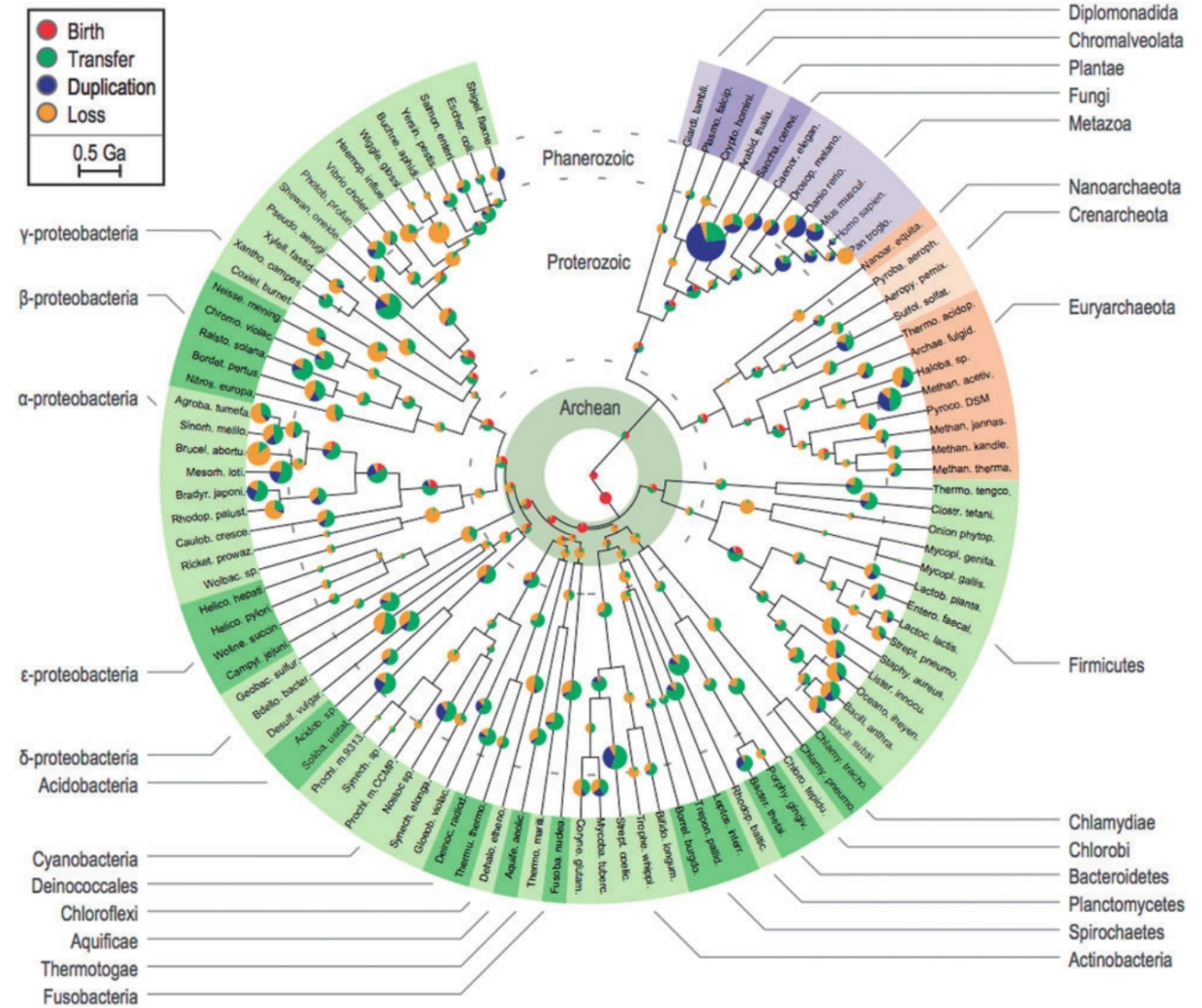
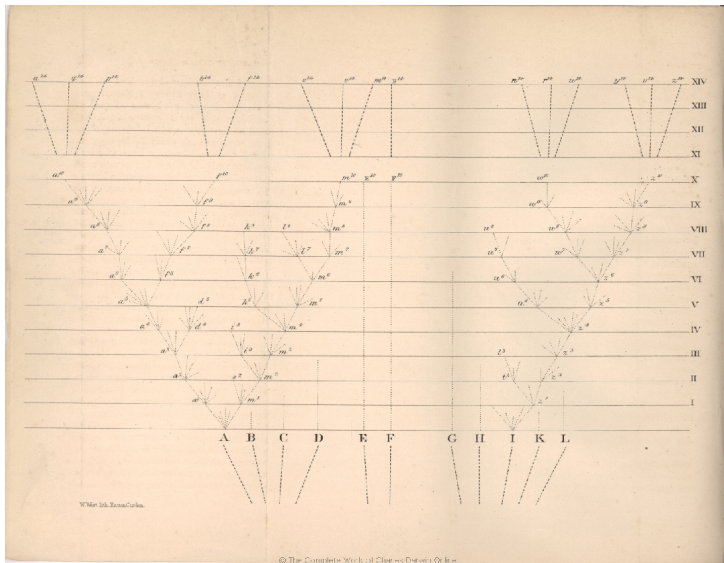
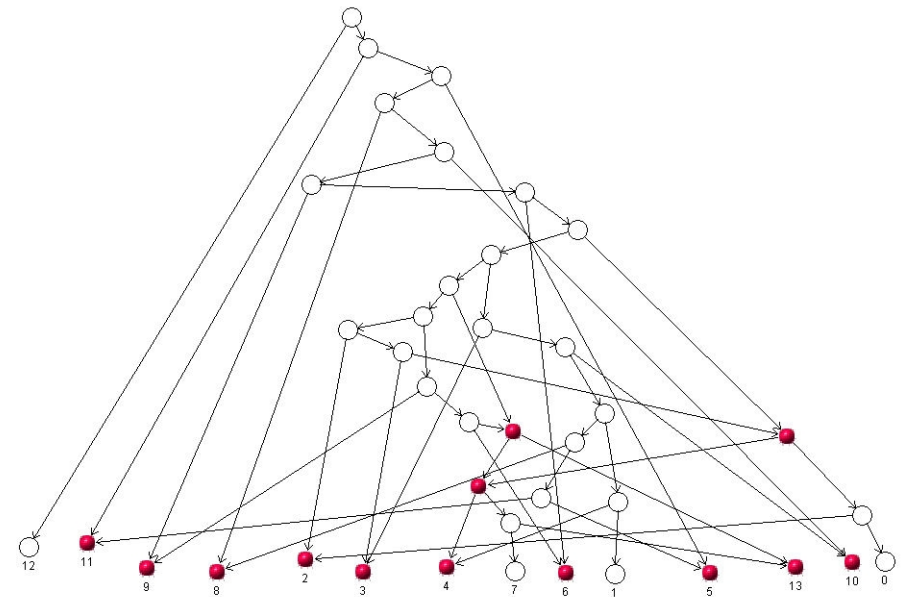
