Online Phylogenetics

Lena Collienne

Biological Data Science Lab
Department of Computer Science
University of Otago

24/02/2020

Online Phylogenetics

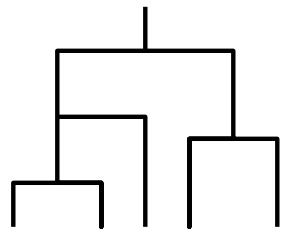
1. Phylogenetic Inference
2. Tree space

Phylogenetic Inference

- Update: adding/deleting taxon
- Request: give tree

Distance Methods

$$\begin{pmatrix} 0 & d_{1,2} & d_{1,3} & d_{1,4} & d_{1,5} \\ d_{1,2} & 0 & d_{2,3} & d_{2,4} & d_{2,5} \\ d_{1,3} & d_{2,3} & 0 & d_{3,4} & d_{3,5} \\ d_{1,4} & d_{2,4} & d_{3,4} & 0 & d_{4,5} \\ d_{1,5} & d_{2,5} & d_{3,5} & d_{4,5} & 0 \end{pmatrix} \Rightarrow$$



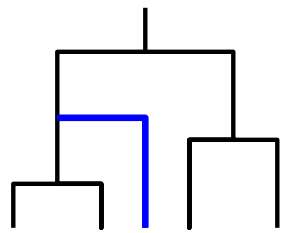
Distance Methods

Stability Analysis

Distance Methods

Stability Analysis

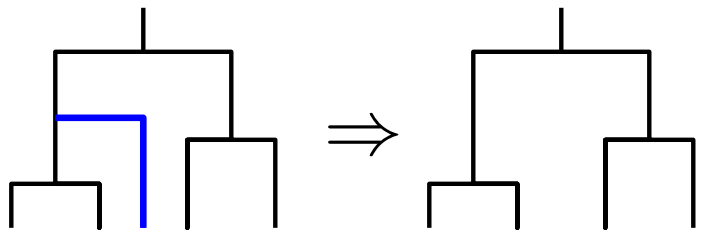
$$\begin{pmatrix} 0 & d_{1,2} & d_{1,3} & d_{1,4} & d_{1,5} \\ d_{1,2} & 0 & d_{2,3} & d_{2,4} & d_{2,5} \\ d_{1,3} & d_{2,3} & 0 & d_{3,4} & d_{3,5} \\ d_{1,4} & d_{2,4} & d_{3,4} & 0 & d_{4,5} \\ d_{1,5} & d_{2,5} & d_{3,5} & d_{4,5} & 0 \end{pmatrix} \Rightarrow$$



Distance Methods

Stability Analysis

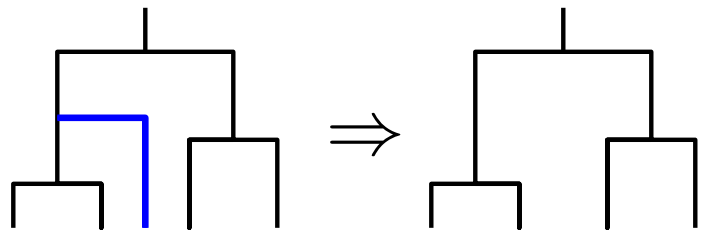
$$\begin{pmatrix} 0 & d_{1,2} & d_{1,3} & d_{1,4} & d_{1,5} \\ d_{1,2} & 0 & d_{2,3} & d_{2,4} & d_{2,5} \\ d_{1,3} & d_{2,3} & 0 & d_{3,4} & d_{3,5} \\ d_{1,4} & d_{2,4} & d_{3,4} & 0 & d_{4,5} \\ d_{1,5} & d_{2,5} & d_{3,5} & d_{4,5} & 0 \end{pmatrix} \Rightarrow$$



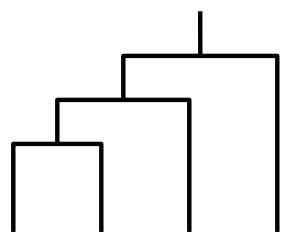
Distance Methods

Stability Analysis

$$\begin{pmatrix} 0 & d_{1,2} & d_{1,3} & d_{1,4} & d_{1,5} \\ d_{1,2} & 0 & d_{2,3} & d_{2,4} & d_{2,5} \\ d_{1,3} & d_{2,3} & 0 & d_{3,4} & d_{3,5} \\ d_{1,4} & d_{2,4} & d_{3,4} & 0 & d_{4,5} \\ d_{1,5} & d_{2,5} & d_{3,5} & d_{4,5} & 0 \end{pmatrix} \Rightarrow$$

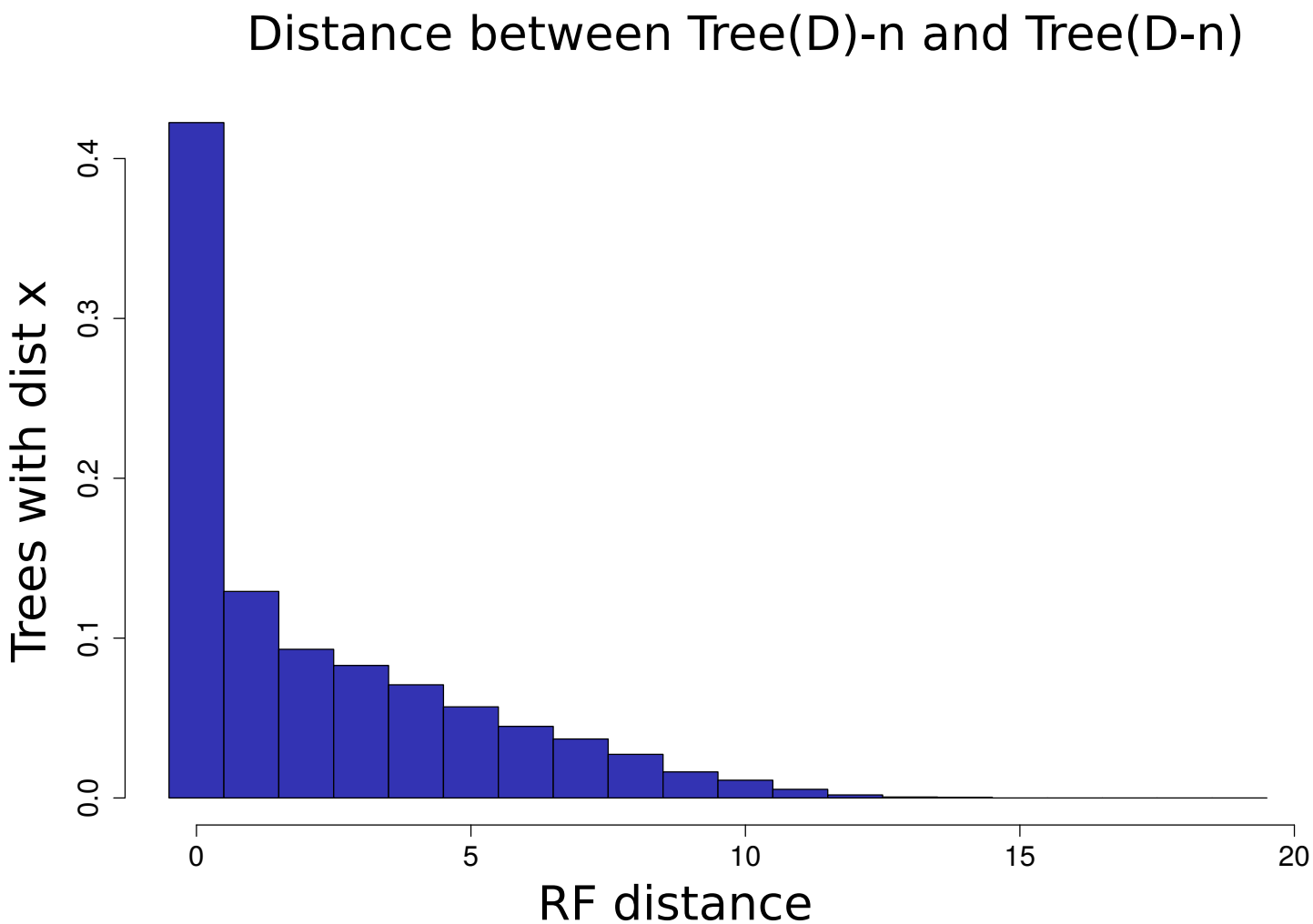


$$\begin{pmatrix} 0 & d_{1,2} & d_{1,3} & d_{1,4} \\ d_{1,2} & 0 & d_{2,3} & d_{2,4} \\ d_{1,3} & d_{2,3} & 0 & d_{3,4} \\ d_{1,4} & d_{2,4} & d_{3,4} & 0 \end{pmatrix} \Rightarrow$$



