SOCRATES

Socially Cognizant Robotics for a Technology Enhanced Society

NRT Trainee Handbook

March 2021

RUTGERS
UNIVERSITY | NEW BRUNSWICK

TABLE OF CONTENTS

WELCOME

Congratulations on becoming an NSF NRT Trainee/Fellow in Socially Cognizant Robotics for a Technically Enhanced Society (SOCRATES)! You will be part of a pioneering graduate program, one of the first of its kind in a new interdisciplinary discipline of socially cognizant robotics.

The program will catalyze a new paradigm of integrative graduate training at the burgeoning interface of society and intelligent devices. This will differ substantially from traditional robotics programs by integrating the disciplines of technology and social sciences towards beneficial societal impact. This will be created by meaningful collaboration among complementary disciplines and groups.

OVERVIEW

SOCRATES will create a new vehicle for graduate training and research that integrates technology domains of robotics, machine learning and computer vision, with social and behavioral sciences (psychology, cognitive science and urban policy planning). The long-term objective is to nurture and mobilize a community of researchers who can draw on sophisticated understanding of social structures and processes in the effective development and deployment of autonomous systems for the benefit of individuals and society.

This training program seeks to identify the critical societal needs that technology can realistically address to catalyze and guide meaningful research. Societal needs include providing inexpensive and effective public services, efficient transportation, and environmental protection. Meeting these needs with robotic systems will transform the future of work via human augmentation and human-technology partnerships.

The SOCRATES traineeship will have broad impacts on workforce development by training future employees of large corporations, start-up companies, and academic institutions to identify societal needs and steer technology toward viable solutions of important social problems. As robots are being deployed in a wider variety of domains, it

becomes important to consider other aspects, such as safety, adaptability to human desires, and nuanced societal impacts, such as privacy, bias and other ethical considerations. At the same time, students with a social science background will develop the skills so as to study the effects of technology on society before its deployment, a skill critically missing currently in the technology industry.

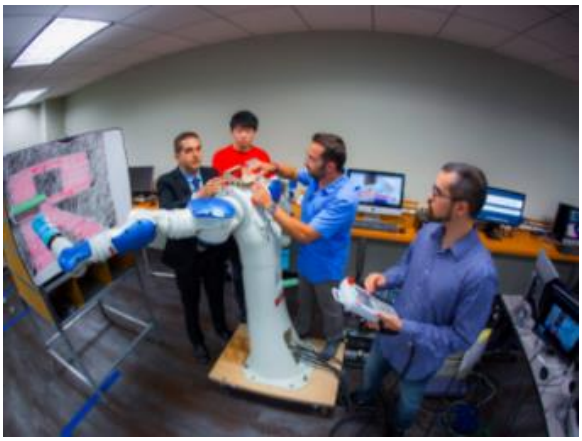
Upon completion of the training program, you will receive a certificate in the new emerging domain of Socially Cognizant Robotics (under development). Additionally, you will be part of an emerging community of interdisciplinary researchers at Rutgers exploring this new research area.

Program Goal

The program is available both to Masters and PhD students and will aim to train a new type of professional, the Socially Cognizant Roboticist. This new role will arise from the convergence of: 1) socially-aware technologists, who must be able to develop intelligent devices that work effectively in the context of human and social behavior; and 2) technology-aware social scientists and policymakers, who can translate studies of robotics' social effects into actionable and technically-viable lessons. The key to fostering such expertise is an intentional, scaffolded training program that weaves these complementary groups and disciplines. Emerging applications of robotics, from telepresence, transportation, elder-care, remote health care, cleaning, to warehouse logistics and delivery, will bring significant changes in individuals' lives and profound social impact, especially relating to the future of work, an area of national priority.

Socrates Program Layout

SOCRATES is structured as an overlay to the existing departmental graduate programs. Students will apply for admission and enroll in their home department (ECE, CS, MAE, Psychology or Bloustein UPPD). Their graduate degree requirements will be determined by their home department. SOCRATES courses may be electives, or depending on the department, may count toward the required courses of the department.



Students will create a plan and timing based on the program requirements and in conjunction with their advisor. The student and advisor will assess progress by comparing progress against the plan and developing a plan for the next year. This evaluation will be stored in aggregated anonymized form over all SOCRATES trainees to help evaluate the students' ability to meet the goals of the program.

During a bi-annual program leadership meeting, student progress and development plans will be discussed.

