Performance of Segmentation Methods to Detect Longitudinal Discontinuities in River Networks

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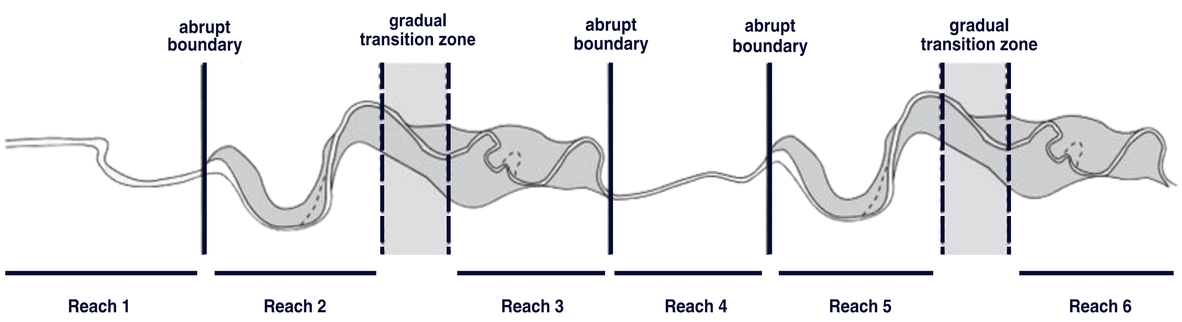
Context and objectives

River segmentation is a crucial step in geomorphic characterization of river network to delineate homogeneous reaches and detect discontinuities. With the increasing availability of high-resolution data to describe longitudinal riverine patterns, the need for automatic segmentation as a summary and analysis tool has become critical. Although many approaches exist, it remains necessary to identify a method suitable for application to river networks to delineate reach boundaries. These discontinuities may exhibit either abrupt changes or gradual transitions, driven by complex interactions among several structural or functional controlling factors.



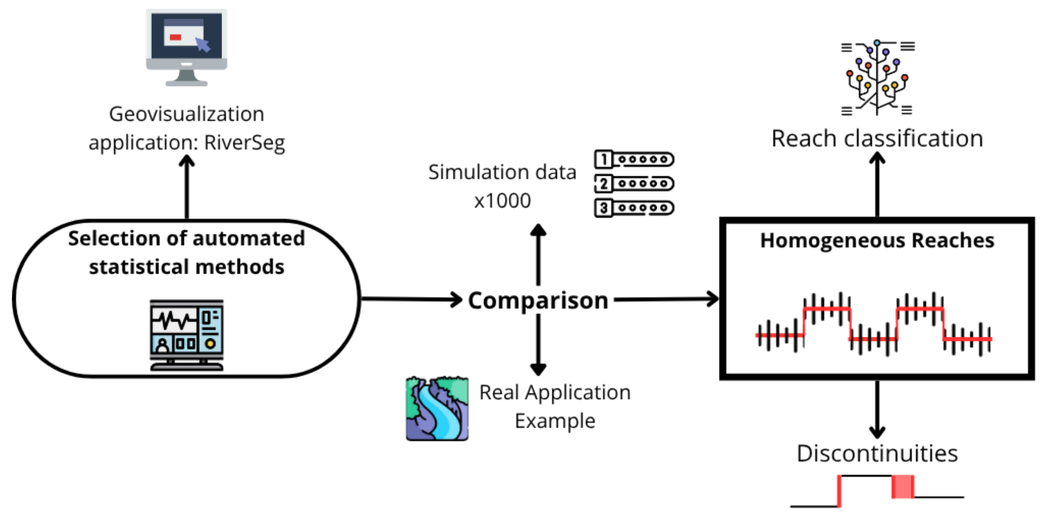
Modified from Fryirs & Brierley, 2012

Methods

Seven univariate automated methods were selected :

- *Bayesian approach* : BEAST
- *Optimization-based methods* : Binary Segmentation, CumSeg, PELT, Segment Neighbourhood
- *Statistical tests* : CPM, Hubert

Comparison is performed using simulated data by varying key parameters such as signal length. Each of the 54 parameter combinations is assessed over 1,000 iterations to ensure statistical reliability. Method performance is evaluated based on three main criteria : accuracy, robustness, and efficiency.



