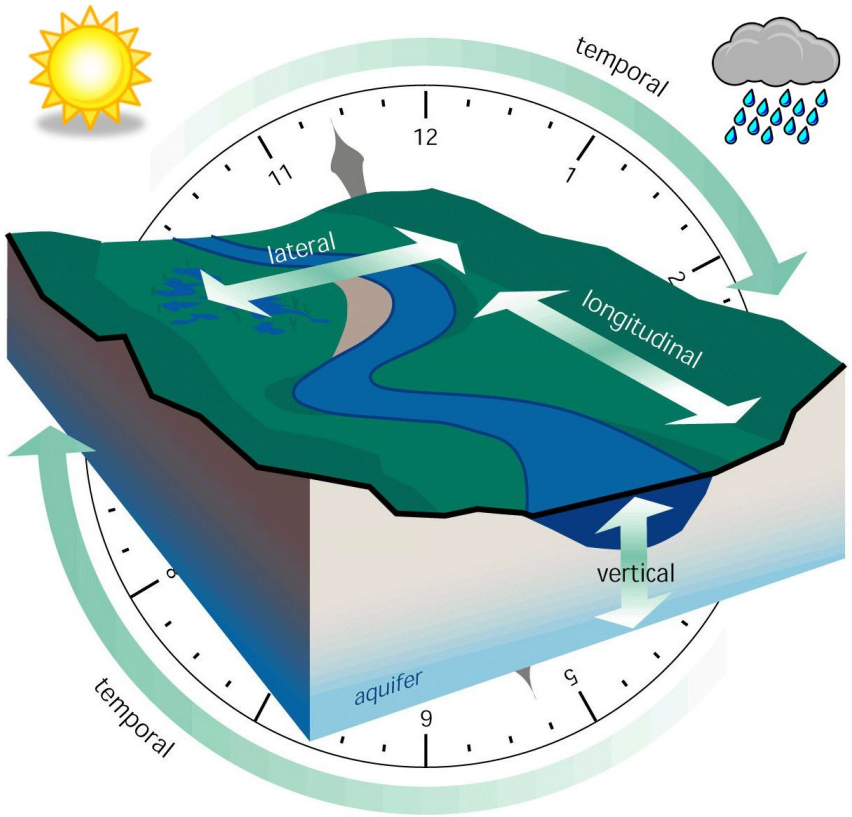
A new tool for river network connectivity assessment

Gonçalo Duarte

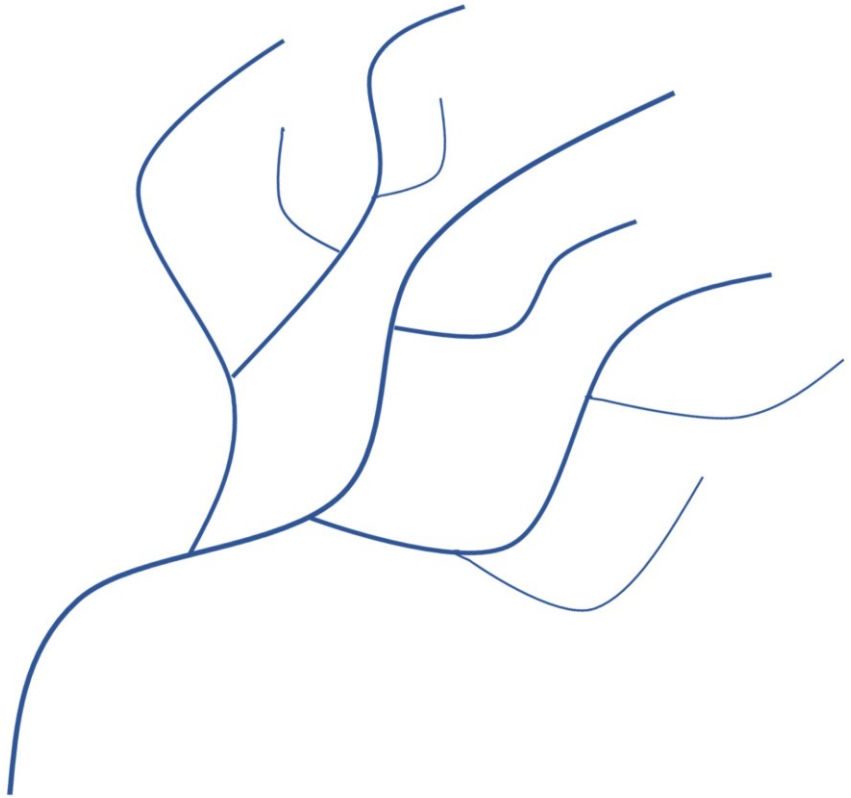
Tamara Leite, Daniel Mameri, Pedro Segurado, Maria Teresa Ferreira & Paulo Branco

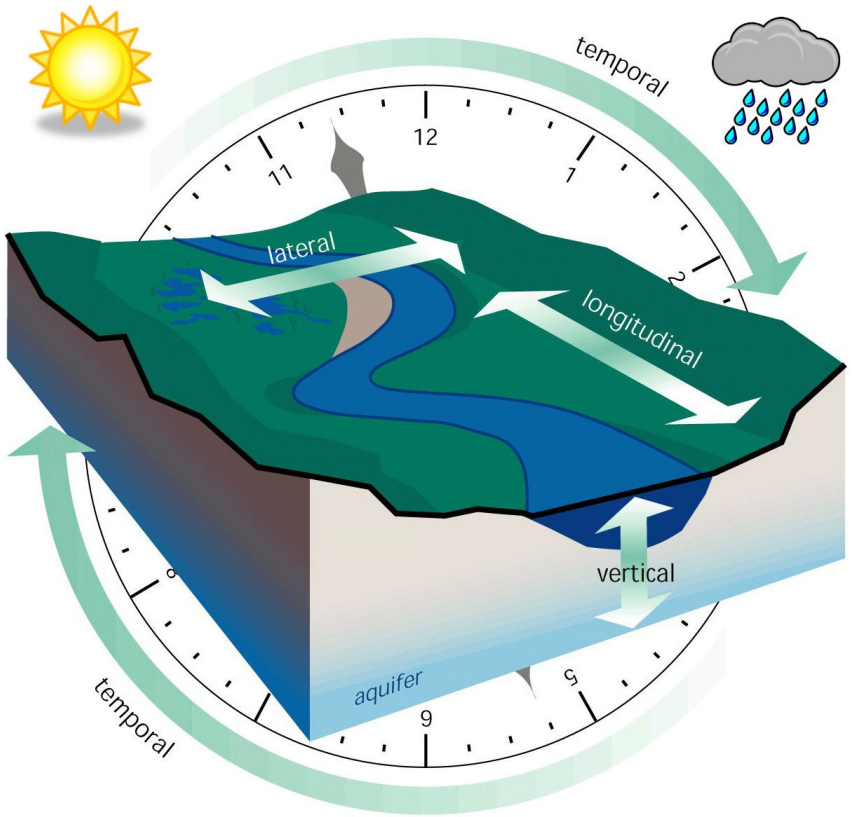
- Connectivity is a crucial attribute of riverscapes



- Connectivity is a crucial attribute of riverscapes

- Longitudinal is the most relevant for freshwater fish





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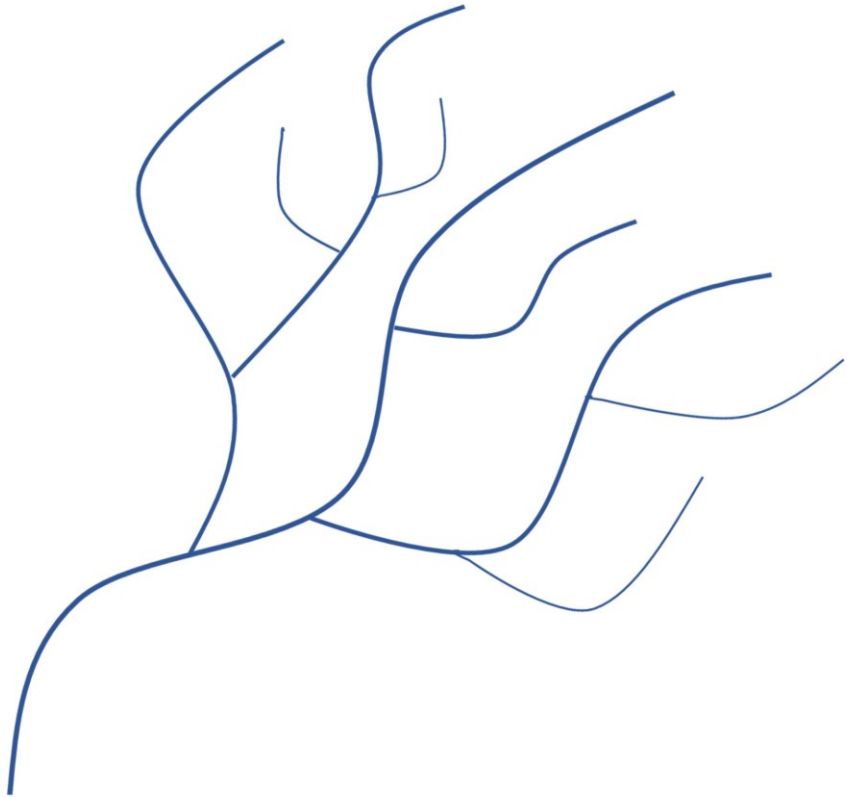

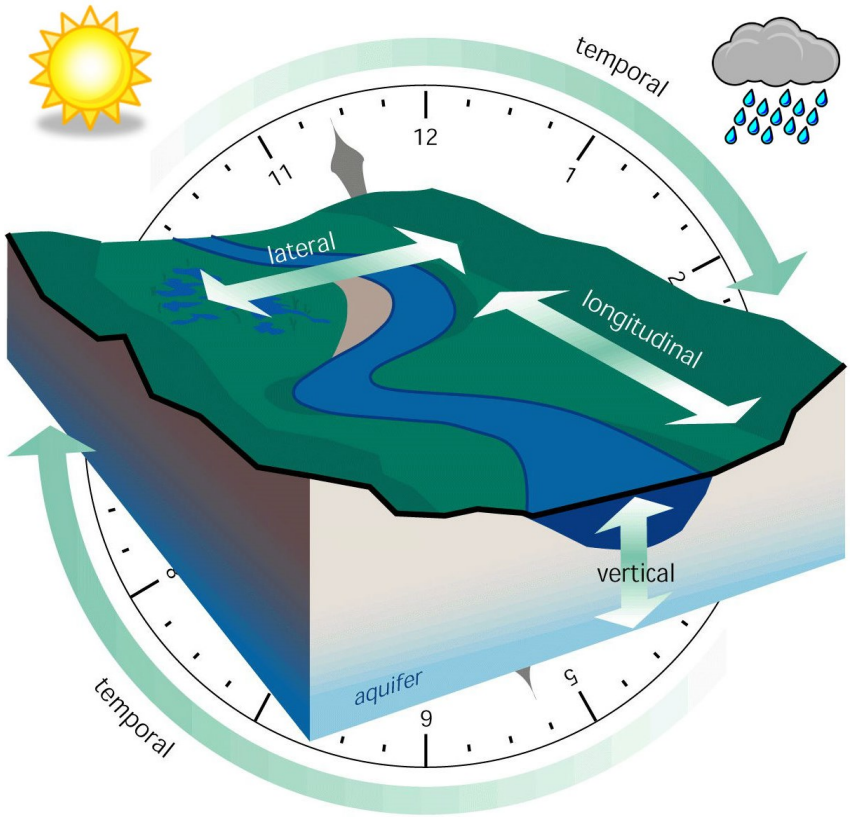

Calculation solutions exist but…

not user friendly

OBJECTIVE

Build a user-friendly and fast app to enable calculating multiple longitudinal connectivity metrics along rivers

