

Using FRED on the Web

Public Health Dynamics Lab Pitt Public Health October 2018

- Senior Research Programmer
- BS Mathematics (University of Pittsburgh)
- MS Computer Management & Information Systems (Southern Illinois University at Edwardsville)
- MS Information Science (University of Pittsburgh)
- PhD Student in Computational Modeling and Simulation (University of Pittsburgh)
- Software Developer for the last 21 years

Overview

Objectives: Learn how to:

- Register on the FRED web site
- Set up projects
- Define parameter settings for FRED simulations
- Submit jobs to the FRED server
- Visualize and download results

iiiii public health FRED Overview

- What is FRED?
 - Software system for developing simulations of population health
 - Uses realistic population models
 - Scales from local to national models

- What does FRED mean?
 - FRamework for Epidemiolgical Dynamics
 - Epidemiology Dynamics = any measurable
 property of a population that changes over time

iiiii public health FRED Overview

- Typical FRED Applications
 - Find expected geo-spatial spread of an epidemic
 - Predict effects of vaccination programs
 - Evaluate interventions such as school closure
 - Evaluate health policies such as paid sick leave
 - Explore interaction of environmental and health dynamics
 - Explore dynamic changes in behavior
 - Stay home (Isolation) decisions
 - Vaccination decisions

iiiii public health FRED Overview

- Why run FRED on the Web?
 - Access to powerful computer resources
 - No software installation on user's computer
 - User can focus on modeling and analysis, not programming

- User login accounts with passwords
- Users can set up and run FRED jobs with no software installation required on the user's computer
- FRED jobs run on the FRED server and results are available through the web
- Users can organize their work flow into Projects
- Users can select specific geographic regions to simulate

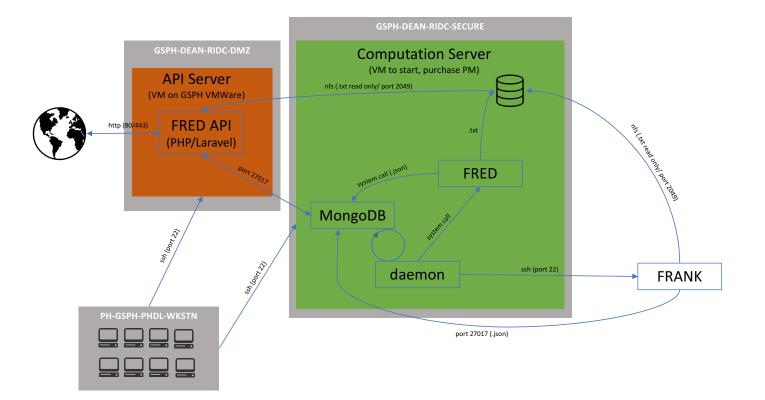
- Users can specify the characteristics of the condition to be simulated
 - States
 - Transitions from State to State
 - Modifiers of those Transitions
 - Importation schedule of Condition (seeds)
 - How many
 - Where they should occur
- Users can download results
 - Raw data
 - Plots
 - Movies

- The underlying FRED software has an almost unlimited number of options / parameters
- Many options are not known until the user defines them (i.e. Conditions / States)
- This makes creating a user interface challenging
 - E.g. can't create a drop-down menu of stuff that isn't there yet
 - Limited screen real estate in a web-browser for so many options
 - Needs to be usable across browsers and devices

Challenges

- One of FRED's best features is its synthetic population
 - Matches the demographic features of a geographic region's population
 - Has one synthetic agent for every real person reported in the census
- Need shared memory (RAM) to be able to create all agents for a given simulation
 - The available RAM on our a machine is a limiting factor in what can be simulated
- The more agents that are created, the longer the simulation takes to run
 - No instant gratification (have to wait for results)

