

Reconstruction Problem
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Motivation
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Event Framework
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Example
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A new event framework for
Co-evolution

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Outline

- 1 Reconstruction Problem
- 2 Motivation: Why new events?
- 3 New event framework
- 4 Example: Host-Parasite Systems

Reconstruction Problem
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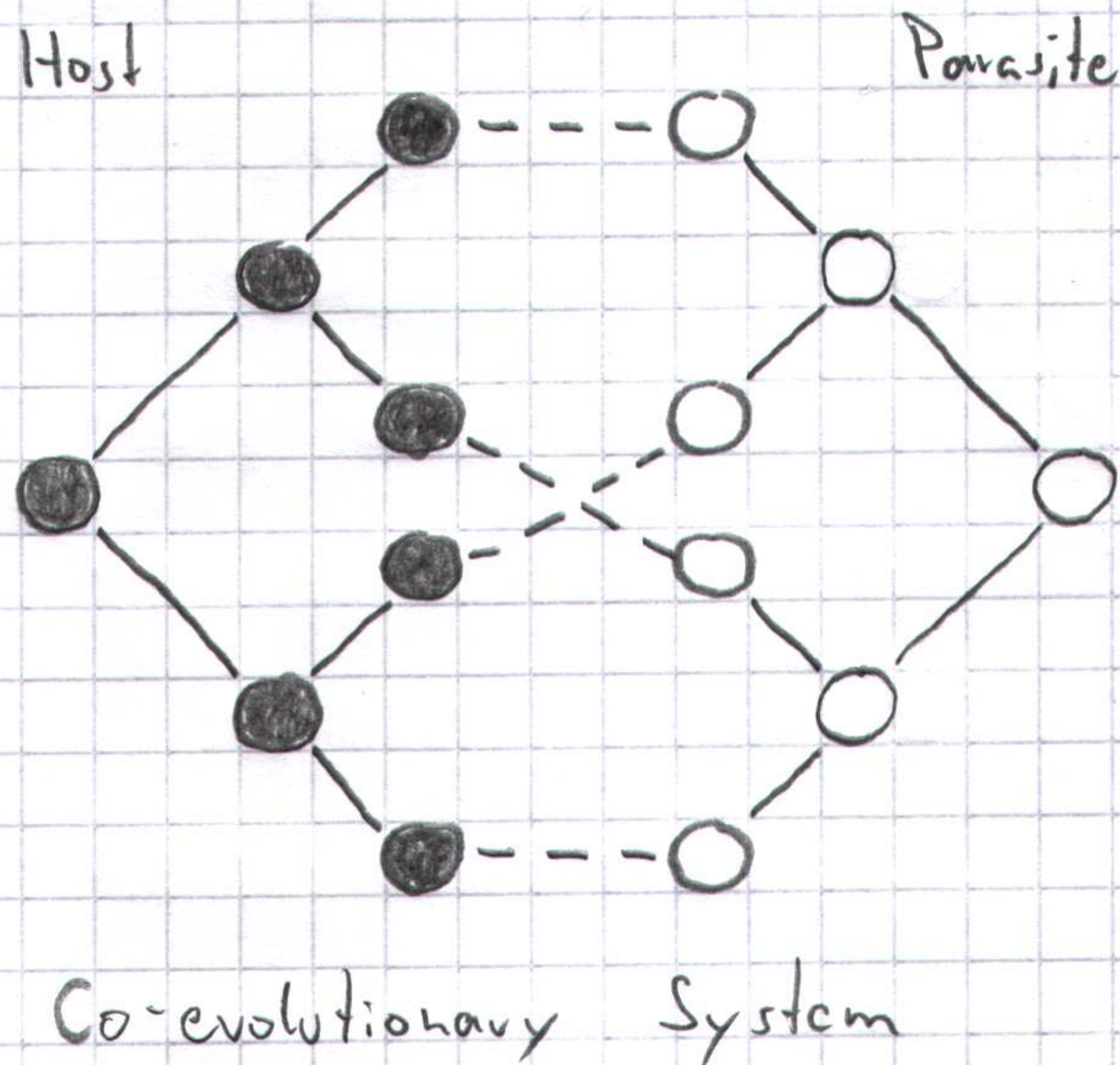
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Co-evolutionary Scenario

- Host phylogeny
- Parasite phylogeny
- Leaf-to-leaf association
 $\varphi_{P,H}$ from parasites
to hosts



