Spaces of Discrete Time Trees

Lena Collienne

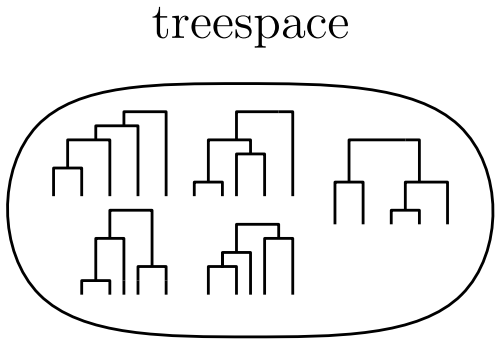
Matsen Group

Fred Hutch
Cancer Center

July 18th, 2023

Overview

Overview



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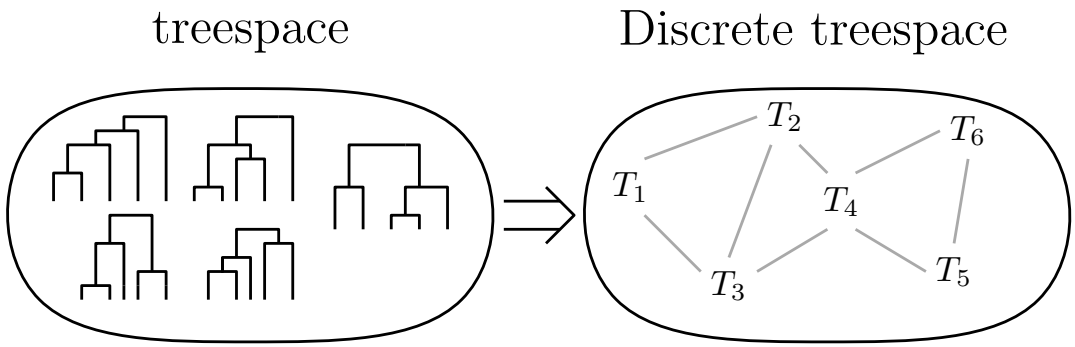

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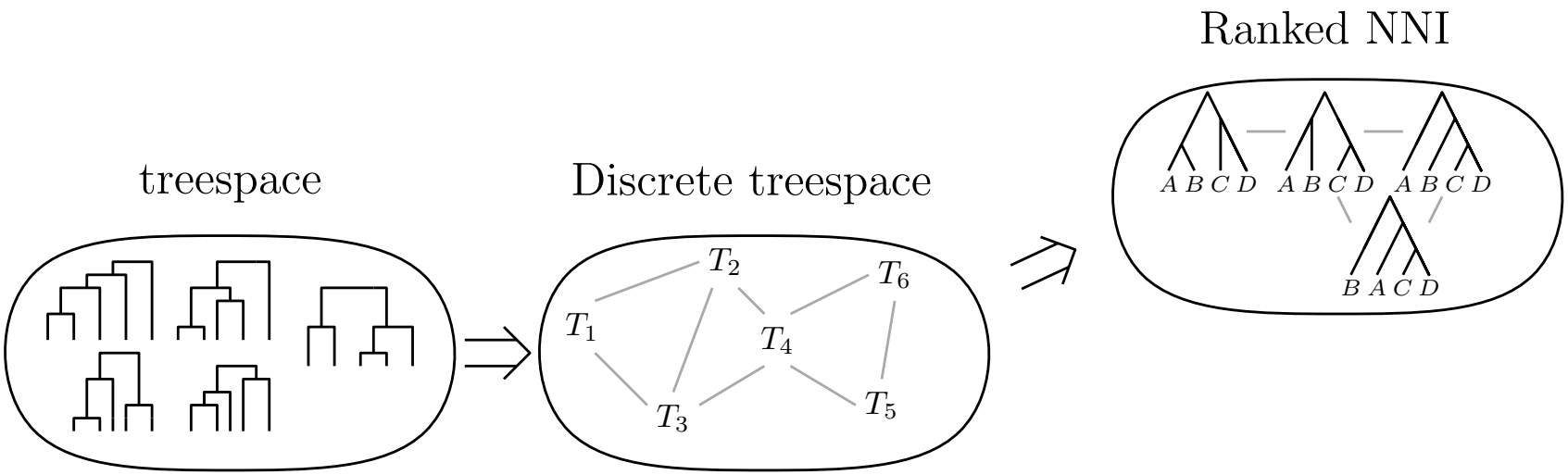
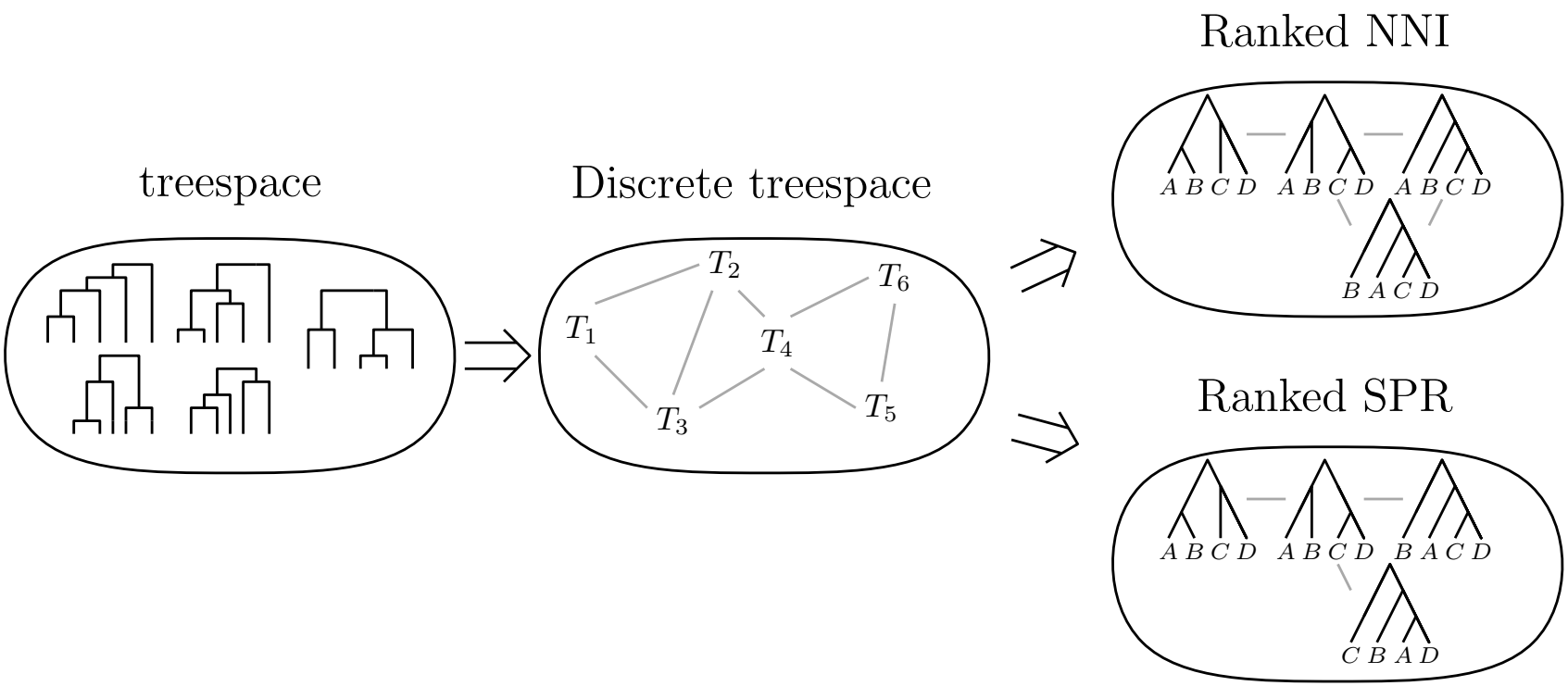

Ranked NNI
treespace
Discrete treespace
T_1
T_2
T_3
T_4
T_5
T_6
A B C D
A B C D
A B C D
B A C D

Overview


Ranked NNI
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T_1
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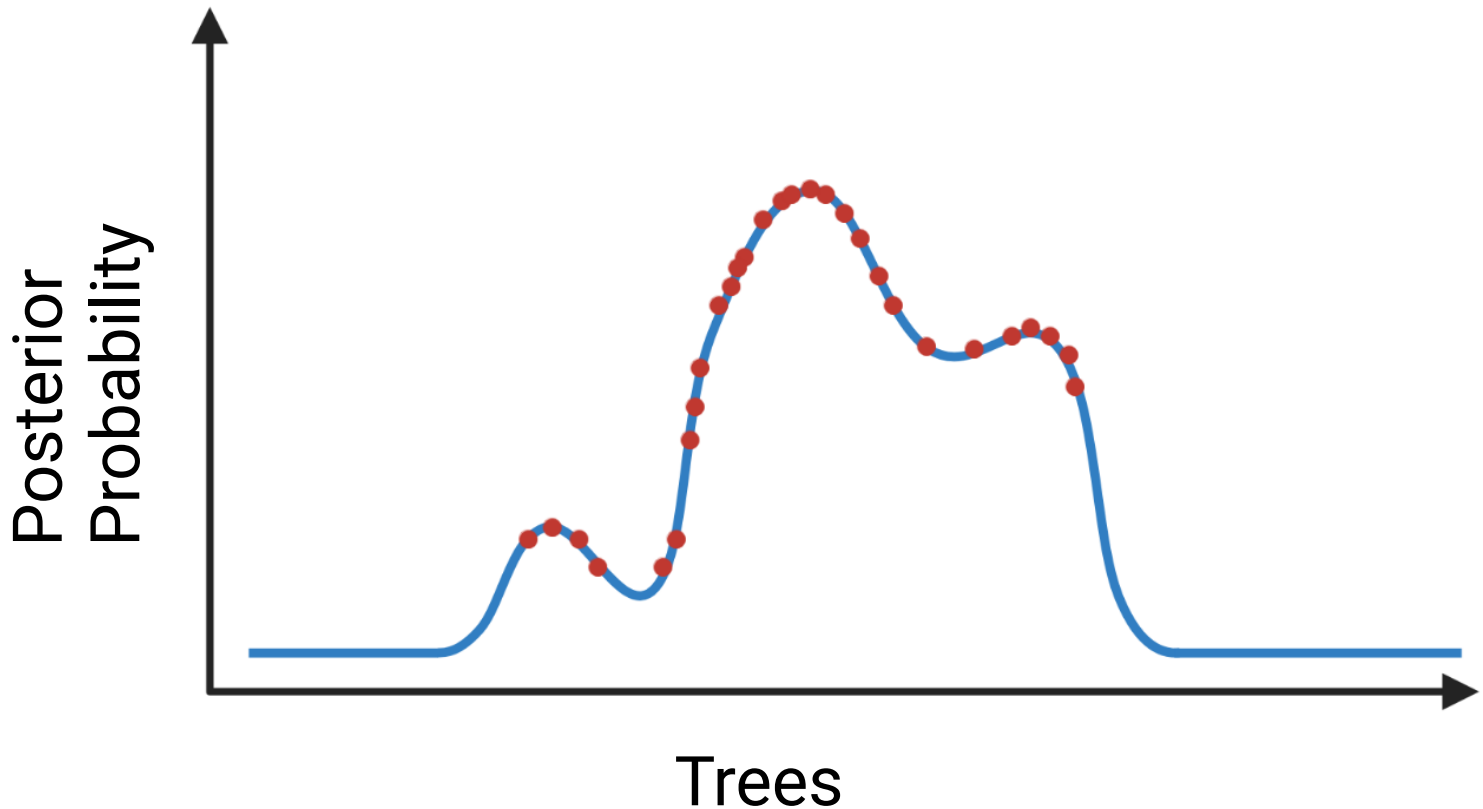
T_6
A B C D
A B C D
A B C D
B A C D
Ranked SPR
A B C D
A B C D
B A C D
C B A D

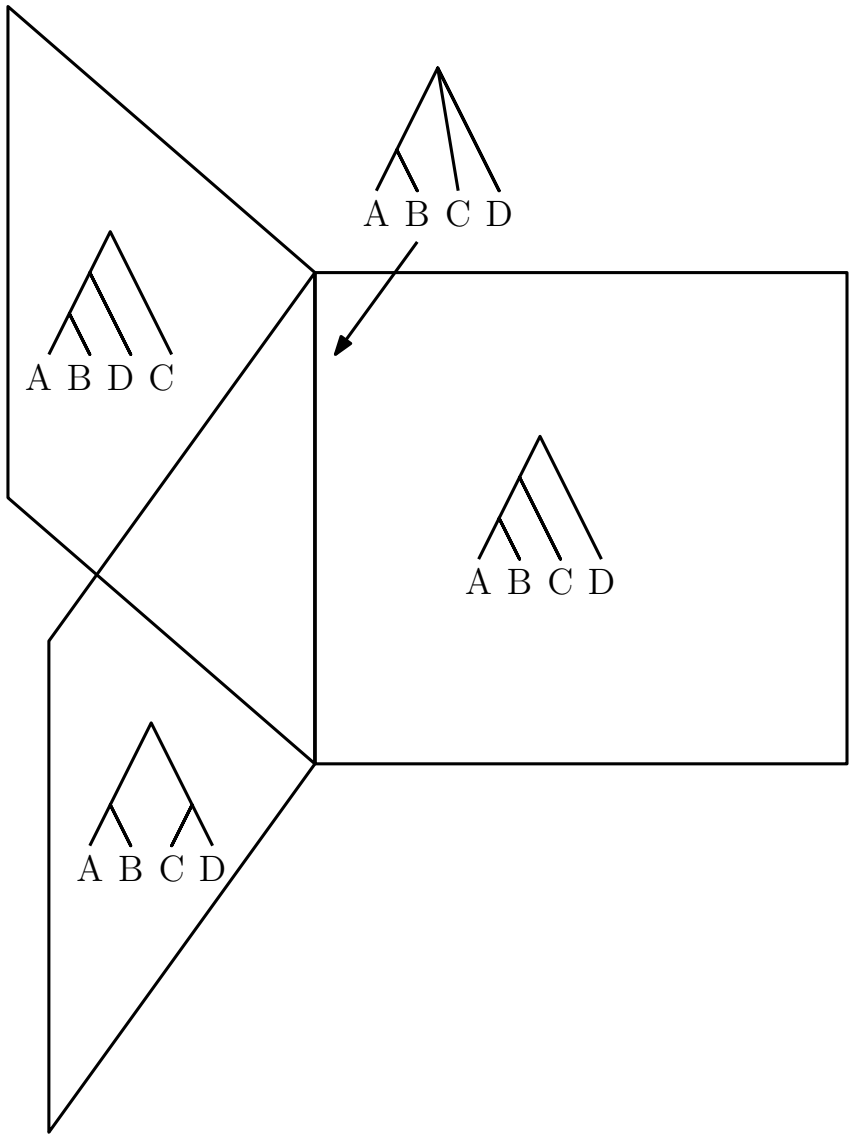
Tree Inference

Bayesian Inference



Treespace

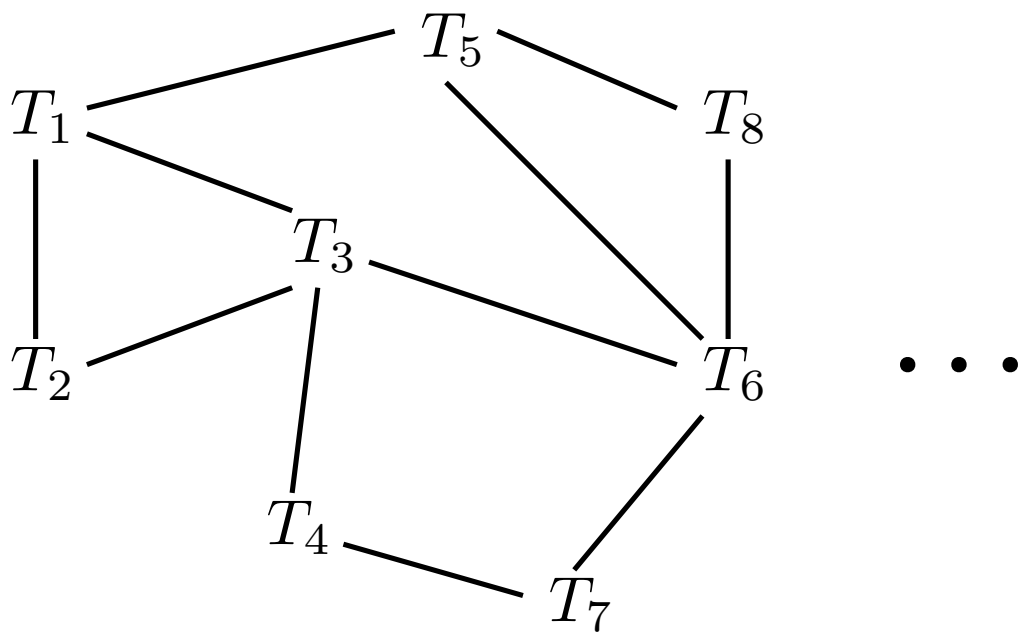
BHV-space



[after Billera, Holmes, and Vogtmann, 2001]

Discrete Treespace

Tree rearrangements



Discrete Treespace

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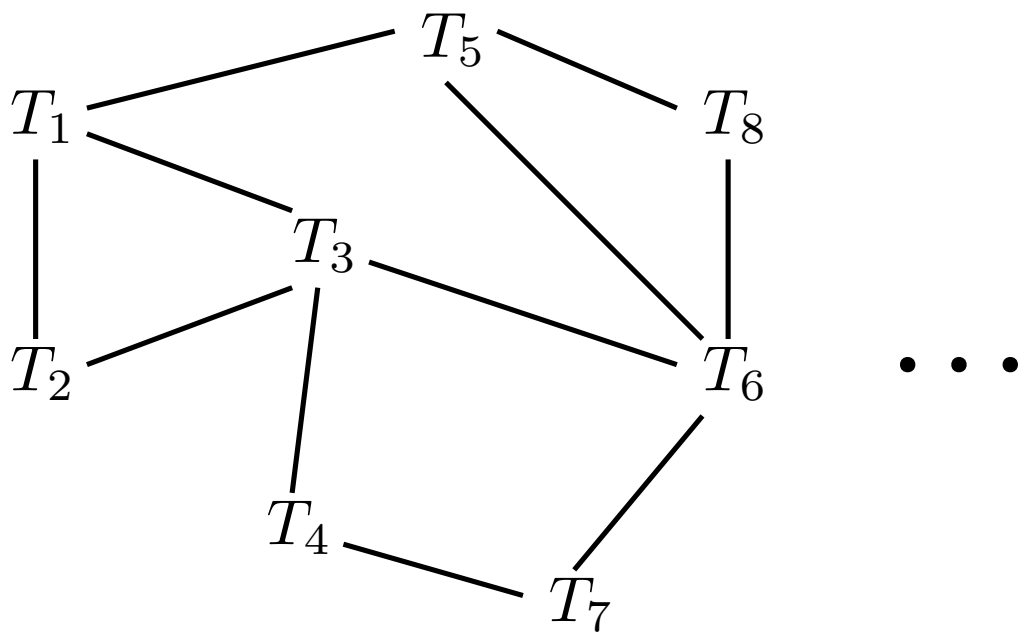
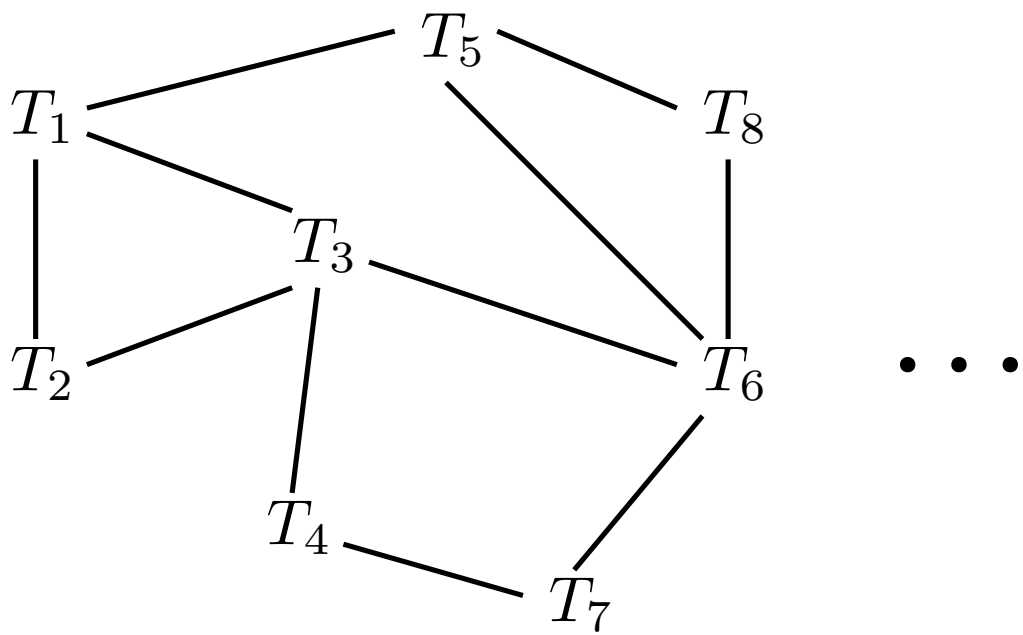


- tree rearrangements: NNI, SPR, TBR

Discrete Treespace

Tree rearrangements



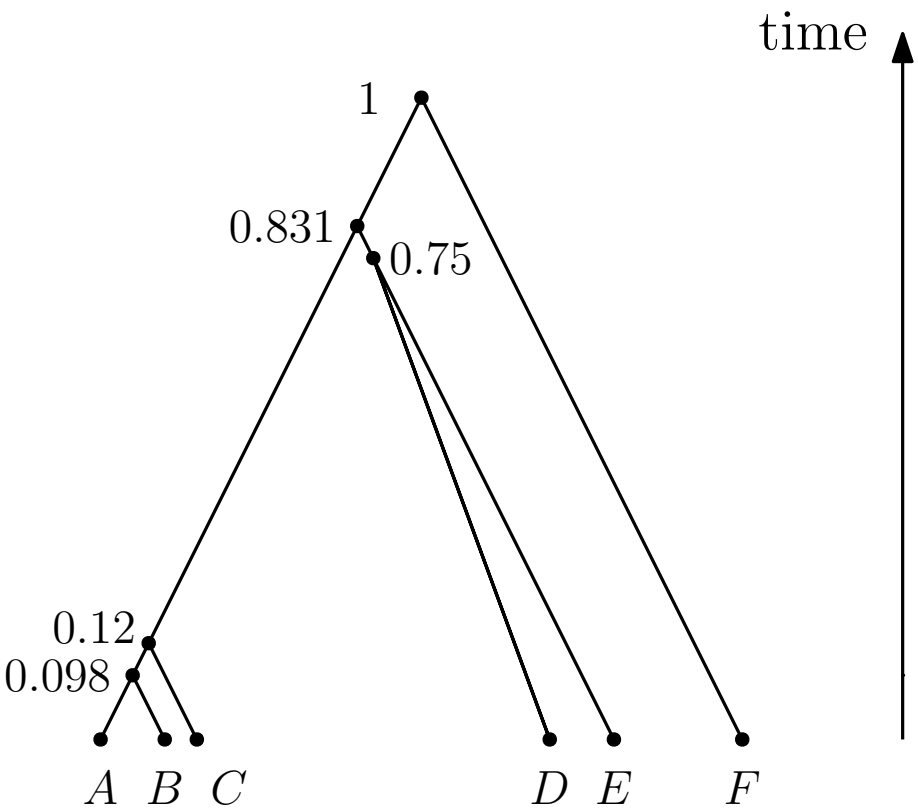
- tree rearrangements: NNI, SPR, $\mathrm{TBR} \rightarrow \mathcal{NP}$-hard

Discrete Treespace

Ranked trees

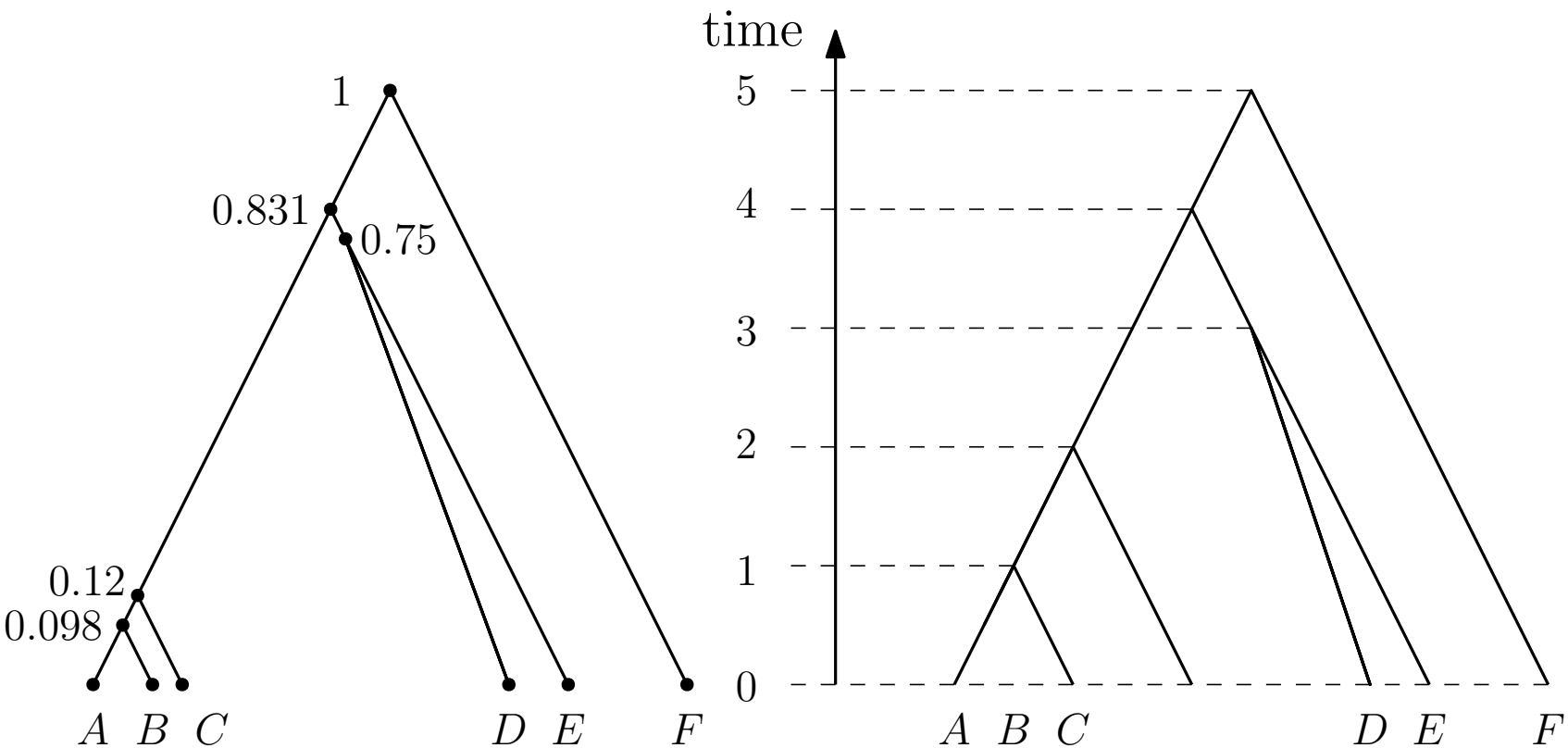
Discrete Treespace

Ranked trees



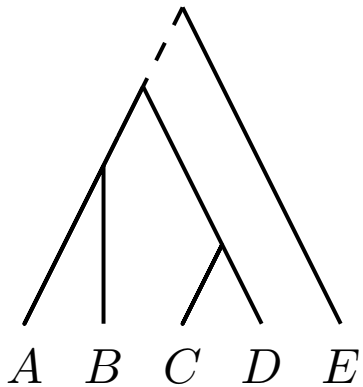
Discrete Treespace

Ranked trees



NNI on Ranked Trees

NNI moves



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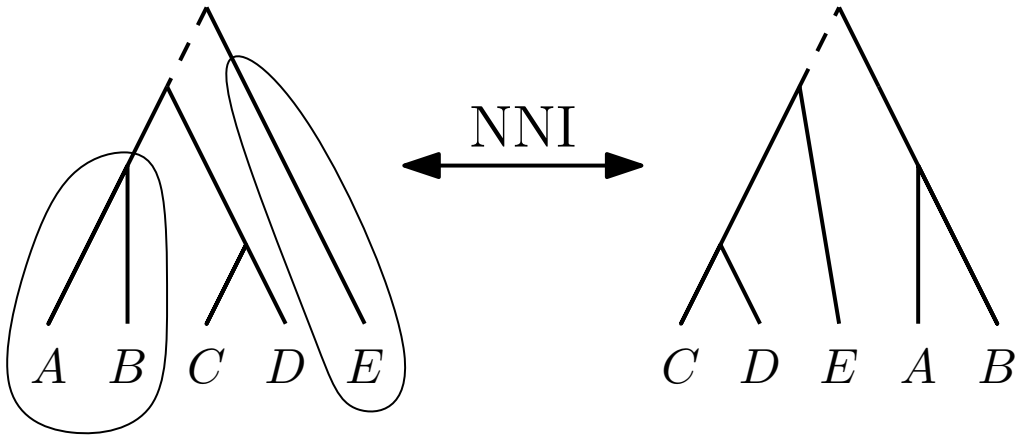

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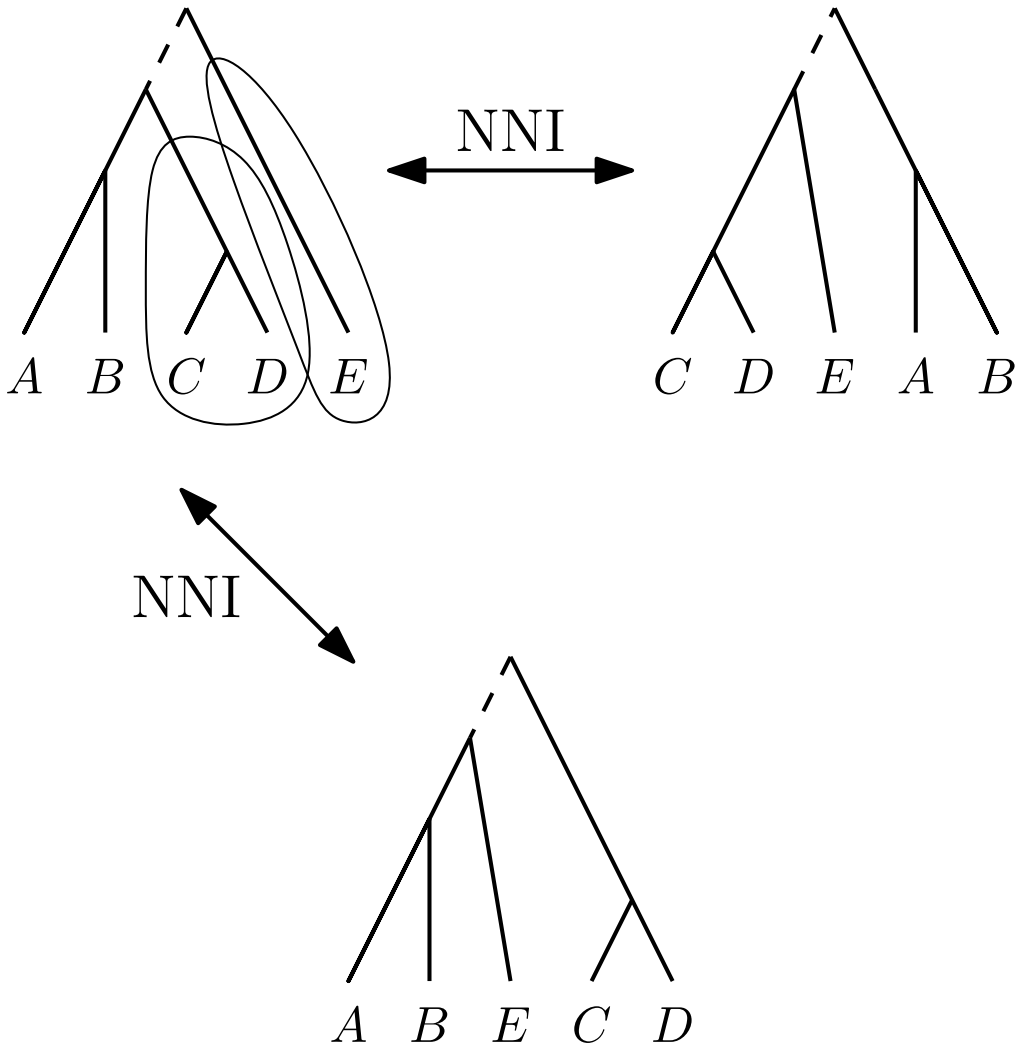

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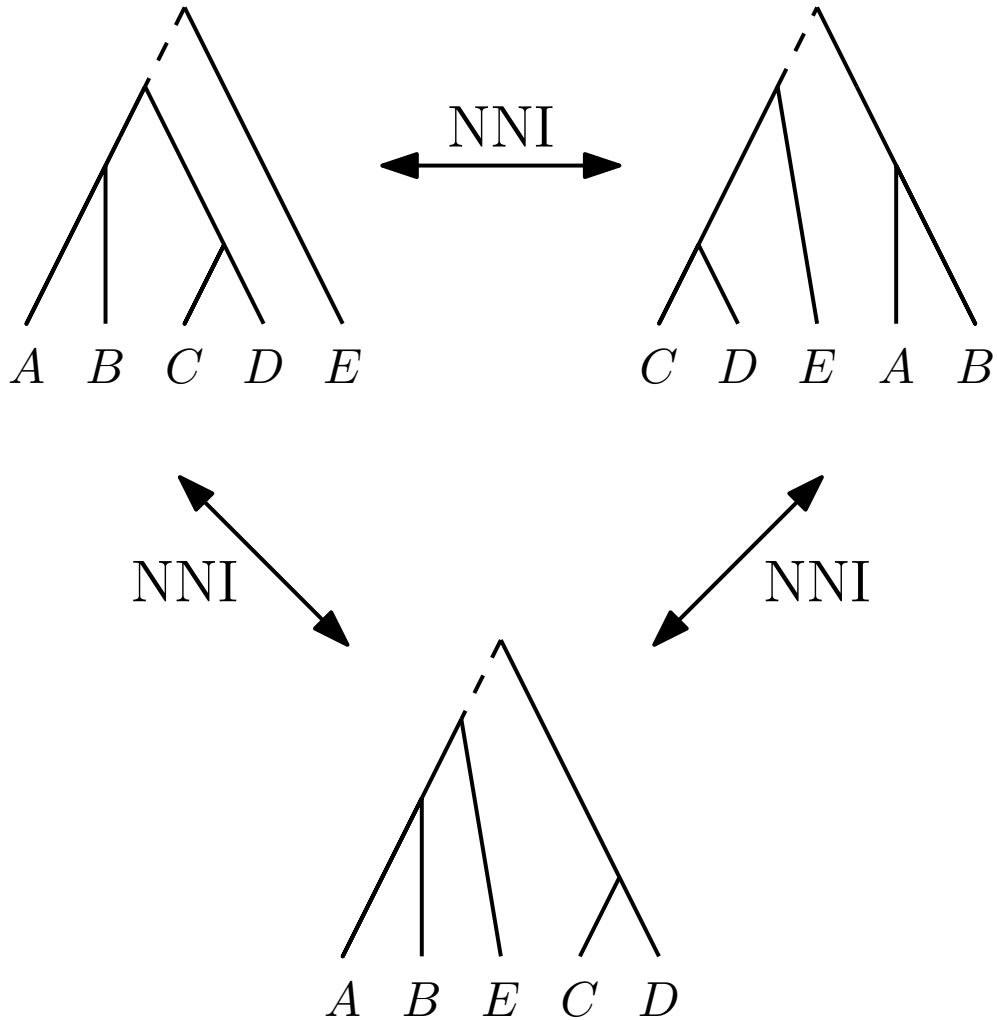

NNI on Ranked Trees

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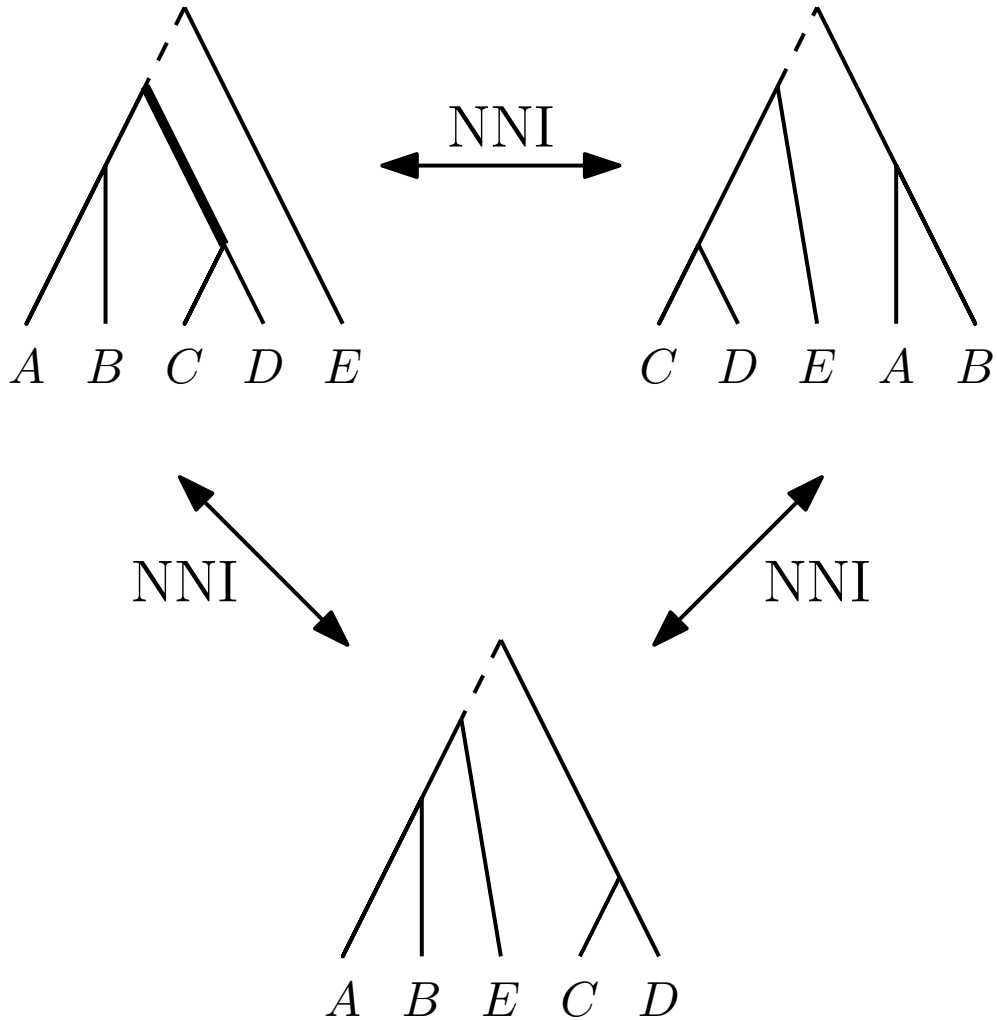
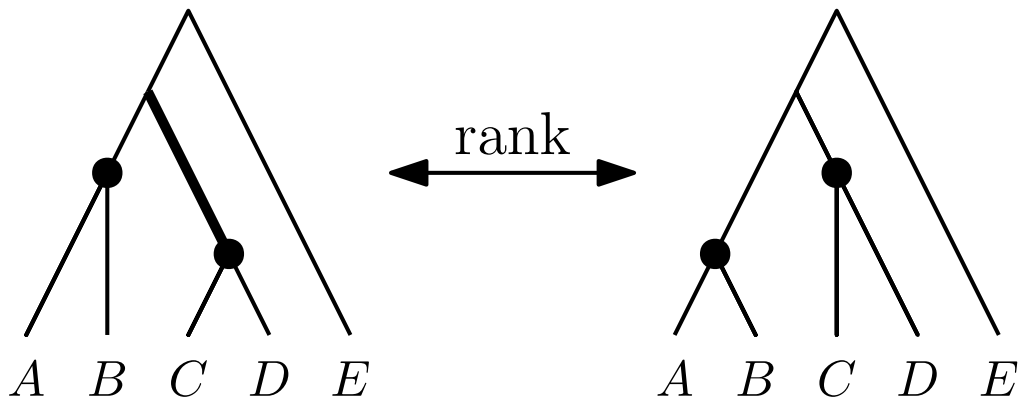
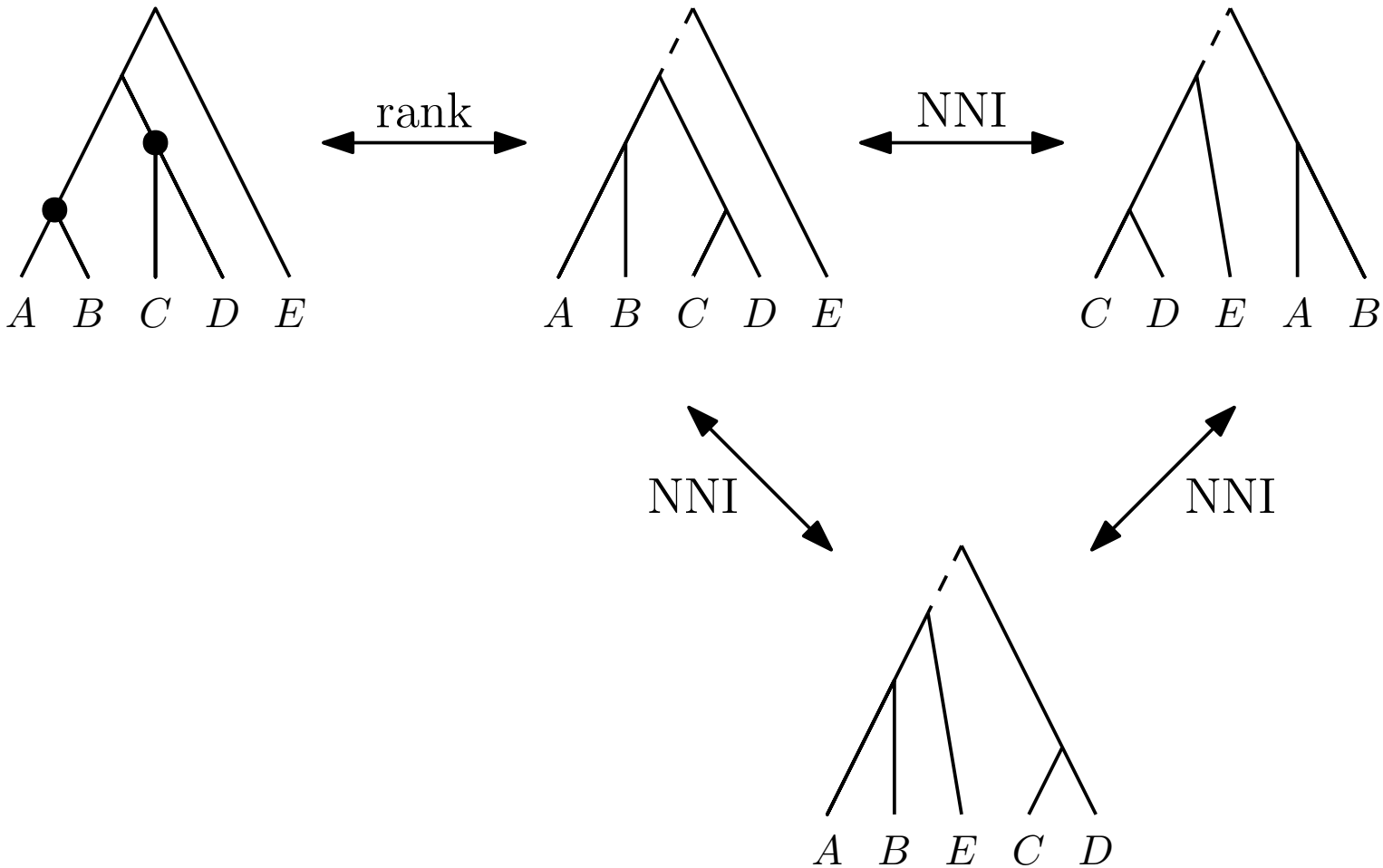


NNI on Ranked Trees

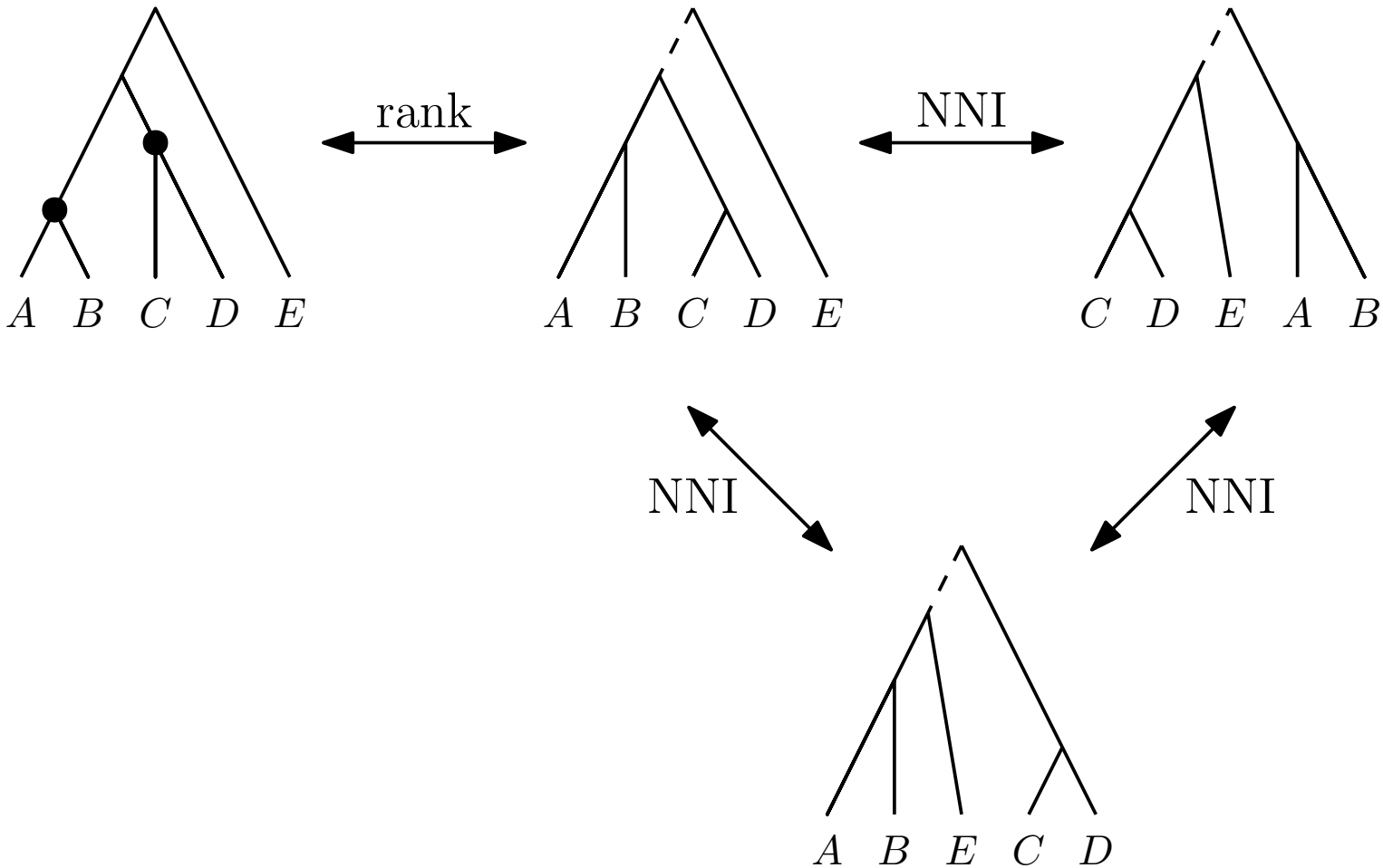
Rank move



RNNI



RNNI



Theorem

Shortest paths in RNNI *can be computed in* $O(n^2)$.

RNNI

Probability Distributions

Lars Berling

RNNI

Probability Distributions


Lars Berling

- Simulate tree + alignment
- Run BEAST2 and log every tree $\rightarrow 1,000$ trees

RNNI

Probability Distributions


Lars Berling

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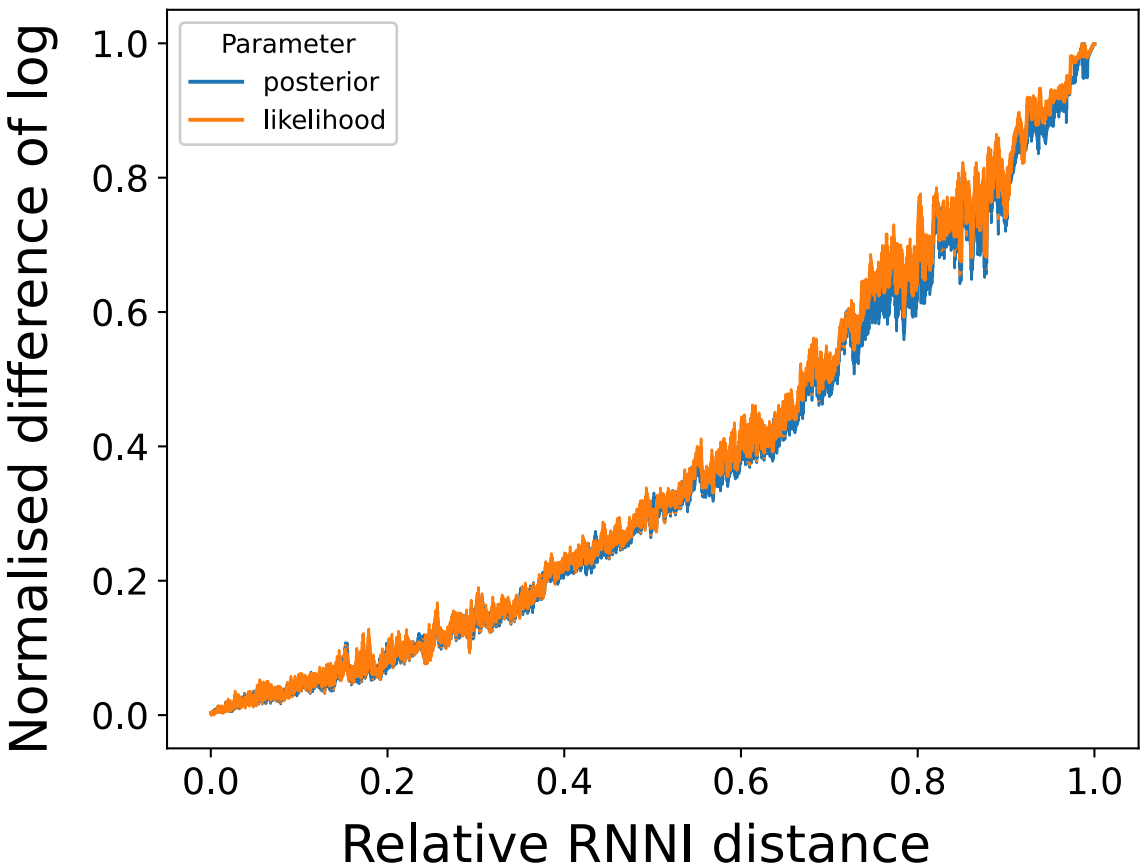
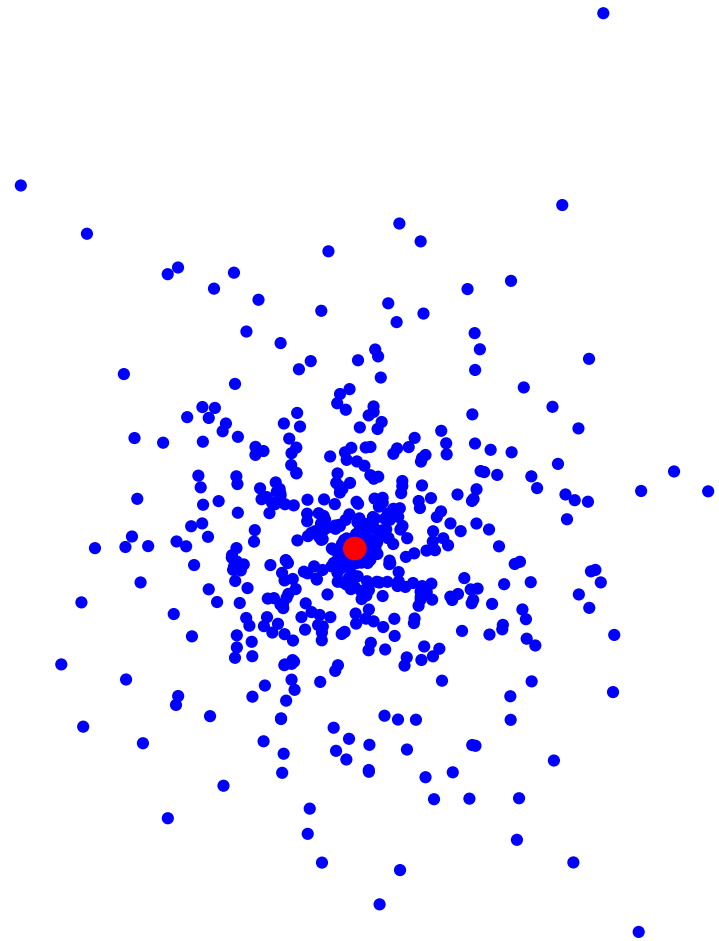


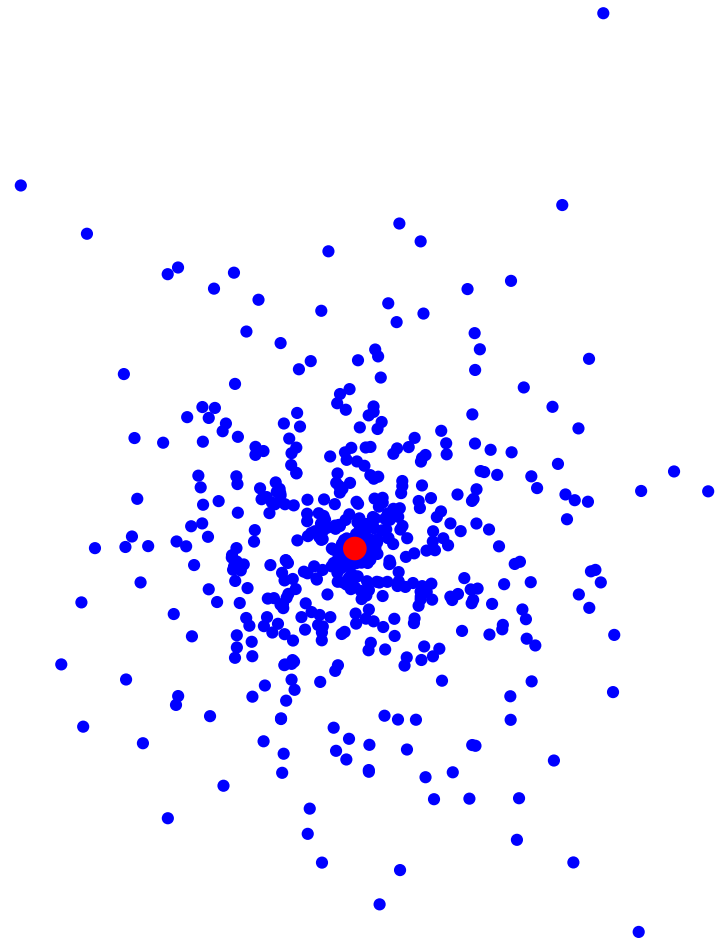
RNNI

Mean trees



RNNI

Mean trees

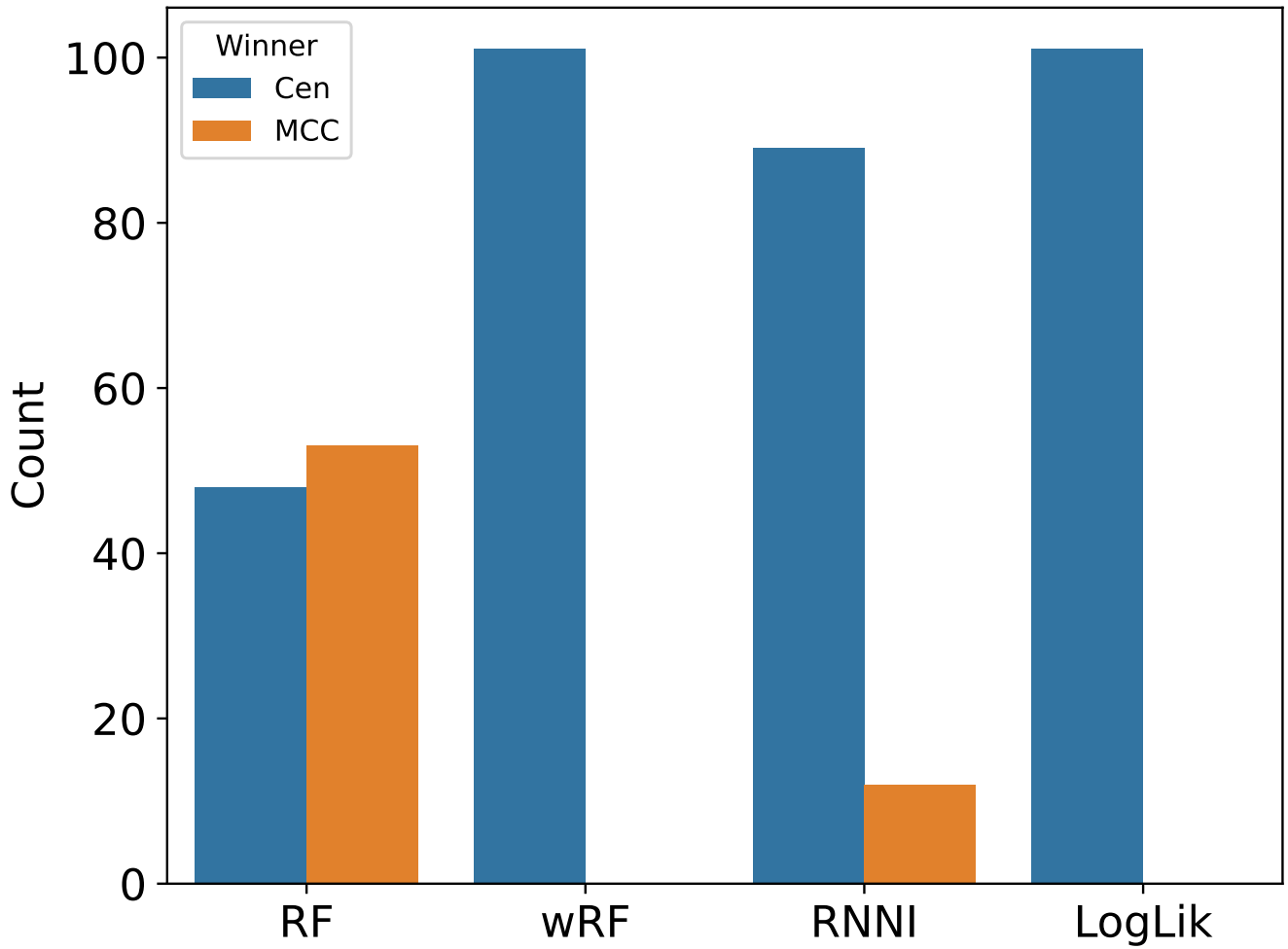


$$\mathrm{Cen}(\mathcal{T}) = \arg\min_{T^*} \sum_{T \in \mathcal{T}} d(T, T^*)^2$$

RNNI

Mean trees

Simulation study + BEAST2



Generalising RNNI

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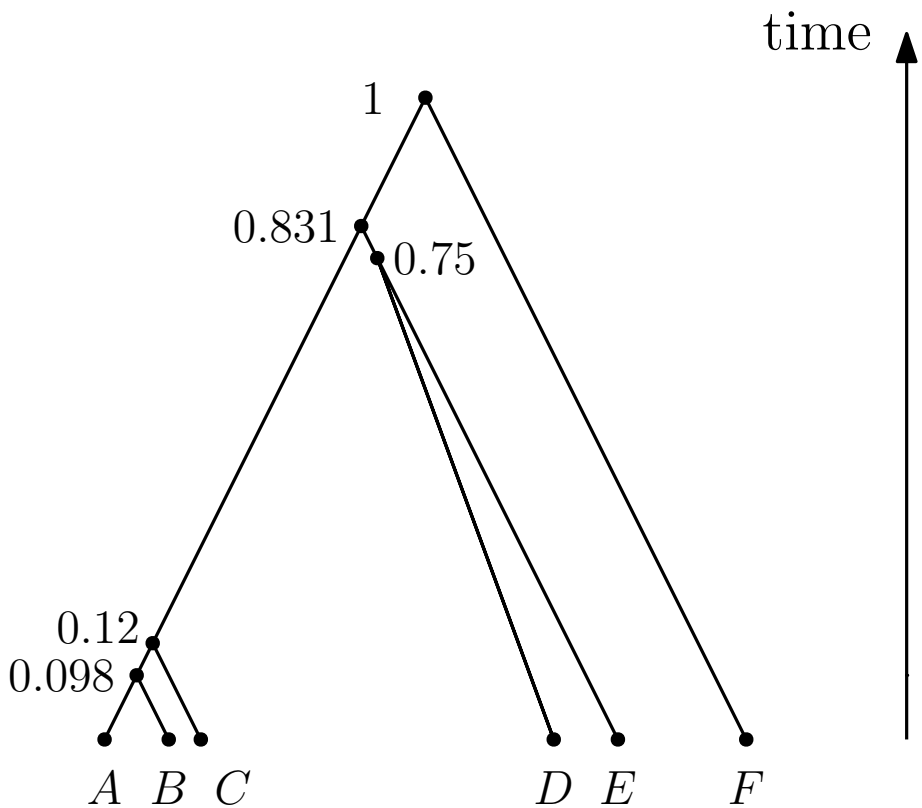
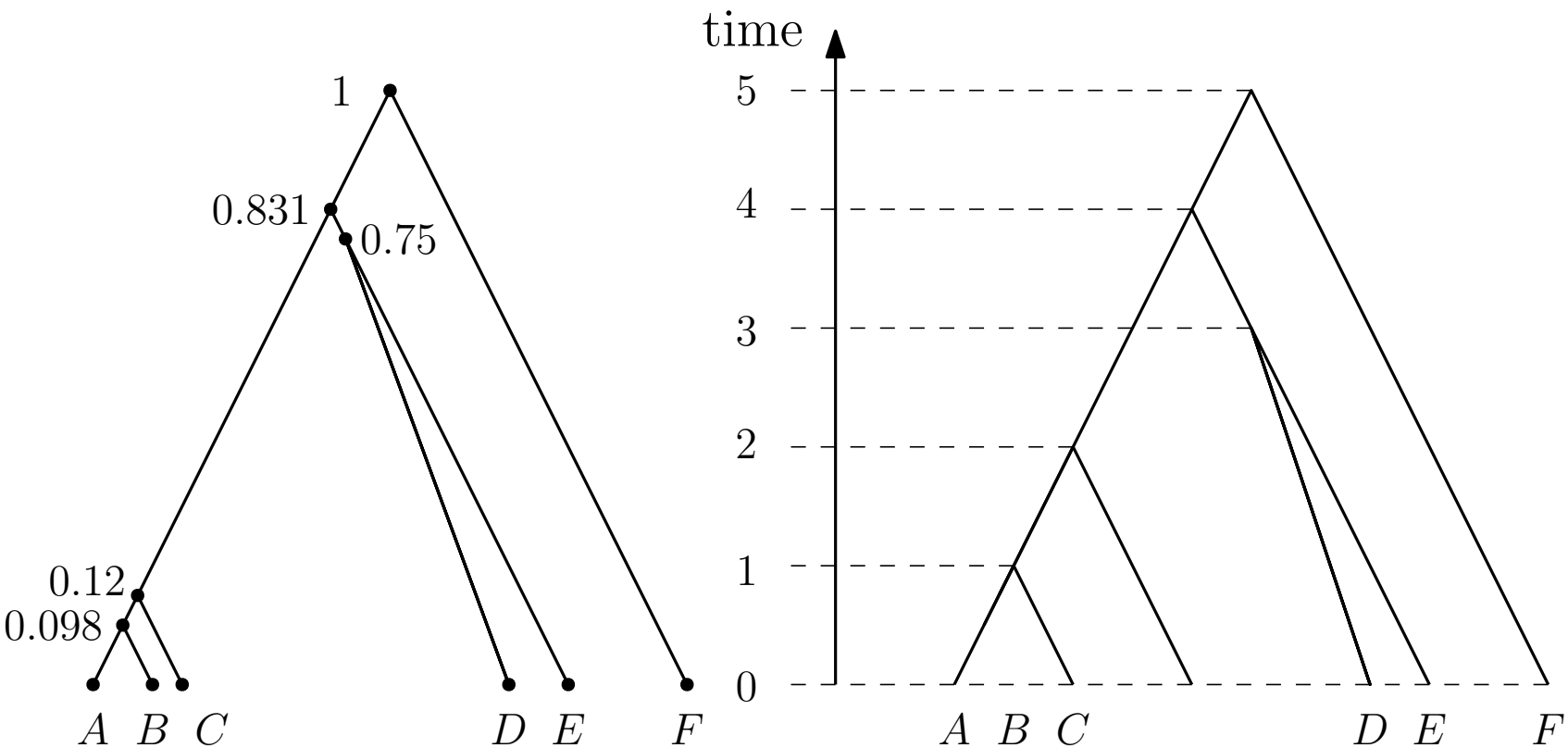
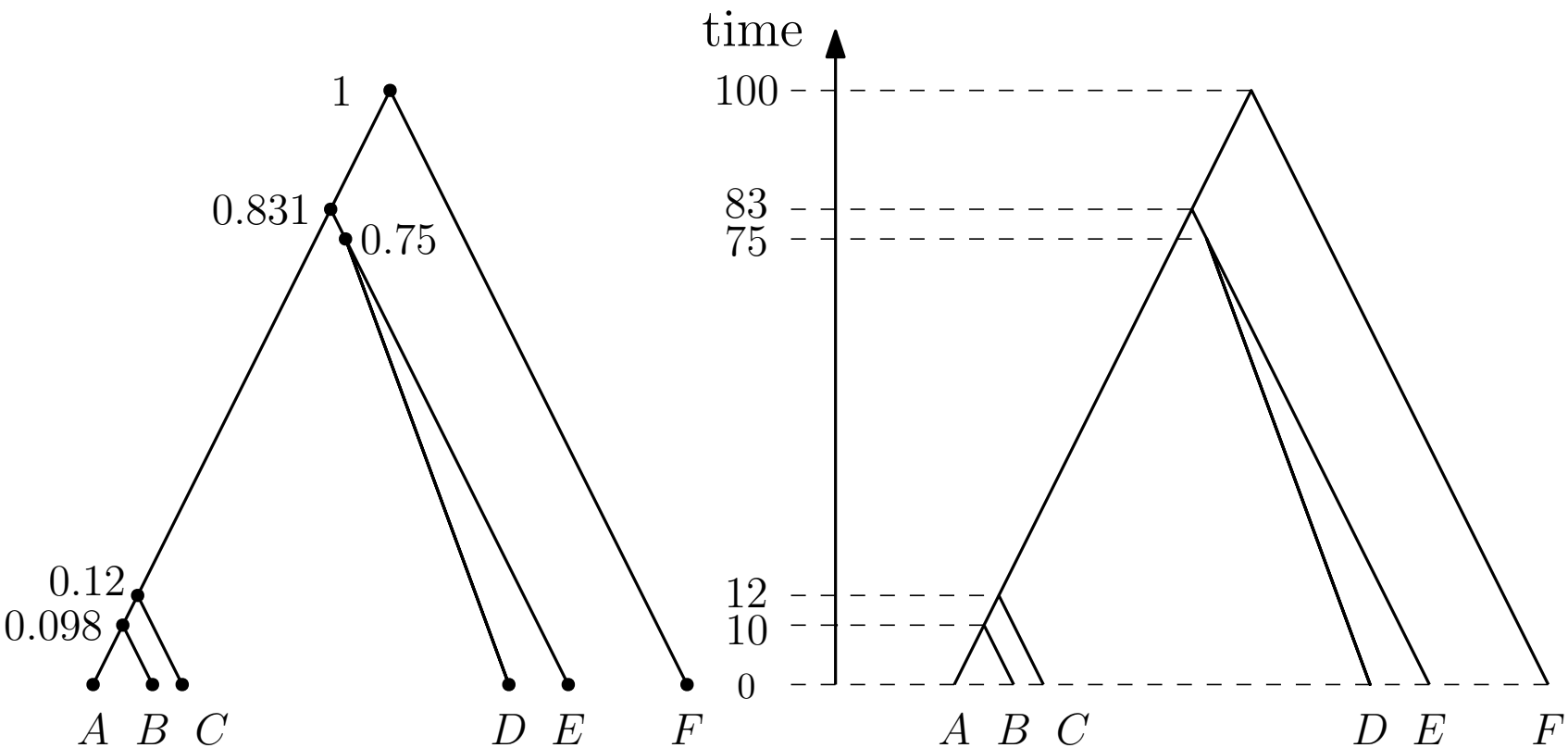


Generalising RNNI



Generalising RNNI

Discrete Coalescent Trees



Subtree Prune and Regraft

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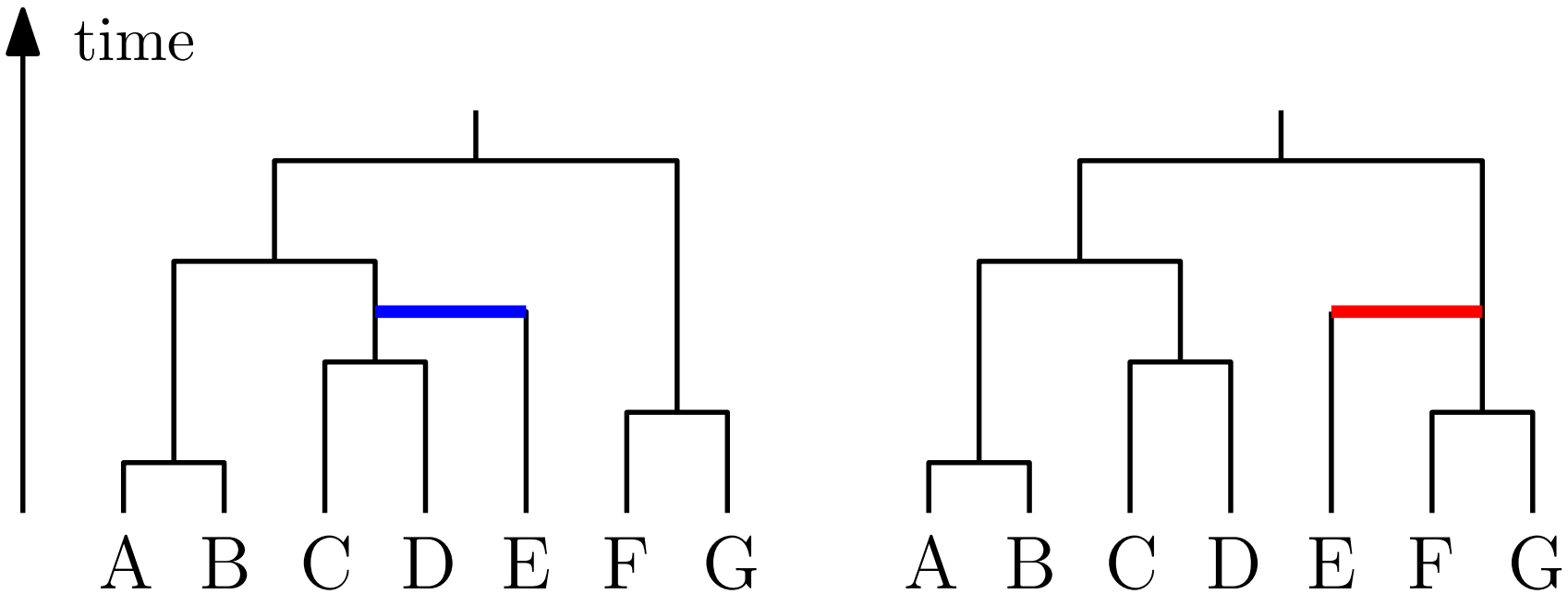

SPR on Ranked Trees

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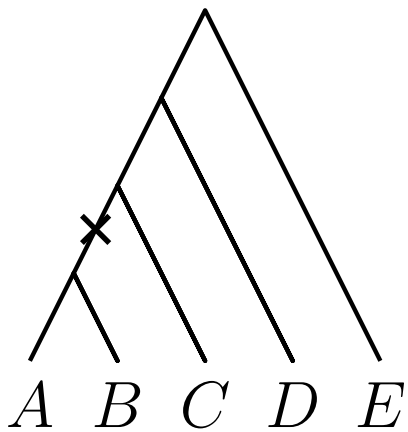

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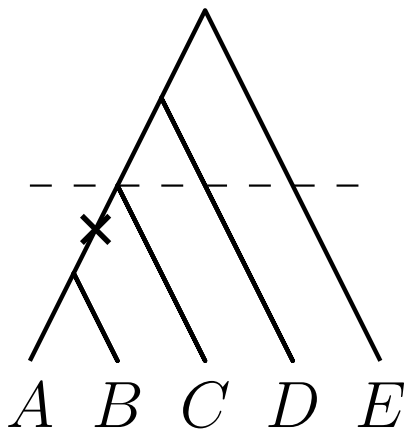

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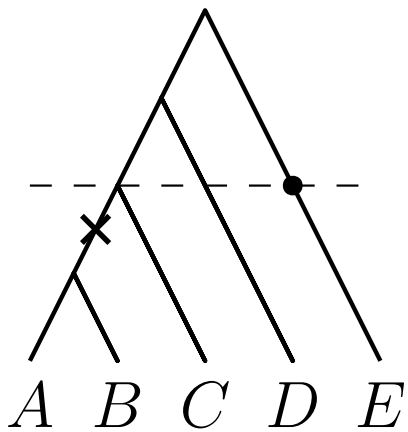
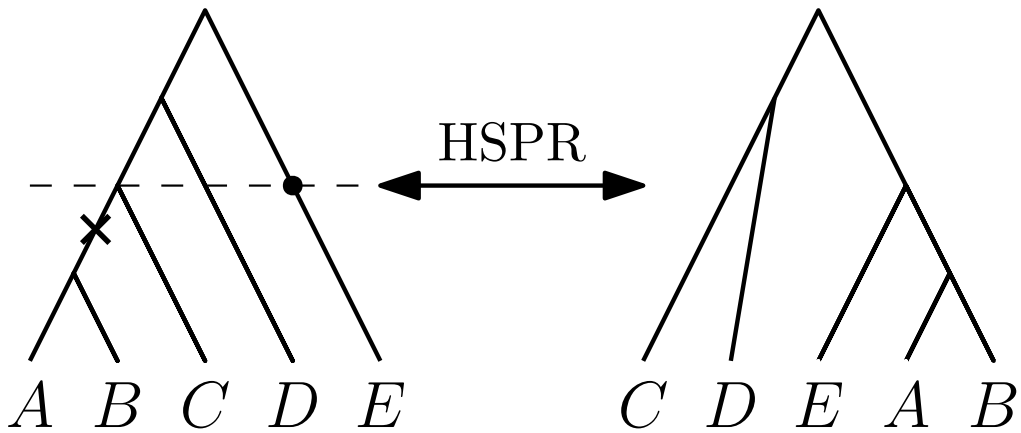


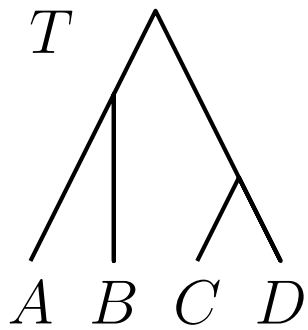
SPR on Ranked Trees

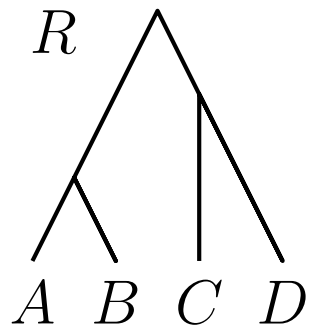
Horizontal SPR



SPR on Ranked Trees

HSPR is connected





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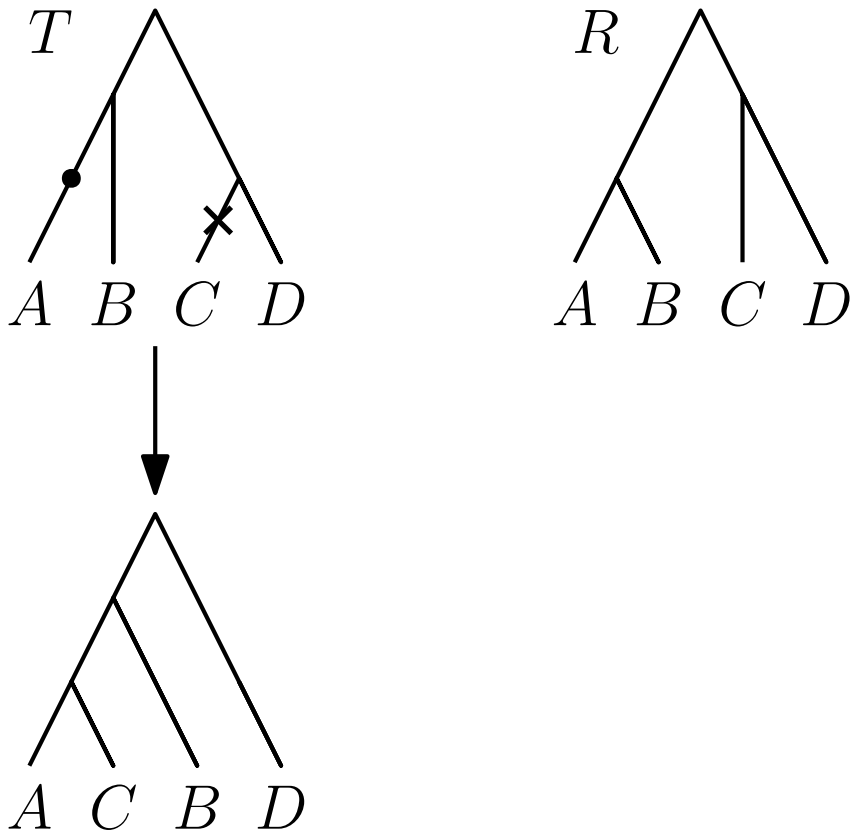

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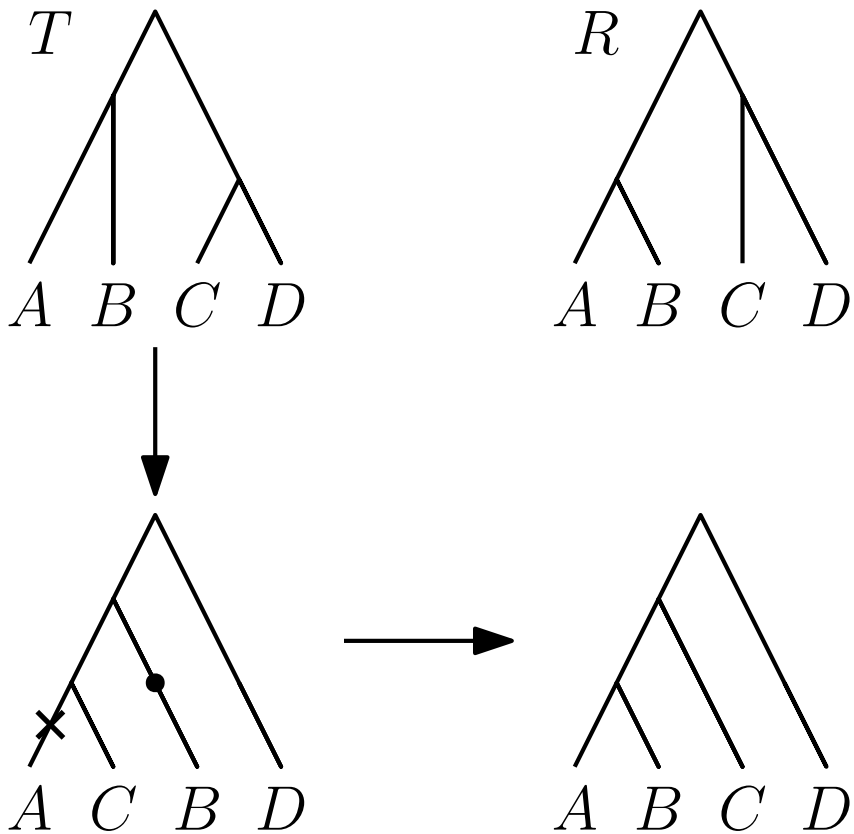

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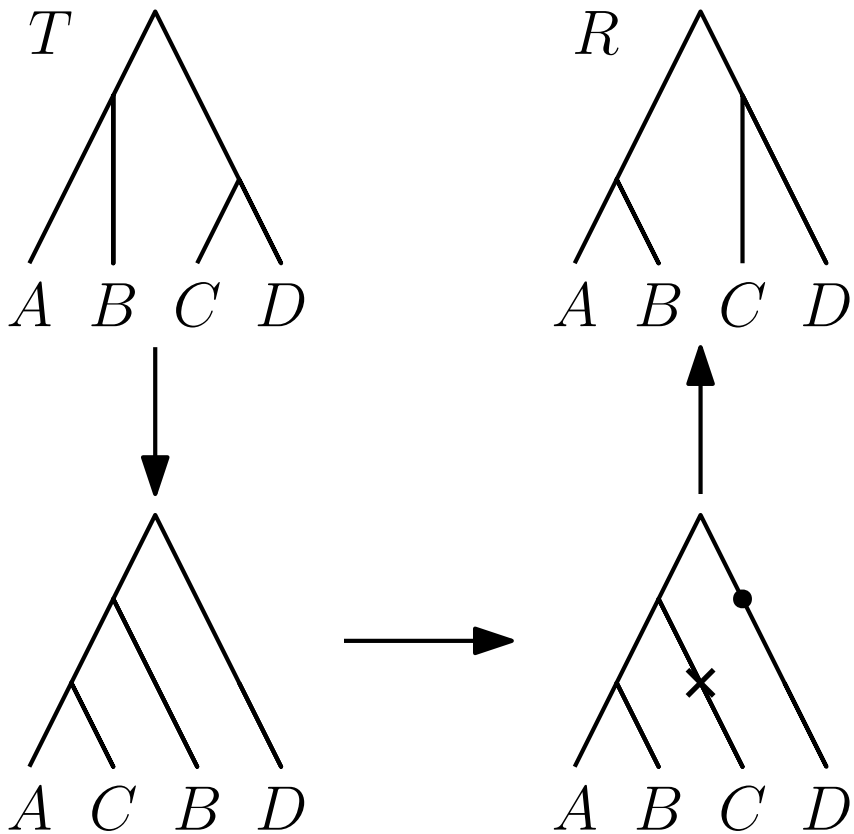

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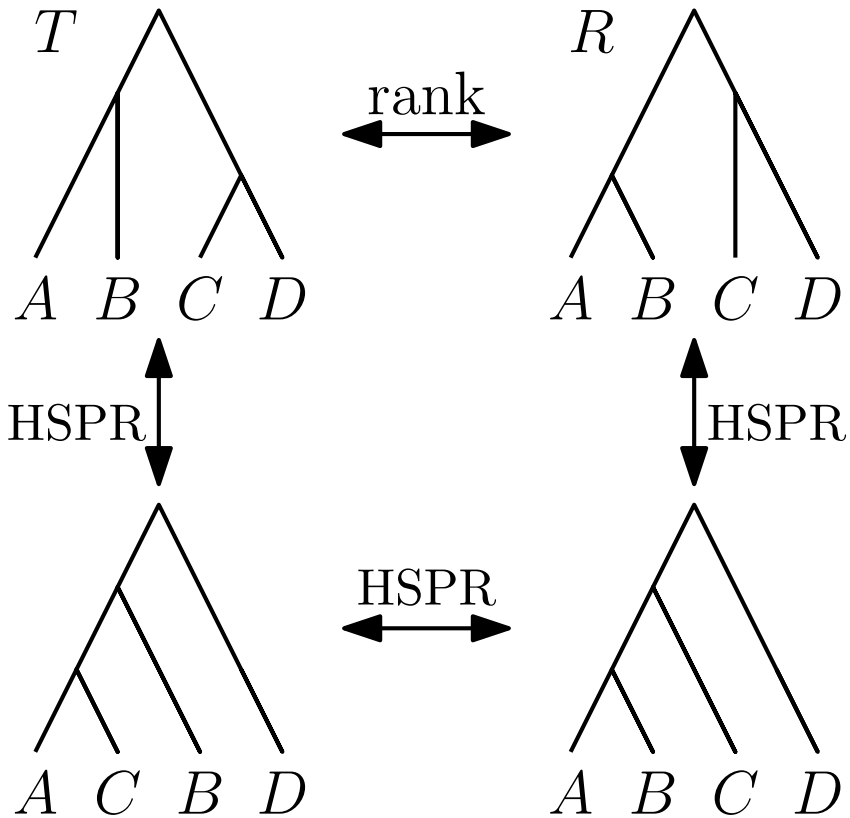
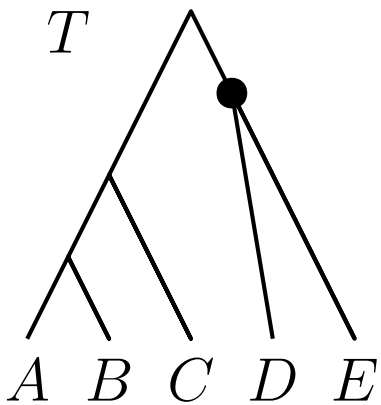
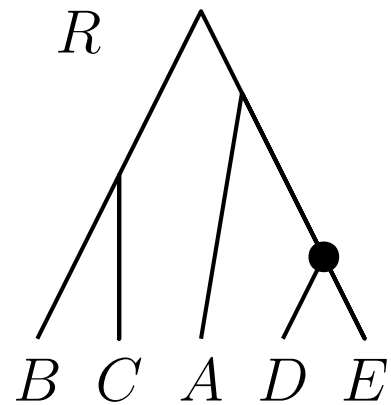


SPR on Ranked Trees

Clusters





SPR on Ranked Trees

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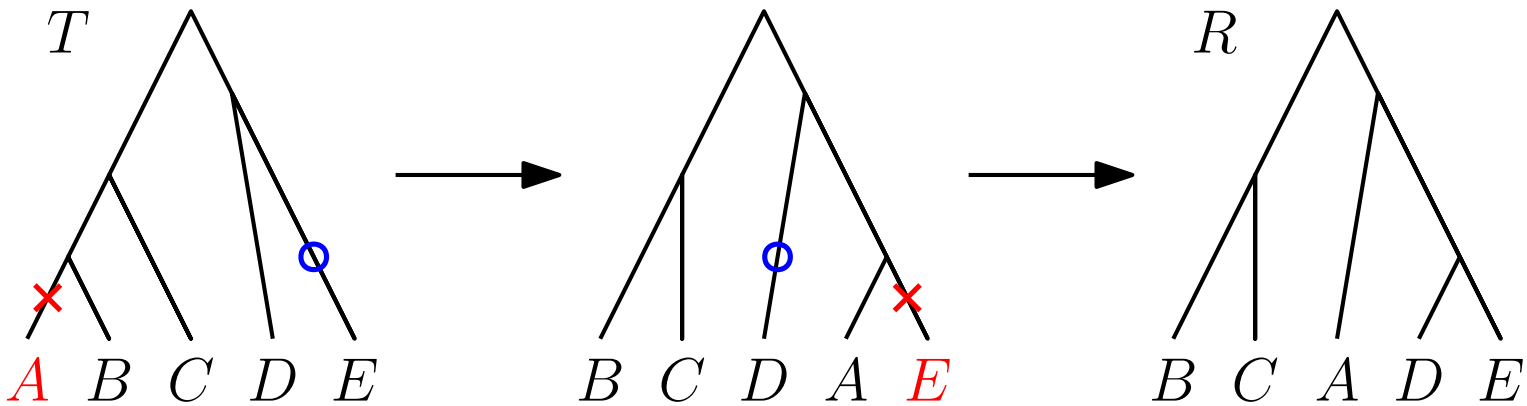

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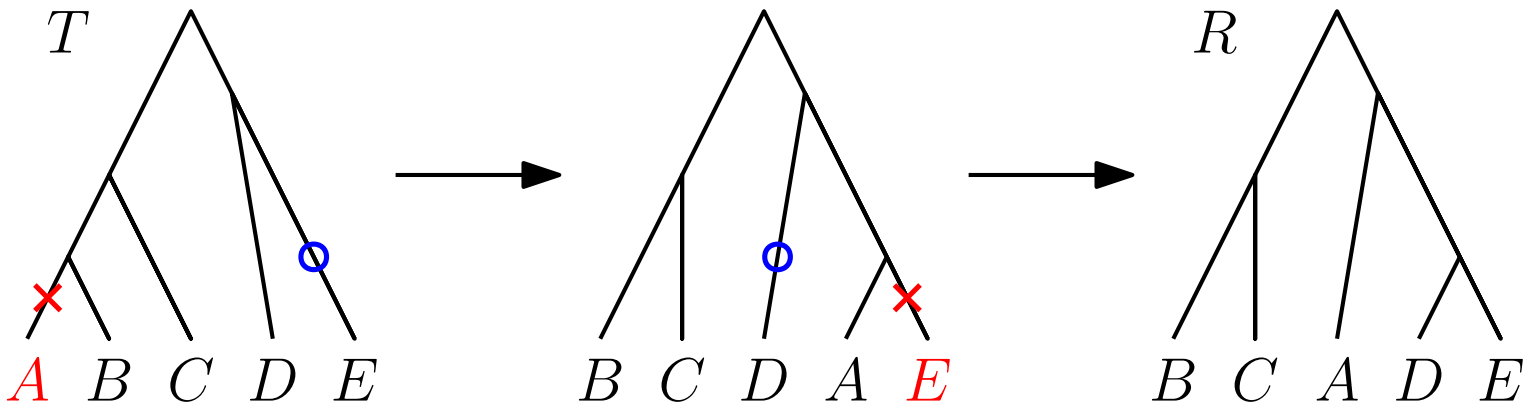


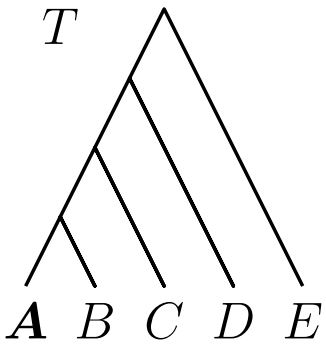
Open Question: What is the complexity of computing distances?

