



THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL



Tutorial: Hands-on with Tmix

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Outline

- Hands-on with Tmix – 90 mins
 - 30 mins: Tmix demo with discussion
 - 45 mins: you run an experiment
 - 15 mins: how can you use Tmix in your projects



Your handout

- Pages 1-5: General information on Tmix
- Pages 6-7: Main tutorial instructions
- Pages 8-11: Instructions for reserving resources through the GENI Portal



Experiment Workflow



Design/Setup



Execute

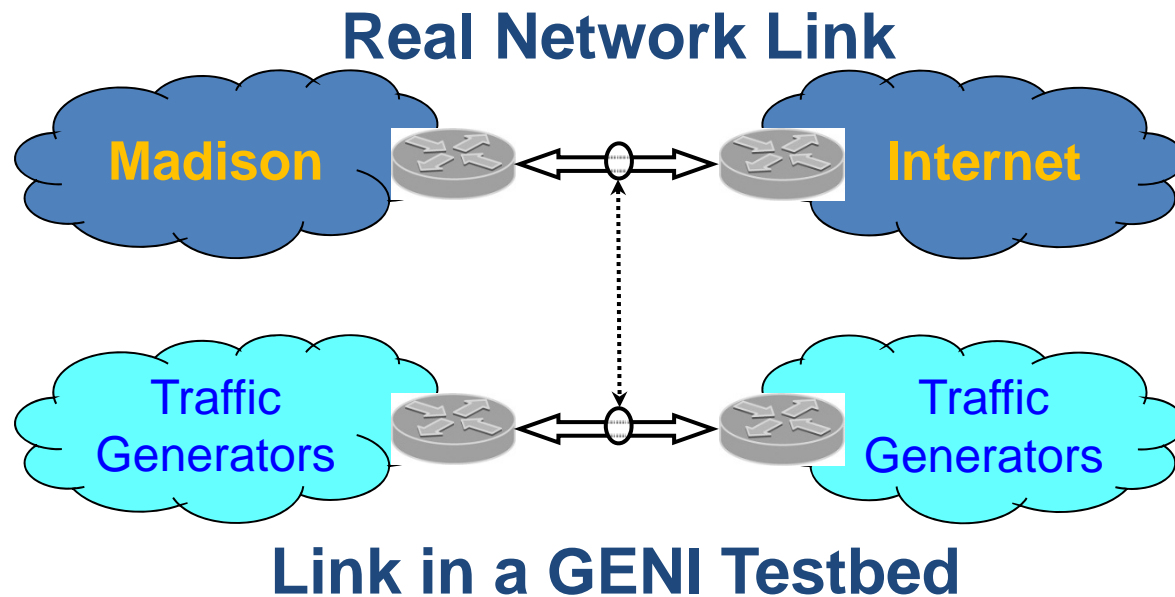


Finish

- **Part I: Design/Setup**
 - Create a slice and reserve resources through the portal
- **Part II: Execute experiment**
 - Run a 10-min Tmix experiment emulating ~25,000 TCP connections as seen on a real production link
- **Part III: Finish**
 - Teardown experiment – delete/release resources