Architecture



Architecture

FRED



User on our website

Website interface

•What a user sees •fred.publichealth.pitt.edu





API Site

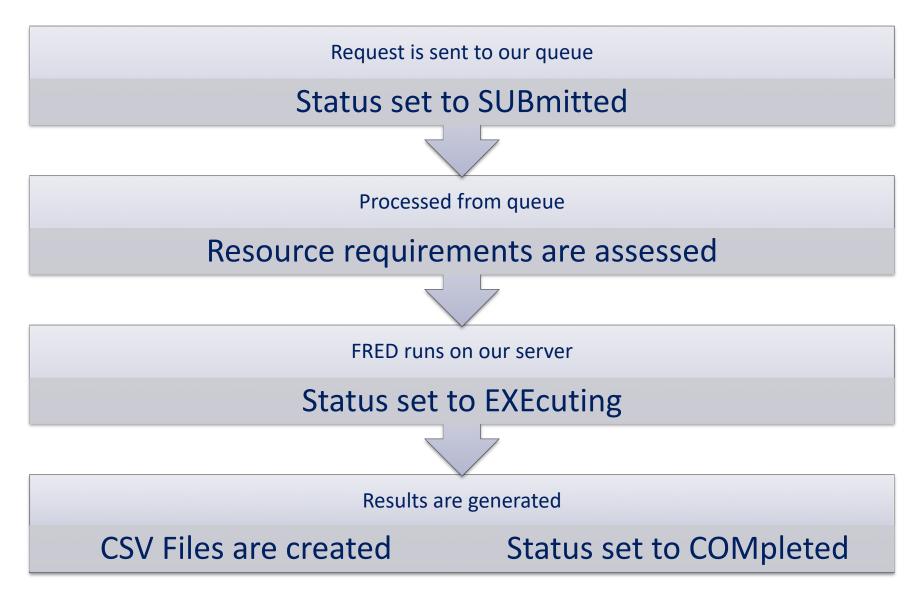
- •Agnostic to the front-end
- •fredapi.publichealth.pitt.edu

Computational Resource

•FRED lives here! •fredcore.publichealth.pitt.edu



iiii PUBLIC HEALTH What happens next?

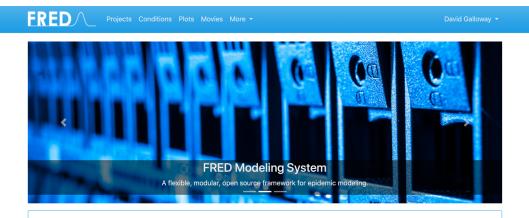


- User doesn't need to install the FRED application
- User only needs to have access to a web browser
- Works on mobile devices
- Jobs are sent to our server
- Website itself asks our server about job status
- Results are stored on our server



- Simple example using a **SHARED** condition
 - Measles
 - Some local counties

Example



Try the new FRED Measles page!

FRED (A Framework for Reconstructing Epidemiological Dynamics) is an agent-based modeling system developed by the Pitt Public Health Dynamics Laboratory.

FRED represents every person in a real geographic region as a separate individual each with her/his own unique social, familial, demographic, behavioral, and health characteristics. Individuals interact within realistic household, school, and workplace social networks.

FRED was originally developed to simulate infectious disease epidemics, but has been extended to enable users to model a wide range of health conditions and to study how patterns of those conditions vary over time in a specific region.

FRED is available through this web interface in the hopes of making large-scale agent-based models more useful to the policy-making community, the research community, and as a teaching tool for students in public health.