Fast performing user-friendly app to work with river networks

Adequate platform to develop new plug-ins

http://rivtoolkit.com/

https://doi.org/10.1111/ecog.04192


RnVConnect

Functions:

- Connectivity Basic Stats
- Connectivity Fragment basic stats
- Probability of Connectivity
- Dendritic Connectivity Index diadromous
- Dendritic Connectivity Index diadromous
- combined Dendritic Connectivity Index
- Flux
- Area Weighted Flux
- Length Weighted Flux
- Integral Index of Connectivity
- Harary Index
- Betweenness centrality

2 basic stats functions

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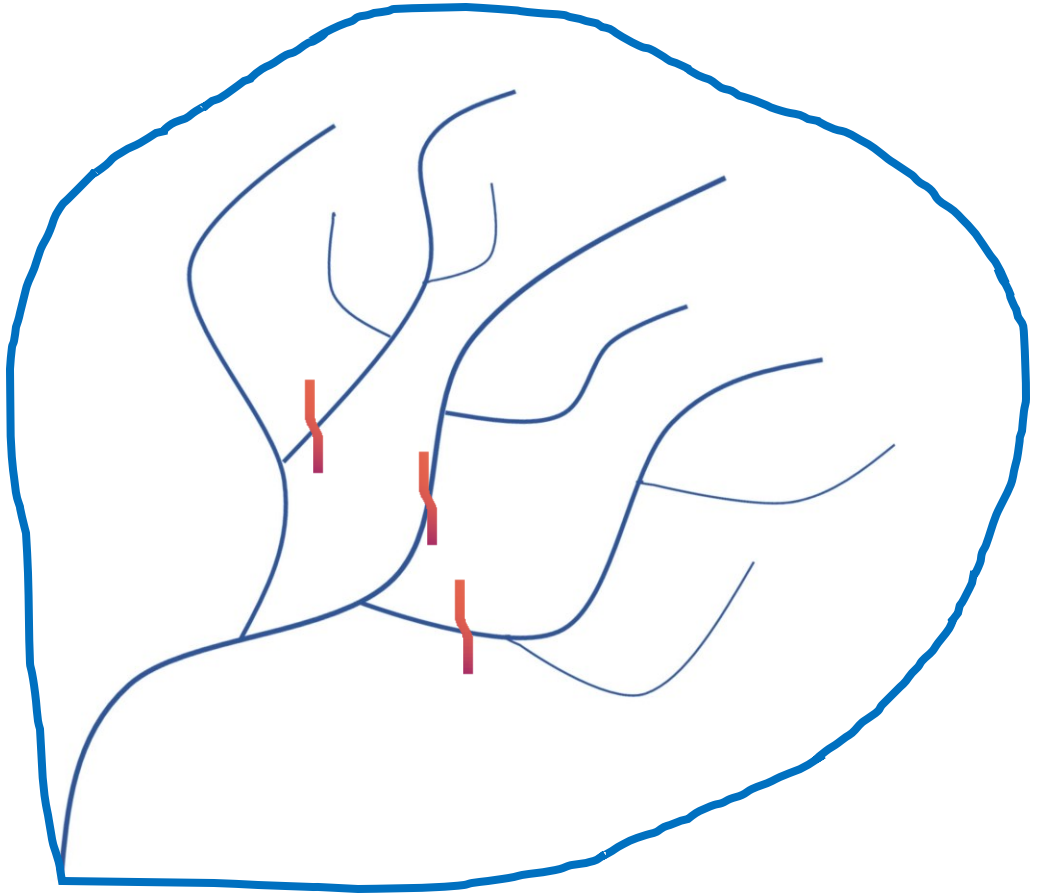
Calculates number of fragments, barriers, segments (nodes) & connections (between segments) per river network



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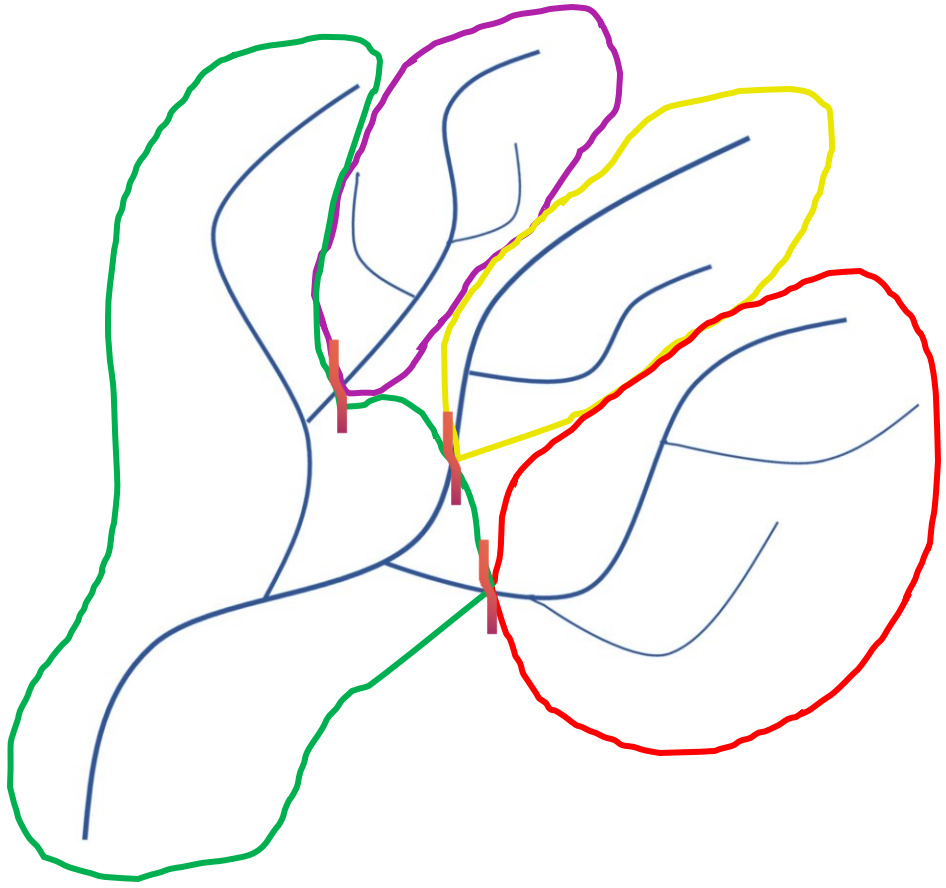
Calculates length, area, number of segments & connections per fragment with a river network



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2 basic stats functions + 10 Indexes

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Provide outputs per river basin

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Provide outputs per river basin

Provide outputs per fragment within a river basin

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Provide outputs per river basin

Provide outputs per fragment within a river basin

Provide outputs per barrier

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Use drainage area has weighing value

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Use drainage area has weighing value

Use river length has weighing value

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Use drainage area has weighing value

Use river length has weighing value

No weighing value

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Probability of Connectivity

$$PC = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} a_i \cdot a_j \cdot p_{ij}^*}{A_L^2}$$

Using drainage area

Dendritic Connectivity Index diadromous

$$DCI_p = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\frac{l_i\, l_j}{L\, L}$$

Using river length

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Dendritic Connectivity Index diadromous

$$DCI_p = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\frac{l_i\, l_j}{L\, L}$$

Allow user-defined variable

Functions:

- CBS
- CFBS
- **PC**
- **DCId**
- **DCIp**
- **cDCI**
- **Flux**
- **AWF**
- **LWF**
- **IIC**
- **H**
- BC

Probabilistic connection VS **Binary connection**

Probability of Connectivity

$$PC = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} a_i \cdot a_j p_{ij}^*}{A_L^2}$$

Integral Index of Connectivity

$$IIC = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} \frac{a_i \cdot a_j}{1+nl_{ij}}}{A_L^2}$$

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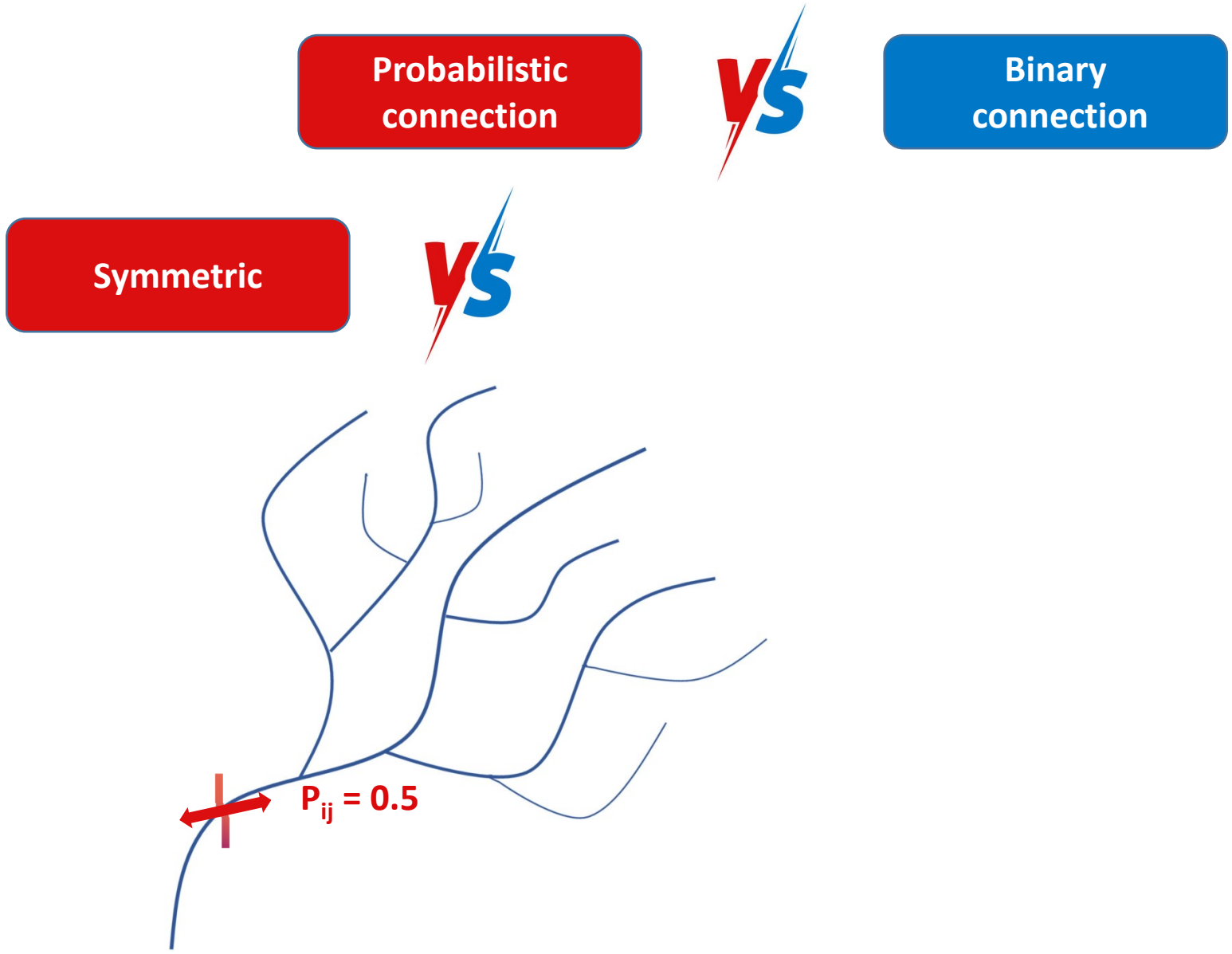