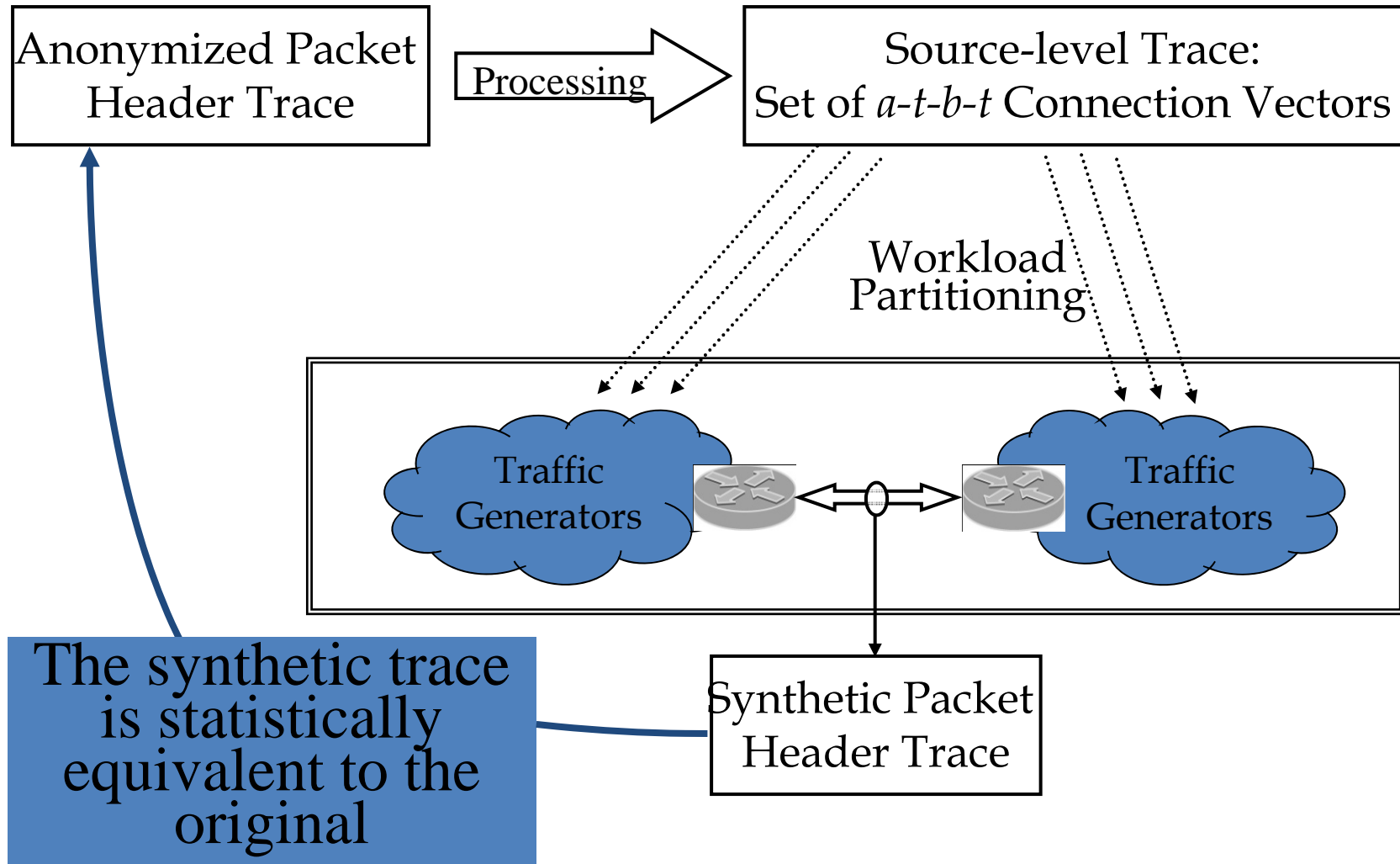
What is Tmix?



- Given a packet header trace, we can generate synthetic traffic in a simulator or testbed that is statistically equivalent to the measured traffic
- **You can emulate an Internet backbone link on GENI**



Source-level Trace Replay



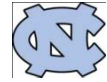
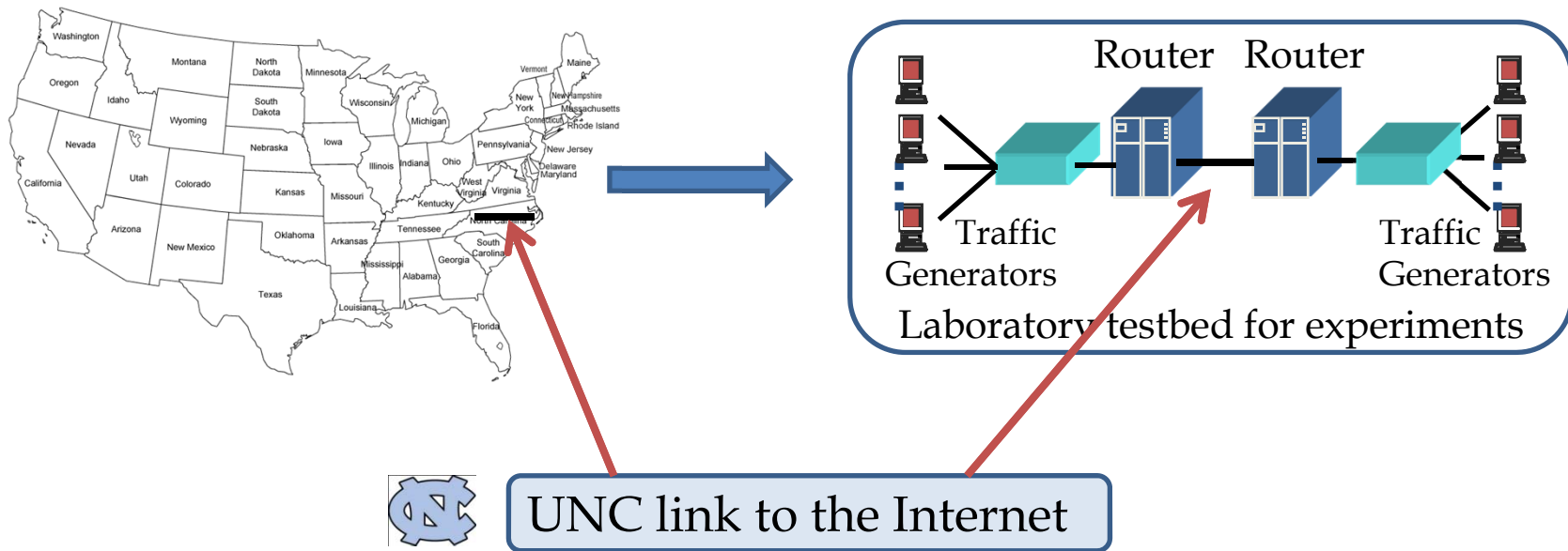