Distance Methods

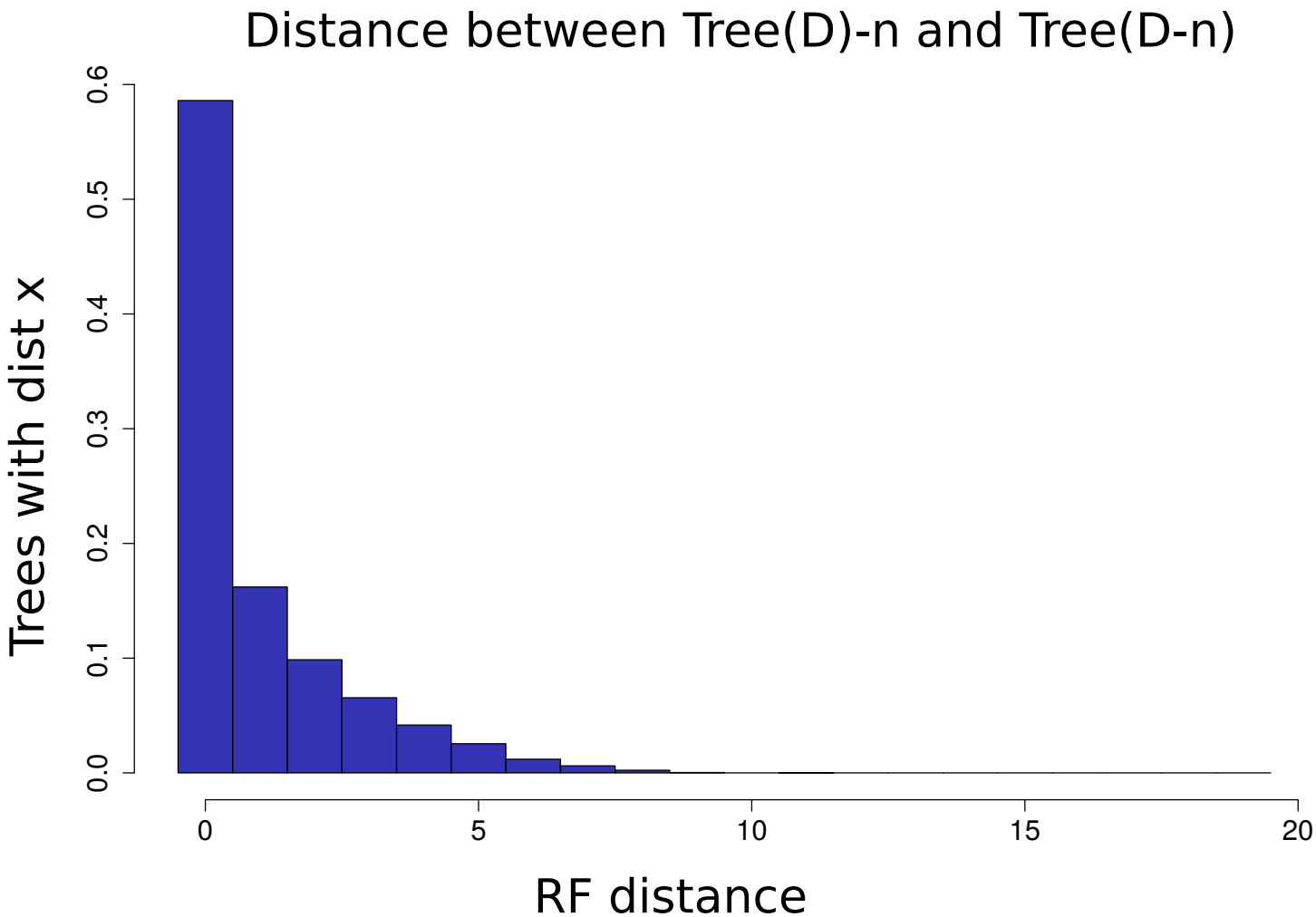
Neighbour Joining



$m = 10000$ trees on $n = 20$ taxa

Distance Methods

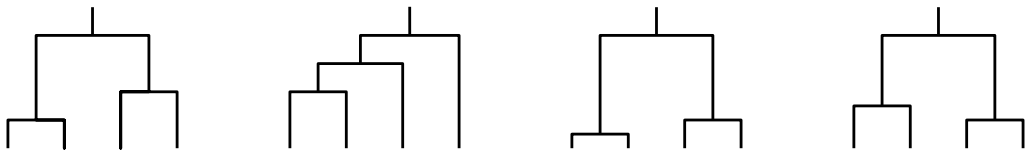
UPGMA



$m = 10000$ trees on $n = 20$ taxa

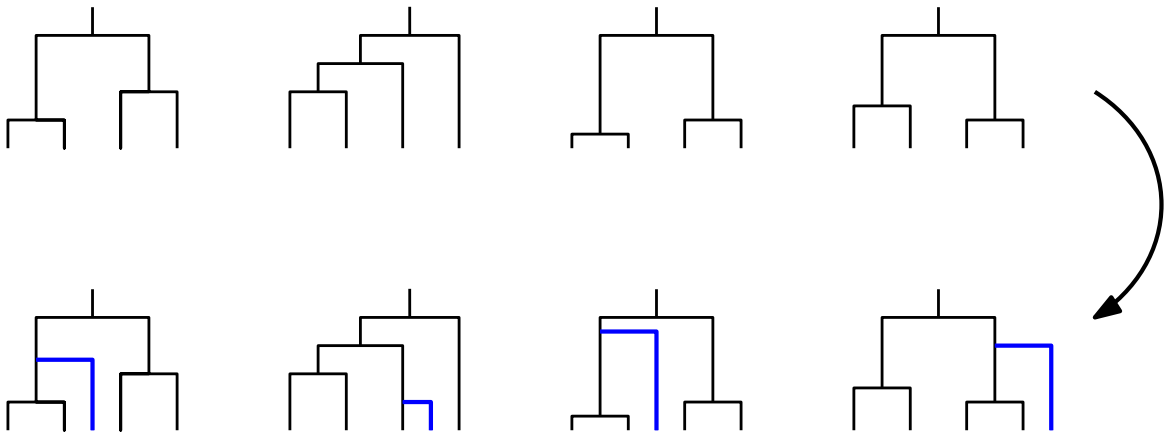
Bayesian Inference

$$\pi(\text{tree}|\text{data}) = \frac{\pi(\text{data}|\text{tree})\pi(\text{tree})}{\pi(\text{data})}$$



