Exploring Simulation Scenarios with Timepoint Thumbnails

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CHALLENGE

When studying a dynamic simulation, it's valuable to see not just the moment-to-moment state, but also a history of how the state has evolved over time.

For a simulation whose output can be summarised as a few numbers, a history could be shown using just line graphs.

What if the simulation cannot be summarised so simply?

APPROACH

Develop animatable thumbnails that capture essential details of the simulation's full output.

Show history as a row of thumbnails spaced evenly in time, that can also move to show the intermediate states.

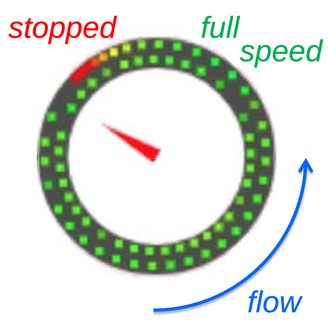
Support the use of multiple history rows in parallel for exploring alternative scenarios.

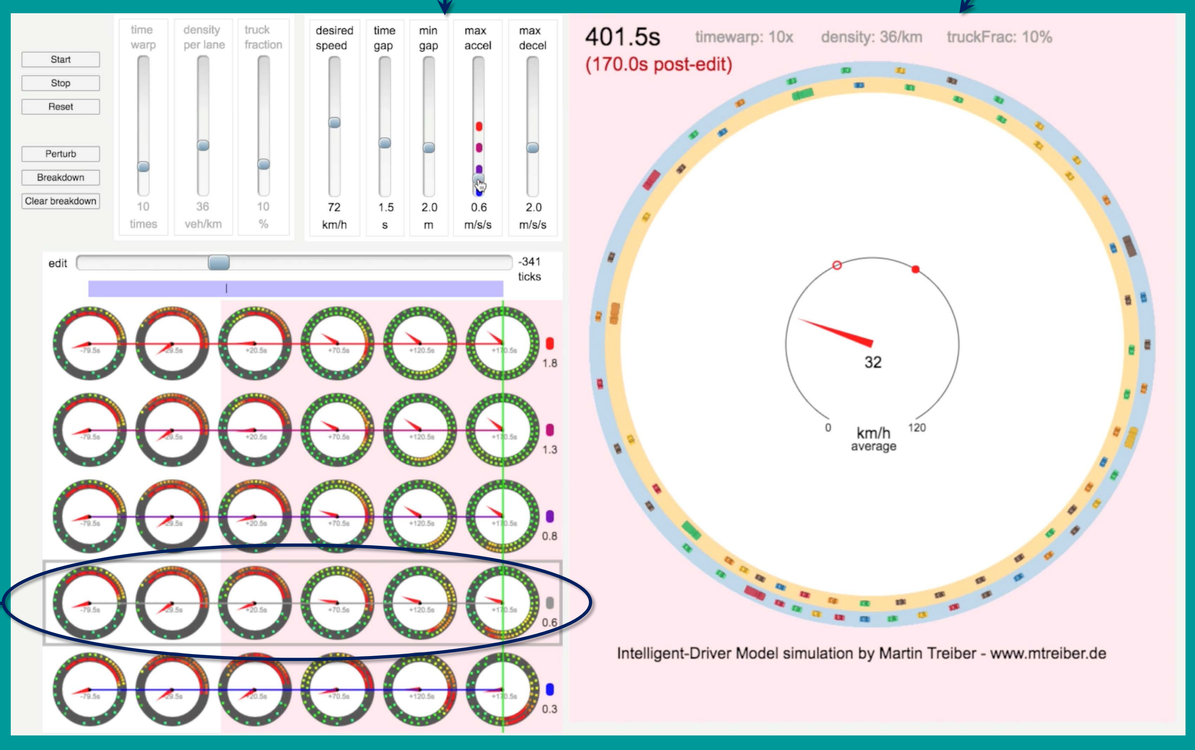
Given a simulation with detailed visual output…

We demonstrate timepoint thumbnails for a traffic simulation [1], under control of a steering interface built using Lively Web [2].

…and suitable summary thumbnails…

The animated thumbnails must summarise the simulation state at each tick. For this simulation we chose to show each vehicle, colour coded by speed, and the average-speed needle.