Citation

If you use FRED in your research, please use the following citation:

Grefenstette JJ, Brown ST, Rosenfeld R, Depasse J, Stone NT, Cooley PC, Wheaton WD, Fyshe A, Galloway DD, Sriram A, Guclu H, Abraham T, Burke DS. FRED (A Framework for Reconstructing Epidemic Dynamics): An open-source software system for modeling infectious diseases and control strategies using census-based populations. BMC Public Health, 2013 Oct;13(1), 940. doi: 10.1186/1471-2458-13-940. PubMed PMID: 24103508

Funding

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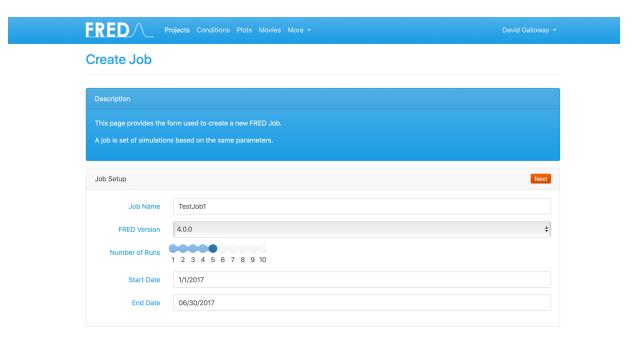
Example

	Projects Conditions Plots Movies More -	David Galloway 🔹
Projects		
Description		
such as all the jobs ass	st of your current Projects. Projects provide a way to organize your work with Fi sociated with a given research study.	
The my projects list si	hows the status of your current Projects. Click on a Project to see the list of FR	ED jobs associated with that Project.
My Projects	nows the status of your current Projects. Click on a Project to see the list of FR	EU JODS associated with that Project.
	nows the status of your current Projects. Click on a Project to see the list of FRE	EU JODS associated with that Project.
My Projects		EU JODS associated with that Project.
My Projects	Created At	EU JODS associated with that Project.

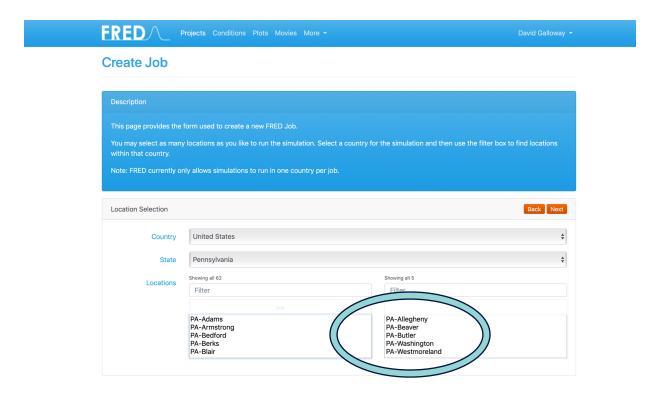
Example

ERED Projects Conditions Plots Movies More -	
Project: Demo2	
Description	
This page provides a list of your FRED Jobs associated with this project and the job's status. When the status automatically refresh and display the updates.	s of a job changes, this page
Once the status of a Job is "completed", click on a Job Name to see the job details. Click the "Create Job" button at the top of the list on the right to create a new job.	
Click the Greate door button at the top of the list on the right to create a new job.	
FRED Jobs	Create Job
None	
FRED Plots	
None	

Example



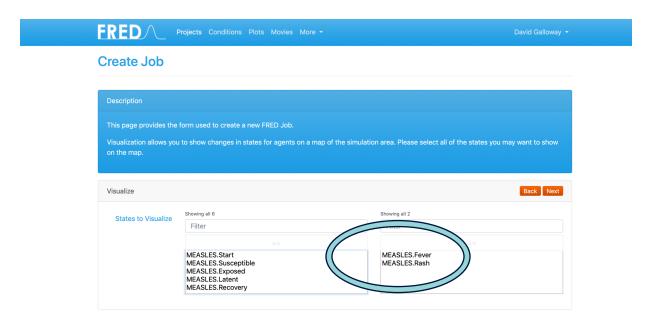
Example



Example

Create Job			
Description			
This page provides the	form used to create a new FRED Job.		
Select as many condition	ons as you need for your simulation. You can use the filter box	to search for conditions.	
Condition Selection			Back Ne
Your Conditions	Empty list	Empty list	
	Filter	Filter	
	>>	<<	
Shared Conditions	Showing all 6	Showing	
Shared Conditions	Showing all 6 Filter	Shoulae Filter	
Shared Conditions			
Shared Conditions	Filter Baseline Influenza (INF)		
Shared Conditions	Filter	Filter	

