

Trails and Networks: Loom; Going from Trails to Networks and Networks to Trails

Binxuan Huang binxuanh@cs.cmu.edu

Originally developed by Kenny Joseph, Aparna Gullapalli





Center for Computational Analysis of Social and Organizational Systems http://www.casos.cs.cmu.edu/



Overview

- What is a trail?
- How do we get trail data?
 - Characterize trail as network data
- Trails and Loom
 - Visualization
 - Networks from trails
 - Finding similar trails





What's a Trail?

- A trail is a trace of the movement of something over time
- Thus, for example, the movement of an attachment through a series of email communications creates a *trail*
- What are some other examples of trails?
 - People moving from place to place
 - Twitter hashtags



. . .



Event Data and trails

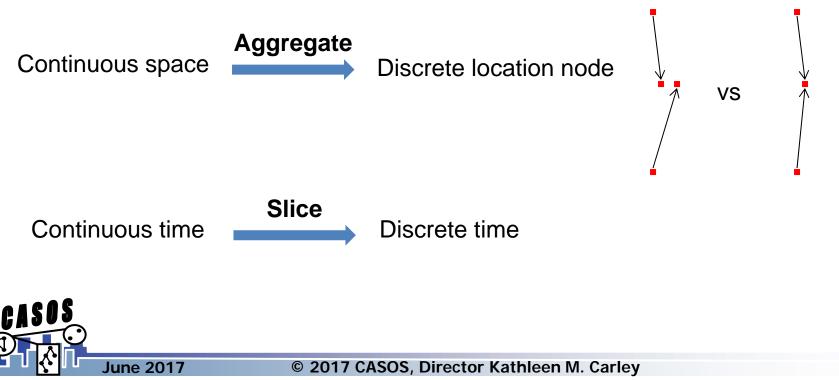
- In a series of relational email events, *information* may flow
- Today look at geospatial trails: agents travelling to different locations



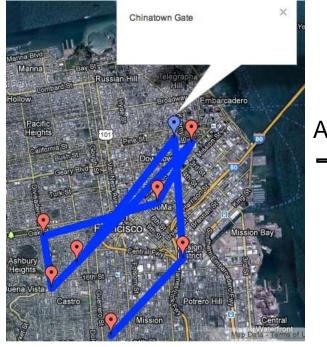


Geospatial Trails

- Usually geospatial trails represent agents travelling in continuous space and time.
- Network data: discrete node and discrete time.







	Time	Location		
	2017, June 7, 9 am	Green St.		
Aggregate	2017, June 7, 10 am	Design District		
Slice	2017, June 7, 11 am	Chinatown Gate		
	2017, June 7, 12 am	16 th st.		





Trails visualization

- ORA Over-time visualizer
 - Benefit: Can see changes in network structure over time
 - Drawback: For sparse trail data, not very effective
- ORA GIS Visualizer
 - Benefit: Can see the spatial distribution of trails
 - Drawback: Lose the temporal information
- Loom
 - Benefit: Can see the temporal distribution and the places travelled to
 - Drawback: Spatial distances, where they exist, are not preserved





What we'll do

- Import a "DynamicMetaNetwork" with spatial information
- Visualization
 - Understand the benefits and drawbacks of different visualizations of trail data
 - ORA Over-time visualizer
 - ORA GIS visualizer
 - Loom
- Finding Similar trails
 - Use Loom to cluster trails
- Obtain networks from trails