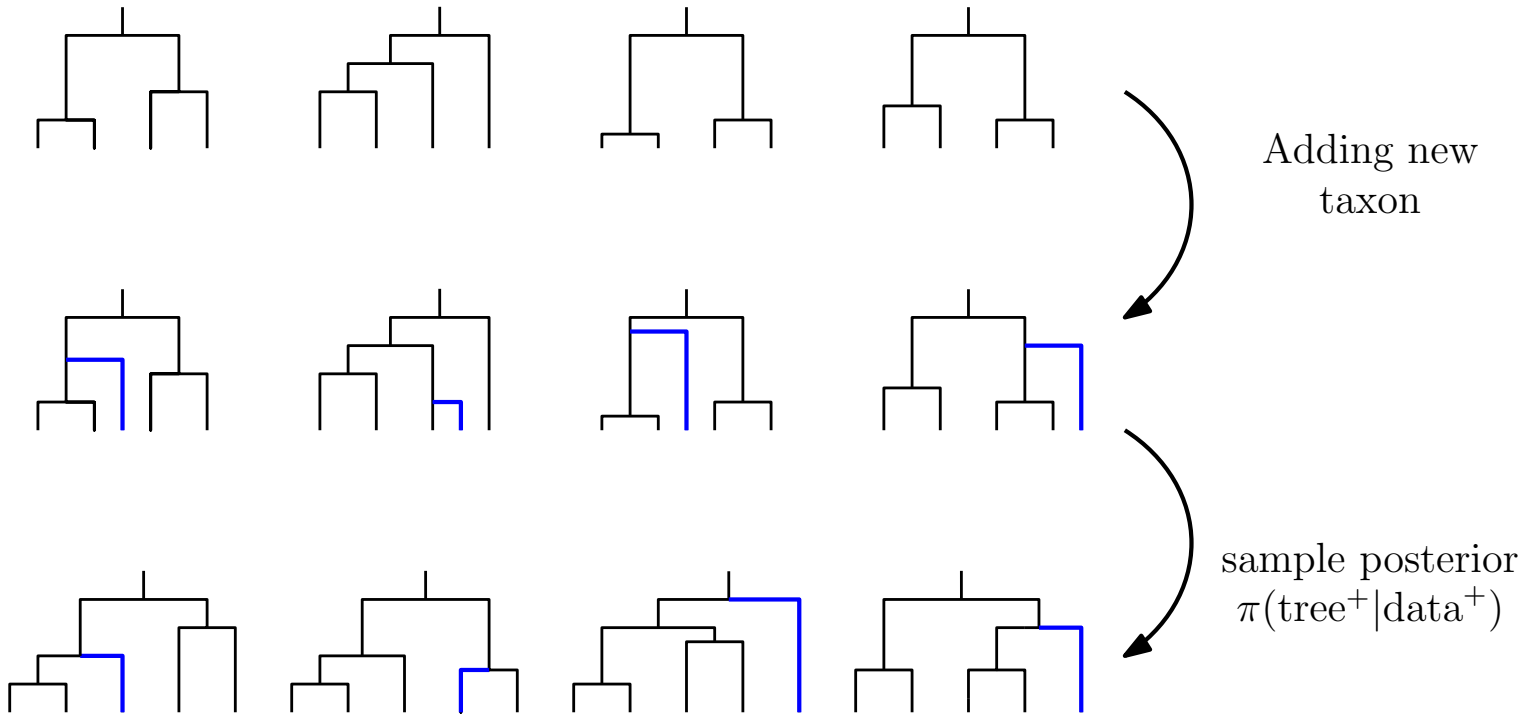
Bayesian Inference

$$\pi(\text{tree}|\text{data}) = \frac{\pi(\text{data}|\text{tree})\pi(\text{tree})}{\pi(\text{data})}$$



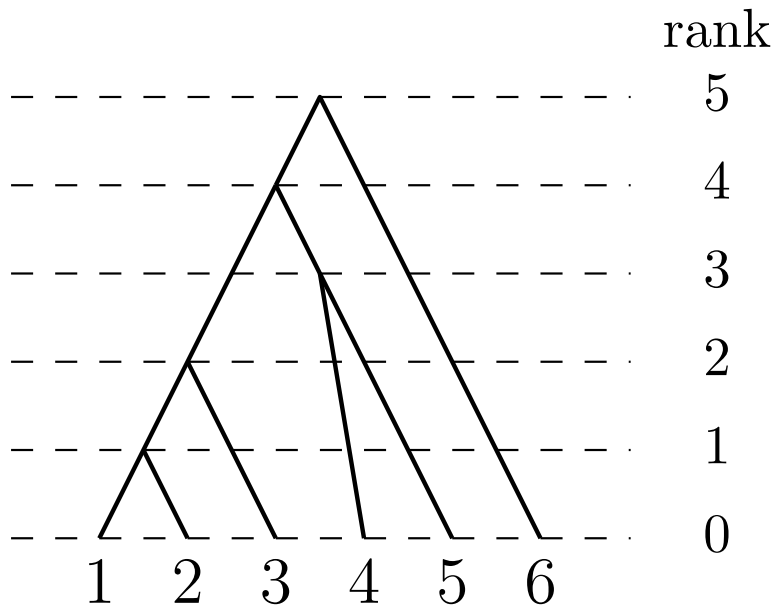
Bayesian Inference

$$\pi(\text{tree}|\text{data}) = \frac{\pi(\text{data}|\text{tree})\pi(\text{tree})}{\pi(\text{data})}$$