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Example

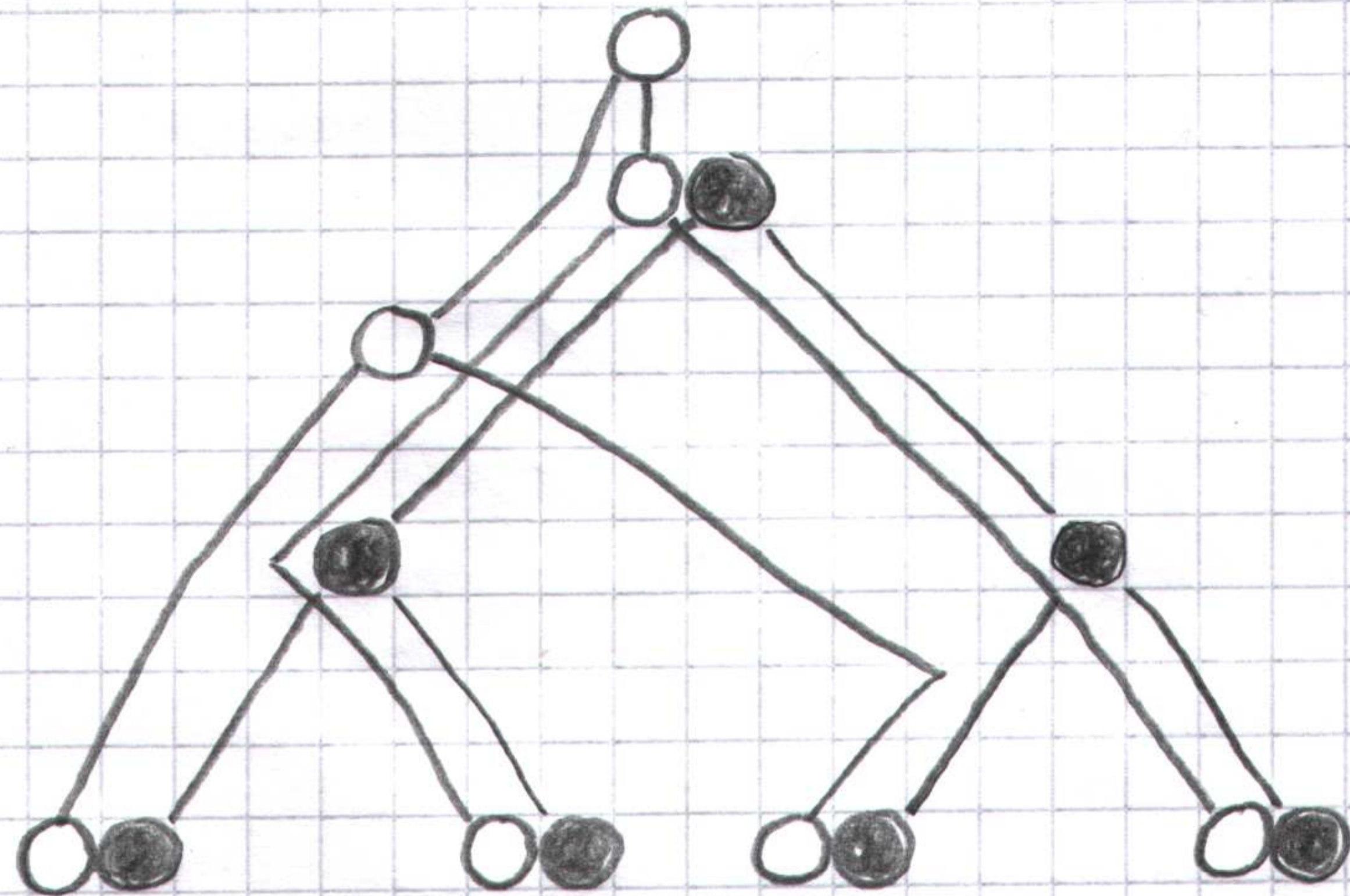
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Co-evolutionary Reconstruction

□ Mapping of parasite tree onto host tree

□ Node-to-node association

□ Node-to-edge association



Co-evolutionary Reconstruction

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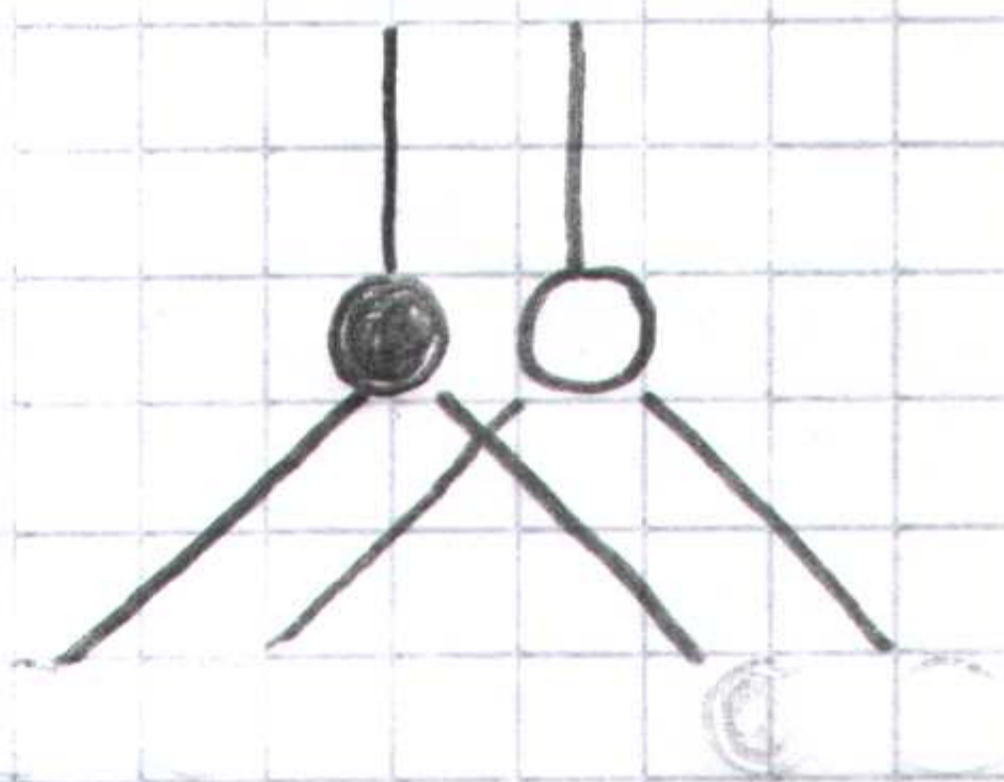
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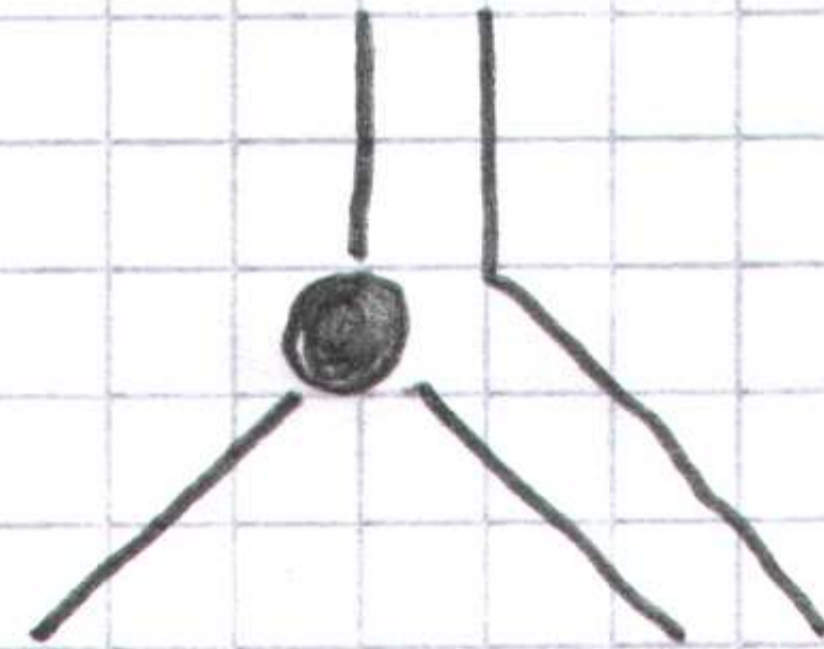
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Co-evolutionary events (4-event model)