Import a dynamic meta-network

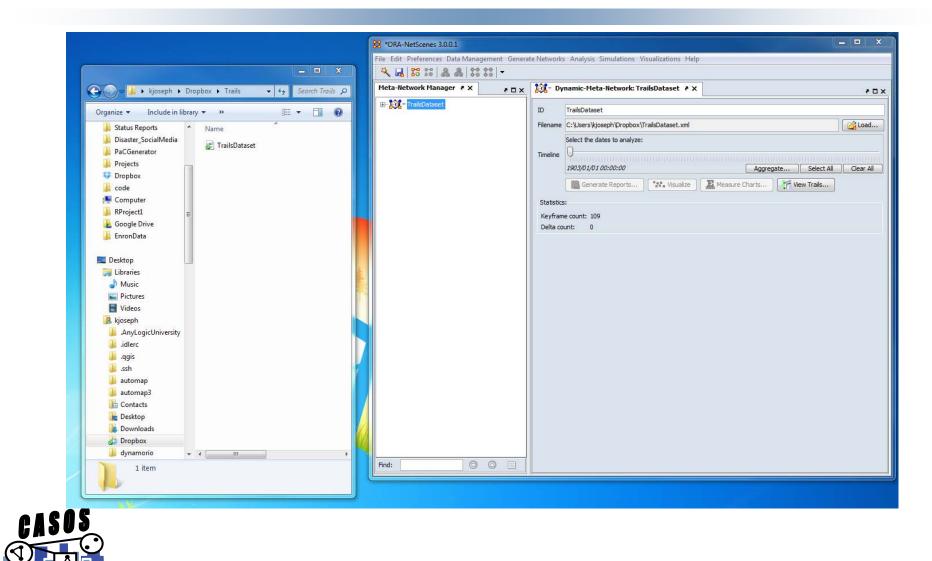
- Same as importing a regular meta-network
 - Drag-and-drop
 - File->Open Meta Network
- Import TrailsDataset.xml





June 2017

Importing





The Data

- Our trail:
 - Locations are our nodes
 - Agents are what is moving between them
- Lets explore the data
 - In ORA proper
 - Networks over time visualizer
 - Geospatial Visualizer





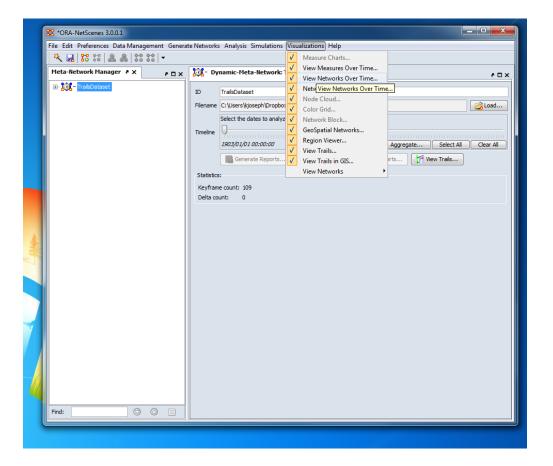
ORA Proper

🔍 🛃 📅 🏗 🍰 🙈 🐯 🎖	• •	te Networks Analysis Simu		actions melp				
Network Manager ₹ X	• - × - ×	•••• Network: Agent x L	ocation ₹×					~ -
1960/01/01 00:00:00	*	Info Editor	'					
± 1961/01/01 00:00:00		Convert Links Remove L	inks Highlight	Hide Displa	v Ontions			
🗉 🚼 1962/01/01 00:00:00			inks riiginigite	That Displa	y options	1	1.	
H 4 1963/01/01 00:00:00		Search nodes 👻 🔍				AND 👻	Highlight matches	s
1964/01/01 00:00:00			Pittsburgh	Seattle	Montreal			
1965/01/01 00:00:00		The Commissioner	V					
1966/01/01 00:00:00		Mr. O'Brien						
		Vince Lombardi	V					
		Lord Stanley						
		Lord Stanley						
H 1971/01/01 00:00:00								
H 1972/01/01 00:00:00								
± 1973/01/01 00:00:00								
H 1974/01/01 00:00:00								
H 1975/01/01 00:00:00								
1976/01/01 00:00:00								
1977/01/01 00:00:00								
1978/01/01 00:00:00								
🚍 🚼 1979/01/01 00:00:00								
Agent : size 4								
Location : size 3								
Agent x Location	E							
1980/01/01 00:00:00								
🗄 🚼 1981/01/01 00:00:00								
🗄 🚼 1982/01/01 00:00:00								
🗄 🚼 1983/01/01 00:00:00								
1984/01/01 00:00:00								
1985/01/01 00:00:00								
1986/01/01 00:00:00								
1987/01/01 00:00:00								
	-							





Networks Over Time Visualizer







Networks Over Time Visualizer

File View Actions Tools Lay		an 🔹 0.0 🛬
	Mr. O'Brien Los Angeles The Commissioner	
Networks Over Time Animation meslices Clustering Phase Duration 1 sec Display Phase duration: 5 sec Node Positioning Constant Auto-Layout ✓ Autozoom	Lord Stanley	Edit Control Image: Contreteee Image
	Vince Lombardi Washington	
Coom: -9 C Hyperbo	olic: 0 7 nodes, 4 links	