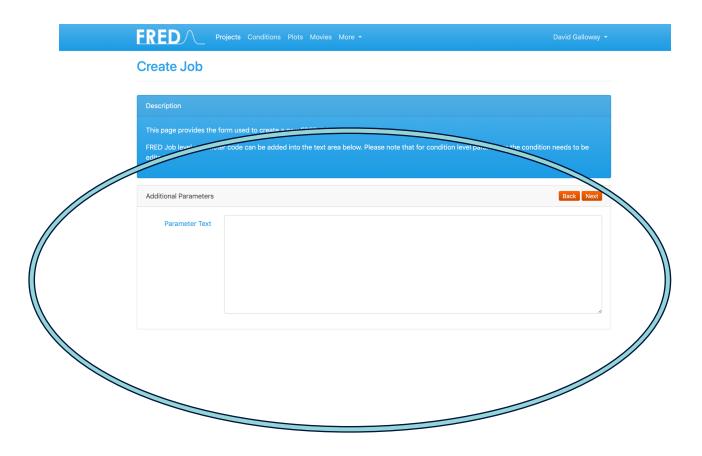
Example



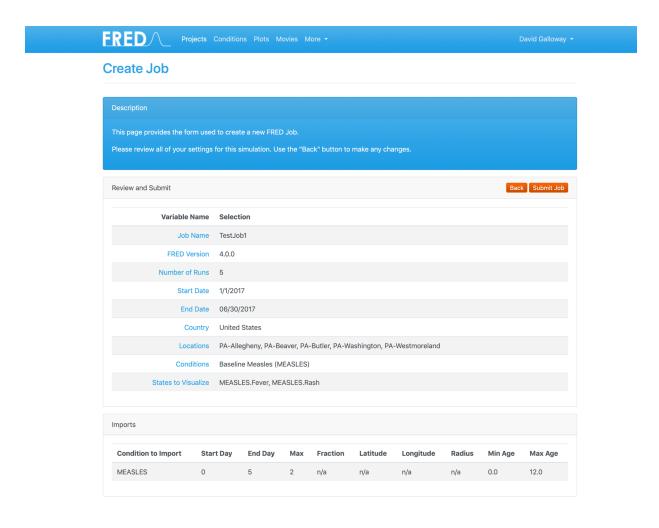
Example

Description										
This page provides the Imports allow you to se					d cases are	placed in the a	vpocod sta	to of the cor	dition	
	ed condition ca		populati	on. All seede			xposed sta			
Imports									Back	Next
Condition to Import	MEASLES									;
Start Day	0									
End Day	5									
Type of import?	🗿 Max F	raction								
Max	2									
Restrict location?	🔾 Yes 🗿 N	0								
Restrict by age?	O Yes ○ N	0								
Min Age	0.0									
Max Age	12.0									
									Add	Import
Imports										
Condition to Import	Start Day	End Day	Max	Fraction	Latitude	Longitude	Radius	Min Age	Max Age	
MEASLES	0	5	2	n/a	n/a	n/a	n/a	0.0	12.0	Delete

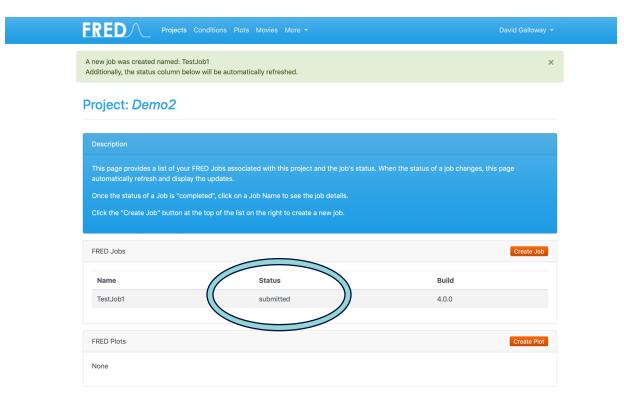
Example



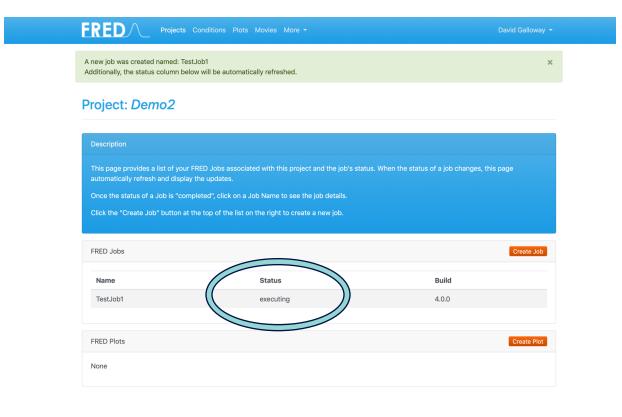
Example



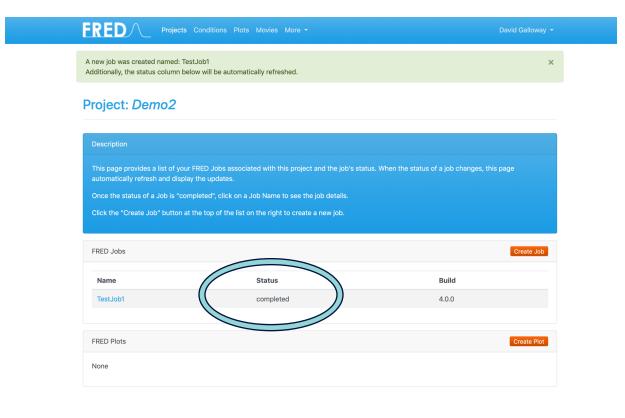
Example



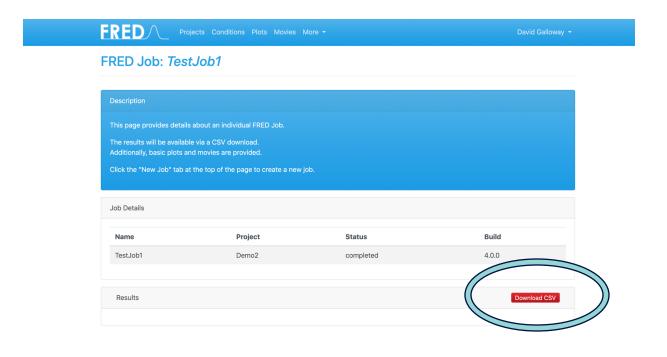
Example



Example



Example



Example

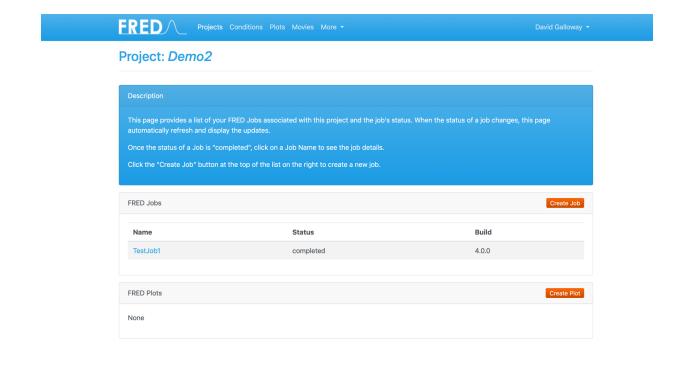
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.2017.12,2142353,0,0,2142353,0,1651355,2142353,4628,358812,52900,18710,18710,170188,17132,47724,151478,12737,40908,103754,7700,47823,62846,1958,15023,15023,1.186228, .2017.12,2142353,0,0,2142353,0,1567308,2142353,46064,334485,575065,20372,20372,190560,18710,15955,17188,14439,47105,118193,8242,53793,71088,2272,1725,1145770 .2017.12,2142353,0,0,2142353,0,1520659,2142353,46649,408706,621694,22428,22428,212988,20372,56214,190560,16153,54146,134346,9112,60216,80200,2689,19984,19984,1.106112 .2017.12,2142353,0,0,2142353,0,1472967,2142353,47692,431028,669386,25370,25370,25370,238358,22428,61510,212988,17132,60461,151478,10817,68039,91017,2994,22978,22978,1.047492