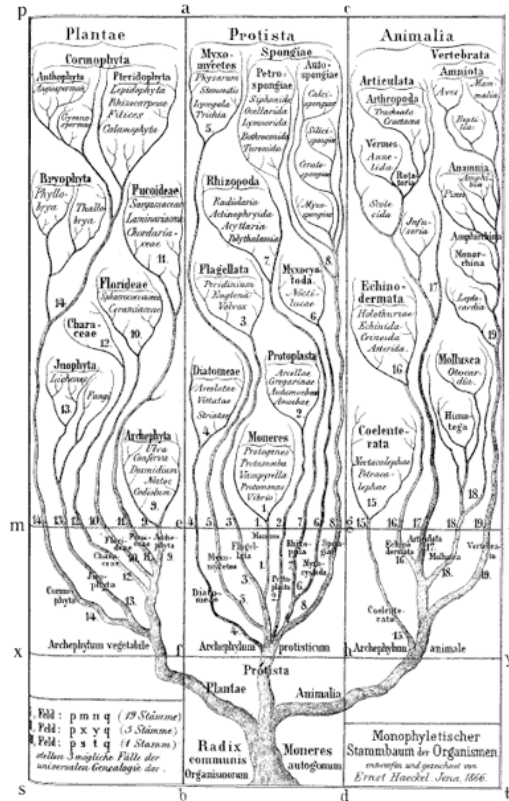
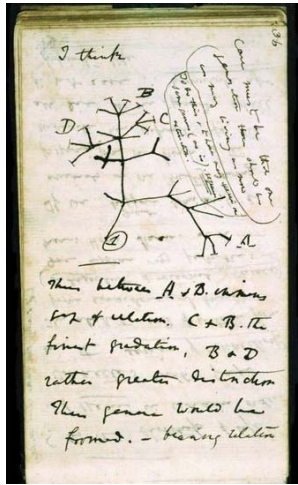