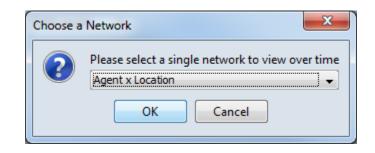


Geospatial Visualizer

*ORA-NetScenes 3.0.0.1			_ D X
File Edit Preferences Data Management Genera	te Networks Analysis Simulations	Visualizations Help	
	ate Networks Analysis Simulations	Measure Charts	
		View Measures Over Time	
Meta-Network Manager 🗧 🗙 📀 🗆 🗙	201 - Dynamic-Meta-Network:	View Networks Over Time	× 🗆 5
	ID TrailsDataset	✓ Network Drill Down	
		✓ Node Cloud	
	Filename C:\Users\kjoseph\Dropbo	✓ Color Grid	Coad
	Select the dates to analyz	Vetwork Block	
	Timeline	GeoSpatial Networks	
	1903/01/01 00:00:00	Region Viewer	Aggregate Select All Clear All
	Converte Donaute	View Trails	
	Generate Reports	View Trails in GIS	arts
	Statistics:	View Networks	
	Keyframe count: 109	view trails in 015	
	Delta count: 0		
Find:			
une 2017 © 2017 (CASOS, Directo	r Kathleen M. C	arlev