- Now we can create a plot
- Let's look at the following states
 - Susceptible
 - Exposed
 - Fever
 - Rash
 - Recovery

Example Plot



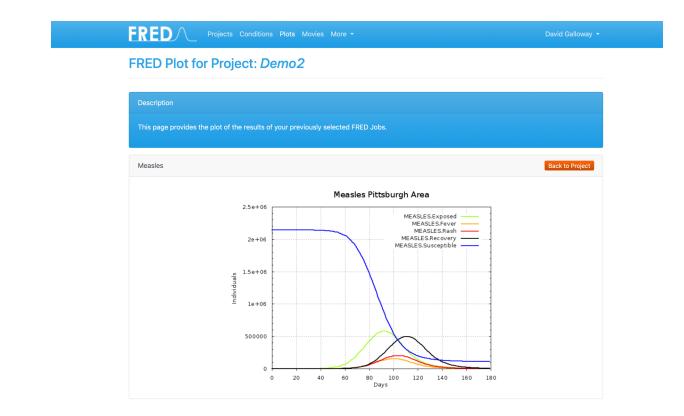
Example Plot

and the second	rojects Conditions Plots Movies More -	David Galloway 👻					
Create Plot for	r Project: Demo2						
Description							
This page provides the form used to create a new FRED Plot.							
You can plot the results additional plotting paran	from any of your "Completed" jobs from this specific project ('Demo2'). Please select the appr neters.	opriate job(s) and any					
	ed the forms within each tab, click "Finish".						
Step 1							
Jobs	TestJob1						
	Find Variables to Plot						
Step 2							
Step 2 Plot Name	Measles						
	Measles Measles Pittsburgh Area						
Plot Name 😧							
Plot Name 🕑 Title	Measles Pittsburgh Area						
Plot Name 🛛 Title Bar Chart 🕑	Measles Pittsburgh Area						
Plot Name Title Bar Chart Error Bars	Measles Pittsburgh Area						
Plot Name Title Bar Chart Error Bars Normalize By Week Show Year	Measles Pittsburgh Area						
Plot Name Title Bar Chart Error Bars Normalize By Week Show Year Show All Runs	Measles Pittsburgh Area						
Plot Name Title Bar Chart Error Bars Normalize By Week Show Year	Measles Pittsburgh Area						
Plot Name Title Bar Chart Error Bars Normalize By Week Show Year Show All Runs	Measles Pittsburgh Area						