□ Describe a reconstruction as set of co-evolutionary events



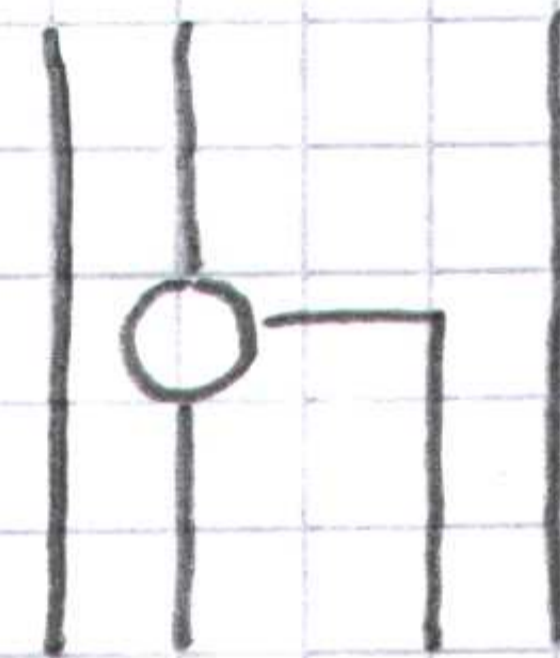
Cospeciation



Sorting



Duplication



Host switch

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State-of-the-art approach

- Define costs for each type of event
- Rate a reconstruction by the sum of all event costs
- chose the one with minimal total costs

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Problem:

Different types of applications require different types
of events

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Motivation 1

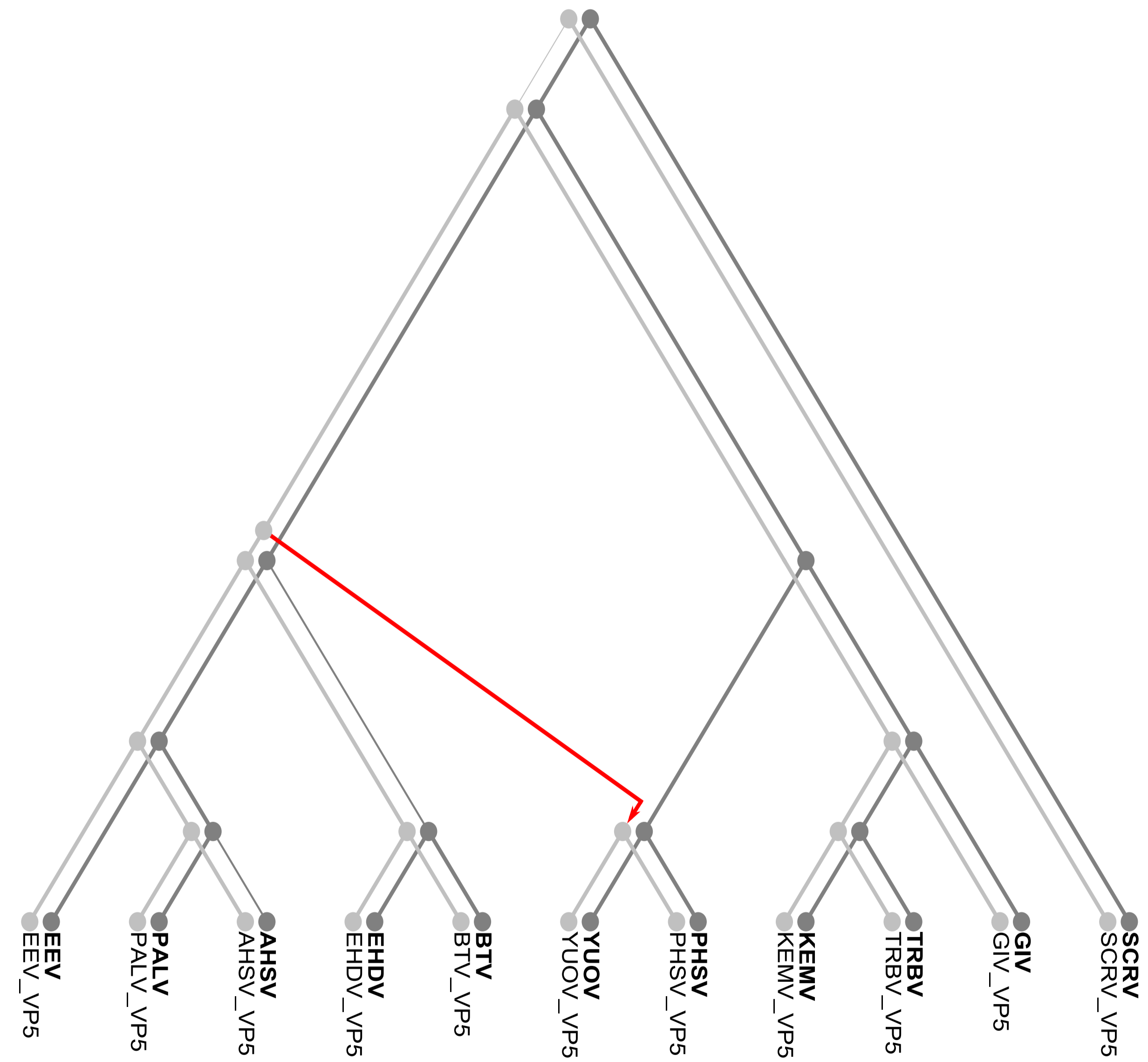
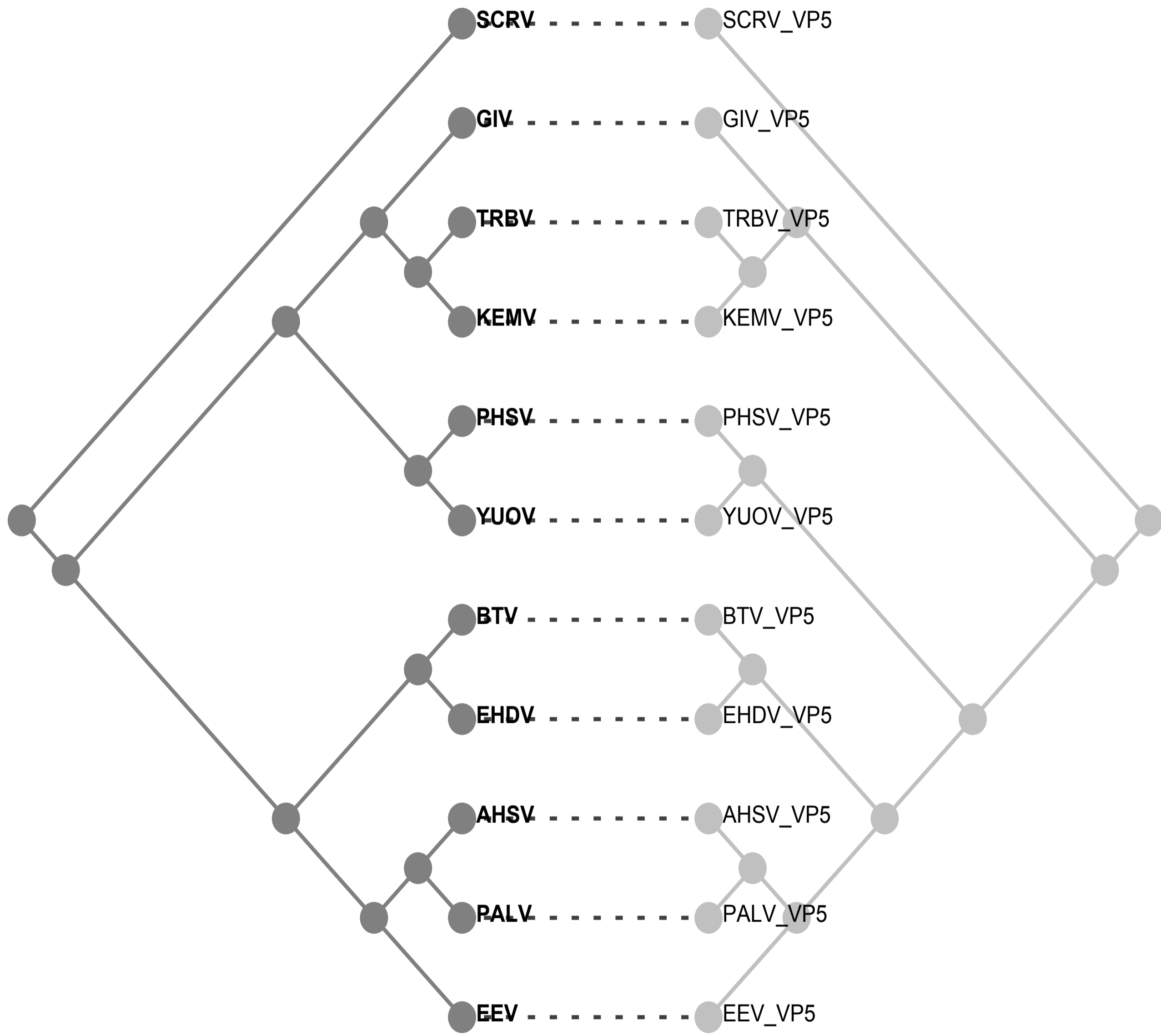
Protein coding regions as parasites on the viral genome

□ Viral phylogeny of 11 orbiviruses

□ one phylogeny for each protein coding region

→ detect potential horizontal gene transfer to explain differences between the trees