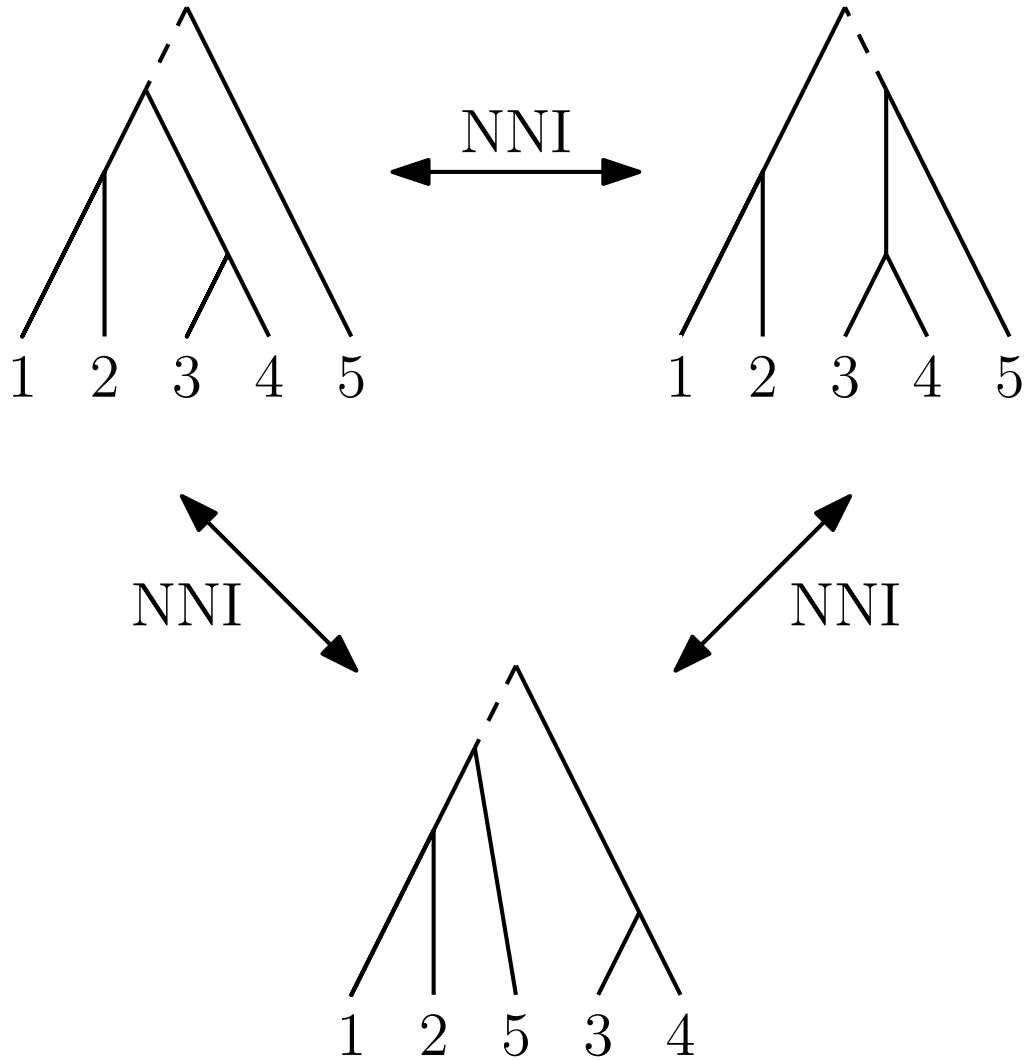
RNNI

Ranked Trees



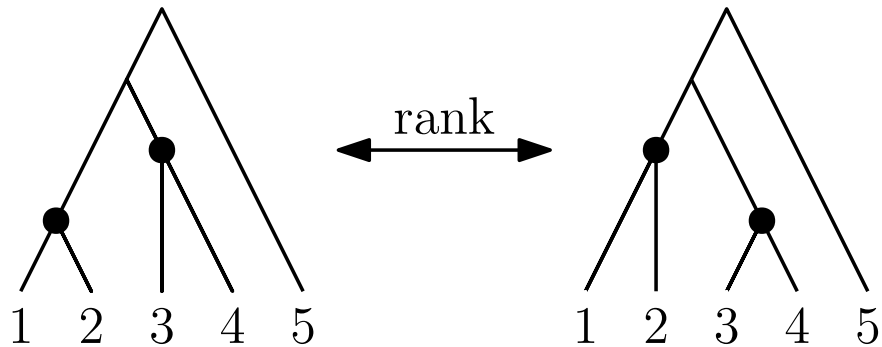
RNNI

NNI neighbours



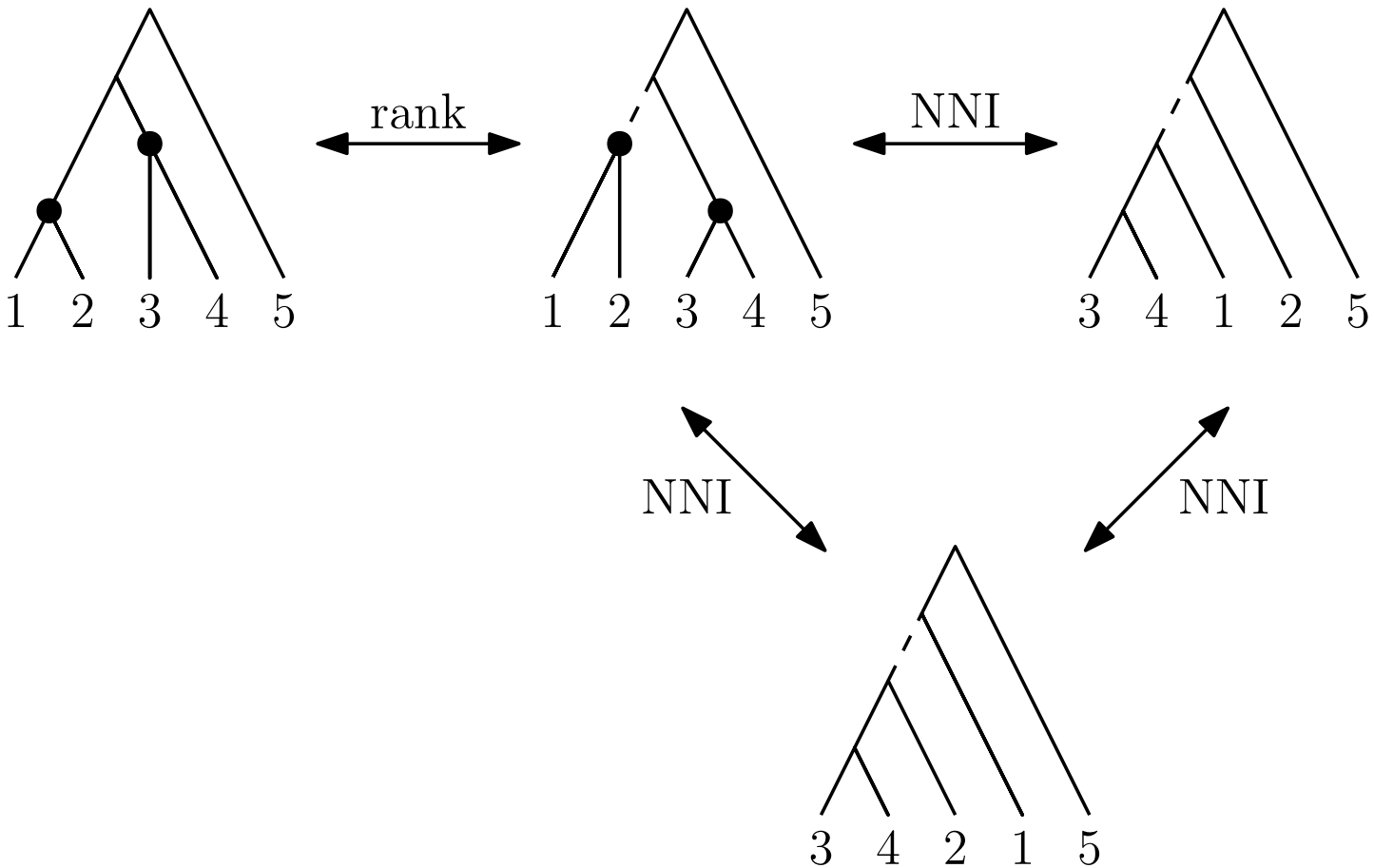
RNNI

Rank move

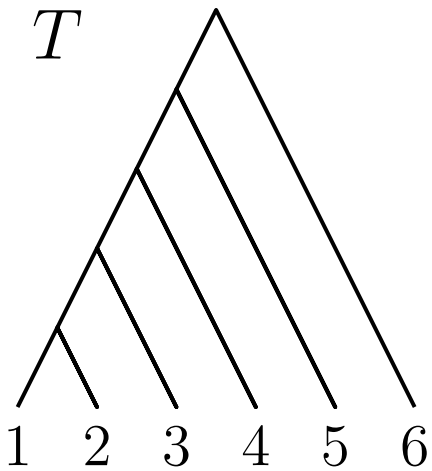


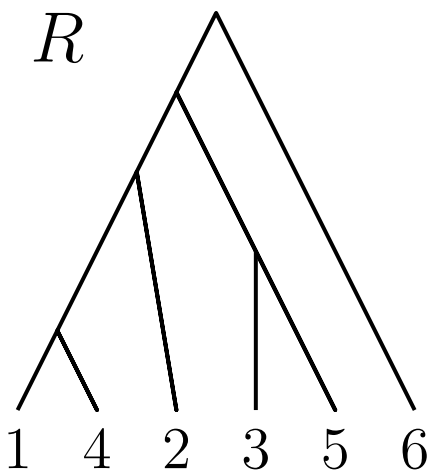
RNNI

Rank move

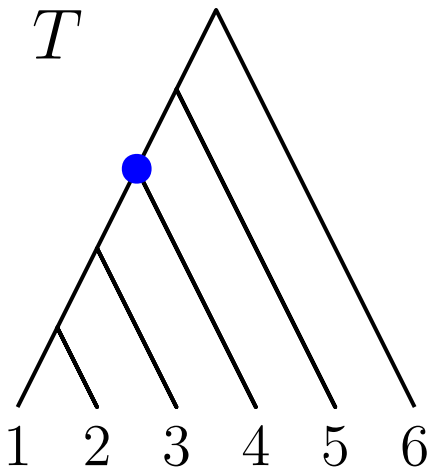


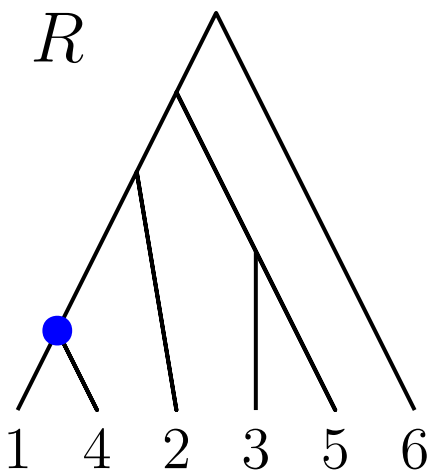
FindPath



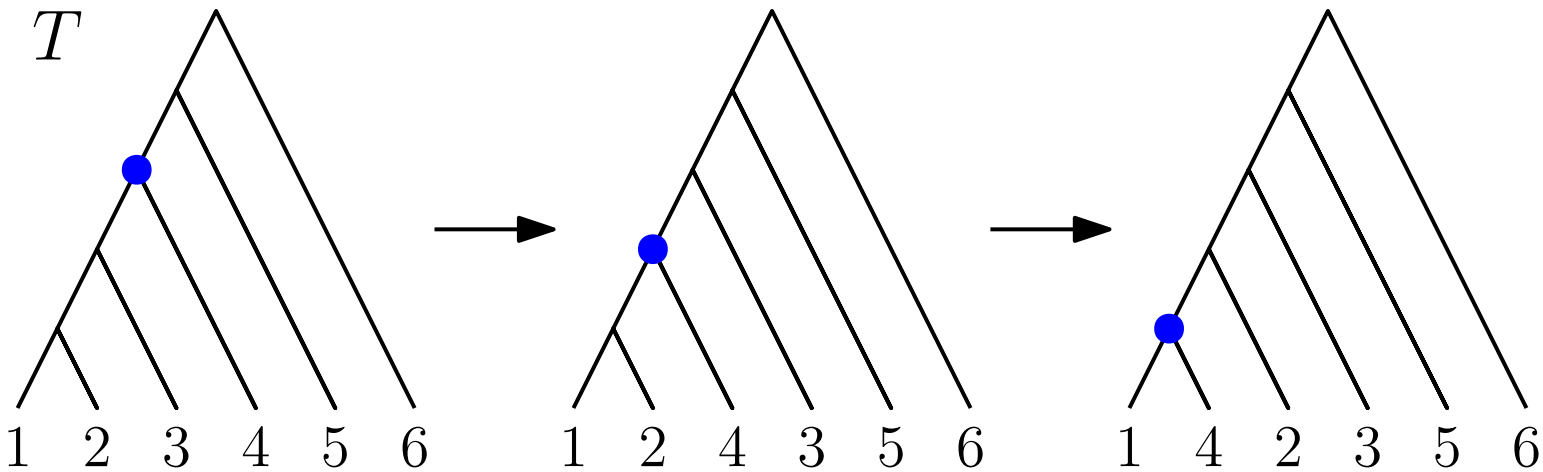


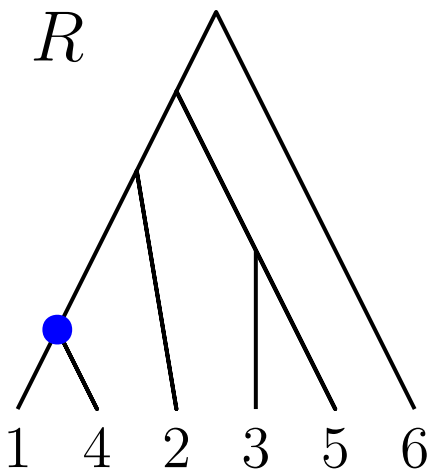