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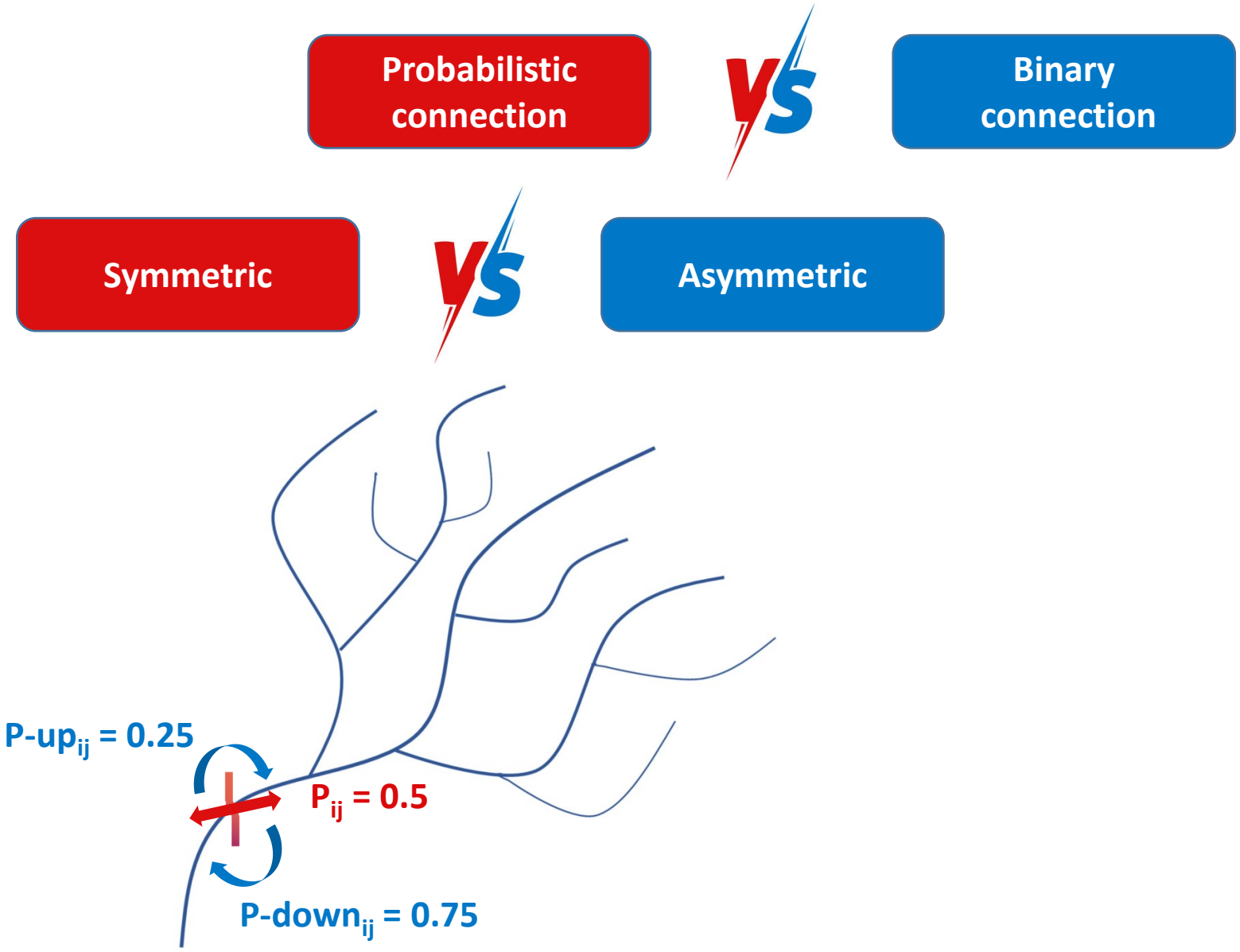

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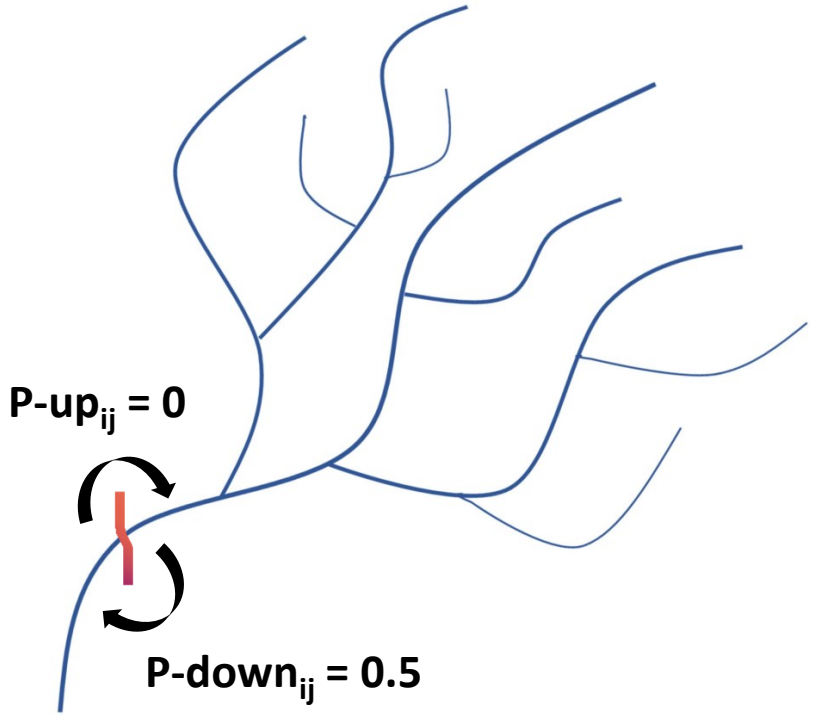
Probabilistic connection vs **Binary connection**

Symmetric vs **Asymmetric**



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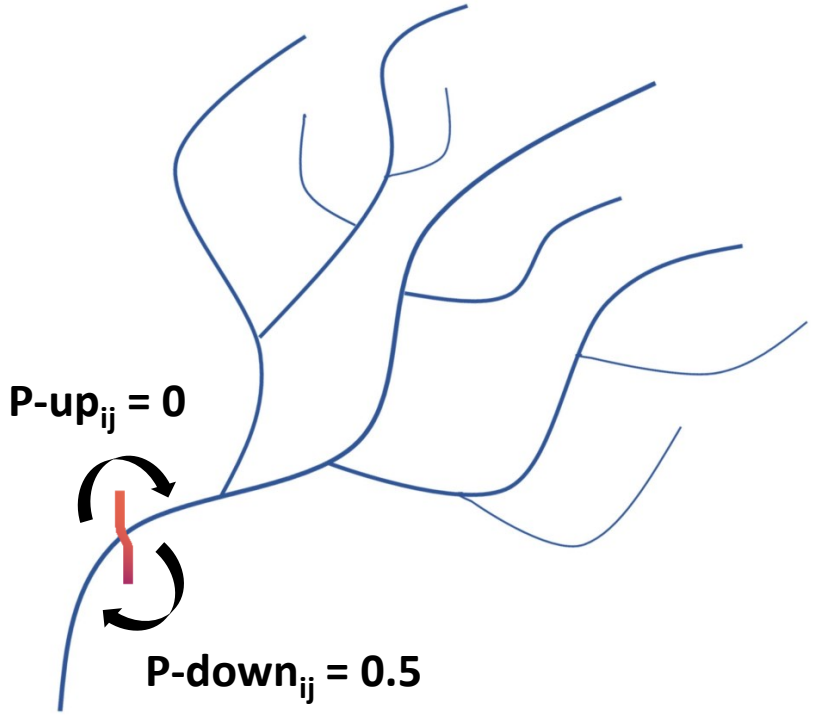

$$DCI_p = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\frac{l_i}{L}\frac{l_j}{L}$$

$$c_{ij} = \prod_{m=1}^{M} p_m^u p_m^d$$

C_{ij} – connection probability

p_m^u – upstream probability of passage

p_m^d – downstream probability of passage

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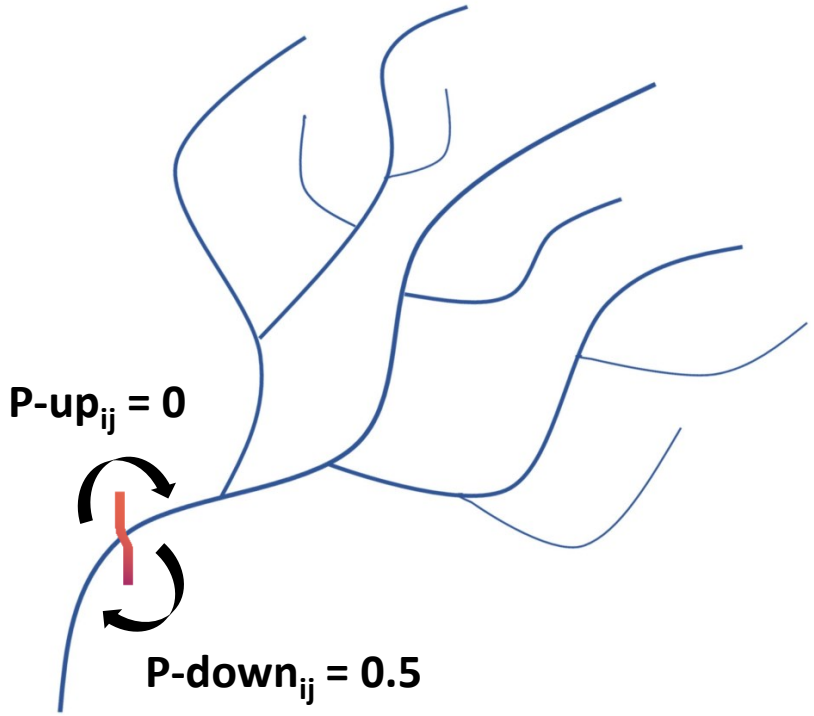
vs **Adirectional**



$$DCI_p = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\frac{l_i}{L}\frac{l_j}{L}$$