Emulating Each TCP connection

- Non-parametric modeling
- Application Data Units (ADUs)
- Round trip time per connection
- Sequential vs. concurrent connections
 - request-response exchanges vs. concurrent exchanges



Simulate Network Traffic on a GENI testbed

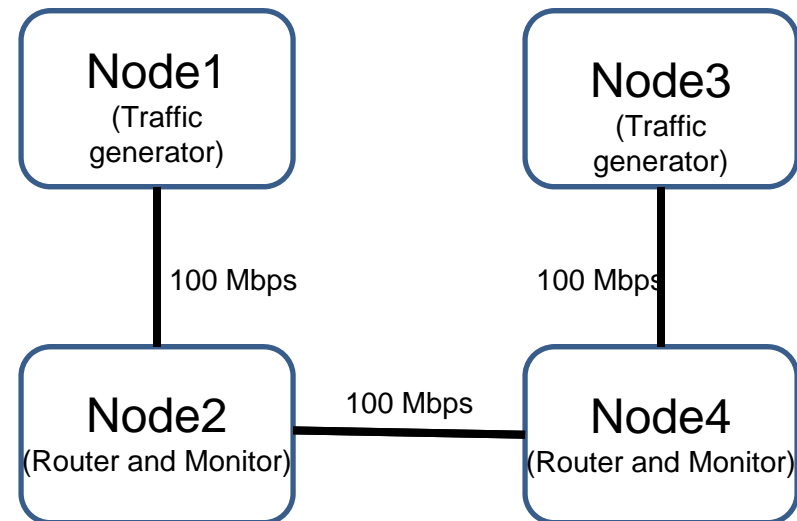


UNC link to the Internet



10-min Experiment

- Traffic generators
 - Generating TCP connections
 - CPU utilization, memory
 - Connection statistics – duration, epoch response times
- In the network: run tcpdump and analyze the pcap trace





10-min Experiment

- Traffic
 - ~25,000 TCP connections
 - Emulating each connection's minimum RTT
 - Average throughput - ~ 15Mbps and 7Mbps in the two directions
 - Collecting various measurements on the end systems - e.g. CPU utilization, memory
 - Connection statistics - duration, epoch response times





Experiment Workflow



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 - Teardown experiment – delete/release resources (save your results first!)

