Representing Time on Story-Telling Maps
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**Introduction**

A main challenge when visualizing movement is the simultaneous depiction of temporal and spatial data. Symbols such as arrows that have an origin and a destination are used to show movement and specific point symbols such as explosion or lightning can be used to represent dynamic events. Labels can be added to show specific time points, duration, or event order information.

We have chosen four cartographic methods to depict temporal events and sequences:

- A single static map with movement arrows and interaction symbols. Use cases: One interaction event.
- A single static map with event sequence labels. Use cases: 2–5 events with minimal spatial overlap.
- Small Multiples (A series of static maps) – each map column shows the state of the story at a different time for each character’s activities. Use cases: Multiple events that overlap in space.
- Map animation – Change is perceived to happen in a single image by displaying several snapshots after each other, each event is added in order of occurrence with all events visible in final frame. Use cases: Numerous events that overlap in time and space.

**Smoothing**

No smoothing
Smoothing algorithms

Discrete moves
PAEK Polynomial Approximation with Exponential Kernel
Bezier Interpolation

**Labeling**

Comparison

**Small Multiples**

**Animation**

**Occlusion**

- Ensuring that lines don’t overlap with icon symbols (that are a fixed size) regardless of extent.

To implement line segment offsets we use the position of the original edge \((x_1, y_1)\) to \((x_2, y_2)\) with length \(l\) to calculate a modified end position, \((x_e, y_e)\), as:

\[
xe = (1 - t)x_1 + tx_2 \\
ye = (1 - t)y_1 + ty_2
\]

The value of \(t\) is calculated as:

\[
t = 1 - \frac{c\rho}{l}
\]

where \(c\) is the ratio of the diagonal of the map full extent to maximum icon diameter and \(\rho\) is an offset factor. \(c\) accounts for fixed icon sizes and dynamic zoom level.

- Show attack and counterattack distinctly and indicate order of occurrence.

Shift line AB to CD where CD is calculated as:

\[
(x_c, y_c) = (x_a - \lambda d_{AC}\sin\theta, y_a + \lambda d_{AC}\cos\theta) \\
(x_d, y_d) = (x_b - \lambda d_{AC}\sin\theta, y_b + \lambda d_{AC}\cos\theta)
\]

for \(\lambda = 1\) if \(x_a > x_b\) and \(\lambda = -1\) otherwise, \(\theta\) is the arctangent of the slope of AB, and \(d_{AC}\) is the desired length of AC calculated as \(c\rho\).