

Preview: PACE 2026

Alexander Leonhardt¹, Manuel Penschuck², Mathias Weller³

¹Goethe-Universität Frankfurt, Germany

²University of Southern Denmark, Odense, Denmark

³CNRS, Université Gustave Eiffel, Paris, France

<https://pacechallenge.org/>

Scientific Topic: Agreement Forests

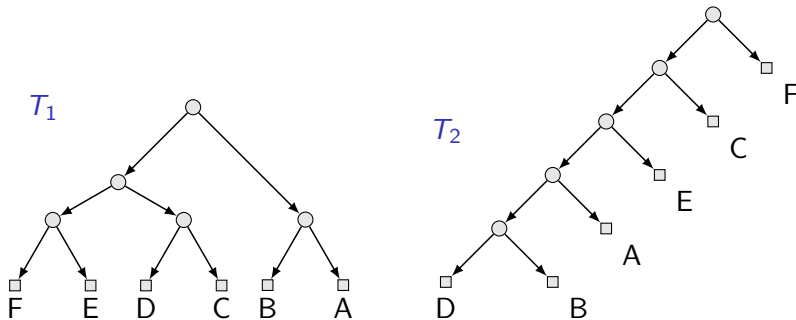
Definition

- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.

Scientific Topic: Agreement Forests

Definition

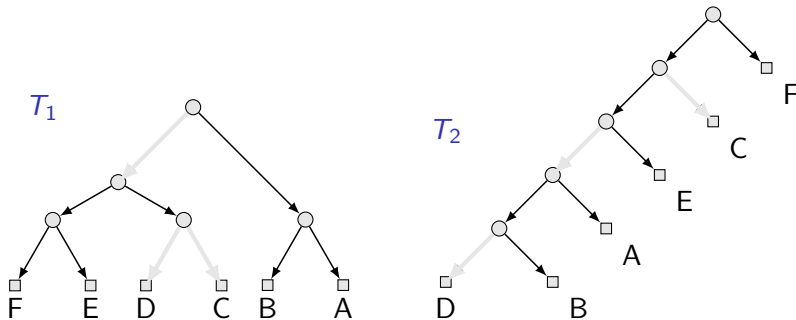
- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.
- ▶ An **agreement forest** of t phylogenetic trees T_1, T_2, \dots, T_t is any forest of phylogenetic trees that can be obtained from each T_i by removing directed edges (+ “cleanup”)



Scientific Topic: Agreement Forests

Definition

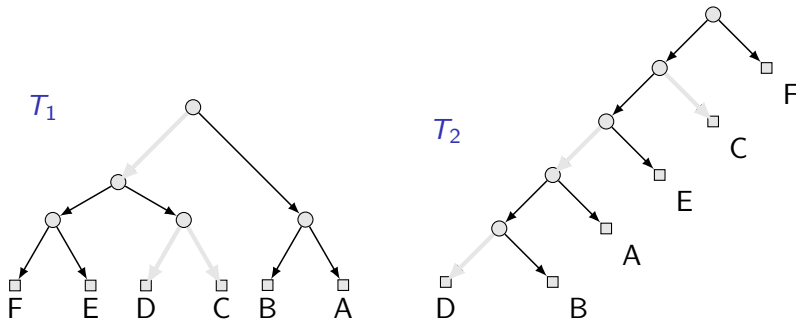
- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.
- ▶ An **agreement forest** of t phylogenetic trees T_1, T_2, \dots, T_t is any forest of phylogenetic trees that can be obtained from each T_i by removing directed edges (+ “cleanup”)



Scientific Topic: Agreement Forests

Definition

- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.
- ▶ An **agreement forest** of t phylogenetic trees T_1, T_2, \dots, T_t is any forest of phylogenetic trees that can be obtained from each T_i by removing directed edges (+ “cleanup”)
- ▶ The number of phylogenetic trees in an agreement forest F is called its **size**. If F has minimum size (maximizes the agreement), it is called a **maximum-agreement forest**.



Scientific Topic: Agreement Forests

Definition

- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.
- ▶ An **agreement forest** of t phylogenetic trees T_1, T_2, \dots, T_t is any forest of phylogenetic trees that can be obtained from each T_i by removing directed edges (+ “cleanup”)
- ▶ The number of phylogenetic trees in an agreement forest F is called its **size**. If F has minimum size (maximizes the agreement), it is called a **maximum-agreement forest**.

Results for $t = 2$, $\text{MAF}(T, T') = k$

- ▶ NP-hard Bordewich & Semple, '04
- ▶ $O(2.35^k n)$ time Chen & Wang, '13
($O(2^k n)$ time claimed) Whidden, '13
- ▶ problem kernel with $28k$ taxa Bordewich & Semple, '05

Scientific Topic: Agreement Forests

Definition

- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.
- ▶ An **agreement forest** of t phylogenetic trees T_1, T_2, \dots, T_t is any forest of phylogenetic trees that can be obtained from each T_i by removing directed edges (+ “cleanup”)
- ▶ The number of phylogenetic trees in an agreement forest F is called its **size**. If F has minimum size (maximizes the agreement), it is called a **maximum-agreement forest**.

Results for $t = 2$, $\text{MAF}(T, T') = k$

- ▶ NP-hard Bordewich & Semple, '04
- ▶ $O(2.35^k n)$ time Chen & Wang, '13
($O(2^k n)$ time claimed) Whidden, '13
- ▶ problem kernel with $28k$ taxa Bordewich & Semple, '05

Results for $\text{MAF}(T_1, T_2, \dots, T_t) = k$

- ▶ $O(3^k n^2 t)$ time Shi et al. '14
 $O(2.42^k n^4 t^3)$ time Shi et al. '18

Scientific Topic: Agreement Forests

Definition

- ▶ A **phylogenetic tree** is a rooted, bijectively leaf-labelled out-branching.
- ▶ An **agreement forest** of t phylogenetic trees T_1, T_2, \dots, T_t is any forest of phylogenetic trees that can be obtained from each T_i by removing directed edges (+ “cleanup”)
- ▶ The number of phylogenetic trees in an agreement forest F is called its **size**. If F has minimum size (maximizes the agreement), it is called a **maximum-agreement forest**.

Results for $t = 2$, $\text{MAF}(T, T') = k$

- ▶ NP-hard Bordewich & Semple, '04
- ▶ $O(2.35^k n)$ time Chen & Wang, '13
($O(2^k n)$ time claimed) Whidden, '13
- ▶ problem kernel with $28k$ taxa Bordewich & Semple, '05

Results for $\text{MAF}(T_1, T_2, \dots, T_t) = k$

- ▶ $O(3^k n^2 t)$ time Shi et al. '14
 $O(2.42^k n^4 t^3)$ time Shi et al. '18

Note: No other parameterization explored!

Organization and Data

Exact/Parameterized Track

- ▶ **t trees**
- ▶ **idea:** instances accompanied by parameters
(with proof, e.g. decomposition)
- ▶ committee takes requests for parameters in the first months
- ▶ parameter statistics of hidden instances available in advance

Organization and Data

Exact/Parameterized Track

- ▶ t trees
- ▶ **idea**: instances accompanied by parameters
(with proof, e.g. decomposition)
- ▶ committee takes requests for parameters in the first months
- ▶ parameter statistics of hidden instances available in advance

Heuristic Track

- ▶ 2 trees
- ▶ as usual

Organization and Data

Exact/Parameterized Track

- ▶ **t trees**
- ▶ **idea**: instances accompanied by parameters
(with proof, e.g. decomposition)
- ▶ committee takes requests for parameters in the first months
- ▶ parameter statistics of hidden instances available in advance

Heuristic Track

- ▶ **2 trees**
- ▶ as usual

Lower Bound Track

- ▶ **2 trees**
- ▶ **idea**: score depends on quality and runtime
- ▶ **idea**: reach approximation as fast as possible

Organization and Data

Exact/Parameterized Track

- ▶ **t trees**
- ▶ **idea**: instances accompanied by parameters
(with proof, e.g. decomposition)
- ▶ committee takes requests for parameters in the first months
- ▶ parameter statistics of hidden instances available in advance

Heuristic Track

- ▶ **2 trees**
- ▶ as usual

Lower Bound Track

- ▶ **2 trees**
- ▶ **idea**: score depends on quality and runtime
- ▶ **idea**: reach approximation as fast as possible

Real-World Data

expect few trees, small MAF, many leaves

Organization and Data

Exact/Parameterized Track

- ▶ **t trees**
- ▶ **idea:** instances accompanied by parameters
(with proof, e.g. decomposition)
- ▶ committee takes requests for parameters in the first months
- ▶ parameter statistics of hidden instances available in advance

Heuristic Track

- ▶ **2 trees**
- ▶ as usual

Lower Bound Track

- ▶ **2 trees**
- ▶ **idea:** score depends on quality and runtime
- ▶ **idea:** reach approximation as fast as possible

Real-World Data

expect few trees, small MAF, many leaves

Generated Data

expect many trees, large MAF, many leaves

Timeline

mostly follows previous PACE-instances

- September '25 Announcement of the challenge and tracks
- October '25 Definition of input and output formats
- November '25 Tiny test set and verifier are provided
- January '26 Release of public instances and details about the benchmark
- April '26 Submission via optil.io opens
- July '26 Final submission deadline and results

Timeline

mostly follows previous PACE-instances

- September '25 Announcement of the challenge and tracks
- October '25 Definition of input and output formats
- November '25 Tiny test set and verifier are provided
- January '26 Release of public instances and details about the benchmark
- April '26 Submission via optil.io opens
- July '26 Final submission deadline and results

– good luck and an enjoyable competition –