The program will consist of both NRT-funded and non-NRT-funded students. The graduate population of Rutgers University draws from both a domestic and an international talent pool, providing trainees the opportunity for a global team and perspective. Students who receive funding from non-NRT sources can still apply and be accepted to the program as a non-NRT funded students and participate fully with all program activities.

Requirements for SOCRATES Trainees:

- ✓ The student's research will fall within the theme of the program. They will be enrolled in one of the following five departments: Electrical and Computer Engineering, Computer Science, Mechanical and Aerospace Engineering, Psychology, or Urban Planning and Policy Development in Bloustein.

- ✓ The student will be in the first 3 years of PhD at Rutgers University and be willing to take 3 NRT courses. These courses are Socially Cognizant Robotics, Robotics and Society, and the SOCRATES Design Course (under development). We expect that these courses will lead to a Rutgers Certificate in Socially Cognizant Robotics, currently in development.

- ✓ The student will have one advisor from the NRT core faculty team and take on two additional co-advisors from the NRT team, with at least one from the cross-discipline field. For example, a STEM (ECE, MAE, CS) student's cross-discipline is social science (Psychology, UPPD) and vice versa.

- ✓ The student will commit to a 12 month CONSECUTIVE funding period (if funded) (THIS IS A REQUIREMENT from the NSF but it can be interrupted by a summer internship).

- ✓ The student will participate in all of the program's activities: novice-to-expert robotics club, monthly chalk-talk meetings during the academic semesters, and an annual robotics workshop.

- ✓ The student should become an integral part of the SOCRATES community for the length of their graduate studies. The goal for the student is to develop research, professional, and communication skills while fostering their network of interdisciplinary collaborators. Students are strongly encouraged to come early to all activities and workshops to take part in the planning process.

- ✓ NRT-funding is limited to US citizens, nationals, and permanent residents. However, NRT trainees may be funded from other sources. International students can participate as NRT trainees without NRT stipend support.
- ✓ NRT-funded trainees are full-time graduate students in their academic programs and are expected not to have outside jobs during the academic year.

Graduation

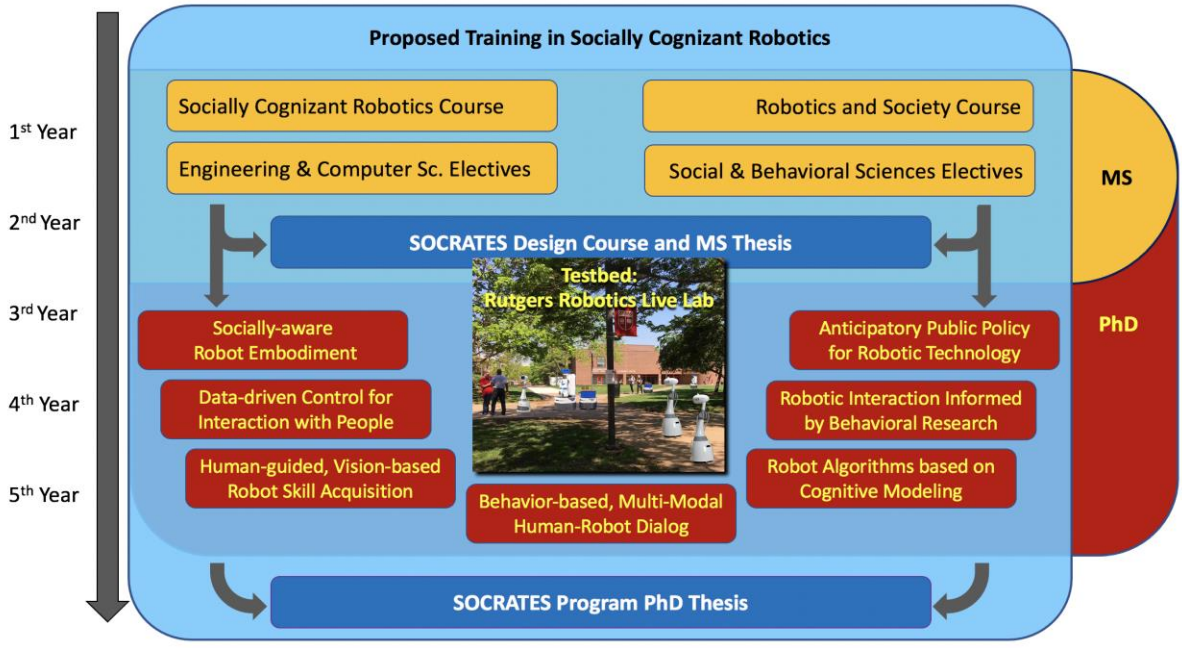
Upon completing the program certificate and a month before graduation, the trainee must inform the Program Coordinate and supply the following information: student's full name, RUID, and the earned degree date. We expect this information to be needed to add the future Socially Cognizant Robotics certificate to your transcript.