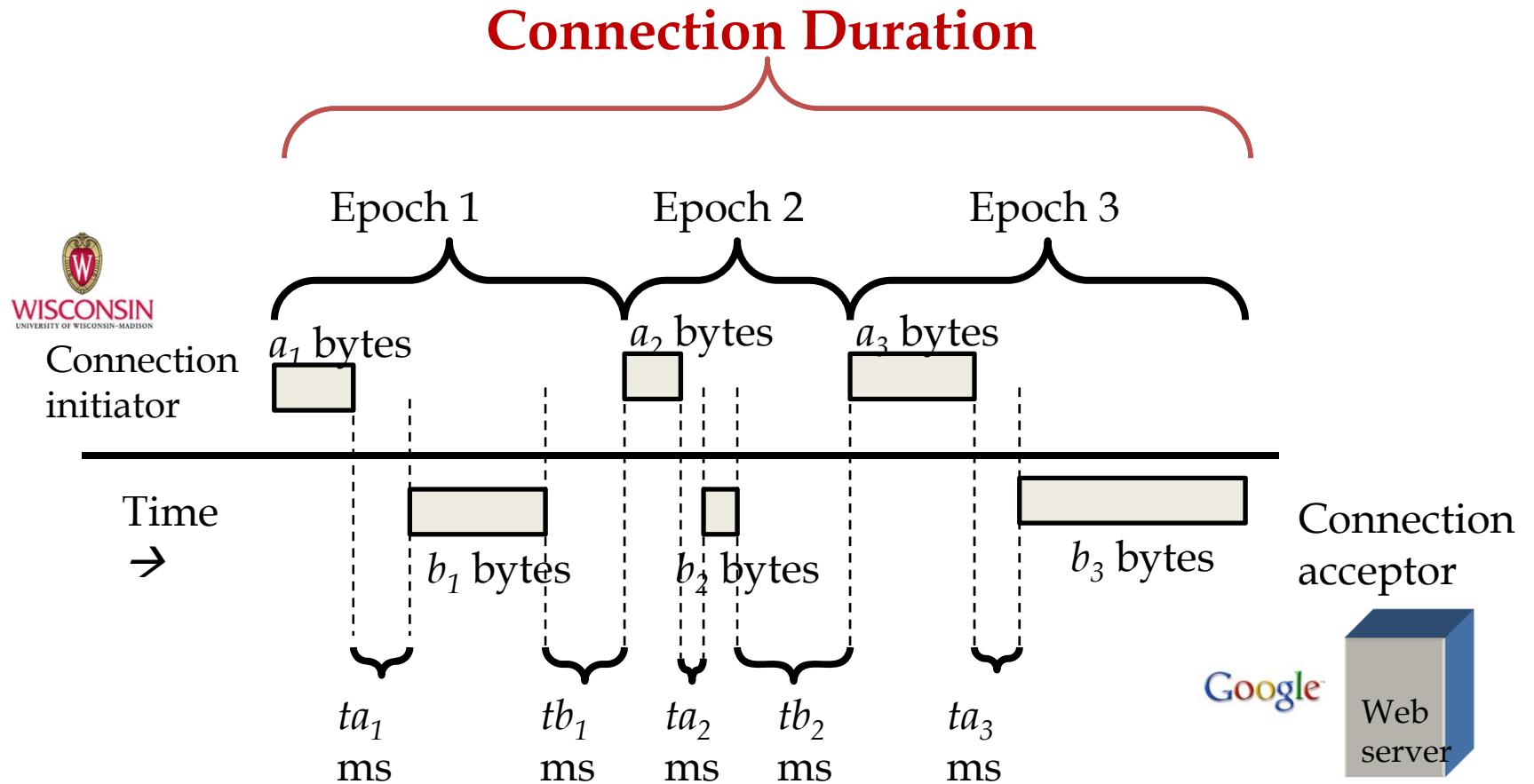


Experiment Results

- Traffic generators – results files (tmix directory)
 - tmixTutorial.unc – incomplete connections
 - tmixTutorial.ts – time series of connection stats, and CPU and memory usage
 - tmixTutorial.rt – Connection duration, total bytes transferred
 - tmixTutorial.ert – Epoch response times