$c_{ij} = 0$

$$c_{ij} = \prod_{m=1}^{M} p_m^u p_m^d$$

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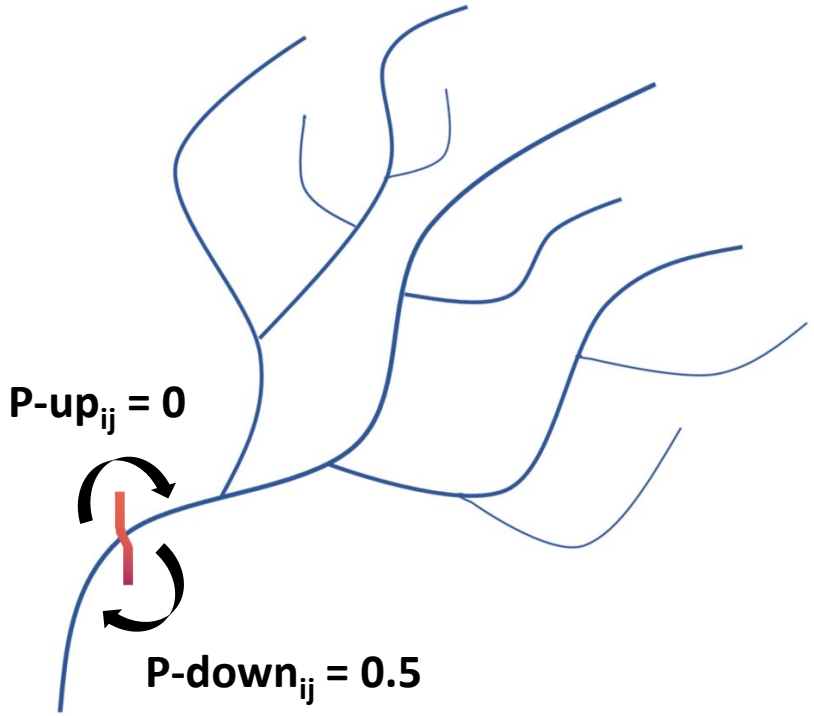

p-up$_{ij}$ ⫫ p-down$_{ji}$

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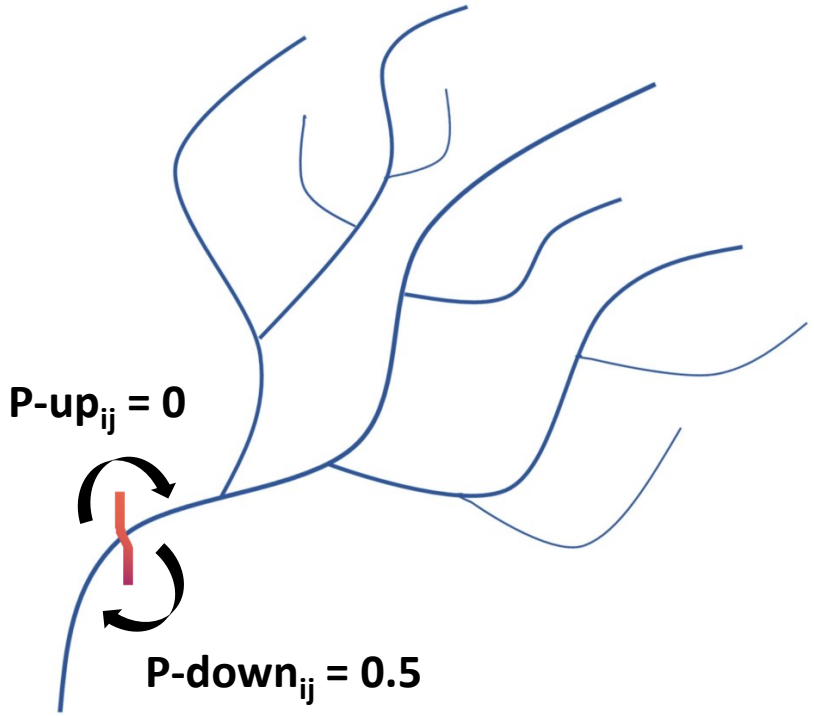

p-up$_{ij}$ ⊥⊥ p-down$_{ji}$

c_{ij} up = 0

c_{ij} down = 0.5

$$DCI_p = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\frac{l_i}{L}\frac{l_j}{L}$$

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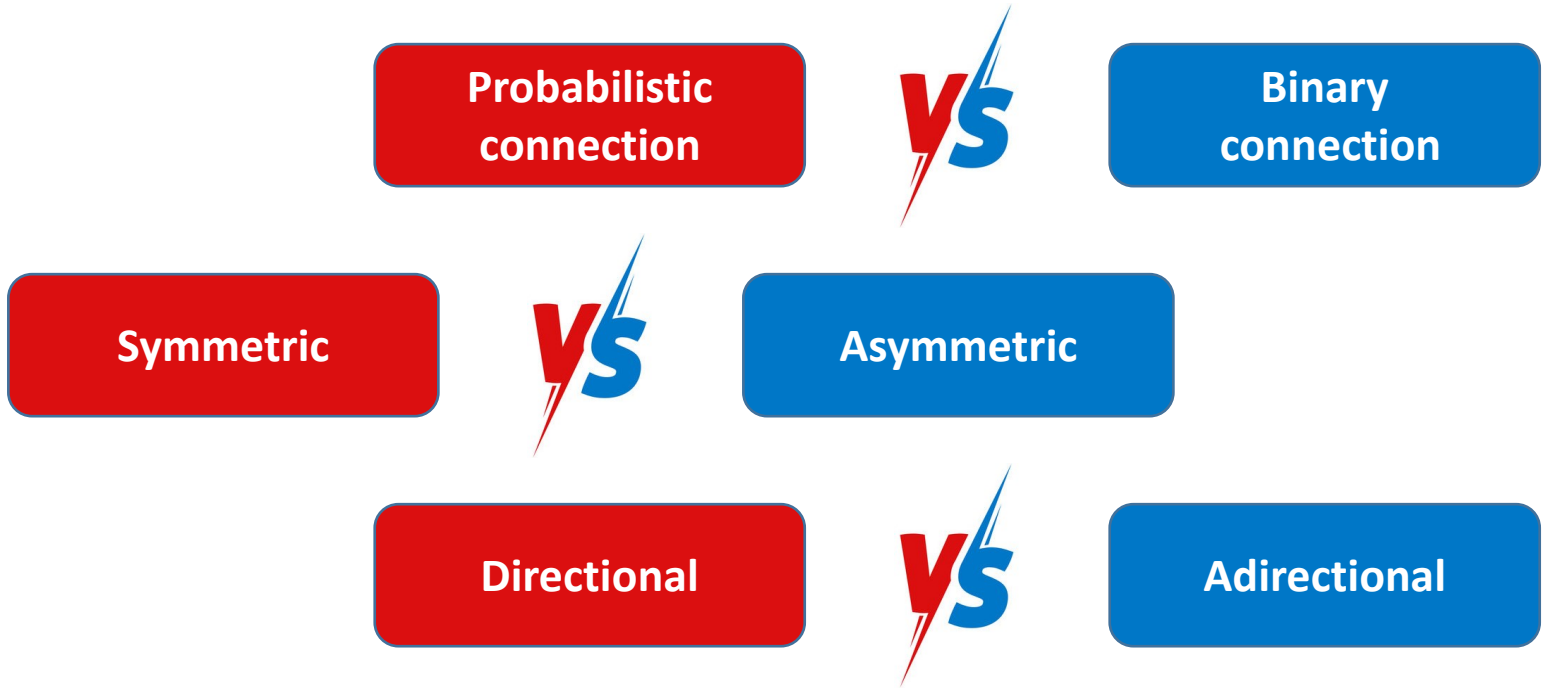

2 basic stats functions + 10 Indexes

7 indexes with user-defined weighing variable

7 indexes with 4 calculation modes

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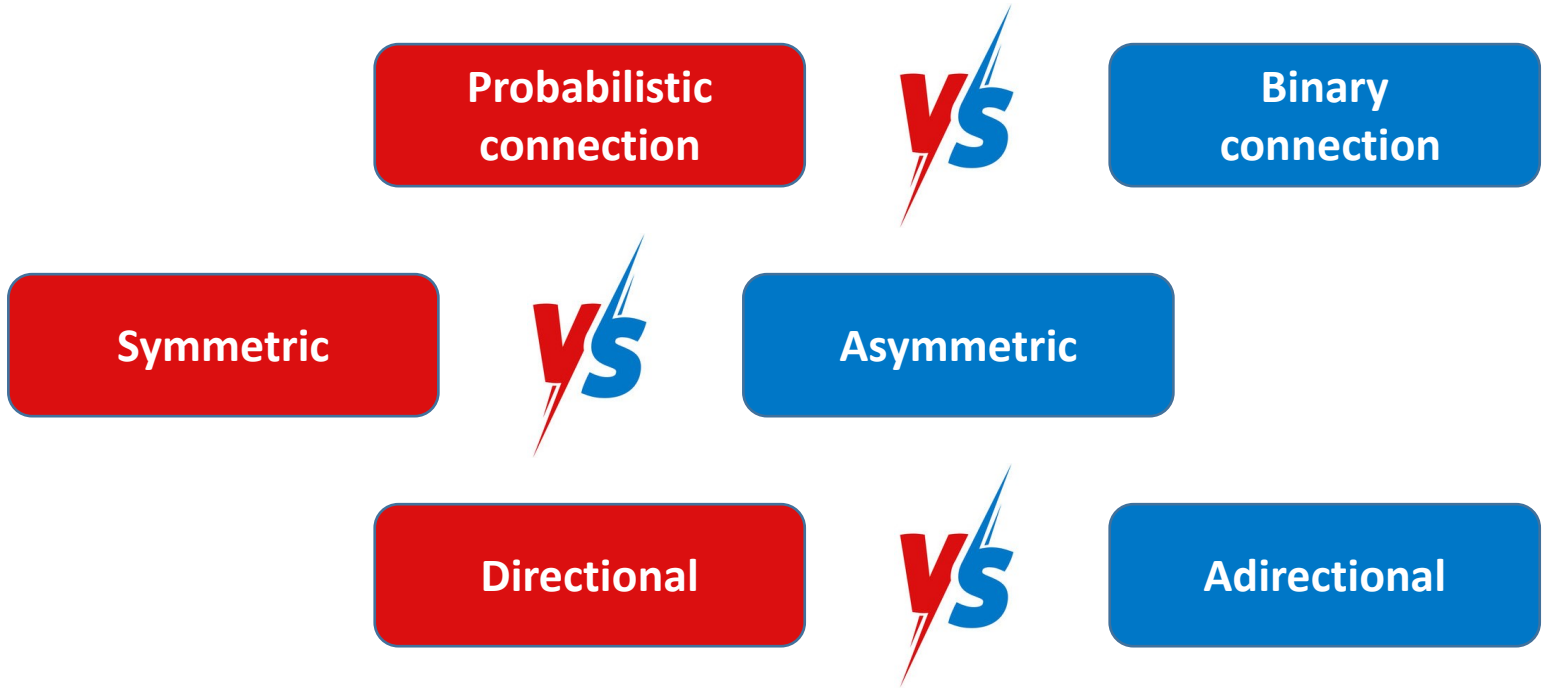