Geospatial Visualizer

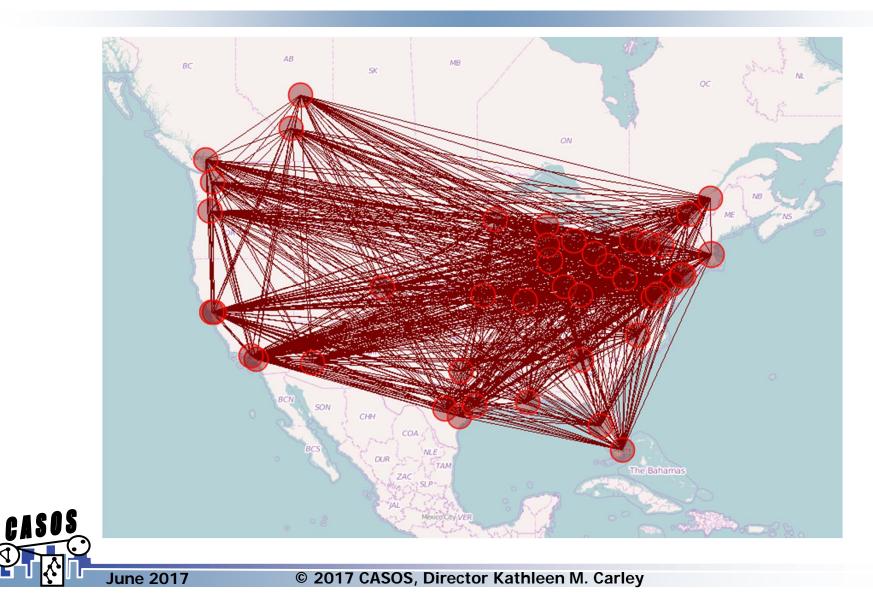




© 2017 CASOS, Director Kathleen M. Carley



Geospatial Visualizer





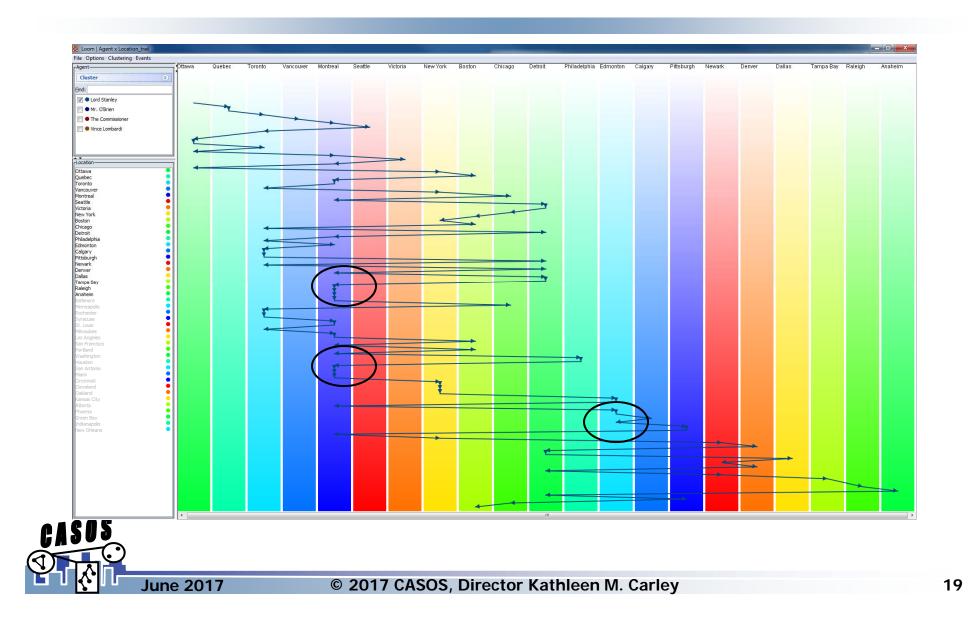
Loom

XX *ORA-NetScenes 3.0.0.1					
File Edit Preferences Data Management Generate Networks Analysis Simulations Visualizations Help					
≪ , , , , , , , , , , , , , , , , , , ,					
	🐹 - Dynamic-Meta-Network: TrailsDataset 🕴 🗙 💦 🗠 🗙				
	ID TrailsDataset				
	Filename C:\Users\kjoseph\Dropbox\TrailsDataset.xml				
	Select the dates to analyze:				
	Timeline U 1903/01/01 00:00:00 Aggregate Select All Clear All				
	Generate Reports				
	Statistics:				
	Keyframe count: 109				
	Delta count: 0				
Eind: 💿 🎯 🗄					





Loom





Trails and Loom

- Visualization of things over time is hard
 - State of the art revolves around animation
 - Loom allows us to visualize trails over time in a static, understandable environment
- Trails may have similar patterns, but these are difficult to observe
 - Loom allows us to cluster similar trails together
- We can get networks from trails, for example, who is connected by the given attachment?
 - Loom allows us to easily export such networks to ORA

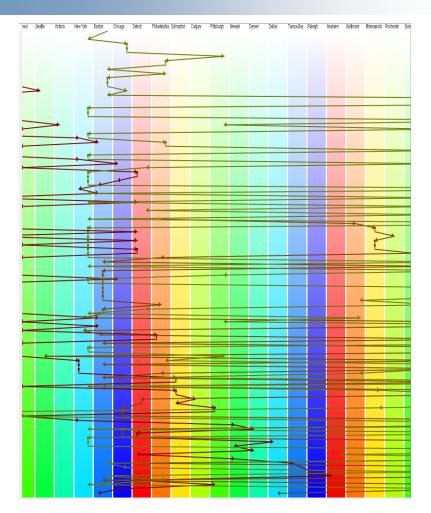


June 201



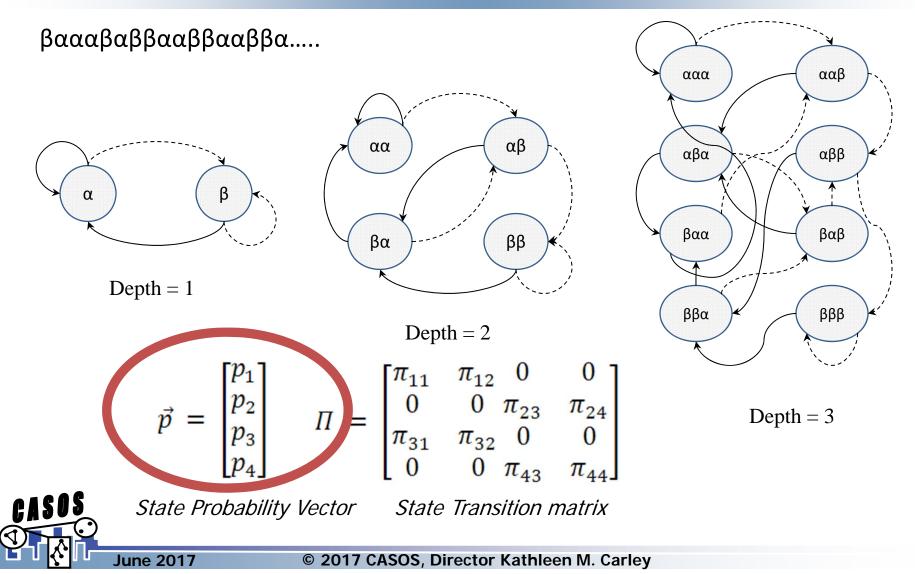
Why cluster?