FindPath



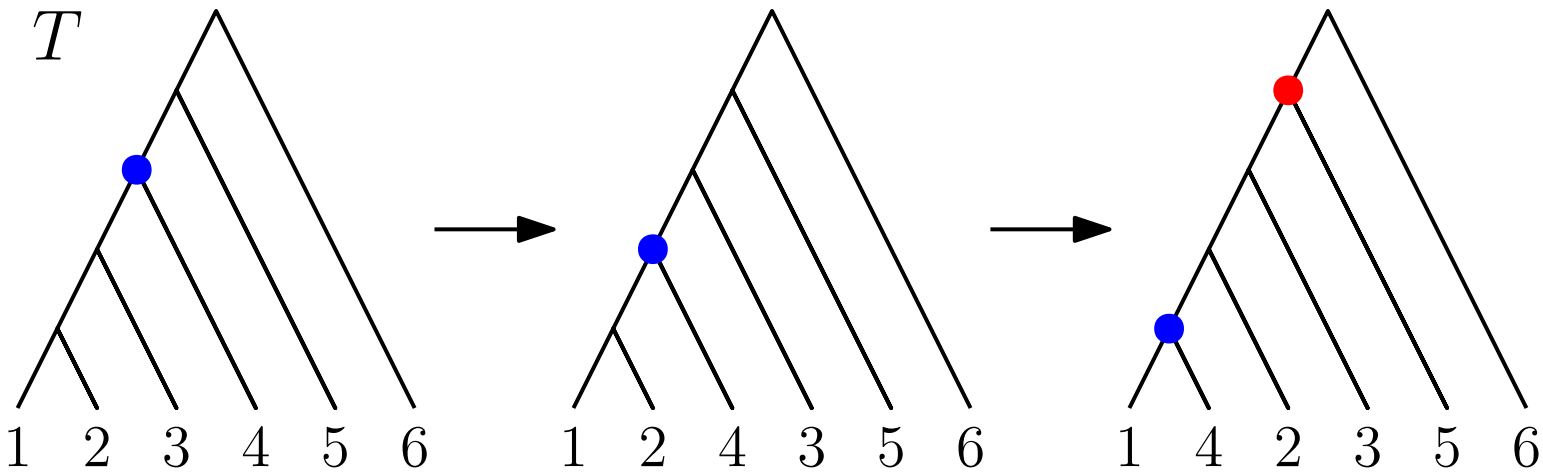


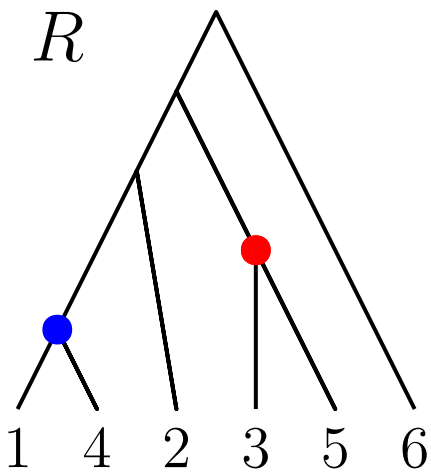
FindPath



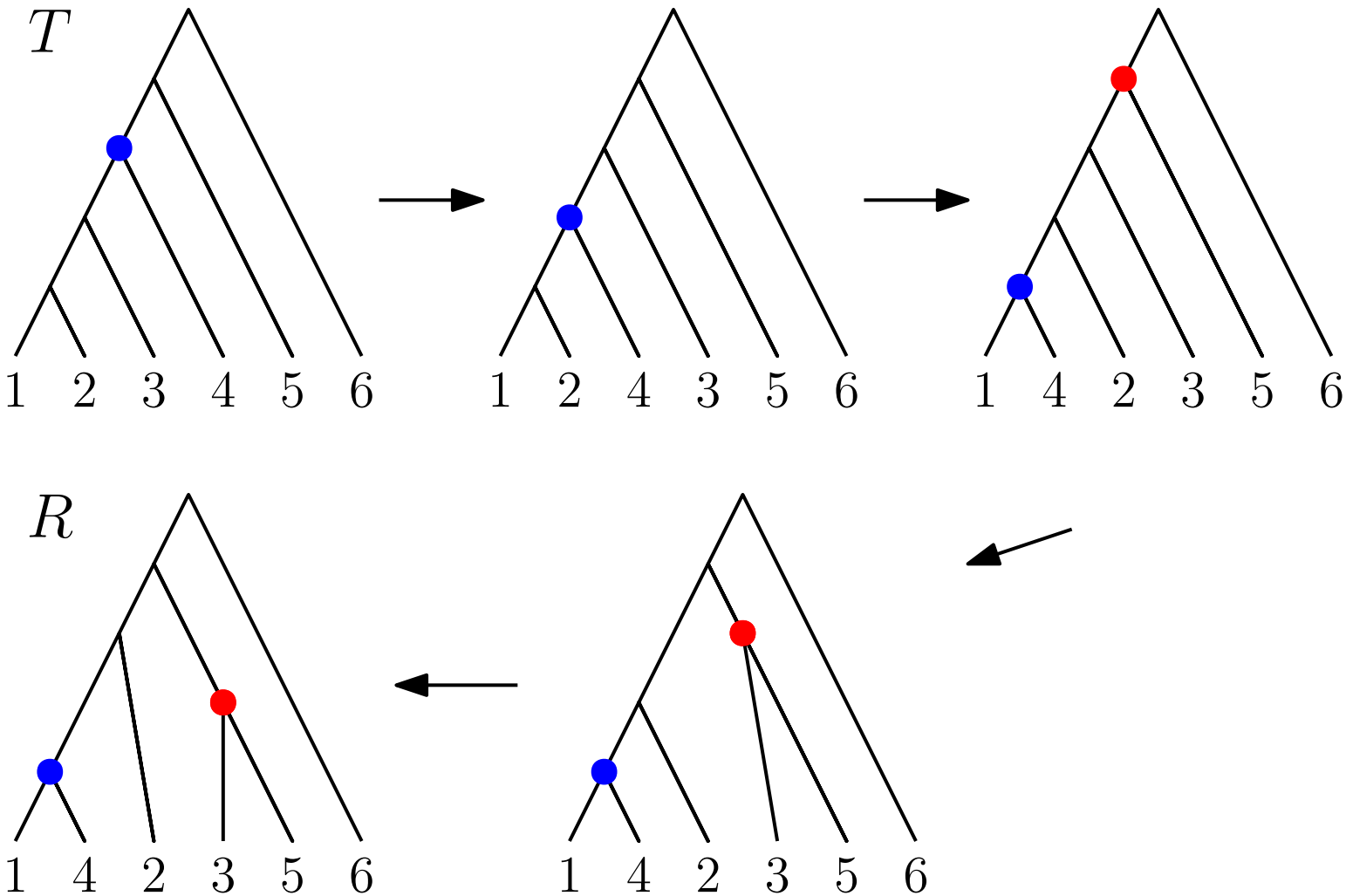


FindPath

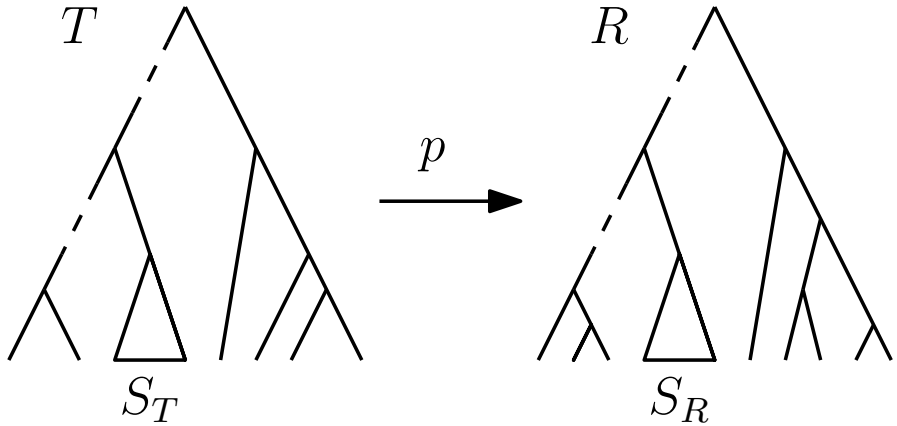




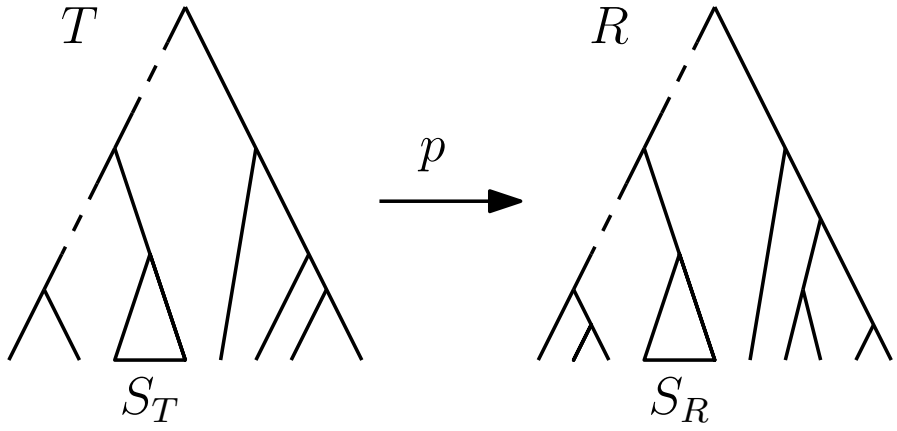
FindPath

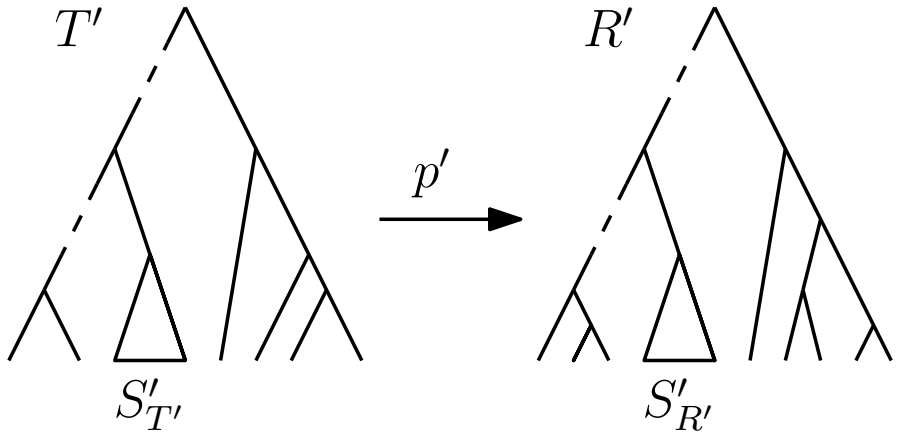


Online FindPath

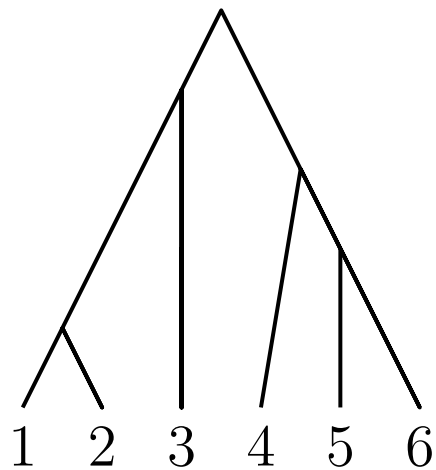


Online FindPath

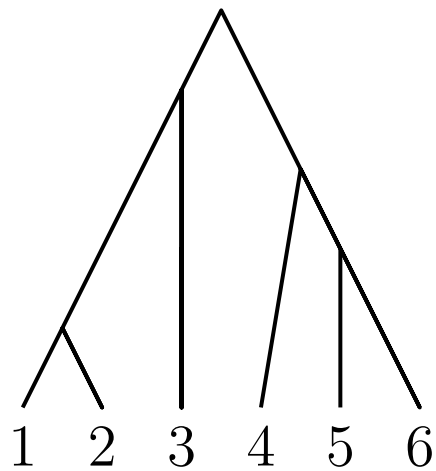




MDTree

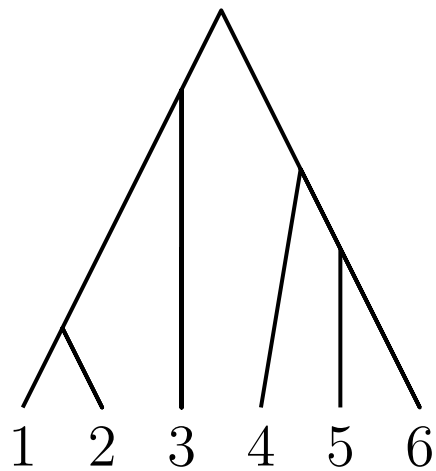