2 basic stats functions + 10 Indexes

7 indexes with user-defined weighing variable

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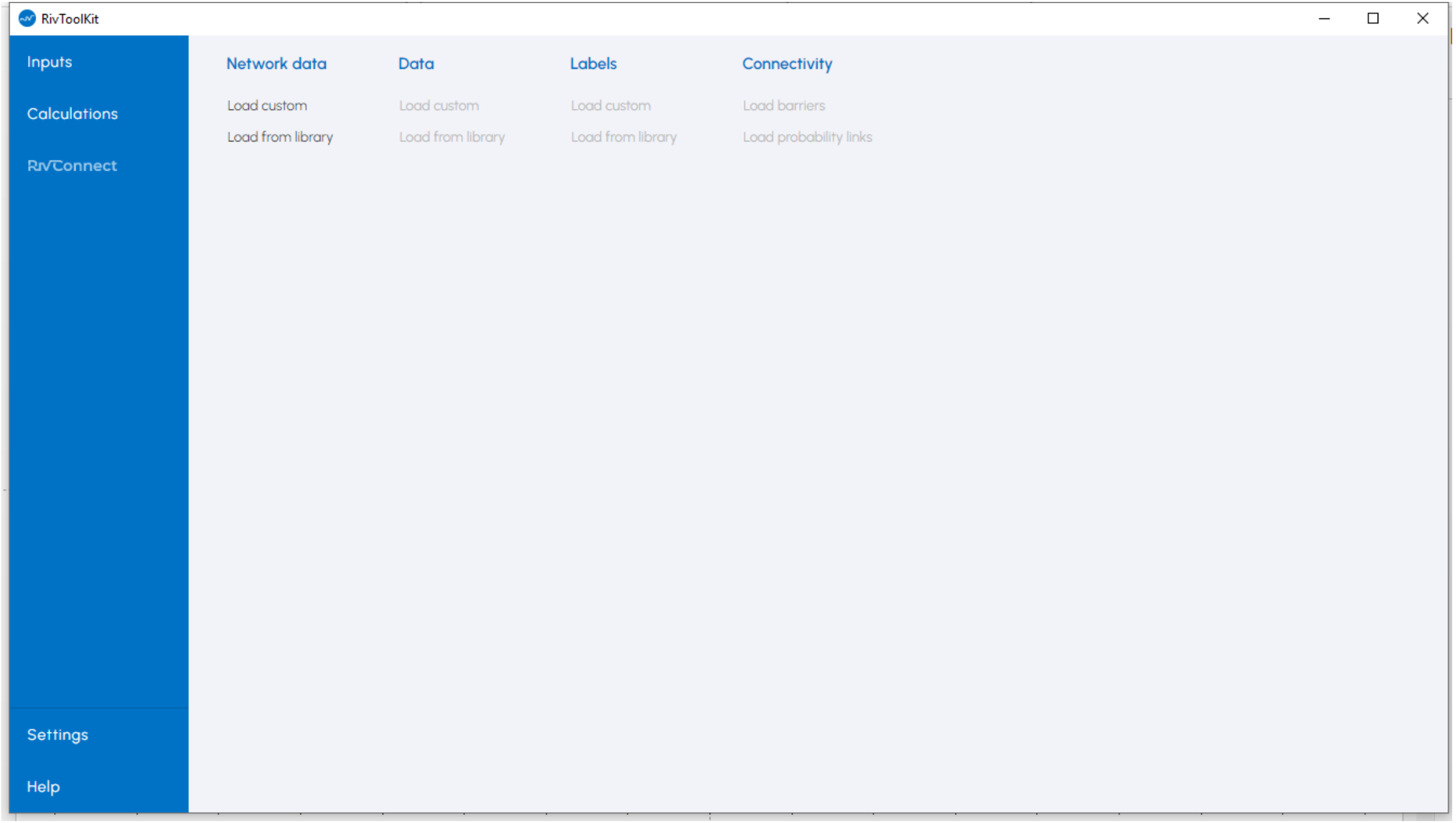
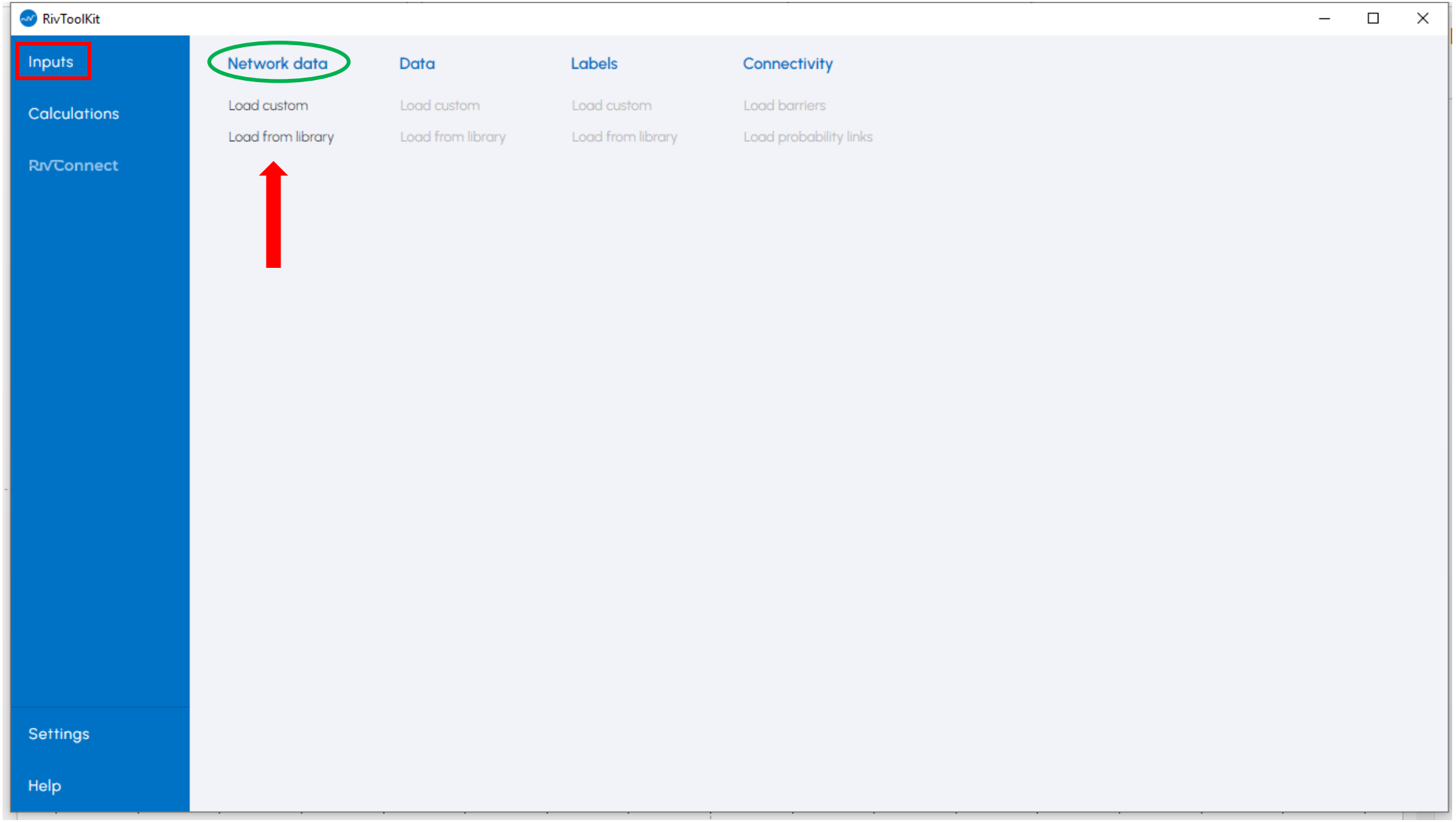
31 standard connectivity metrics