Example Plot

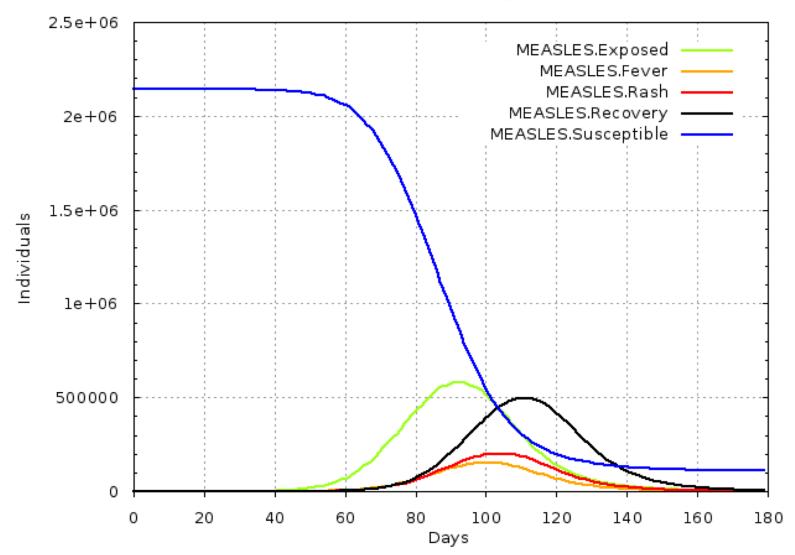
RED	Projects	Conditions Plots Movies More -		David Galloway
	TestJob1	Popsize	Popsize	Blue 🗳
	TestJob1	MEASLES.Exposed	MEASLES.Exposed	Green-Yellow \$
	TestJob1	MEASLES.Fever	MEASLES.Fever	Orange \$
	TestJob1	MEASLES.Immune	MEASLES.Immune	Blue \$
	TestJob1	MEASLES.Latent	MEASLES.Latent	Blue \$
	TestJob1	MEASLES.newExposed	MEASLES.newExposed	Blue 🗳
	TestJob1	MEASLES.newFever	MEASLES.newFever	Blue \$
	TestJob1	MEASLES.newImmune	MEASLES.newImmune	Blue 🗳
	TestJob1	MEASLES.newLatent	MEASLES.newLatent	Blue 🗳
	TestJob1	MEASLES.newRash	MEASLES.newRash	Blue 🗳
	TestJob1	MEASLES.newRecovery	MEASLES.newRecovery	Blue \$
	TestJob1	MEASLES.newStart	MEASLES.newStart	Blue \$
	TestJob1	MEASLES.newSusceptible	MEASLES.newSusceptible	Blue \$
	TestJob1	MEASLES.Rash	MEASLES.Rash	Red \$
	TestJob1	MEASLES.Recovery	MEASLES.Recovery	Black \$
	TestJob1	MEASLES.RR	MEASLES.RR	Blue \$
	TestJob1	MEASLES.Start	MEASLES.Start	Blue \$
	TestJob1	MEASLES.Susceptible	MEASLES.Susceptible	Blue \$

Example Plot



Example Plot

Measles Pittsburgh Area



- We can also make a movie
- I'm just going to show the new agents who are in the following states on a given day
 - Fever
 - Rash

Example Movie

FRED Projects Con	ditions Plots Movies More -	
Create Movie		
Description		
This page provides the form used to You can create movies from any of yo Please select the appropriate job and Once you have completed the forms	l any additional movie parameters.	
Step 1		
doL	TestJob1 Find Variables to Display	\$

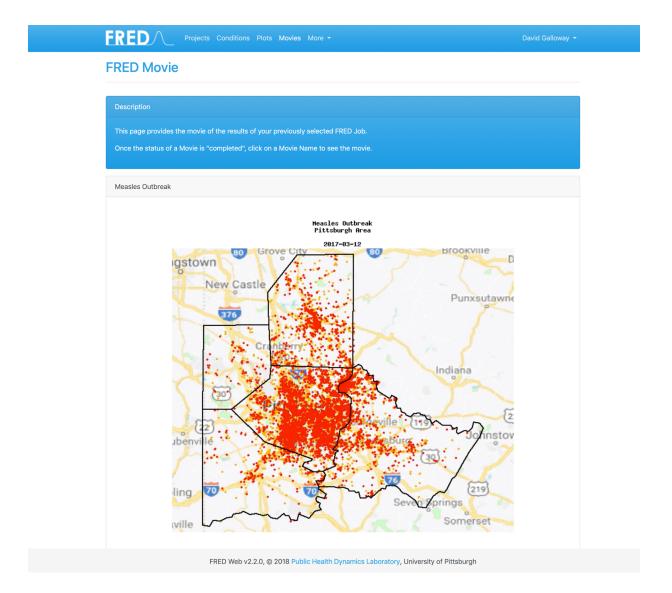
FRED Projects Co	nditions Plots Movies More -	
Create Movie		
Description		
You can create movies from any of y Please select the appropriate job an	d any additional movie parameters.	
Once you have completed the forms	within each tab, click "Finish".	
Step 1		
Job	TestJob1	\$
	Find Variables to Display	
Step 2		
Movie Name 🔗	Measles Outbreak	
Title	Measles Outbreak	
Subtitle	Pittsburgh Area	
Left Caption		
Left Caption Color	¢	
Center Caption		
Center Caption Color	\$	
Right Caption		
Right Caption	\$	