- Why are we interested in trails and trail clustering?
 - Gain information by analyzing agents across space and time together.
 - Interested in grouping agents that display same behavior across time. E.g. visit the same locations across time.





Carnegie Mellon Feature vector representation using PFSA





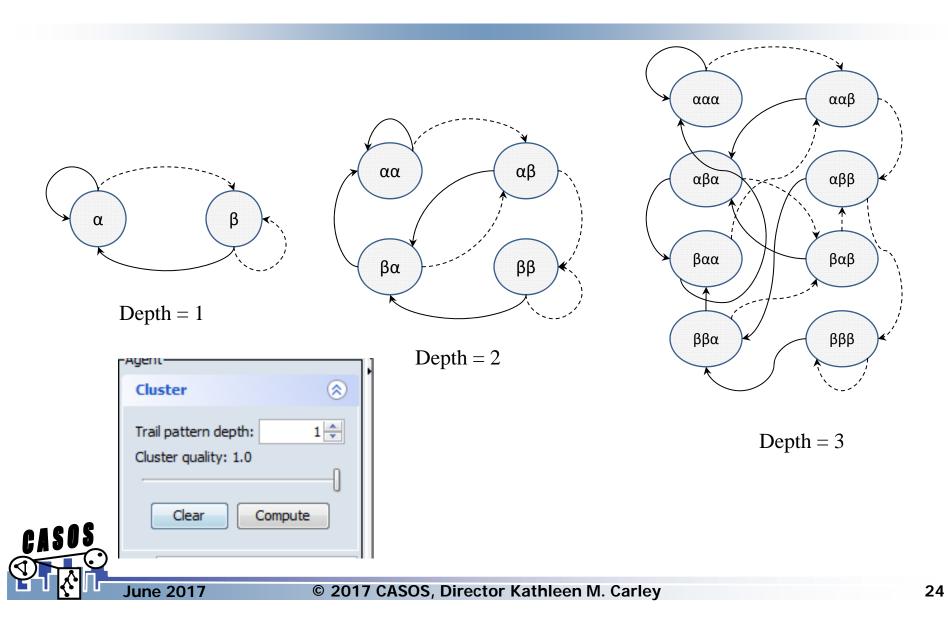
Clustering of Trails using PFSA

- Each trail is now represented by a numerical feature vector, the state probability vector of the derived PFSA (the model of the generative process).
- To look at joint spatiotemporal behavior we now cluster the agent trails based on their feature vectors.
- This is done using a two step process.
 - A coarse clustering step : Trails are initially grouped coarsely according to the locations visited, irrespective of the frequency of the visits.
 - A cluster refining step : The coarse clusters are each then clustered using agglomerative clustering to derive groups of trails which visit "similar" locations with "similar" frequencies.





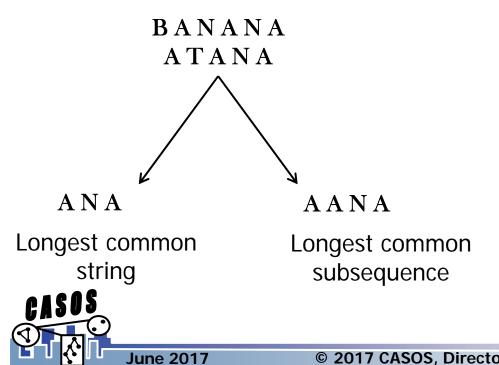
Refining the Coarse Clustering

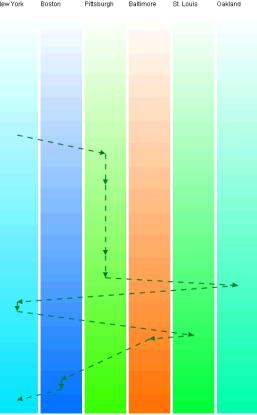




Viewing time sequences

- Each cluster contains trails with similar patterns in the sequences of locations visited
- Thus extract the longest common subsequence amongst all the trails belonging to a cluster.







What we'll do

- Import a "DynamicMetaNetwork" with spatial information
- Understand the benefits and drawbacks of different visualizations of trail data
 - ORA Over-time visualizer
 - ORA GIS visualizer
 - Loom
- Use Loom to cluster similar trails
 - The high level concept
 - The details
- Obtain networks from trails





Generating Networks from Trails

 We can better understand how different cities relate via championships by getting networks out of them

What we'll do

- Generate the networks
- View them in ORA Proper
- Use ORA Network Visualizer





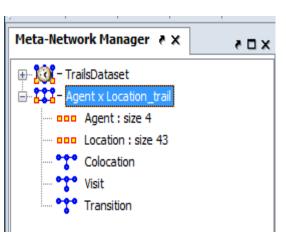
Exporting the Matricies

88 L	🔀 Loom Agent x Location_trail				
File	Options Clustering Events				
	Open Save as	(
	Export to ORA-NetScenes		Transition/Colocation/Visit Matrix		
	Save Image as		Trail Matrix		
-			Visible Visitation Frequency Matrix		
	Clear Compute]			





What we now have



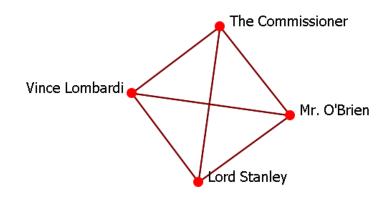
- ORA uses the entire trailset and outputs a single meta-network
 - Colocation An edge is created between the trophies if they ever existed at the same place at the same time
 - Visit Matrix An edge is created between city and trophy if the city ever won that trophy
 - Transition An edge is created between cities if a trophy ever traveled from one to the other in consecutive years





Colocation

Agent x Location_trail



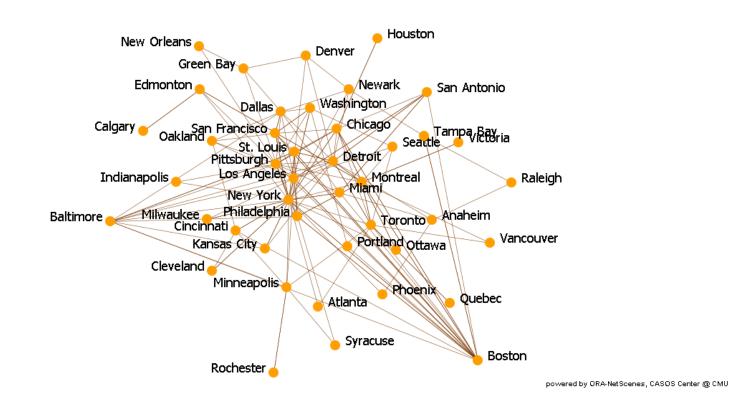


powered by ORA-NetScenes, CASOS Center @ CMU



Transition

Agent x Location_trail

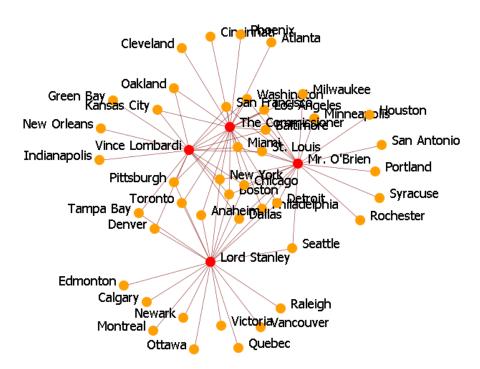






Visit

Agent x Location_trail



June 2017

© 2017 CASOS, Director Kathleen M. Carley

powered by ORA-NetScenes, CASOS Center @ CMU



lune 201

Summary

- We discussed what a trail was a trace of the movement of something through a network over time
- We used an example dataset and looked at trail data three different ways – in the Networks Over Time visualizer, the GIS visualizer and Loom
- We talked about how to find similar trails in Loom

• We looked at how we can get new, interested CASOS networks out of our trail data