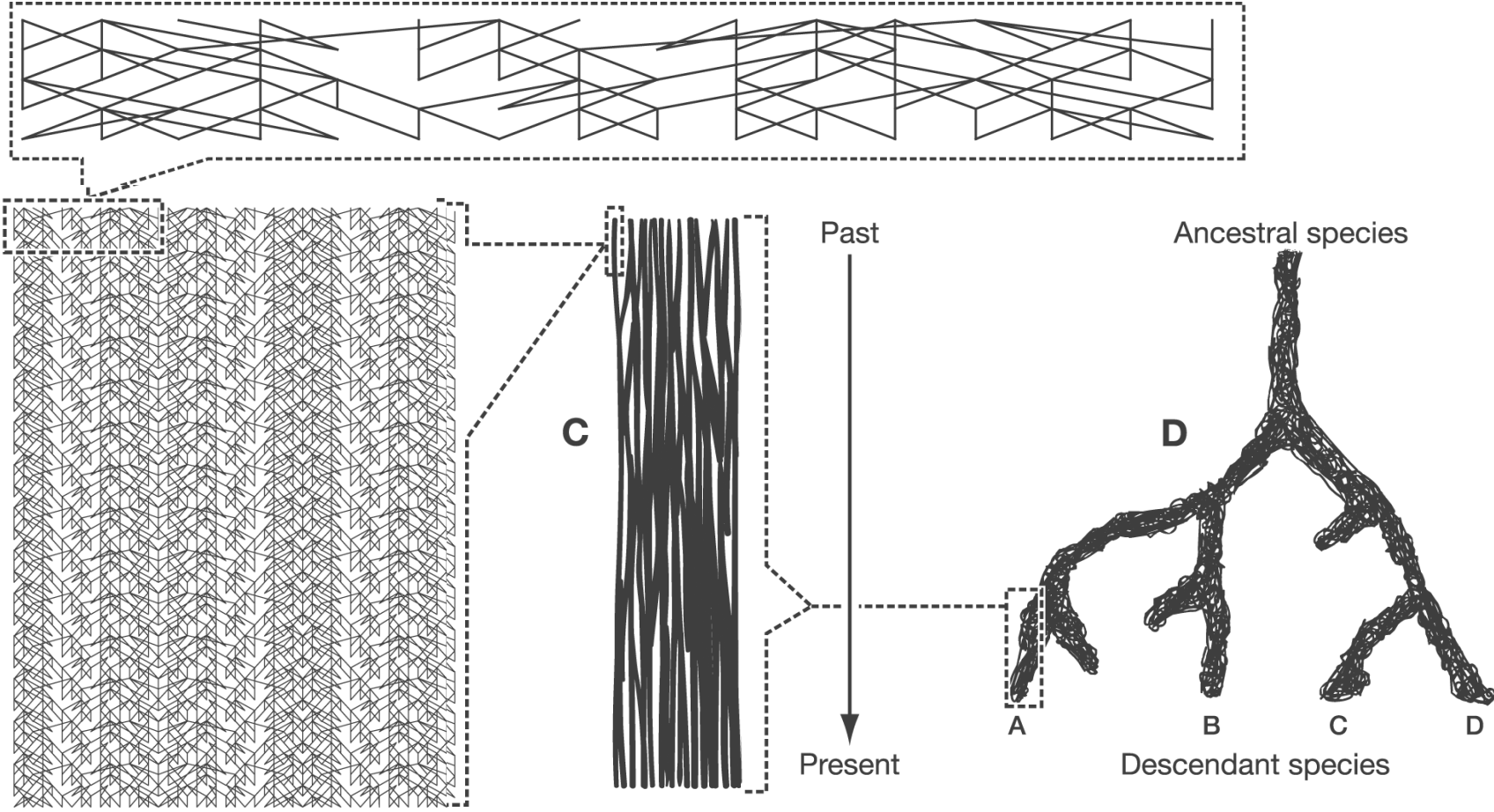
Topologias: grafos, enumeração e espaço



Modelo de representação:

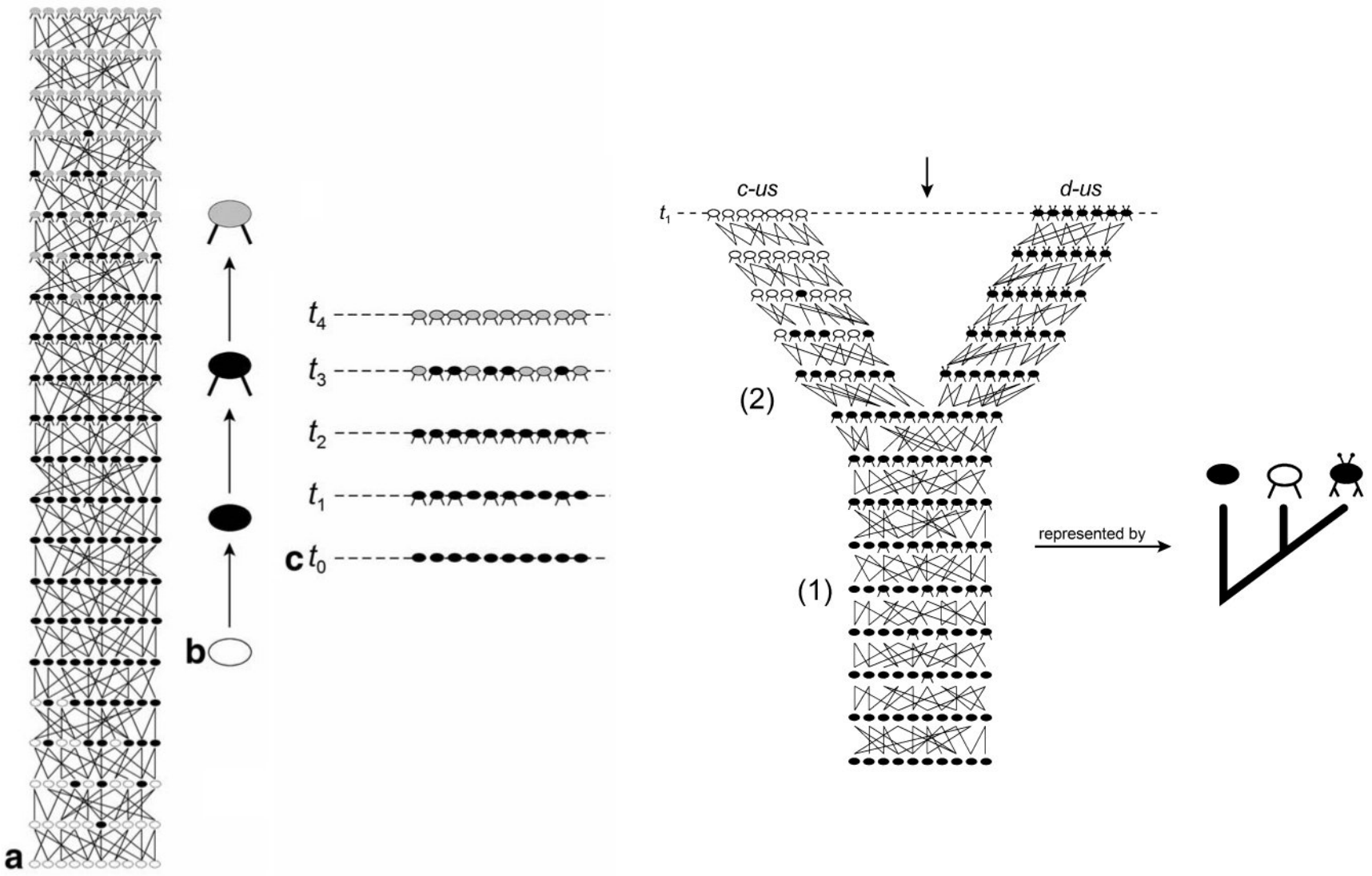


Modelo de representação:

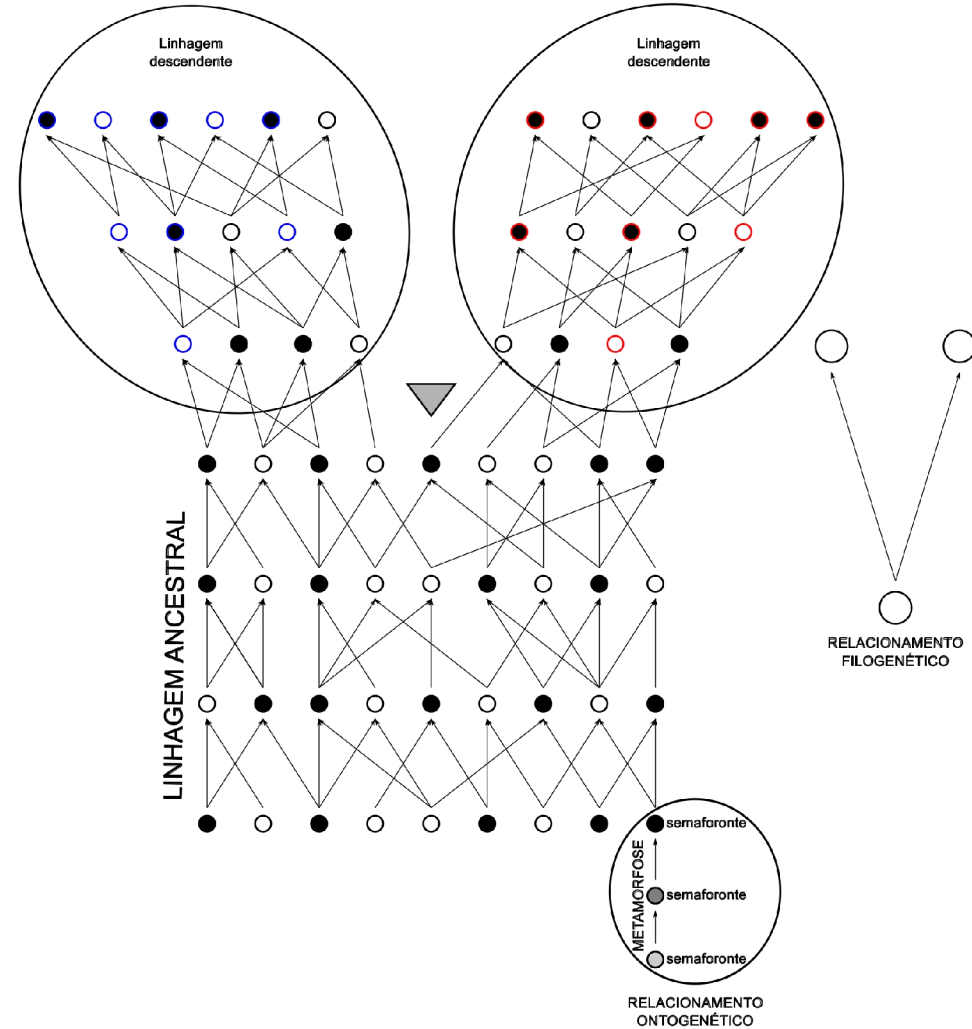
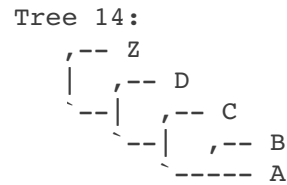
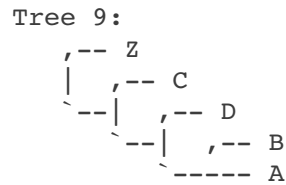
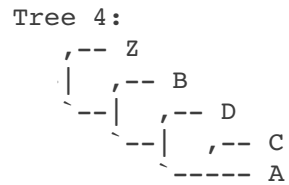
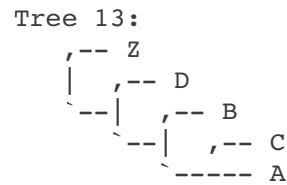
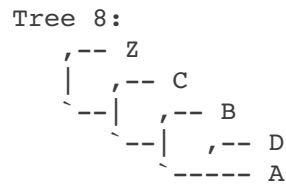
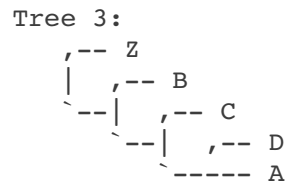
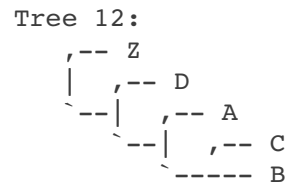
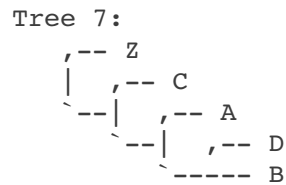
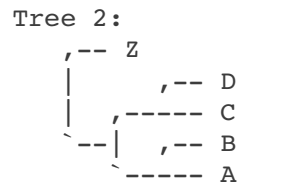
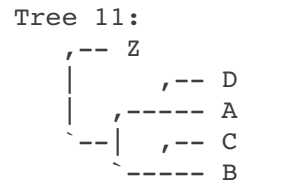
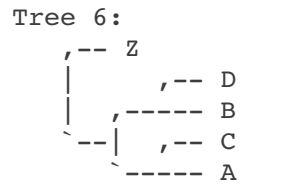
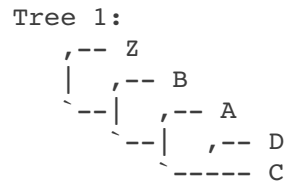
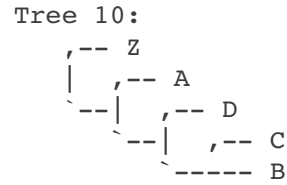
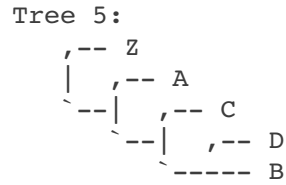
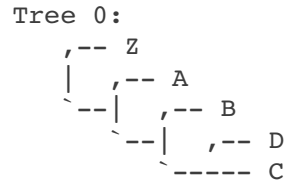