MDTree

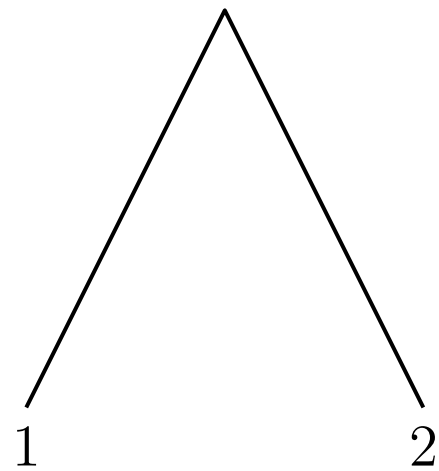


$[1, 2, 6, 5, 4, 3]$

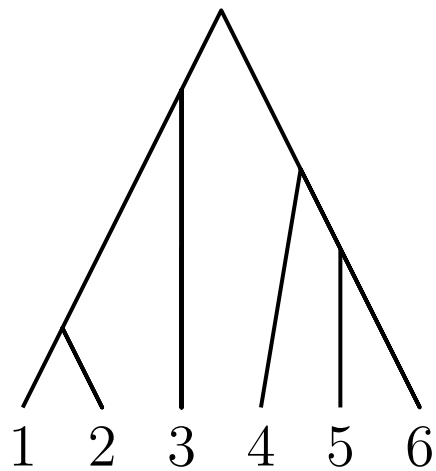
MDTree



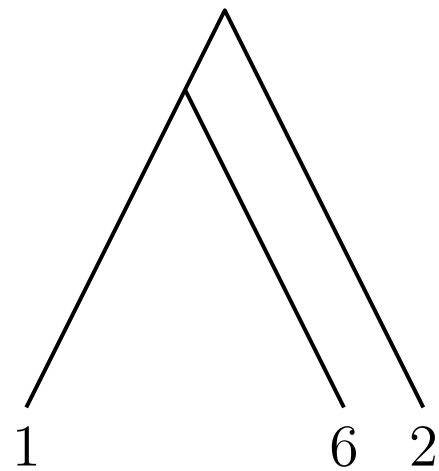
$[1, 2, 6, 5, 4, 3]$



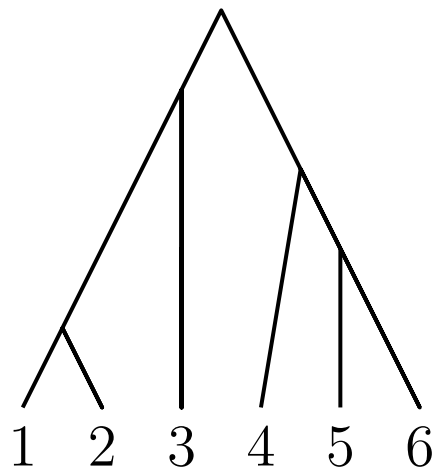
MDTree



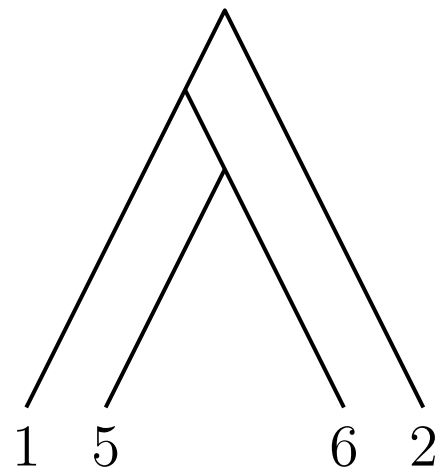
$[1, 2, 6, 5, 4, 3]$



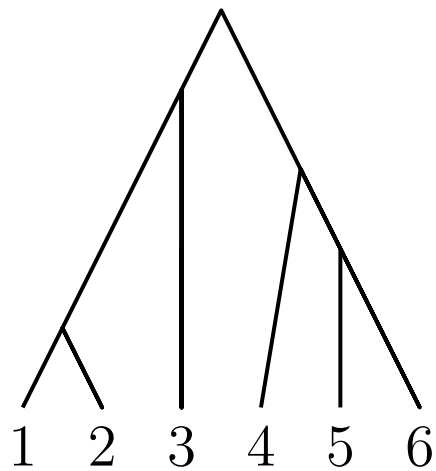
MDTree



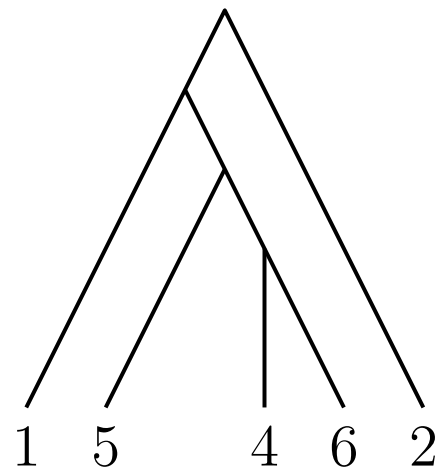
$[1, 2, 6, 5, 4, 3]$