Problem: no interpretation of the duplication event



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Motivation 1

Protein coding regions as parasites on the viral genome

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Motivation 2

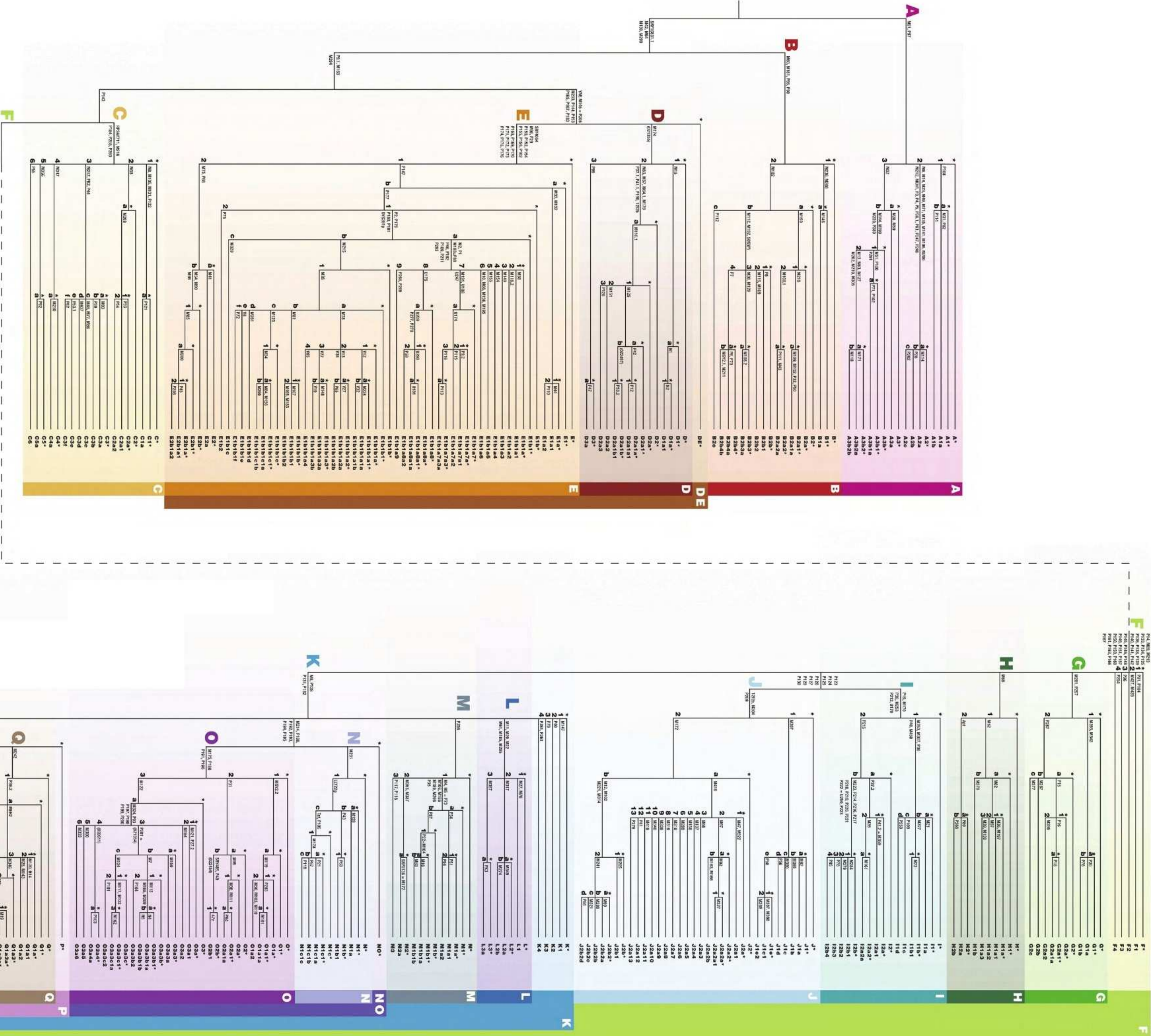
Languages as parasites on the human genome

□ Phylogeny of Y Chromosome Haplotypes

□ Phylogeny of indo-european languages

→ detect movement of large speaker groups

Problem: no interpretation of the cospeciation event



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Motivation 2

Languages as parasites on the human genome

□ Phylogeny of Y Chromosome Haplotypes

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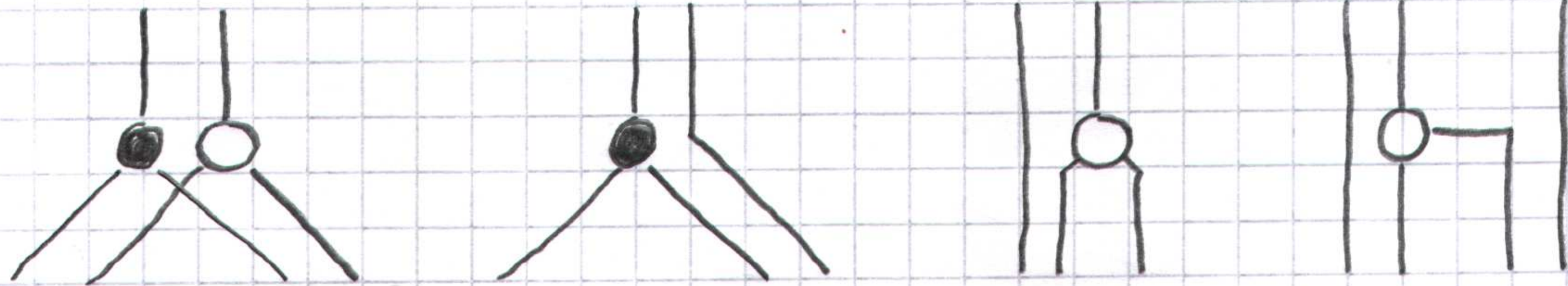
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Motivation 3

Multi-host parasites



Problem: events do not allow multi-host parasites

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Goal:

- Customizable event definitions to match different types of applications
- Reconstruction method that can handle all these different event definitions