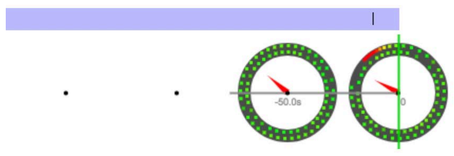
…display the simulation history.

History appears as a row of thumbnails. The rightmost thumbnail shows the latest state; each one to the left shows the state as it was 5 seconds earlier. *[Why are there five such rows in this picture? See item D in box to right.]*

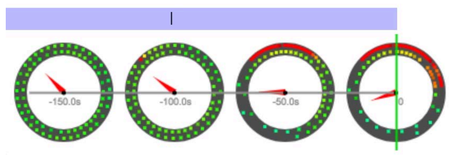
There are two main display modes:

Mode A: Simulation running

i. For the first few seconds of running the simulation, there is just one thumbnail. The vehicles are seen speeding around the ring.

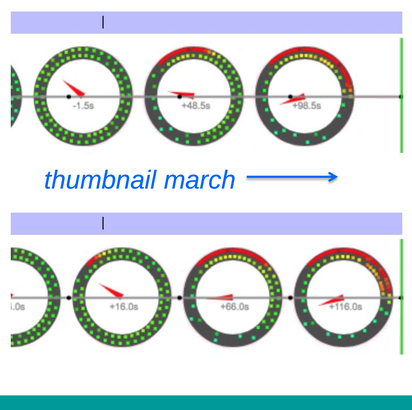


ii. After 5s another thumbnail appears, showing the state 5s (which is 50 simulated traffic seconds) in the past. The user has now triggered an event that blocks one traffic lane; this event is seen in the strip above the thumbnails, moving left.



iii. A little over 100 simulated seconds since the blockage event, its impact has just appeared in the thumbnail centred at the -100s point. Many vehicles in the two later thumbnails are now slow or stationary.

Mode B: Simulation paused ("marching mode")



iv. The user pauses the simulation and turns on marching mode: the thumbnails now march along the timeline, replaying every tick from the recorded history. The centre of the third from right is about to encounter the blockage event.

v. A moment later, that thumbnail shows the blockage. This mode can be continued indefinitely, with new thumbnails constantly being introduced from the left.

How this helps support exploration

A. Multiple chances to watch a transient effect
If something dramatic happens in the simulation, the user can see it being played out many times as it reaches successive thumbnails.

B. Convenient browsing of recorded history
In "marching mode", the transit of one thumbnail after another on the march establishes a form of "timeless motion" [3], giving the user unlimited opportunities to watch recorded situations play out repeatedly.

C. Replay with adjustable starting conditions
In the figure above, the user has rewound time by 170 simulated seconds. Time "in the future" with respect to the rewind is given a pink background. Any adjustment to a simulation-parameter slider shows instantly how the history *would have played out* under the new conditions.

D. Parallel exploration of multiple scenarios
The figure also shows how timepoint thumbnails can help in making comparisons between scenarios. The user has set up five values for the "max accel" parameter, leading to five rows of thumbnails showing the respective results. Note the different states in the rightmost thumbnails.

Acknowledgements

Timepoint Thumbnails were first designed and prototyped by media-interface researcher Robert Ochshorn, and relate to two of his video projects [4, 5]. I also gratefully acknowledge the support of all my colleagues in Viewpoints Research Institute and in Y Combinator Research's Human Advancement Research Community.

See demo at https://tinlizzie.org/traffic/

Notes and Resources

[1] This is a minor adaptation of a ring-road example implemented by Martin Treiber at the Technical University of Dresden, downloaded from www.mtreiber.de in early 2015.

[2] D. Ingalls, R. Krahn *et al.,* The Lively Web. https://lively-web.org

[3] F. Lam and J. Donath. Seascape and Volcano: Visualizing Online Discussions Using Timeless Motion. Extended abstracts of ACM CHI 2005.

[4] R. Ochshorn. *Chewing.* https://rmozone.com/snapshots/2013/05/chewing.h264.mov

[5] R. Ochshorn. *livezoom.* https://rmozone.com/snapshots/2013/05/livezoom/