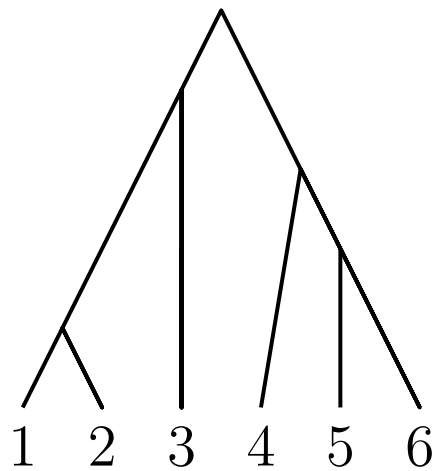
MDTree



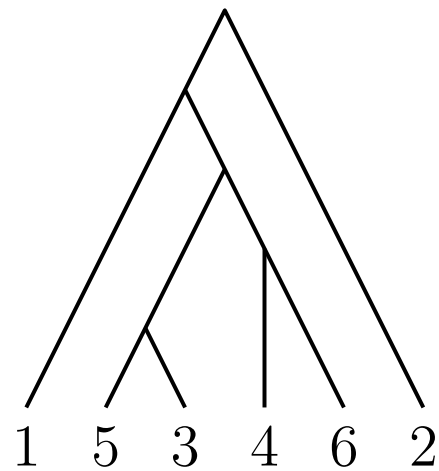
$[1, 2, 6, 5, 4, 3]$



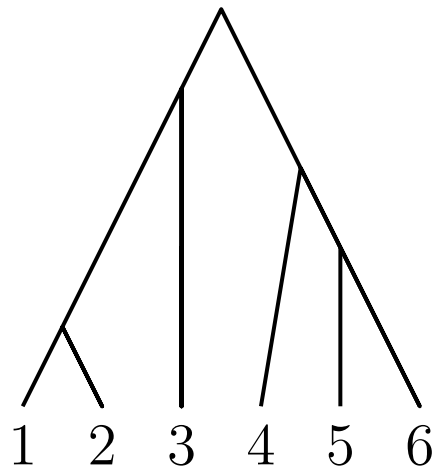
MDTree



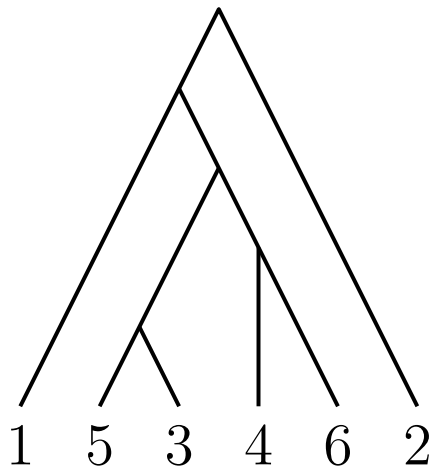
$[1, 2, 6, 5, 4, 3]$

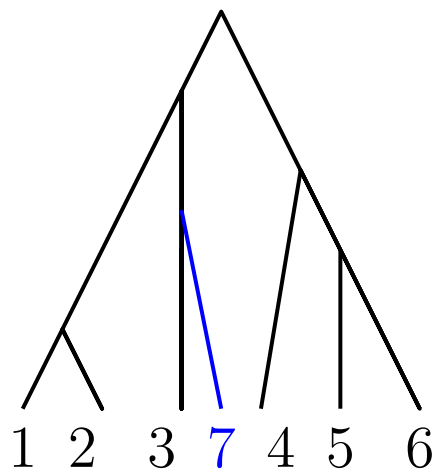


Online MDTree

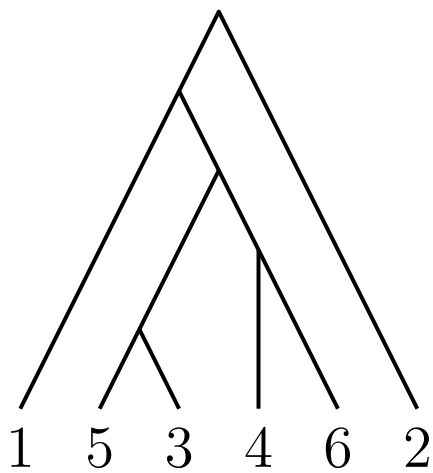


$[1, 2, 6, 5, 4, 3]$

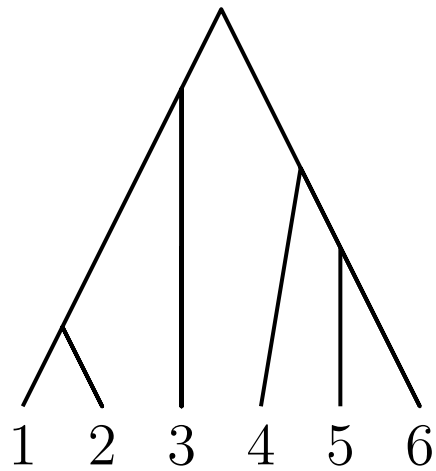




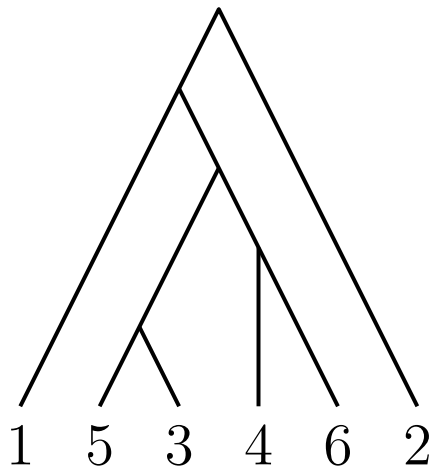
$[1, 2, 6, 5, 4, 3]$