REQUIREMENTS

Certificate in Socially Cognizant Robotics

The proposed educational requirements is expected to lead to a certificate in Socially Cognizant Robotics, which can be attained by both NRT trainees and students participating in parts of the program. **This certificate is in the planning stage and we expect to have it approved soon.** The program is expected to be available to both MS and PhD students and will follow established standards for certificate programs at Rutgers University. The certificate program provides an important avenue toward institutionalization of the training program. https://gsnb.rutgers.edu/certificate-program-application

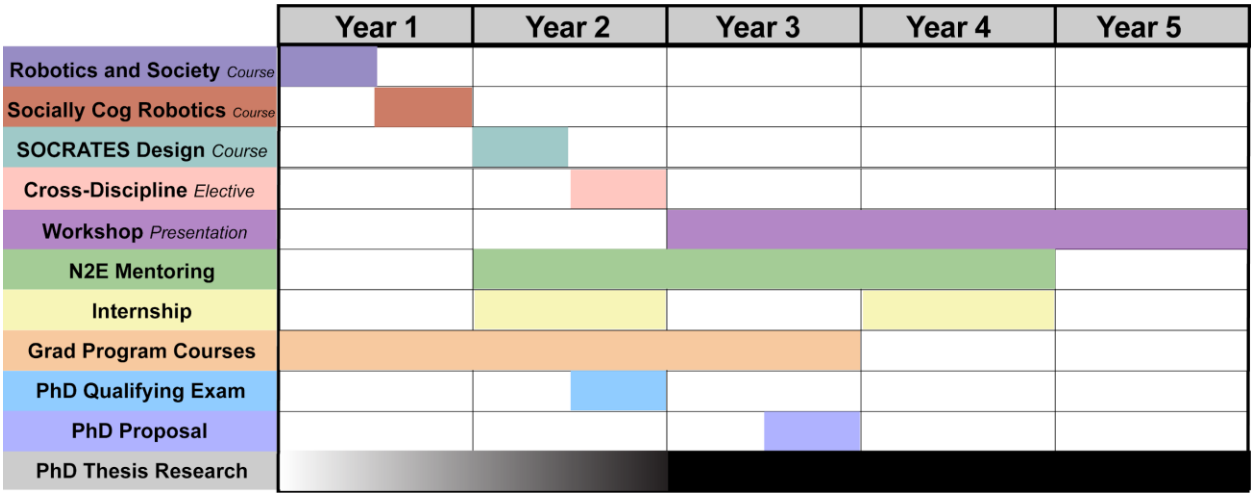
5 Year Sample Paths to a PhD



Coursework

The educational goal of SOCRATES is to create an integrated cohort of technologists, behavioral and social scientists with a shared vision of socially cognizant robotics. This translates to a deep, multidisciplinary understanding of how robots interact with

individuals and society as well as the technical skills to implement this vision. The coursework and research program will guide the students towards socially beneficial applications of robotics. MS students will be required to complete a research thesis.



Robotics and Society Course
This course will examine the interplay of technology and society, giving students an understanding of the ethics, unintended consequences, and social implications of robotics. *A sequence of foundational lectures will be offered to provide both technical and social science students with the core prerequisite skills.*

Socially Cognizant Robotics Course
Students will be exposed to the foundations of robotics and state-of-the-art developments to learn the expected trajectory of robot capabilities that will impact individuals and society. The course will be designed to accommodate the entry knowledge of social science students at Rutgers.

Socially Cognizant Robotic Design (SOCRATES Design Course) Graduate students will gain hands-on experience on a practical project, working together with students from other participating disciplines. In the first few weeks of the semester, the students guided by the professor will choose a project, which (i) has clearly-defined goals and assessment criteria, and (ii) requires contributions and perspectives from the varying disciplines.