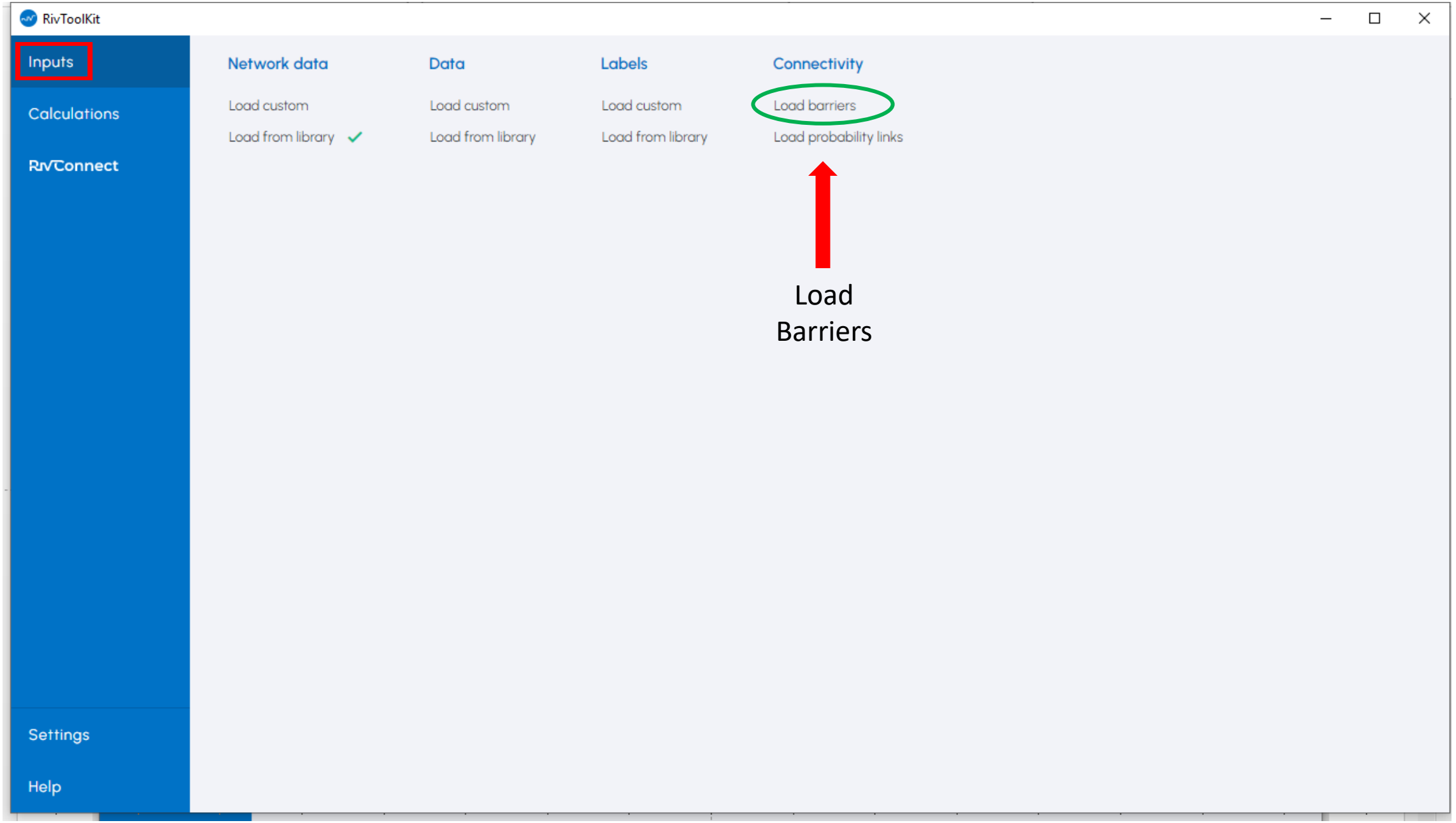
User friendly Interface



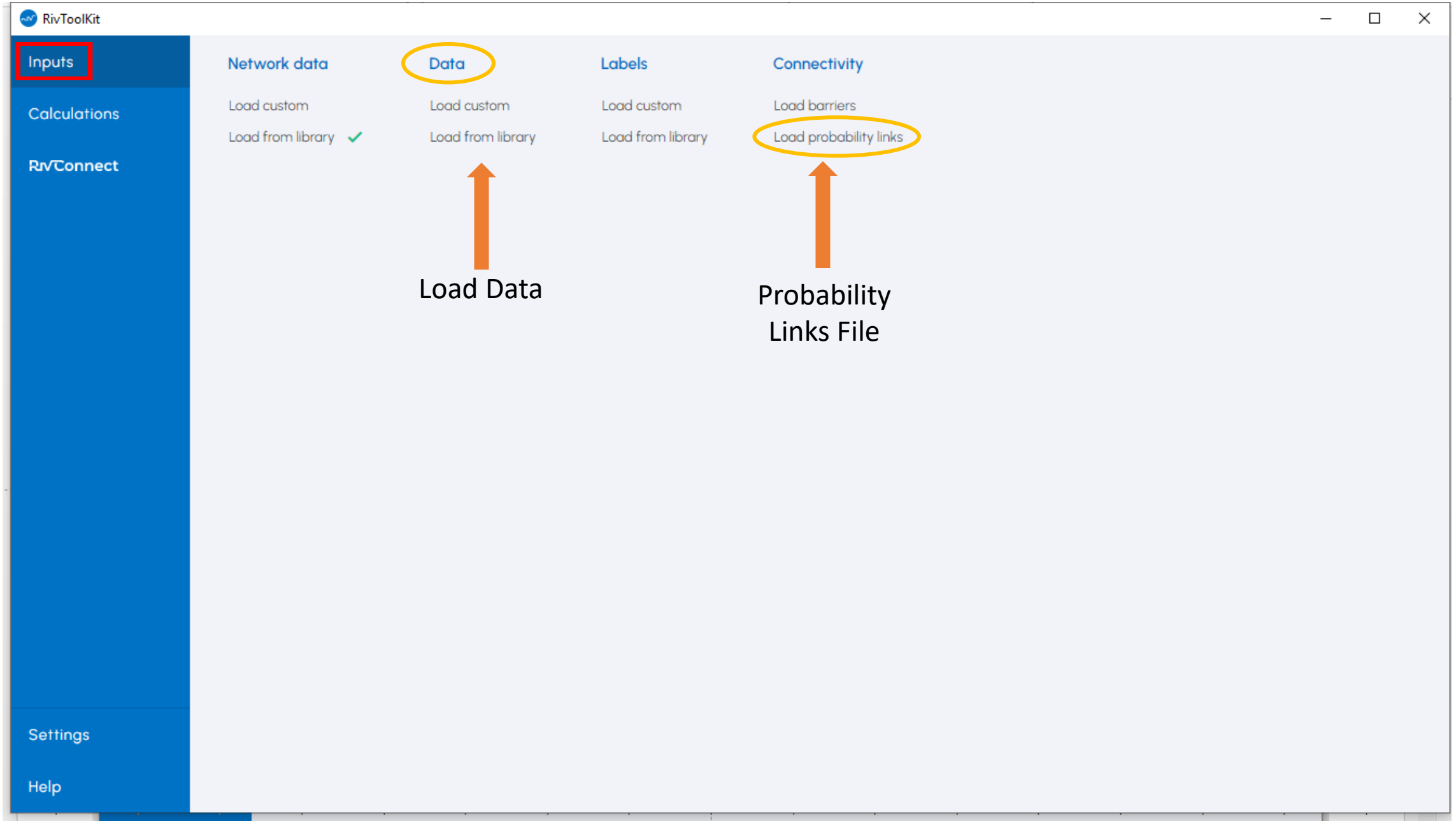
Load River network



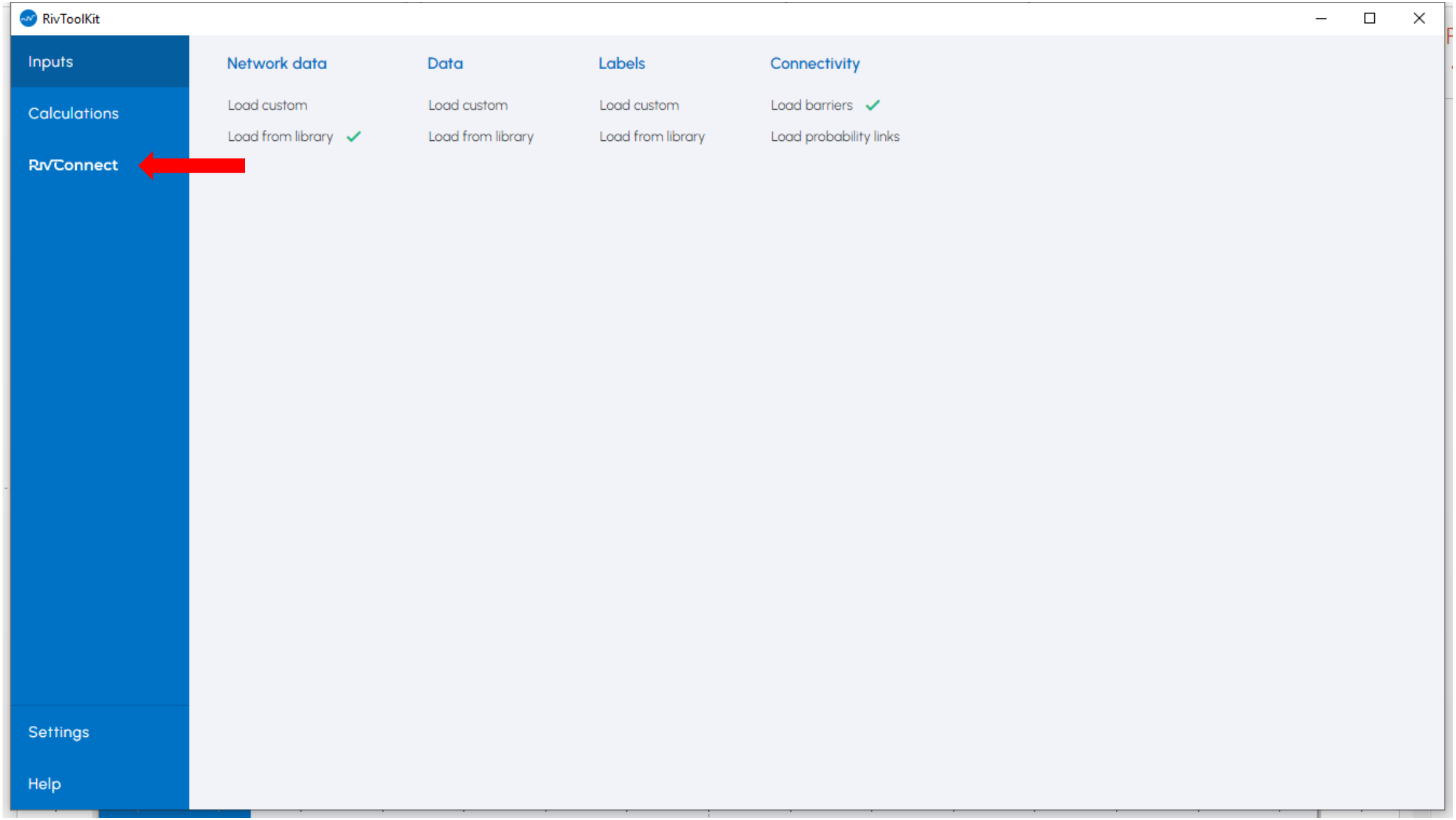
Load Barriers



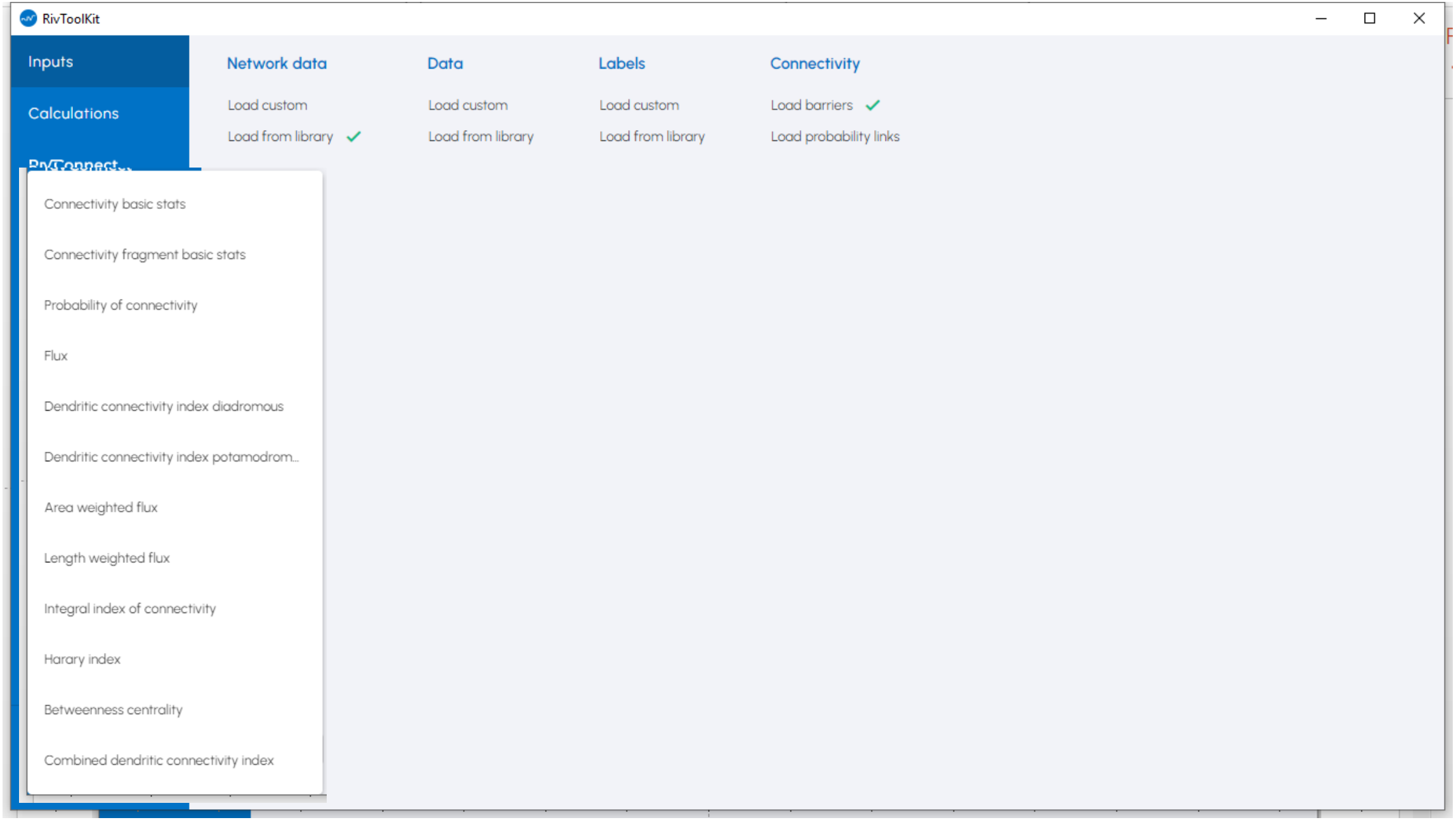
Optional inputs



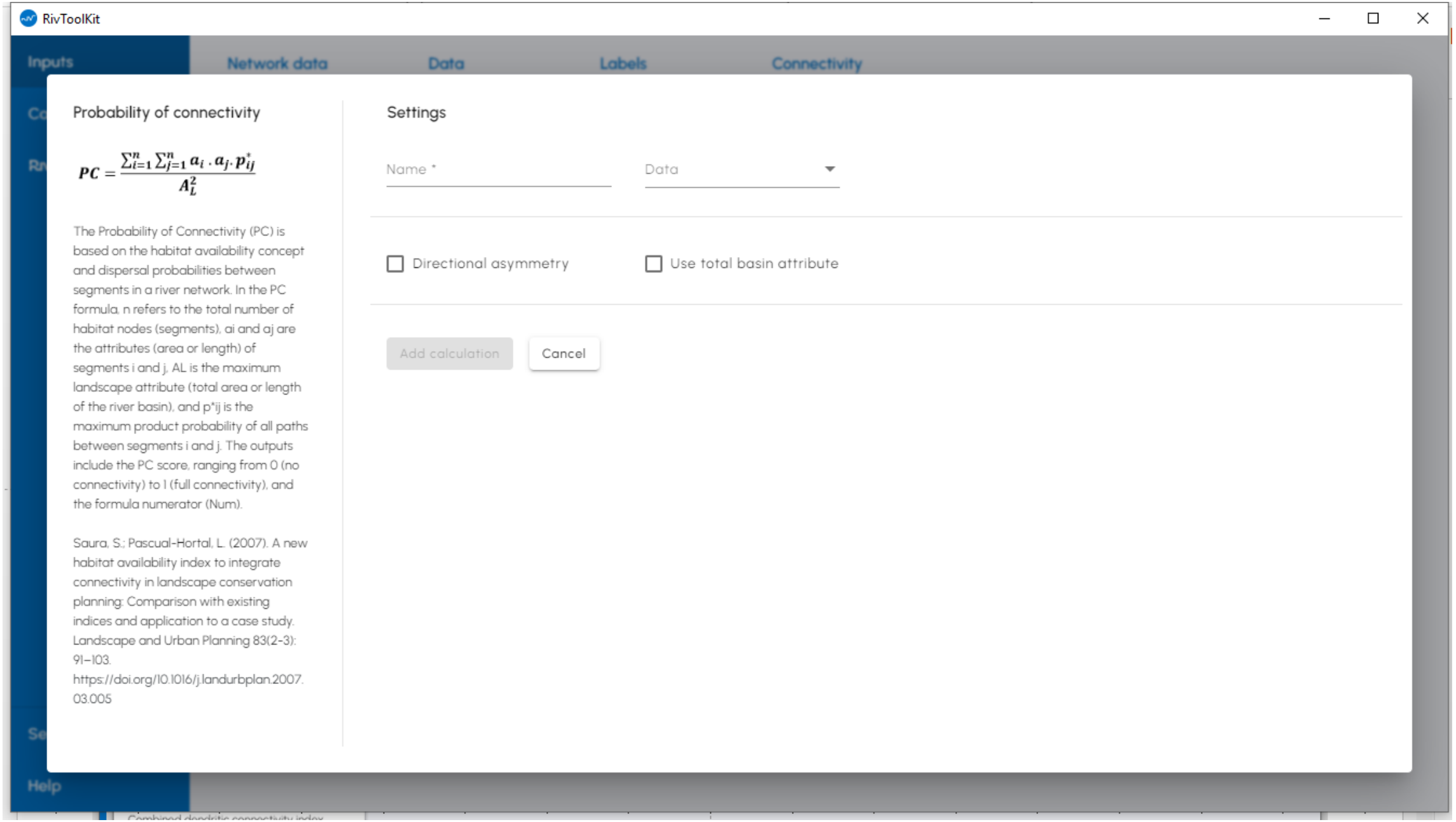
Use RivConnect



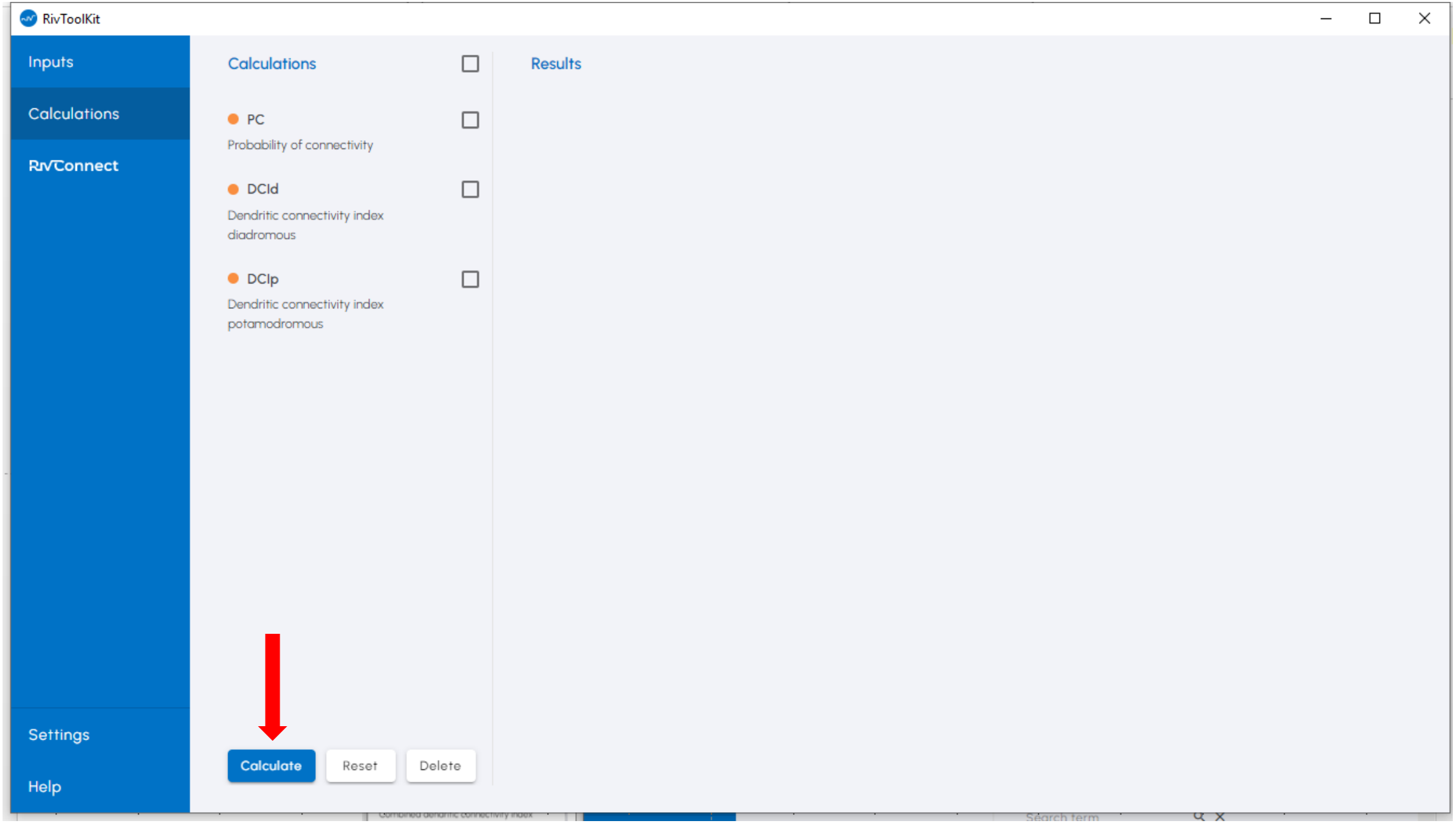