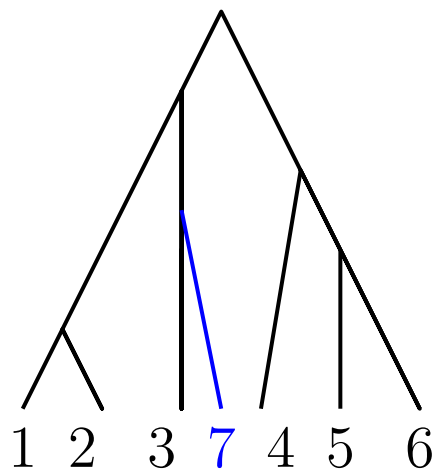


Online MDTree

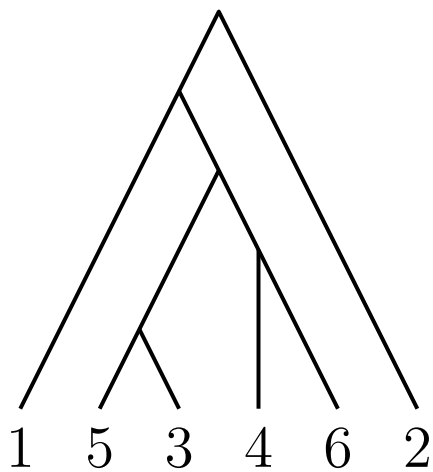


$[1, 2, 6, 5, 4, 3]$

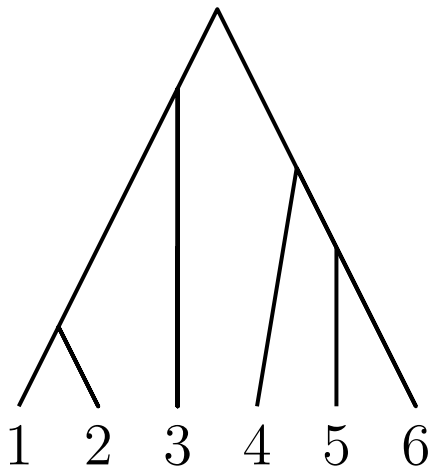




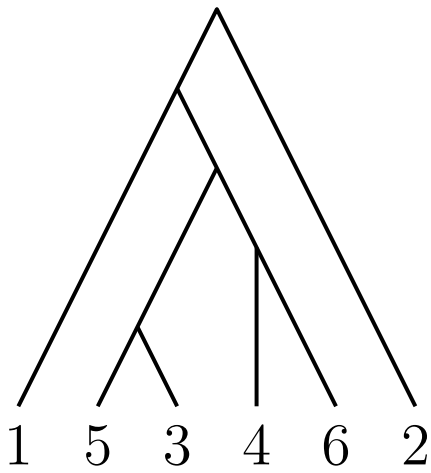
$[1, 2, 6, 5, 7, 4, 3]$

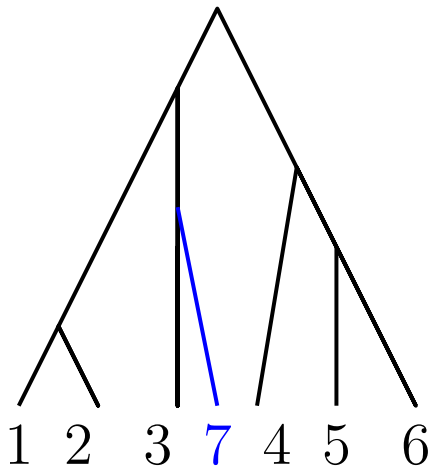


Online MDTree

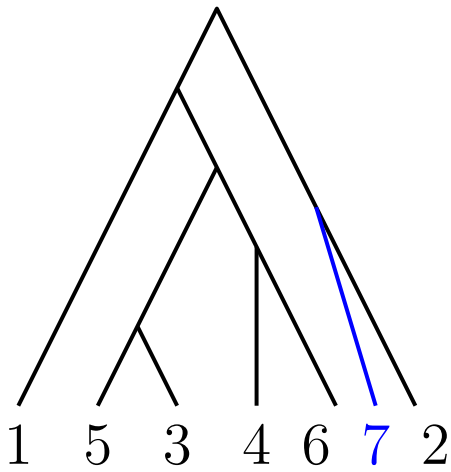


$[1, 2, 6, 5, 4, 3]$





$[1, 2, 6, 5, 7, 4, 3]$



Acknowledgements

Alex Gavryushkin (University of Otago)
David Bryant (University of Otago)