James Houghton: Personal Statement

I am applying to participate in the doctoral program of the System Dynamics Group in the Sloan School in order to focus on a research question that I am personally compelled by, and well positioned to answer. The Sloan School is one of few places where I can expect guidance and sponsorship from a broadly interdisciplinary set of experts relevant to my interest. The Sloan PhD program is an ideal springboard for moving into further research following my course of study, and a venue for social engagement and impact in the wider world.

My Research Interest

Simulation of the social, economic, and political components of historical social movements to assess strategies for the climate advocacy movement

The developing social movement to combat climate change has much to learn from other social movements throughout history, such as the abolition of the British slave trade or the civil rights movement in the United States. As each social movement takes place in a unique social, political, and economic environment, it is important to take context into account when drawing lessons from these examples.

I propose to use complex systems modeling and modern data science techniques to model the climate advocacy movement and a set of historical case studies that are parallel in one of a number of ways: necessity of deep changes to economic production systems, scientific understanding as the impetus for change, power imbalances between interest groups, modern communication, and the need for international collaboration. These models can facilitate the study of historical social movements in context, and help evaluate how strategies drawn from history can be adapted to the present day.

Historical Social Movements:

- Abolition of the slave trade and of slavery
- Civil rights
- The end of apartheid
- Marriage equality
- The temperance movement
- Bans on CFCs or leaded gasoline
- The Indian independence movement

My Research Strategy

There are a variety of existing sociological hypotheses that try to explain the mechanics of social movements. My work with the System Dynamics Group will formalize the structures and feedback loops described by these hypotheses as complex systems models. I will then compare simulated behaviors with historical data, using statistical, machine learning, and data science techniques. Building interactive simulations will allow me to explore how hypothetical changes to strategy would influence the progress of each social movement, and look for parallels and generalizable lessons that can be applied to the climate advocacy movement. These simulators can then serve as learning aids for social movement leaders.

The lessons learned from models of historical social movements will aid in the construction of detailed models of the climate advocacy movement in the modern context. These models will allow for the identification of leverage points where actions by citizens, business leaders, politicians, and other motivated parties can have large impacts; and for the development of strategies for action that are robust to system changes.

My interest in the Sloan School and the System Dynamics Group

This project is strongly interdisciplinary, and to address each part of the problem I will need guidance from experts in complex social systems modeling, history, social movement theory, economic sociology, international politics, statistics, data science, law, and the influence of science and technology on policy, among others. Cambridge, MIT, and Sloan in particular have one of the highest concentrations of these abilities anywhere in the world. Because of their strong involvement with the wider world, Sloan faculty can introduce me to stakeholders from all parts of the climate movement, and put me in the right places to learn and make an impact.

System dynamics modeling forms the core of this project because it is one of few methodologies able to represent the wisdom of such varied disciplines in a rigorous, quantitative way. My experience with complex systems modeling will allow me to begin research as soon as I join the program. The community of modelers in the Sloan School is an invaluable aid for developing my abilities for research and teaching, and will help me to contribute to the system dynamics field and to our understanding of social movements.

I see the doctoral program as a fundamentally different pursuit from my prior education. As an undergraduate I exposed myself to a large variety of fields, taking enough classes to fill three additional semesters at a normal load. This breadth helped me to discern my interest and natural abilities. In contrast, I approach the doctoral coursework and research with clearly defined focus. I aim to master the skills that my project demands and to build upon existing research in system dynamics literature.

My Preparation for This Effort

Over the last few years, my work in the Sloan School has allowed me to develop the theoretical and methodological tools that I will need to approach this problem. Working with DARPA, I have published models describing the influence of cultural narratives on collective behavior, using the 2011 riots in the UK as a case study. I tested a dynamic hypothesis for how latent ideas in a population are activated, and how this activation propagates through a population – the essence of a social movement.