Rutgers Robotics Live Lab Orientation
Prior to the *Socially Cognizant Robotic Design* course, trainees and other participants will take part in a 2-day hands-on orientation on the capabilities of the Rutgers Robotics Live Lab. Since this lab is dynamic and evolves to multiple devices across campus, a unifying documentation and software portal will enable cataloging and descriptions of the current inventory and capabilities. The orientation will be rotated among SOCRATES faculty.

First Year: **Robotics & Society** *(Curriculum prepares STEM and social science students for quantifying societal impact)* **Socially Cognizant Robotics** *(Pre-req for Socially Cognizant Robotic Design)*				
Second Year: **Socially Cognizant Robotic Design** *(SOCRATES Design Course)*				
ECE **Electrical & Computer Engineering**	**CS** **Computer Science**	**MAE** **Mechanical & Aerospace Engineering**	**Psych/CogSci** **Psychology Cognitive Science**	**UPPD** **Urban Planning & Policy Development**
Machine Vision **Robotic Systems** **Convex Optimization** **Sensor-based Systems** **Virtual Reality**	**Computational Robotics** **Intro to Machine Learning** **Machine Learning** **Computer Vision** **Robot Manipulation**	**Robotics & Mechatronics** **Design of Mechanisms** **Analytical Dynamics** **Special App. in Control**	**Computational Cognition** **Human Decision Making** **Perception & Action** **Bayesian Cogn. Modeling**	**Labor Market Policy** **Green Buildings** **Bicycle & Pedes. Planning** **Public Informatics** **Urban Planning Studio**

SOCRATES Elective Courses

Beyond the above mentioned courses, the participating trainees will also have the opportunity to select elective courses from the various departments in order to satisfy their degree requirements. The table above provides an overview of available courses that can be used for the SOCRATES program.

Novice-to-Expert (N2E) Robotics Club

The goal of this robotics club is to broaden participation from both STEM and social science students. The N2E Robotics Club will have student-taught 1-hour modules on robotics and robotics coding. Each SOCRATES trainee will teach 1 module per semester for 3 semesters with a target audience of undergraduates and first-year graduate students throughout Rutgers.

Chalk-Talk

Trainees and participants will meet in monthly gatherings over brown-bag lunches for faculty talks and reading group discussions. Some of these meetings will be dedicated to graduate student workshops for developing writing and presentation preparation skills, building CVs/resumes, general job search strategies, passing technical interviews, and responsible research. This series will introduce new students to current research areas affiliated with the program, as well as connect senior NRT trainees with newer cohorts. One of the Chalk-Talk meetings series is a career panel focused on career and internship preparation with an external speaker recruited from Rutgers alumni and from the industry. The goal beyond the talks themselves, is to foster a sense of community and a common knowledge base among students from varied disciplinary backgrounds.

Annual Rutgers Robotics Workshop

The workshop will focus on presenting research talks and posters and will be held annually as part of the SOCRATES program. This will include both internal and external speakers as well as poster sessions. One session of the workshop will be devoted to a career panel with external participants providing a talk on what-to-expect from careers and internships in industry. The Robotics Workshop Poster Session will be important for students. NRT trainees will be required to participate in the session with poster presentations in the 3rd to 5th year of their PhD program or the final year of their Master's program.