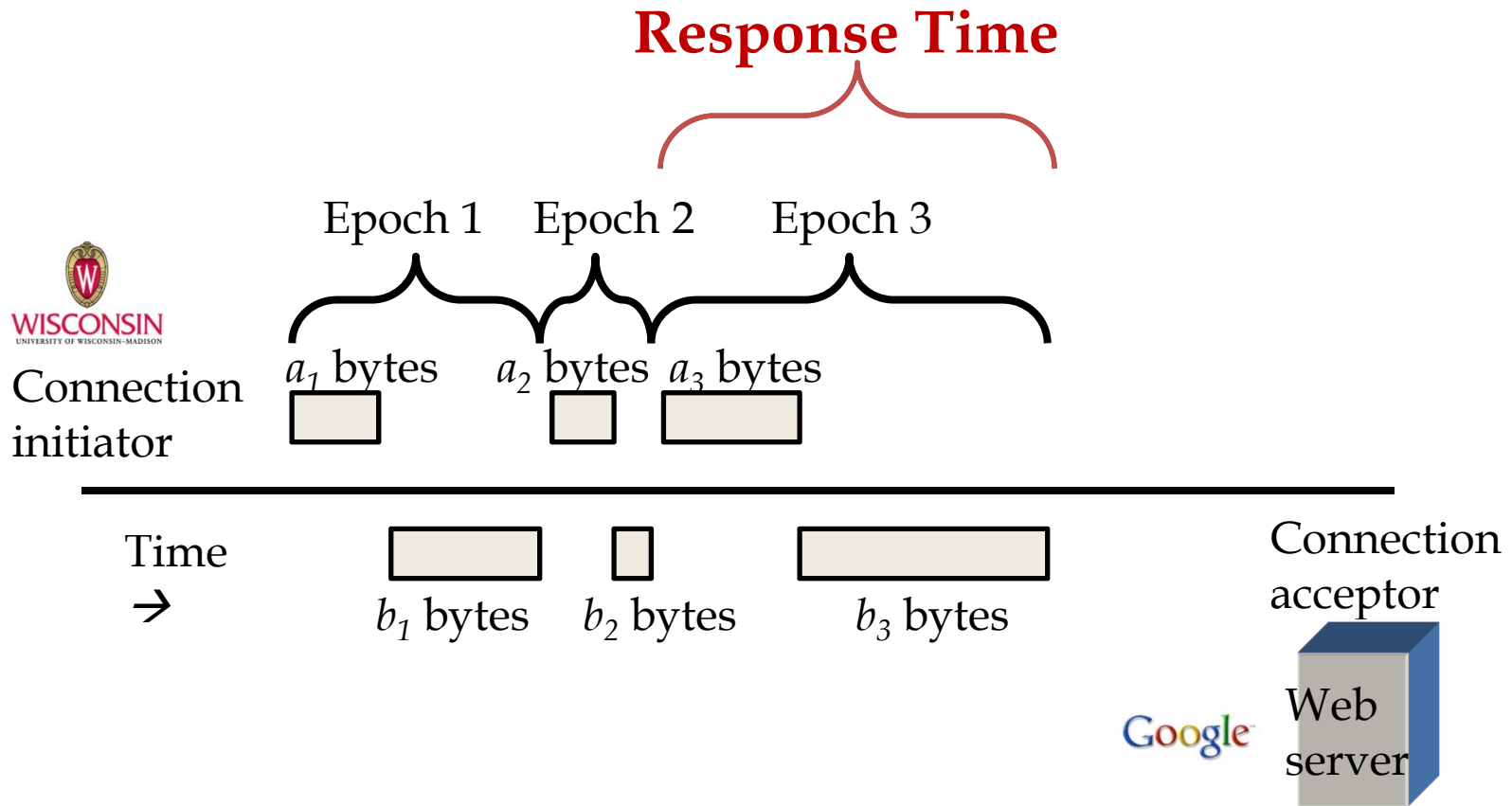


Performance Metrics: **Connection Duration**





Performance Metrics: **Response Time**

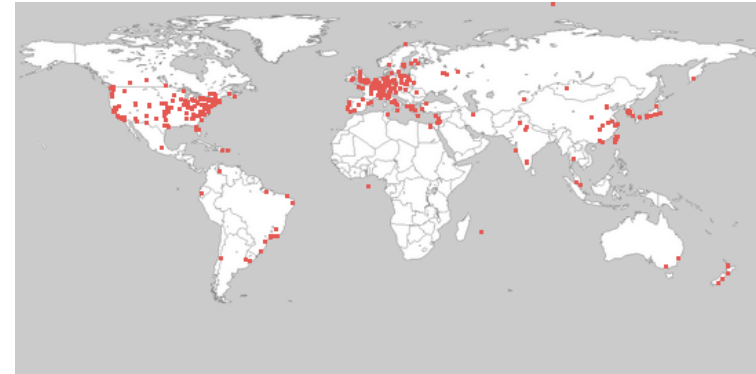




Tmix Experiments on GENI



ProtoGENI



PlanetLab



What's Next?

- This tutorial was a starting point...
- Tmix enables realistic traffic generation on GENI for any experiments you design
 - Testing network protocols
 - Router testing, queue management
 - Any experiment where you need to simulate network traffic
- Contact us (aikat@cs.unc.edu) – we want to help you use Tmix in your next set of experiments

<http://cs.unc.edu/~aikat/geni>



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Thank you!

Evaluations

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