Example Movie

RED	Projects Conditio	ns Plots Movies			
	Right Caption Color		\$		
	Show Census Tracts				
	Add Grid				
	Run Number				
	Line Width 😧				
	Min X				
	Max X				
	Min Y				
	Max Y				
	Start Day				
	End Day				
	Interval				
Step 3 😯					
Display?	Movie Variable	Point Size (0	- 0.100)	Period	Color
	MEASLES.Fever	0.002			Red 🗘
	MEASLES.newFever	0.002			Orange 🗘
	MEASLES.Rash	0.002			Red 🛟
	MEASLES.newRash	0.002			Red \$
					Create the Movie

Example Movie

lovies			
101165			
Description			
This page provides a list of your	current Movies.		
If the status is "Complete", click	on a movie name to view the movie.		
If the status is "Complete", click	on a movie name to view the movie.		
If the status is "Complete", click My Movies	on a movie name to view the movie.		Create Mov
	on a movie name to view the movie.	٠	Create Mov Delete?
My Movies	Status Created	Nt 14 18:52:03	
My Movies Name	Status Created A completed 2018-10-		Delete?

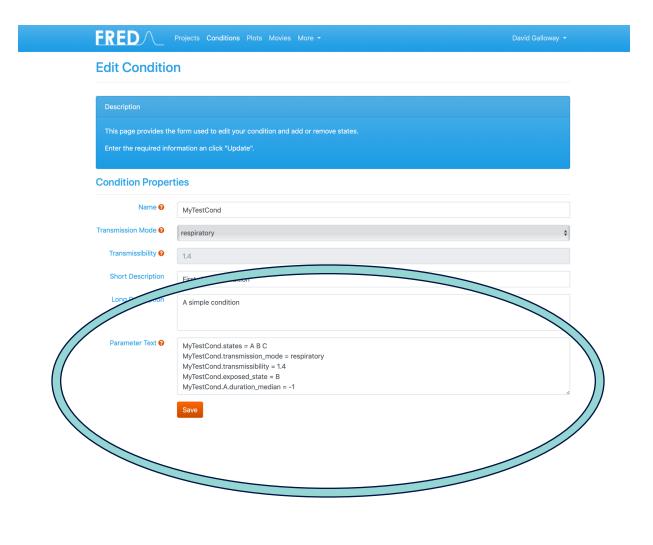




Create Conditions

- We will be doing this in the workshop
- I wanted to briefly discuss the Parameter Text box
- On the Condition page allows user to enter:
 - Transitions (in addition to what is on the GUI)
 - Transition Factors that alter the transition probabilities
 - Side effects

Create Conditions



- As I mentioned in the Challenges
 - Many parameters /options are not known when the condition is created (they are user-defined)
 - The Parameter Text box is a work-around for the short-term
 - The parameters will still be validated
 - But, allows flexibility for user to submit additional parameters
 - Will be using this more during the Hands-on portion



- Any thoughts?
- Questions?
- Concerns?

FRED: Development Team

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FRED Resources

• FRED Web:

http://fred.publichealth.pitt.edu

• FRED Github:

https://github.com/PublicHealthDynamicsLab/FRED

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Robert Wood Johnson Foundation

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The Benter Foundation

Thanks!