis, and Evaluation of New Metalloporphyrin Drug Candidates

Jyoti Tibrewala (Chemistry)

The metalloporphyrin structural motif is found throughout biology, playing an essential role in enabling protein function. Their ubiquitousness in living systems, combined with their known reactivity, make metalloporphyrins a highly desirable target for drug development. Our research interests involve the design, synthesis, and evaluation of metalloporphyrin-based catalysts to decompose peroxynitrite. Peroxynitrite (ONOO–) can be formed in vivo by the combination of nitric oxide and superoxide, both of which are upregulated under inflammatory conditions. The biological targets of peroxynitrite include various proteins, lipids, and DNA; the consequences of interactions with its biological targets have implicated peroxynitrite in such diseases as diabetes, arthritis, and myocardial infarction. Our group has been at the forefront of developing metalloporphyrins to decompose peroxynitrite; the current gold standard catalyst FP15, developed in our group, has shown remarkable activity toward peroxynitrite decomposition both in *in vitro* models of protein nitration, and in small animal models of a number of diseases. We have recently developed a next-generation compound that catalytically outperforms FP15 and has the added benefit of a more facile synthesis. We are currently working to scale up the next-generation compound for use in toxicology studies as well as small animal models of diseases, including diabetes, to more thoroughly compare our new drug to the existing standard.

Jyoti Tibrewala is a fourth-year graduate student in the Department of Chemistry. Her thesis advisor is Professor John T. Groves.

19) Flow and Self-assembly of Confined Thin Polymer Film via Electrohydrodynamic Instabilities

Ning Wu (Chemical Engineering)

The polymer melt confined between two planner electrodes with an air gap can flow and self-assemble into ordered micro-structures under the influence of an electric field. Motivated by the variety of patterns observed in experiments, we describe, from theoretical and numerical analyses, how nonlinear effects govern the growth of instabilities and determine the final patterns. In particular, by using a weakly nonlinear analysis we find that the second- and third-order nonlinear interactions among different Fourier modes favor the growth of hexagonal patterns, in agreement with experimental observations. We also investigate the time evolution of the system energy numerically. A coarsening phenomenon similar to spinodal decomposition and dewetting is observed.

We have also integrated the conventional lithography technique and this novel self-assembly phenomenon to guide the thin polymer film into various patterns with perfect alignment over regions much greater in extent than their natural domain sizes, which significantly reduces the efforts on the mask patterning in conventional pattern transfer techniques. The mechanisms for formation of several novel and hierarchical patterns we observed recently will be discussed, which demonstrates the versatility of this patterning technique. This first step in enabling engineering of electrohydrodynamic patterning over large areas opens the path towards applications requiring larger areas of well-arrayed patterning, like chemical and biological sensors, biomaterial scaffold, etc. Other potential applications of the electrohydrodynamic instabilities, like mixing of binary micro-fluids at low Reynolds number regime, will also be discussed.

Ning Wu is a fifth-year Ph.D. student in the Department of Chemical Engineering. Ning has been awarded to the Porter Ogden Jacobus Fellowship for the year of 2007–2008. He also received the Kristine M. Layn Award for Outstanding Achievement in Research in Chemical Engineering Department.

Talk session II

The second talk session will take place from 2:15–3:45p.m. in Friend Center 4.

Using zebrafish as a model to study cystic kidney diseases
Jessica Sullivan-Brown (Molecular Biology)

Cystic kidney diseases (CKD) are common heredity disorders affecting up to 1 in 2000 adults every year. These diseases are complex and little is known about the initial mechanisms resulting in cyst formation. Zebrafish are an attractive model for studying the earliest cellular defects resulting in renal cystogenesis because its kidney (the pronephros) is simple and genes that cause CKD in humans, cause pronephric dilations in zebrafish. By comparing phenotypes in three different mutants, *locke*, *swt* and *kurly*, we find that dilations occur in the medial tubules, a location similar to where cysts form in some mammalian diseases. We show that defects common to human CKD, such as an increased number of cells, are secondary consequences of dilation. Cilia motility defects are the first observed phenotype in each mutant prior to nephron dilation. We have discovered that *swt* mutation encodes a novel leucine rich repeat containing protein (LRRC50) that is expressed in tissues containing motile cilia. Interestingly, these zebrafish mutants also display incorrect placement of organs along the left and right sides of the body. Left-right patterning defects are also found in some types of CKD in humans. Although the formation of kidney cysts and organ patterning defects seem to be unrelated, it is becoming more evident that cilia have essential roles in both these processes. We hope that by studying a simpler organism like zebrafish, we can better understand the mechanisms leading to CKD and left-right patterning defects in humans.