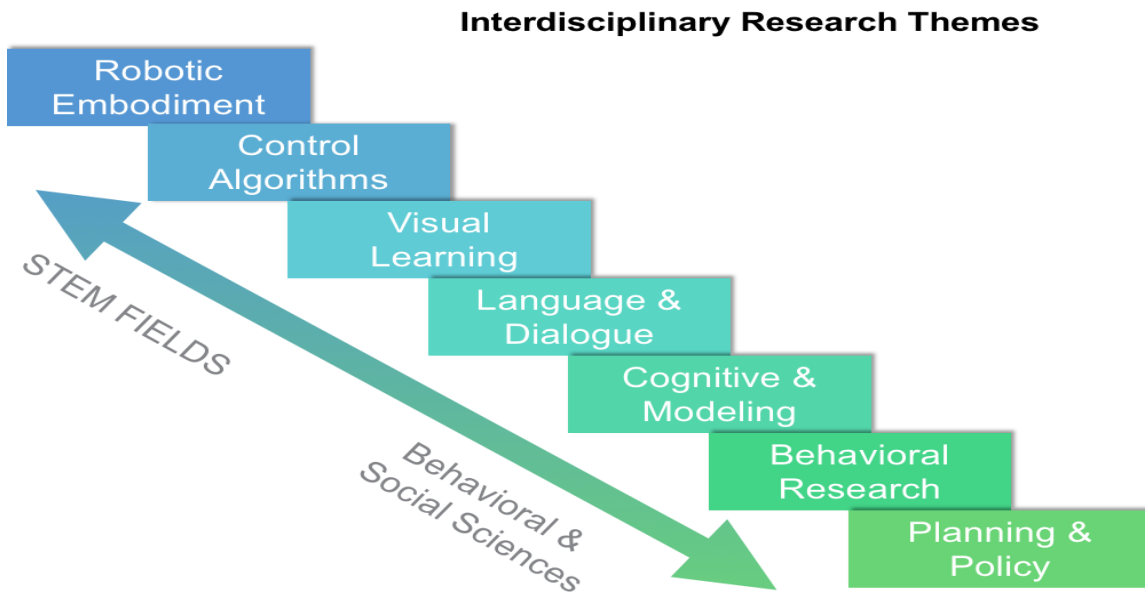
Internships
Students in robotics, vision and machine learning are in great demand and the industry opportunities are strong. We are leveraging the interest of industry in these skills to build a SOCRATES Industry Consortium. These summer internships will be considered a requirement unless unanticipated problems arise in internship availability. Faculty advisors will help ensure that the internship requirement is met by monitoring timely application and interacting with the Industry Consortium to build lists of internship opportunities. Moreover, faculty will interact with the industry consortium members to encourage and create experiences that build on SOCRATES goals within the context of the technology testbeds in the company so that the experience is fruitful and synergistic.

Professional Development

An important component of the traineeship is professional development. Throughout the year, the SOCRATES program will offer a number of opportunities for trainees to learn skills that can help them achieve their career goals. Trainees are expected to attend these events unless prior arrangements are made.

Research

The research agenda of SOCRATES integrates seven main disciplines spanning STEM fields to social sciences; i.e., from traditionally technical disciplines, such as **robot embodiment** and **control,** to areas which support human interaction, such as **visual learning** and **language processing**, to **cognitive modeling,** that enable more high level human-robot cooperation, and finally to areas which bridge robotics with individuals and the society at large via **behavioral research** and **public policy.** Unlike typical programs in human-centered robotics, the Socially Cognizant Robotics program goes beyond human-robot interaction to robot-society interactions with an overarching goal of enhancing life for both the individual and society.



CONTACTS FOR THE SOCRATES PROGRAM

Kristin J. Dana, Professor
Electrical and Computer Engineering, School of Engineering
kb572@cs.rutgers.edu
http://www.ece.rutgers.edu/~kdana

Kostas Bekris, Associate Professor
Computer Science, School of Arts and Sciences
kb572@cs.rutgers.edu
https://robotics.cs.rutgers.edu/pracsys/

Jacob Feldman, Professor
Psychology, School of Arts and Sciences
jacob.feldman@rutgers.edu
https://ruccs.rutgers.edu/jacob/

Clinton Andrews, Professor
Urban Planning and Policy Development, Bloustein School of Planning and Public Policy
cja1@rutgers.edu
https://bloustein.rutgers.edu/andrews/

Jingang Yi, Professor
Mechanical and Aerospace Engineering, School of Engineering
jgyi@soe.rutgers.edu

Pernille Hemmer, Associate Professor
Psychology and Cognitive Science, School of Arts and Sciences
pernille.hemmer@rutgers.edu

Aaron Mazzeo, Associate Professor
Mechanical and Aerospace Engineering, School of Engineering
aaron.mazzeo@rutgers.edu

Hal Salzman, Professor
Bloustein School of Planning and Public Policy
hsalzman@rutgers.edu

Matthew Stone, Professor
Computer Science, School of Arts and Sciences
mdstone@cs.rutgers.edu

Kathy Haynie, External Evaluator
Haynie Research and Evaluation
kchaynie@alumni.stanford.edu

Linda Post, Program Coordinator
Electrical and Computer Engineering, School of Engineering
socrates-coordinator@rutgers.edu

SOCRATES Program Website: https://robotics.rutgers.edu/

Related Schools at Rutgers University

- https://bloustein.rutgers.edu/
- https://sas.rutgers.edu/
- https://soe.rutgers.edu/

***SOCRATES is supported by the National Science Foundation Grant* # 2021628**