Fonte: Dr. David Baum, Department of Botany, University of Wisconsin.

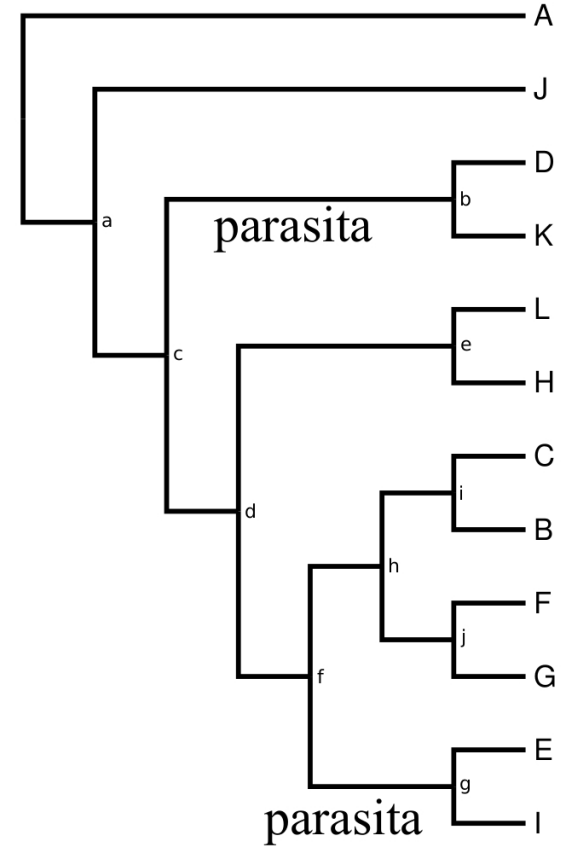
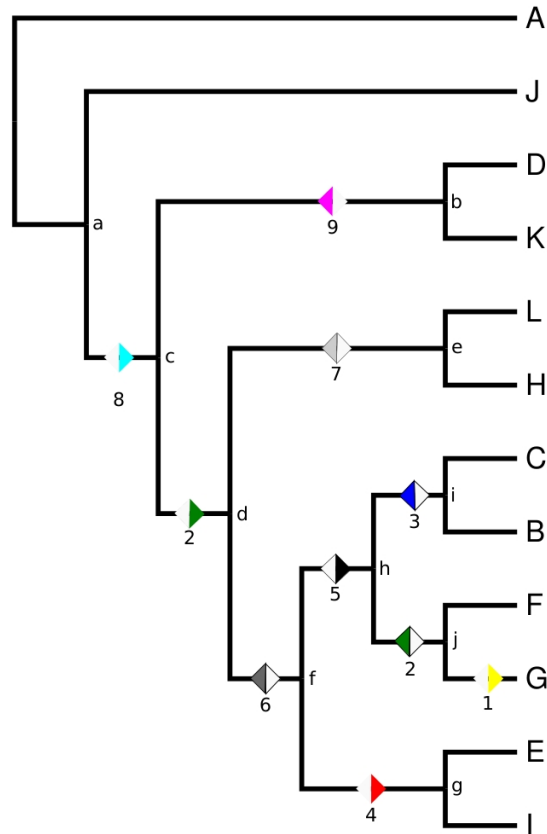
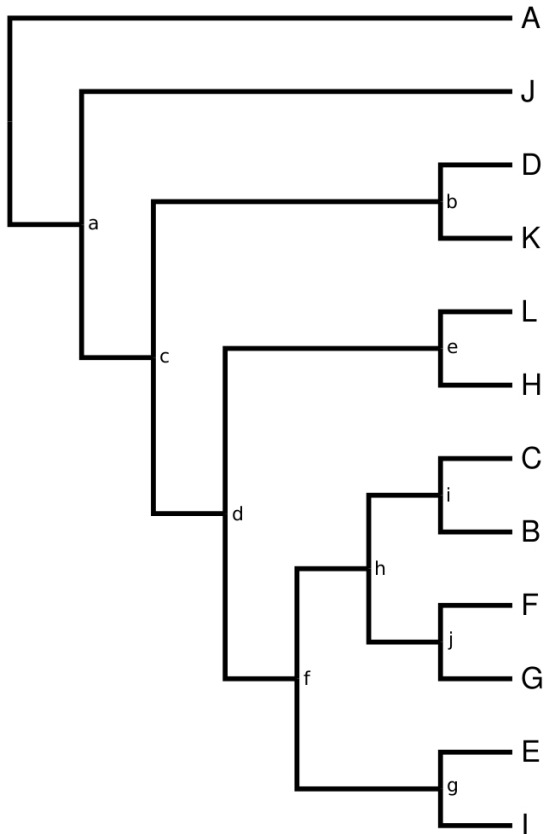
Modelo de herança:



Modelo de representação:

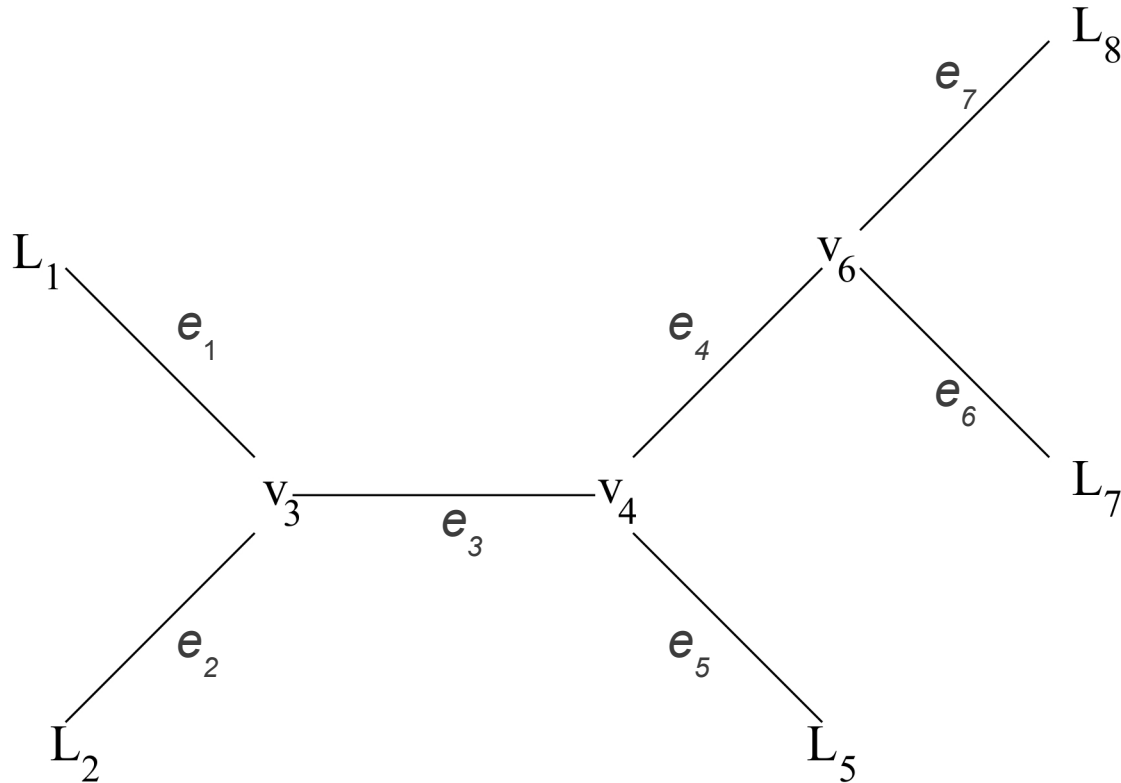


Cladogramas, árvores e cenários:



Grafos:

Objetos matemáticos que consistem de um par de conjuntos (V,E) de *vertices* (nós, V) e *edges* (linhas entre nós, ramos, E).



O **grau** de um nó é o número de ramos conectados a ele.