Comparison of Segmentation Methods

- Each method demonstrates potential in specific scenarios. No single method performs optimally across all criteria
- Knowledge of the methods is necessary to obtain optimal results, as the choice of method depends on both the data and the purpose of the case study

BEAST	Speed	Mean length	Rand	Jaccard
Low r	□	■	■	□
High r	□	■	□	□
High S	□	■	□	□
Gamma	□	■	□	□
Gradual	□	□	□	□

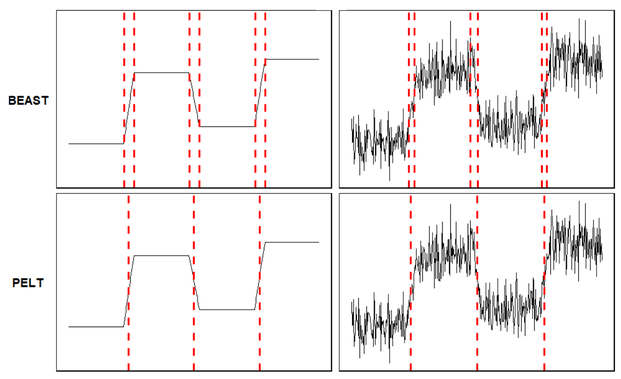
BinSeg	Speed	Mean length	Rand	Jaccard
Low r	■	□	□	□
High r	■	□	□	□
High S	■	□	■	□
Gamma	■	■	■	■
Gradual	■	■	□	□

CPM	Speed	Mean length	Rand	Jaccard
Low r	■	■	■	■
High r	■	□	□	□
High S	■	□	□	□
Gamma	■	■	■	■
Gradual	■	□	□	□

Hubert	Speed	Mean length	Rand	Jaccard
Low r	□	■	■	■
High r	□	□	□	■
High S	□	□	■	■
Gamma	□	□	□	■
Gradual	□	■	□	□

CumSeg	Speed	Mean length	Rand	Jaccard
Low r	□	□	□	□
High r	□	□	□	□
High S	□	□	□	□
Gamma	□	□	□	■
Gradual	□	□	□	□

PELT	Speed	Mean length	Rand	Jaccard
Low r	■	□	□	□
High r	■	■	■	■
High S	■	□	■	■
Gamma	■	□	■	□
Gradual	■	■	□	□

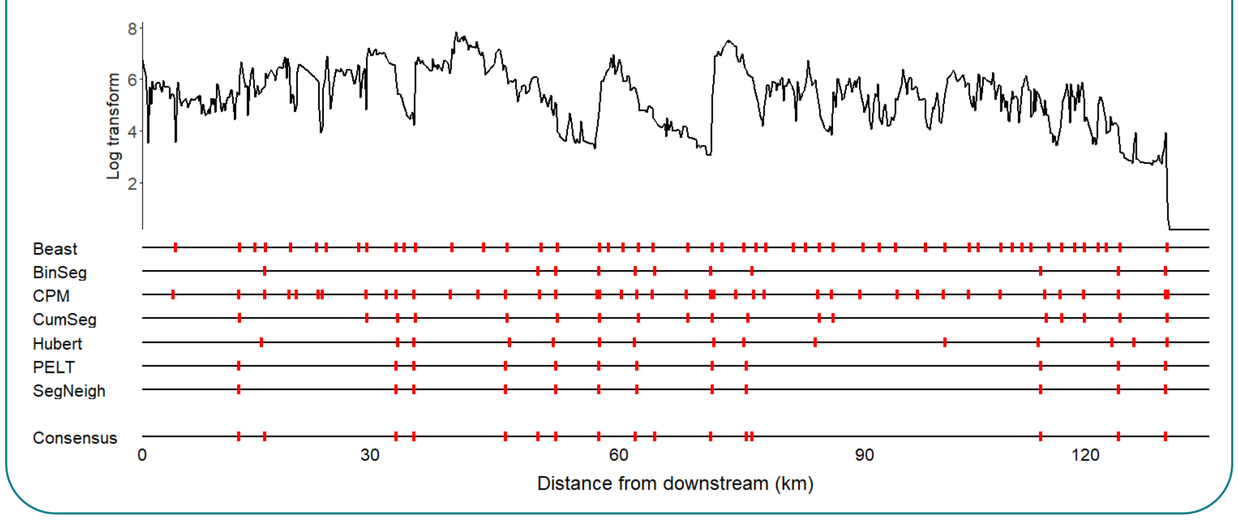


SegNeigh	Speed	Mean length	Rand	Jaccard
Low r	□	□	□	□
High r	□	■	■	□
High S	□	□	■	□
Gamma	□	□	■	□
Gradual	□	□	□	□

PELT method is efficient to delineate homogeneous river reaches… however, BEAST appears to be more suitable for studying reach boundaries

Case study : The Drac river course

Application to the Active Channel Width followed by Consensus algorithm that combines the outputs of the individual segmentation methods



Reach Boundaries : Isère Network (France)

Reach boundaries are identified by segmenting key geomorphic metrics extracted with the Fluvial Corridor Toolbox (FCT) for the Isère River network (France). Homogeneous reaches are then classified to define channel patterns, followed by an analysis of abrupt and gradual discontinuities along the network to better understand the transitions and their controlling factors