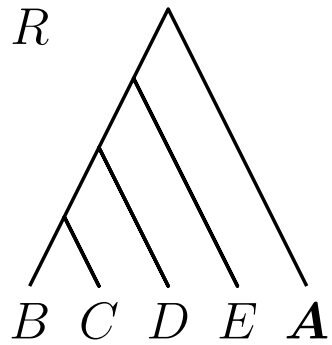
SPR on Ranked Trees

Adding leaves

SPR on Ranked Trees

Adding leaves





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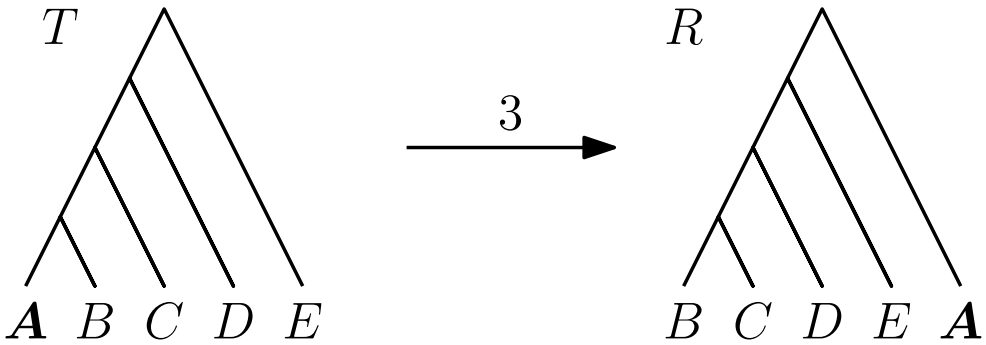
Adding leaves



SPR on Ranked Trees

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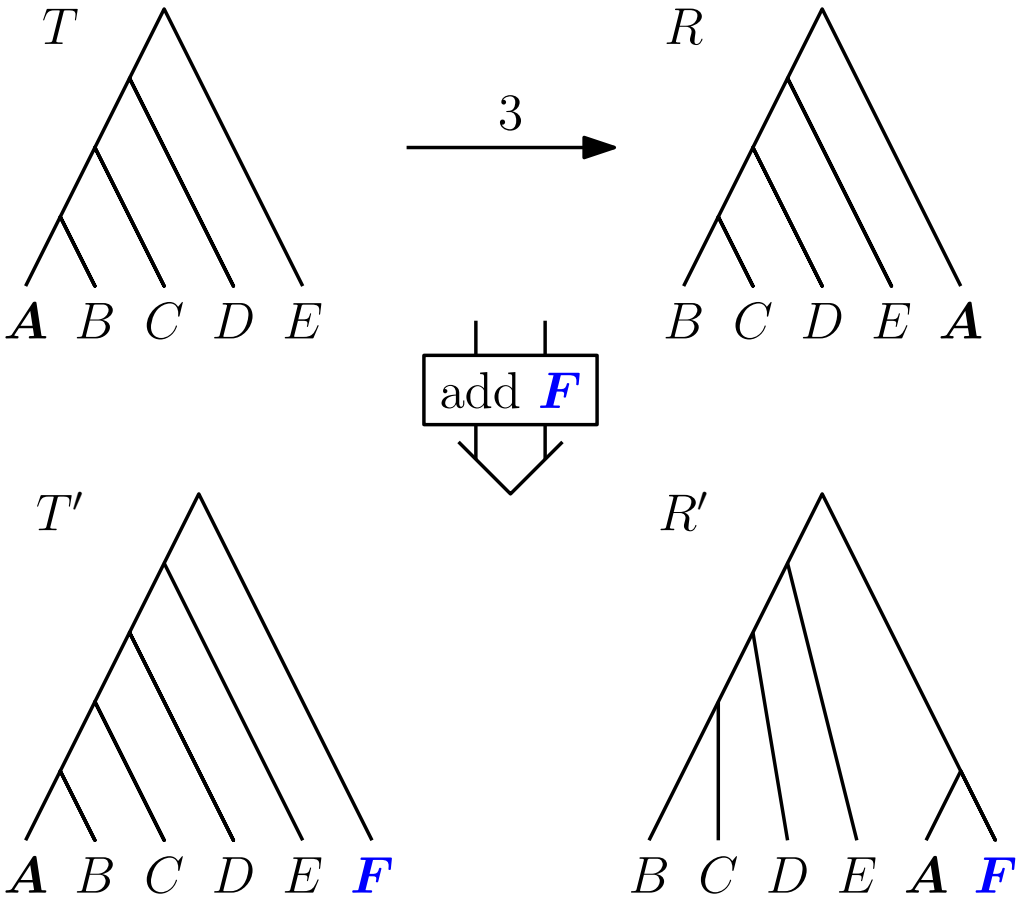

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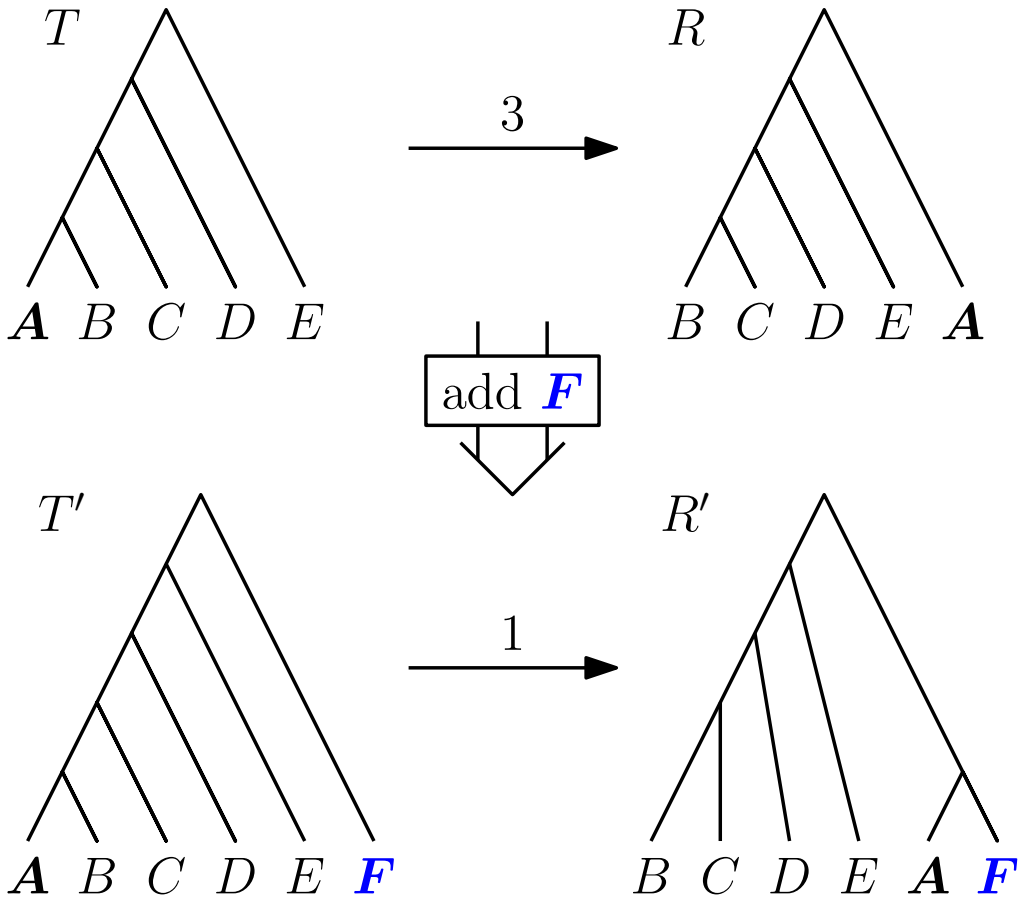

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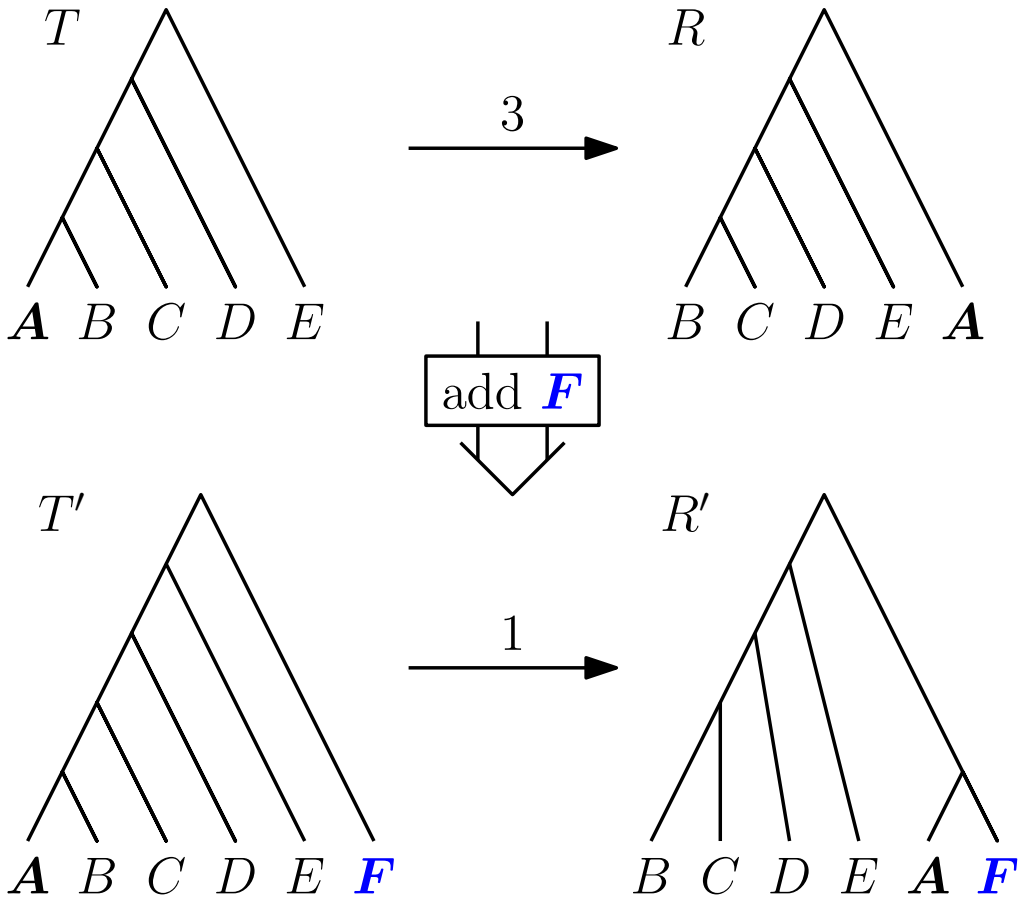
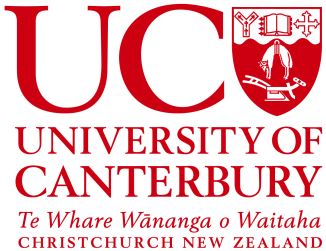
Adding leaves



Theorem

Adding a leaf to a tree can decrease the distance by $O(n)$.

Thank you



- Alex Gavryushkin
- Lars Berling

- David Bryant

- Chris Whidden

Supplement

Probability distributions in BHV-space