Perimeter evolution

Nodes move outwards, expanding the perimeter as the simulation advances in discrete time steps.

The move direction for each node is determined by considering its two neighbours.

A line is drawn between the nodes on either side of the moving node, and the move direction is perpendicular to that line (see orange arrow).

When contracting, the direction of movement is simply rotated 180 degrees (see blue arrow). This is not an exact reversal: some information is lost so the contraction does not perfectly follow the expansion, especially when the line is very irregular.

In each time step:
- move direction for every node is calculated,
- corresponding rate of spread (ROS) is obtained from the driving model,
- safe time step is dynamically calculated (see below),
- move vectors for all nodes are applied,
- nodes are inserted and removed to maintain line fidelity,
- deep invaginations and line contortions are detected and removed.

The time step must be limited or the nodes may travel too far and skip over significant spatial variations in the ROS. For each time step, the maximum ROS of all the nodes is calculated and used to derive the maximum safe time.

ROS is directional

Perimeter spread algorithms used in models such as FARSITE (Finney, 2004) and Prometheus (Tymstra et al., 2009) use the maximum ROS and corresponding direction. This drives the movement of perimeter nodes. In Tirailleur, the direction of spread for each node arises from the perimeter geometry itself, and becomes one of the input arguments for the ROS calculation.

The geometry is more straightforward than the elliptical spread and wavelet approach used in other models, but now the ROS function must return a value for the movement of each node.

Contortion problems

The developing perimeter can become contorted. Loops form by nodes crossing each other’s paths. These problems are typical of such models and have been well documented since their inception. (For example, Knight and Coleman, 1993; Bose et al., 2009).

Our approach is simple. After each time step, we explore the perimeter to detect contortions. These are clipped out from the line, and the perimeter is reformed.

References: