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A multiple flow direction algorithm for computing intra hillslope flow length maps

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For many, mainly hydrological, applications, information is required on the distance along flow paths between specified positions. A simple DEM based example is the distance from hillslope grid cells towards the channel network. This distance is required in certain semi-distributed hydrological models, because it's frequency distribution determines how hillslope width varies with position along the hillslope, and thus measures topographic convergence and divergence.

The traditional way of measuring these flow path distances is to take a steepest-descent route between the source and destination positions. However, it is well known that although single flow direction algorithms may be appropriate for convergent parts of the landscape, it isn't for divergent hillslopes. This is widely recognised, and has led to the development of many multiple flow direction algorithms for computing upstream contributing area, which is a similar problem.

We present a multiple flow direction algorithm for computing flow paths lengths. Because every grid cell is connected to the channel network by multiple flow paths, there is not an single, unique, flow path, and consequently not an unique flow path length. Instead, every grid cell has a flow path length distribution. Our proposed model tracks the mean flow path length, ignoring higher moments of this distribution.

We present the algorithm and it's variants, and show examples of resulting flow path length maps. We analyse and discuss hillslope width functions that are derived with the algorithm.