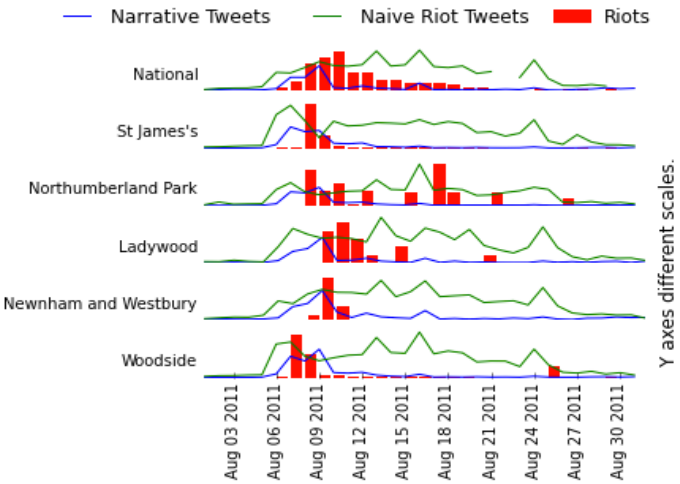


Figure 1: Geographically disaggregated messaging and behavior data used to parameterize system dynamics models of narrative influence

To support this work, I developed methods for combining textual information from social media and news sources with event data and socio-demographic data to parameterize geographically disaggregated SD models of the relationship between opinion and action. These will be essential tools for understanding how social movements result in political changes. A sample of our case study data is shown in Figure 1.

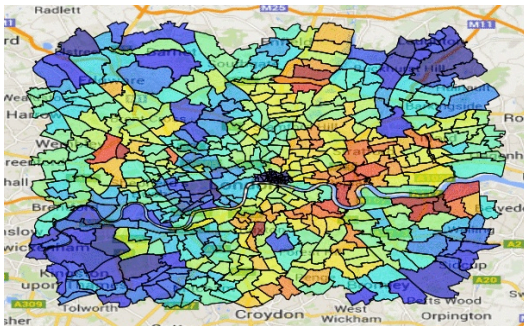
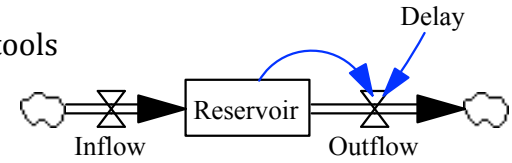


Figure 2: System dynamics model prediction of narrative activity, by ward. London.

I then devised methods for applying Markov Chain Monte Carlo (MCMC) techniques to these highly parallel models using the Sloan School's computing cluster. The MCMC yielded confidence measures for inferred parameters, from which we could evaluate the robustness of policy recommendations to model error. A snapshot of our case study results can be seen in Figure 2. Such statistical techniques will be useful for estimating the reliability of social movement strategies derived from our models.

To view the problem from an organizational (rather than geographic) perspective, I applied linear discriminant analysis to group-identified textual data. This machine learning technique was able to reveal inter-group polarization, and to track changes in alignment between three or more groups. Similarly, when modeling social movements we can use this technique to track how various groups work together or against one another, and how this changes with time.

The narrative influence project required me to create tools for merging system dynamics models with external data science utilities. One of these tools is 'pysd' – a library for importing system dynamics models from Vensim or XMILE into Python, where they can interface with state of the art machine learning and big data tools, as demonstrated in Figure 3. Out of this effort grew a comprehensive publication of methods for data inclusion in system dynamics models, presented at the 2014 International System Dynamics Conference.




```
import pysd
model = pysd.read_vensim('Delay_1.mdl')
stocks = model.run(params={'delay':5})
stocks.plot()
```

Figure 3: pysd merges the SD modeling capability of Vensim with the Machine Learning and Big Data capabilities of Python.

My Vision for Post-Doctoral Research and Implementation

After concluding my doctoral program, I intend to seek a position in the system dynamics field that will allow me to continue my research, teach, publish my work for popular and academic audiences, and engage with the climate movement.

As the effort to combat climate change plays out, I foresee the need to return to models of the climate movement and to update strategy recommendations based upon new knowledge and changes to the system.