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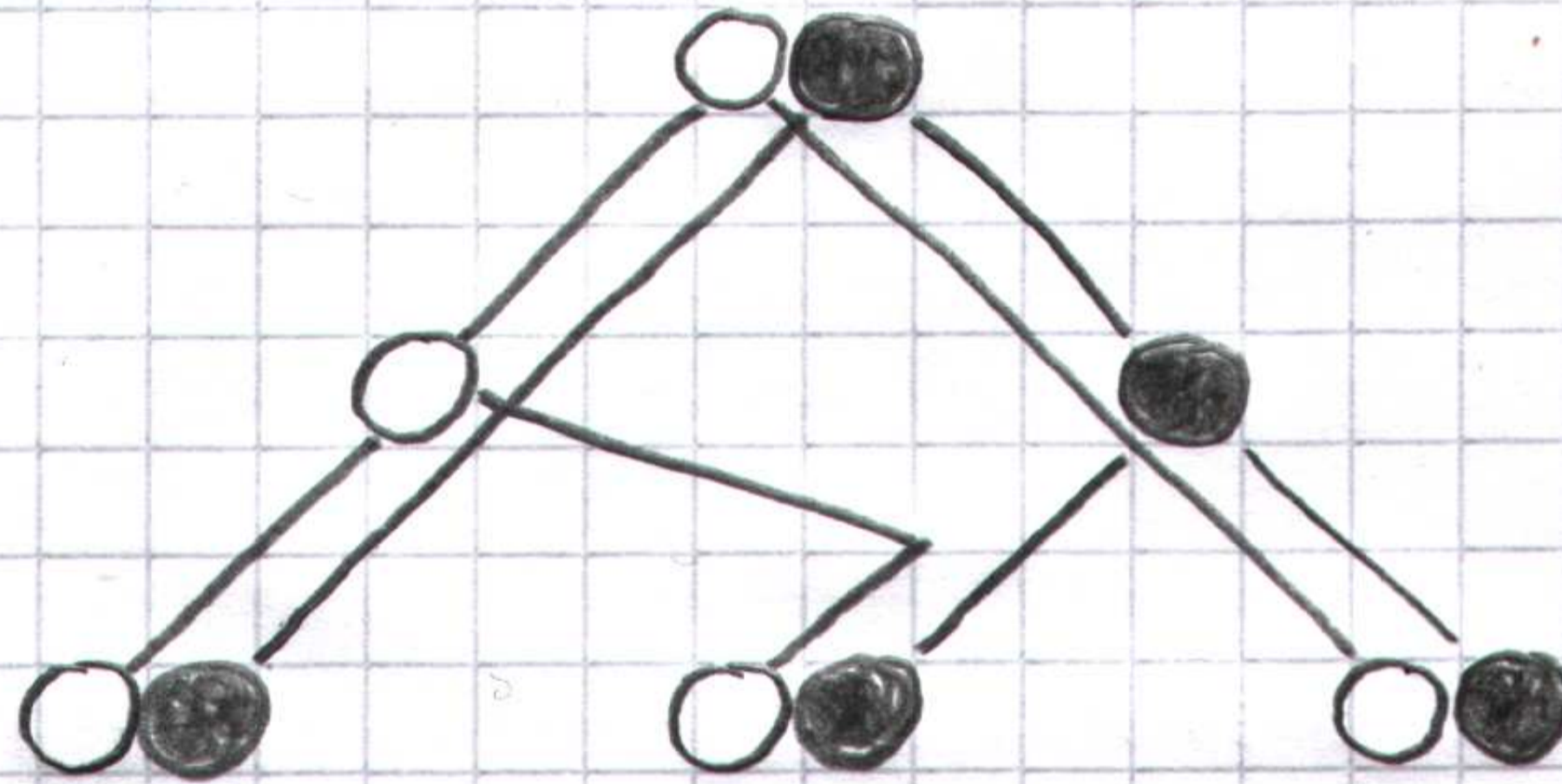
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Generalization of the Reconstruction

□ Edge-to-edge associations instead of node-to-node and node-to-edge



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General event model framework

□ Define events as description of local association scenarios

p_h	p'_h	p_h	p'_h	$p_{h.1}$	$p_{h.2}$	$p_{.1h}$	$p_{.2h}$	$p_{.1h.1}$	$p_{.2h.1}$	$p_{.1h.2}$	$p_{.2h.2}$
1	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0	0	1	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1	1

x' = parent of x
 x_i = i th child of x

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Example for Host-Parasite Systems

① Cospeciation



ph	$p'h'$	ph'	$p'h$	$ph_{.1}$	$ph_{.2}$	$p_{.1}h$	$p_{.2}h$	$p_{.1}h_{.1}$	$p_{.2}h_{.1}$	$p_{.1}h_{.2}$	$p_{.2}h_{.2}$
1	*	*	*	0	0	0	0	1	0	0	1
1	*	*	*	0	0	0	0	0	1	1	0

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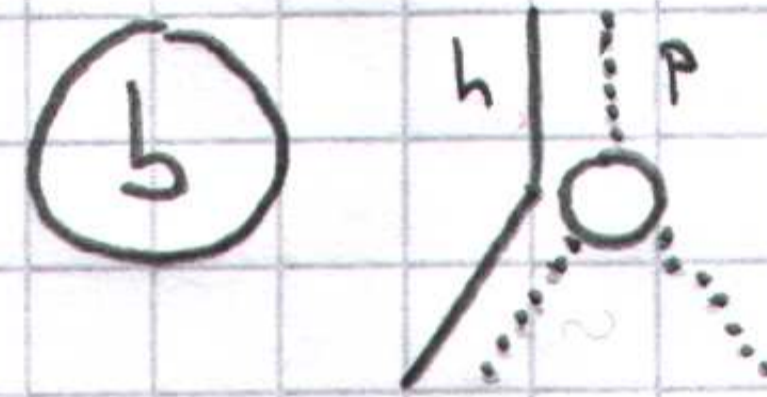
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Example
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Example for Host-Parasite Systems

② Sorting



p_h	p'_h	p_h	p'_h	$p_{h,1}$	$p_{h,2}$	$p_{,h}$	$p_{,h}$	$p_{,h,1}$	$p_{,h,1}$	$p_{,h,2}$	$p_{,h,2}$	
1	*	*	*	1	0	0	0	*	*	0	0	①
1	*	*	*	0	1	0	0	0	0	*	*	
1	*	*	*	0	0	1	0	*	0	*	0	②
1	*	*	*	0	0	0	1	0	*	0	*	