Select the Function



Set up the function



Calculate


RivToolKit
Inputs
Calculations
RivConnect
Settings
Help
Calculations
Results
PC
Probability of connectivity
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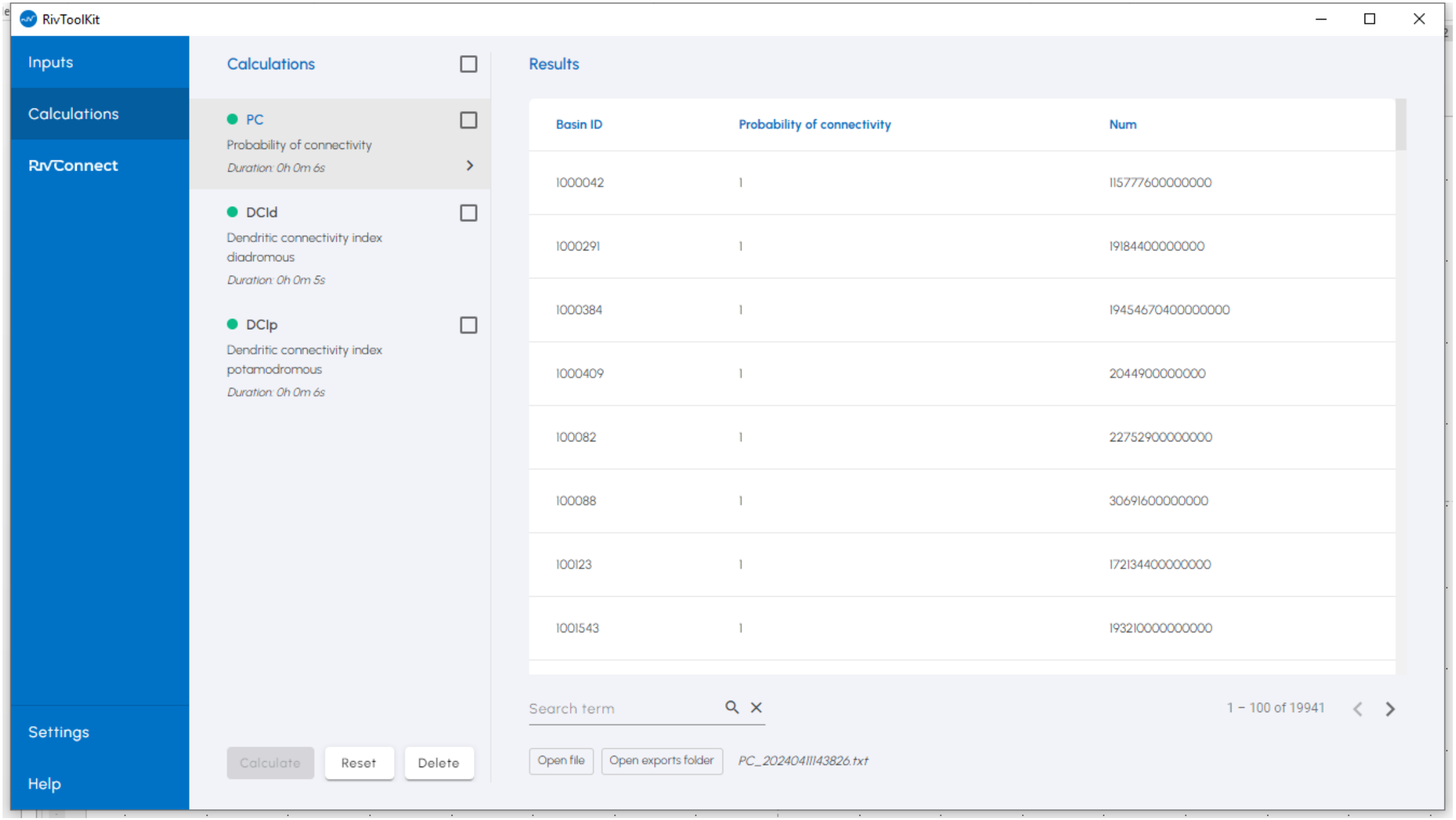
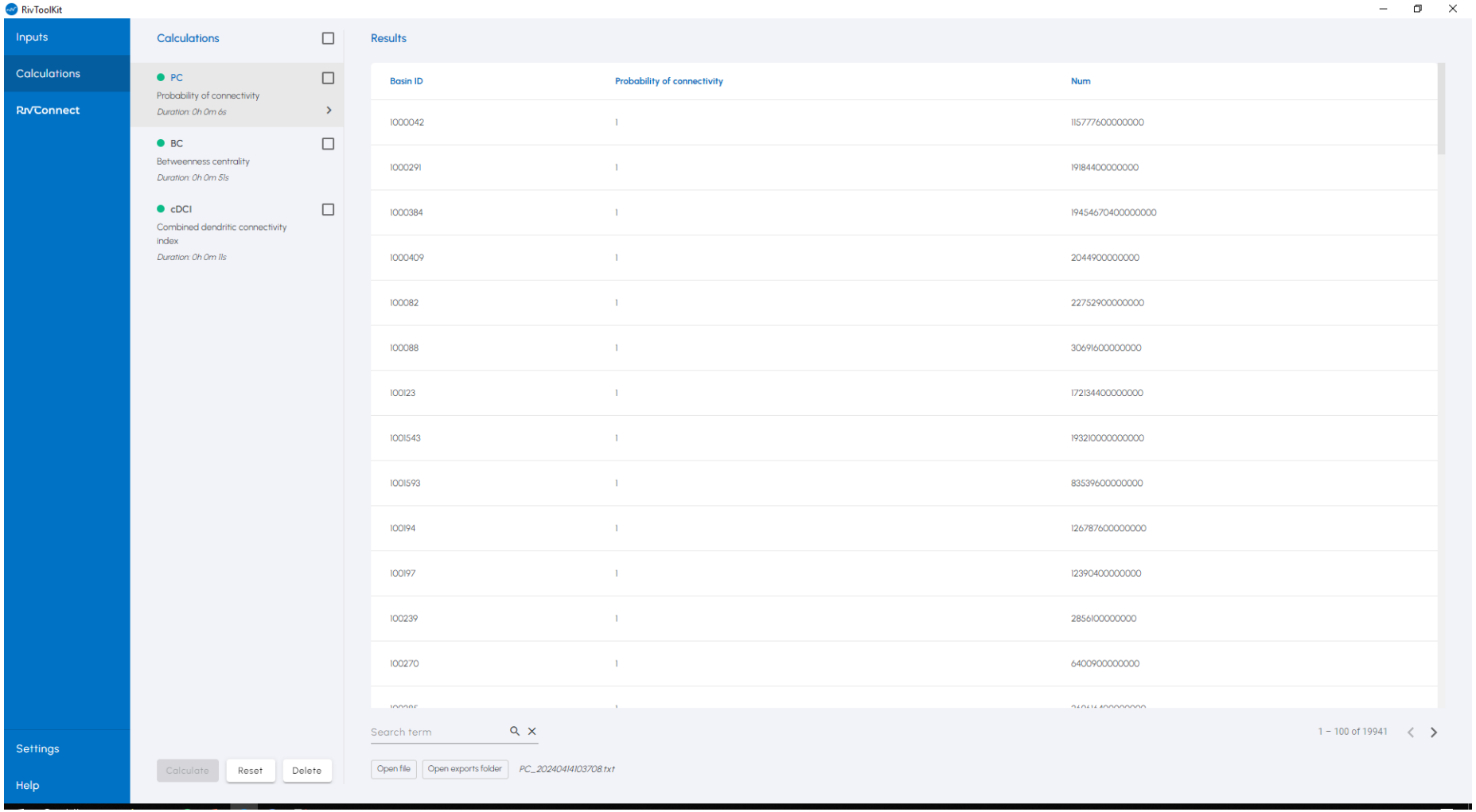
Visualize results