Jessica Sullivan-Brown is a sixth-year graduate student in Rebecca Burdine's laboratory. She studies the interesting connections between renal cyst formation and left-right patterning defects. In addition, she enjoys sharing science with family and friends and in outreach programs.

Global Seismic Tomography: Efficient Algorithms for Recovery of Sparse Models from Noisy Data

Philip Vetter (Applied and Computational Mathematics)

Knowledge of most of the earth's interior can only be attained through indirect measurements. The deepest direct measurements of the Earth's interior do not even penetrate 0.2% of the way to the center.

One of the indirect measurement methods available is the study of seismic data. The sudden failure of stressed geological structures releases energy in the form of seismic waves that propagate through the complex interior of the earth and are detected in seismic monitoring stations at the earth's surface. Inverting seismic measurements to obtain information about the deep interior of the earth is a difficult challenge: sufficiently energetic seismic events are few, unpredictable and generally beyond our control; energy is diffracted and reflected on its journey; detectors cover limited locations; and—especially if the goal is to image the entire earth down to the core-mantle boundary—the dataset sizes are too huge to analyze on a single computer.

We attack this problem by specially tailoring a variety of techniques from different disciplines. To estimate the influence on seismic energy paths of particular volumes within the earth we use finite-frequency tomographic methods such as the banana-doughnut kernels of geophysicists F. A. Dahlen and G. Nolet. To compress the information contained in these kernels, and to regularize the inverse problem without smoothing away discontinuities, we apply techniques of harmonic analysis such as the Daubechies wavelets. To invert noisy seismic measurements through the compressed kernels and reconstruct a sparse model of the interior of the earth we modify Landweber iterative algorithms. To make these inversions computationally feasible we explore and implement modifications to accelerate their convergence. Finally we explore and implement algorithmic modifications to parallelize the inversion for high-performance computing environments.

Philip Vetter is a research assistant in Applied and Computational Mathematics. His research is a collaboration with faculty members Ingrid Daubechies and Guust Nolet and postdocs Huub Douma, Massimo Fornasier and Ignace Loris.

Gravitational Lensing of the Cosmic Microwave Background
Sudeep Das (Astrophysics)

The Cosmic Microwave Background (CMB) is the relic radiation left over from the Big Bang, the singular event that is believed to have ushered the Universe into existence. This radiation consists of particles of light which started their journey about 13 billion year ago and are picked up by our telescopes today. During their journey they interact with the gravitational field of the massive structures in the universe, and get deflected. This phenomenon is called the Gravitational Lensing of the CMB and has a lot of information encoded in it, potentially telling us how the Universe has evolved over time and why its expansion is accelerating now. I will present a simple description of the effect and explain what it has in store for us.

I was born and brought up in Kolkata, India, where I obtained my Bachelor's in Physics from the prestigious Presidency College. Then I went on to complete my Master's in Physics from the Indian Institute of Technology, Kanpur. Now, I am a fourth-year graduate student at the Astrophysics Department and finishing up my thesis with Professor David Spergel.

Are Coal-Miners' Sons More Responsive to the Poor? Assessing the Impact of Senators' Socioeconomic Backgrounds on Differential Responsiveness

Nicholas Carnes (Politics)

Several recent studies have found evidence that the American political system is highly responsive to wealthy citizens and unresponsive to citizens of more modest means. However, efforts to explain this pattern of differential responsiveness as the product of inequalities in political knowledge and participation among low- and high-income citizens have yielded null results. In this paper I consider an alternative explanation derived from a point of convergence between the popular lore about American politics and research in social psychology, namely, that elected officials are less responsive to the poor because most of the people in office are brought up in affluent backgrounds that render them prejudiced against or "out of touch" with individuals of more modest means. Using data on public opinion and Senators' voting behavior during the 101st, 102nd, and 103nd Congresses (1989–1994), I find that Senators who grew up in more affluent homes and who attended more selective universities were less responsive to poor constituents than Senators who came from more humble backgrounds, even when controlling for factors commonly thought to influence legislative behavior such as party identification and campaign contributions.

Nicholas Carnes is a graduate student in the Department of Politics and a member of the interdisciplinary Joint Degree Program in Politics and Social Policy. His research interests center on the relationship between inequality, politics, and public policy.

Organizing committee

Shin-Yi Lin (Co-Chair, graduate student)
Lesley Chuang (Co-Chair, graduate student)

Susan Conlon (Princeton Public Library)
Mike Fisher (graduate student)
Andréa Granstedt (graduate student)
Philip Martin (Pace Center)
David Potere (graduate student)
Daniel Stanton (graduate student)
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