Reconstruction Problem
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Motivation
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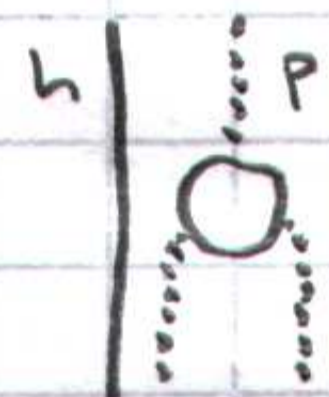
Event Framework
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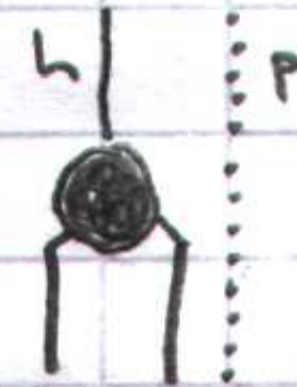
Example for Host-Parasite Systems

③ Duplication

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②



p_h	p'_h	p_h	p'_h	$p_{h,1}$	$p_{h,2}$	$p_{,h}$	$p_{,h}$	$p_{,h,1}$	$p_{,h,1}$	$p_{,h,2}$	$p_{,h,2}$	
1	*	*	*	0	0	1	1	*	*	*	*	①
1	*	*	*	1	1	0	0	*	*	*	*	②

Reconstruction Problem
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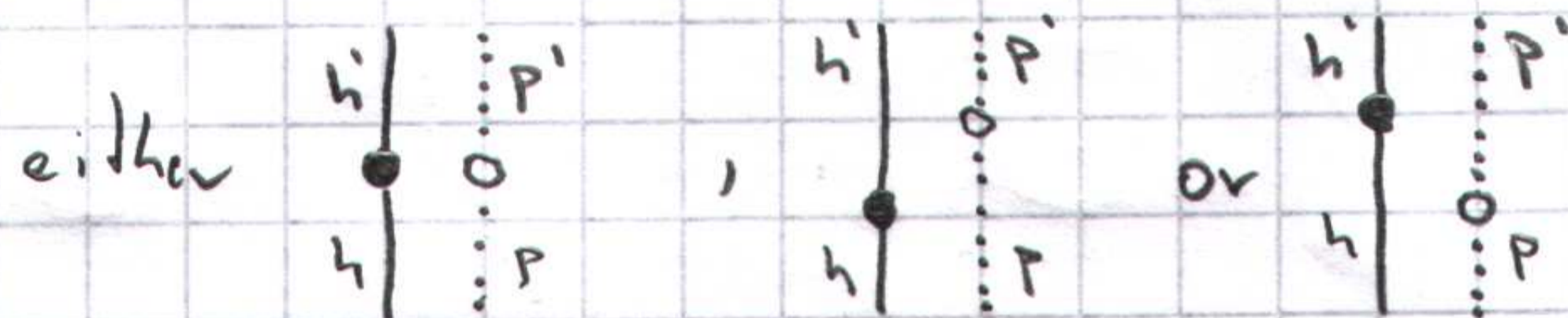
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Example for Host-Parasite Systems

⑤ Constraints



p_h	p'_h	p_h	p'_h	$p_{h,1}$	$p_{h,2}$	$p_{h,1}$	$p_{h,2}$	$p_{h,1}$	$p_{h,1}$	$p_{h,2}$	$p_{h,2}$
1	*	1	1	*	*	*	*	*	*	*	*
1	*	*	*	1	*	1	*	*	*	*	*
1	*	*	*	1	*	*	1	*	*	*	*
1	*	*	*	*	1	1	*	*	*	*	*
1	*	*	*	*	1	*	1	*	*	*	*