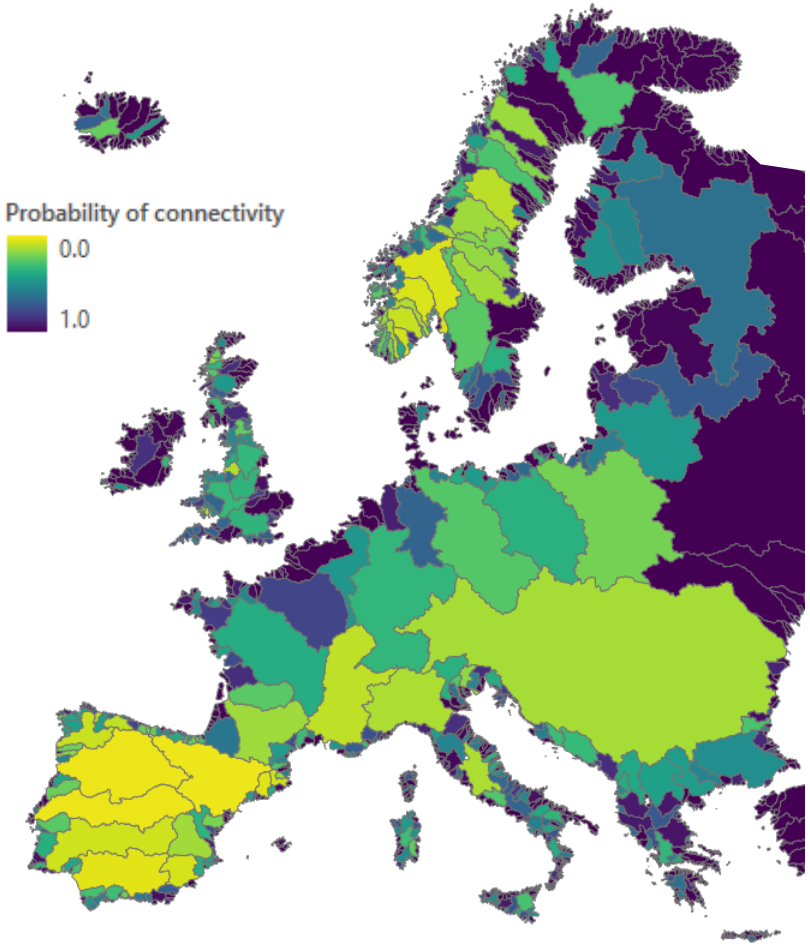
Example

- Amber barrier data above 5m
- CCM2 sea outlet basins with at least strahler 3
- BC representation: Tagus basin

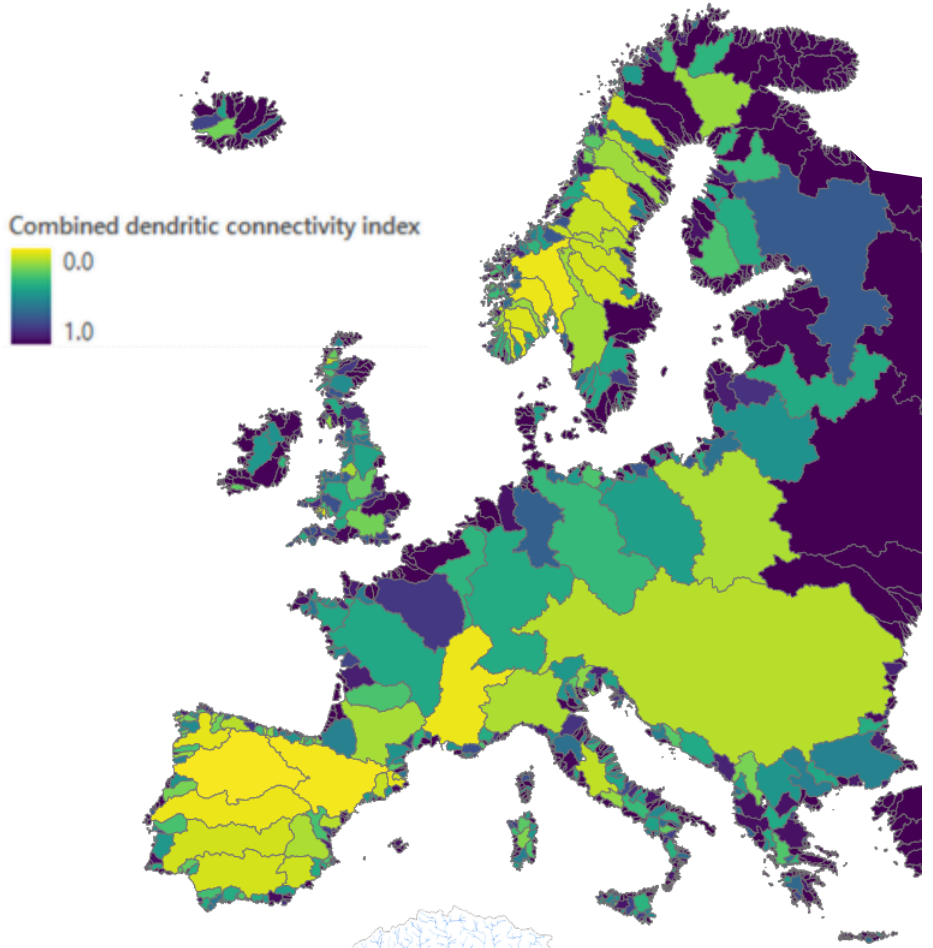


Example representation

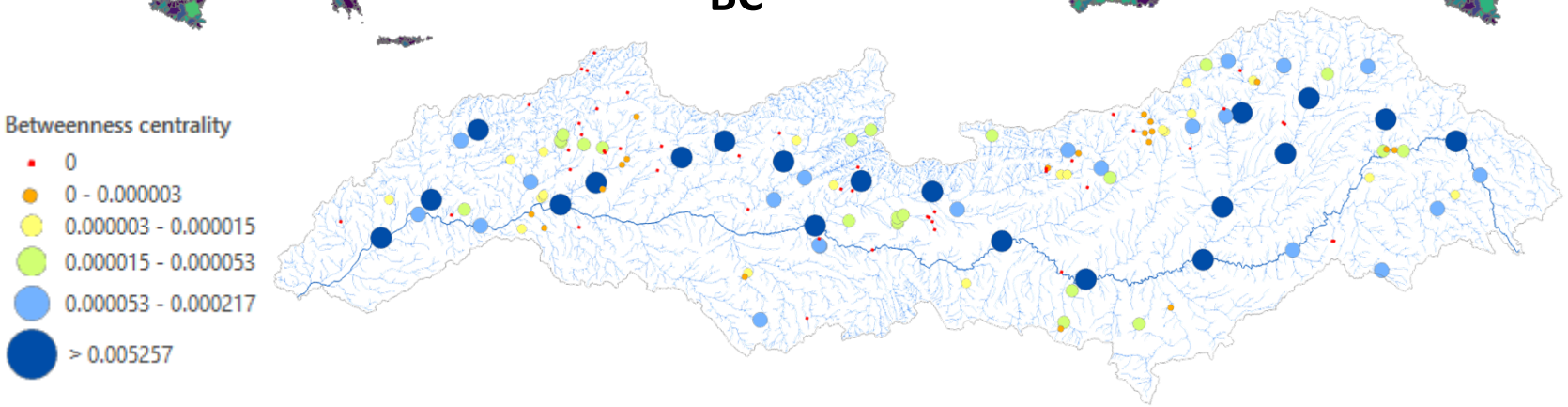
PC



cDCI



BC



Future developments:

- Fully integration into the RivTool platform RivTool

RivConnect

https://shorturl.at/cOU39

Download and help us improve

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- New functions
  - Catchment Area-based Fragmentation Index (CAFI)
  - Catchment Area- and Rainfall-based Fragmentation Index (CARFI)
  - River Regulation Index (RRI)
  - River Connectivity Index (RCIvol; RCIclass; RCIrange)
  - Biodiversity Index (BI)

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- Graphic representations for enhanced visualization
- Online workshops

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- Graphic representations for enhanced visualization
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- Integration with other plug-ins

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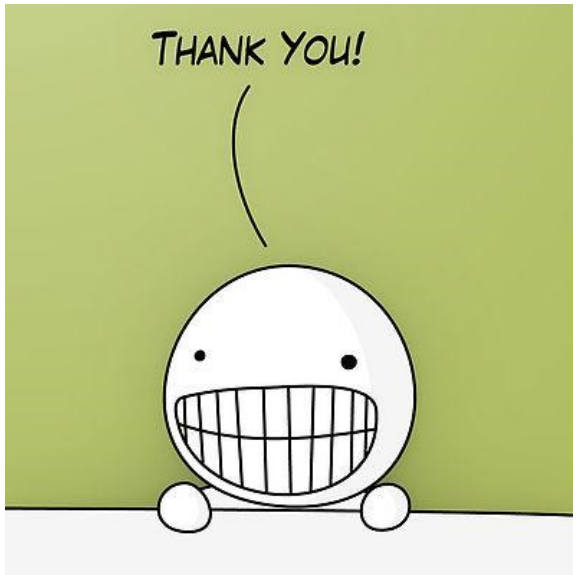
RivFish RivUnit RivOpt

RivConnect

FREE FLOW



Dammed Fish

Gonçalo Duarte
(goncalo.f.duarte@campus.ul.pt)

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