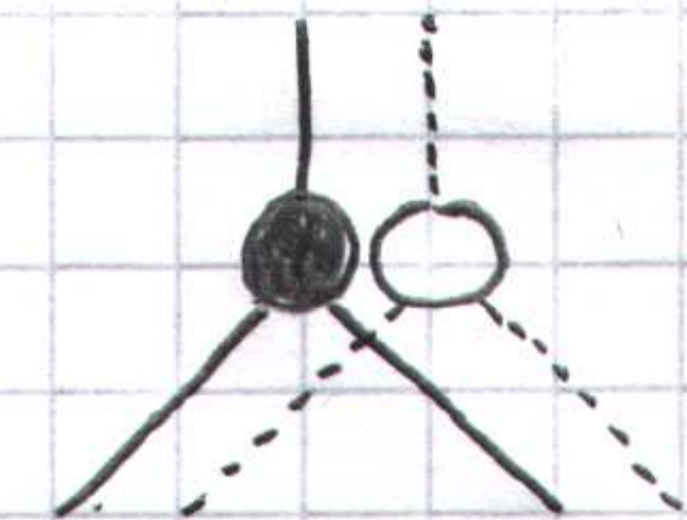
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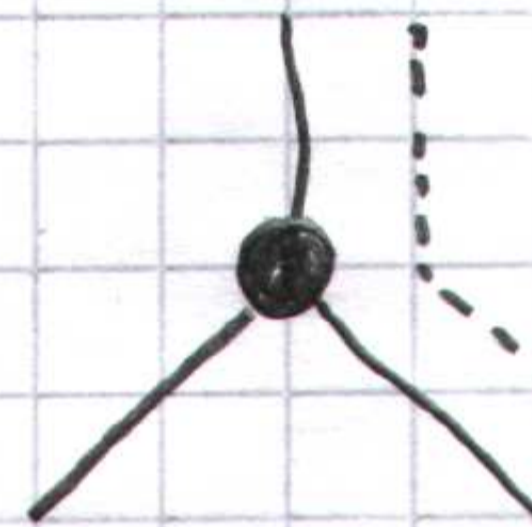
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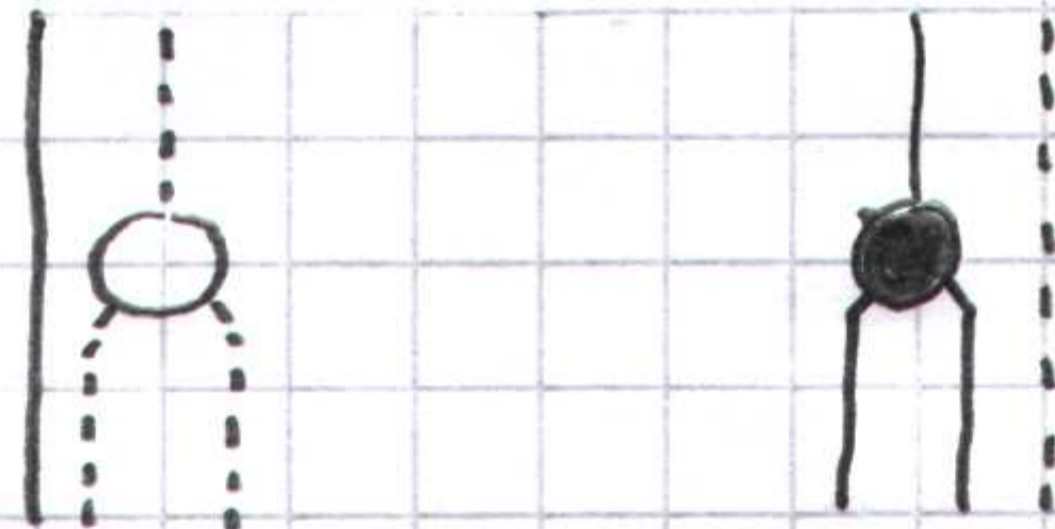
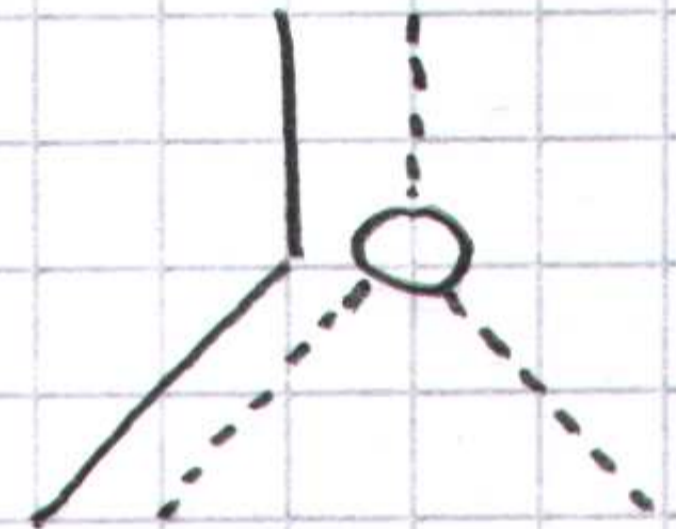
Example for Host-Parasite Systems



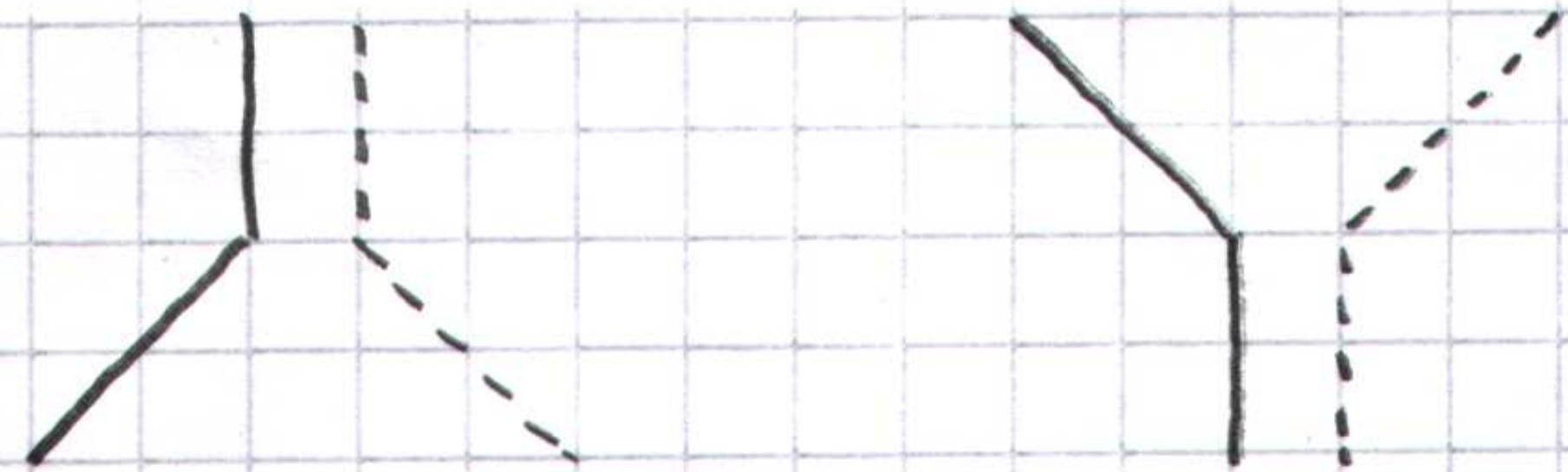
Cospeciation



Sorting



Duplication



Switching

Reconstruction Problem
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Summary

- Framework for defining individual co-evolutionary events based on local association scenarios to match different types of applications

Outlook

- Need for a fast reconstruction algorithm

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Thank You ...

Supported by the German Research Foundation through the project "Deep Metazoan Phylogeny" SPP 1774