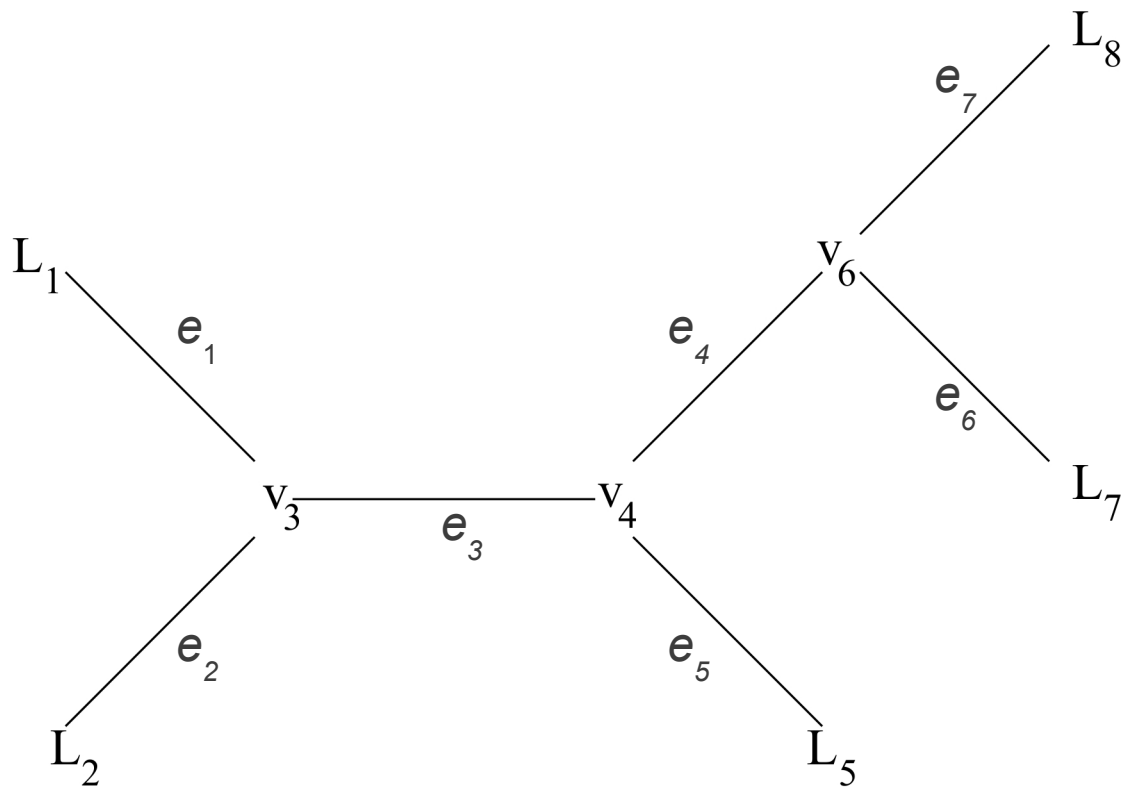
Terminais, *leaves* (L), são nós de grau 1 e são conectados a um outro nó por um único ramo.

$L = \text{OTUs}$
 $V = \text{HTUs}$

Uma topologia $T = (V,E)$ é um grafo conectado sem ciclos.

Grafos:

Uma topologia T é **binária** quando todos os nós internos possuem grau 3.

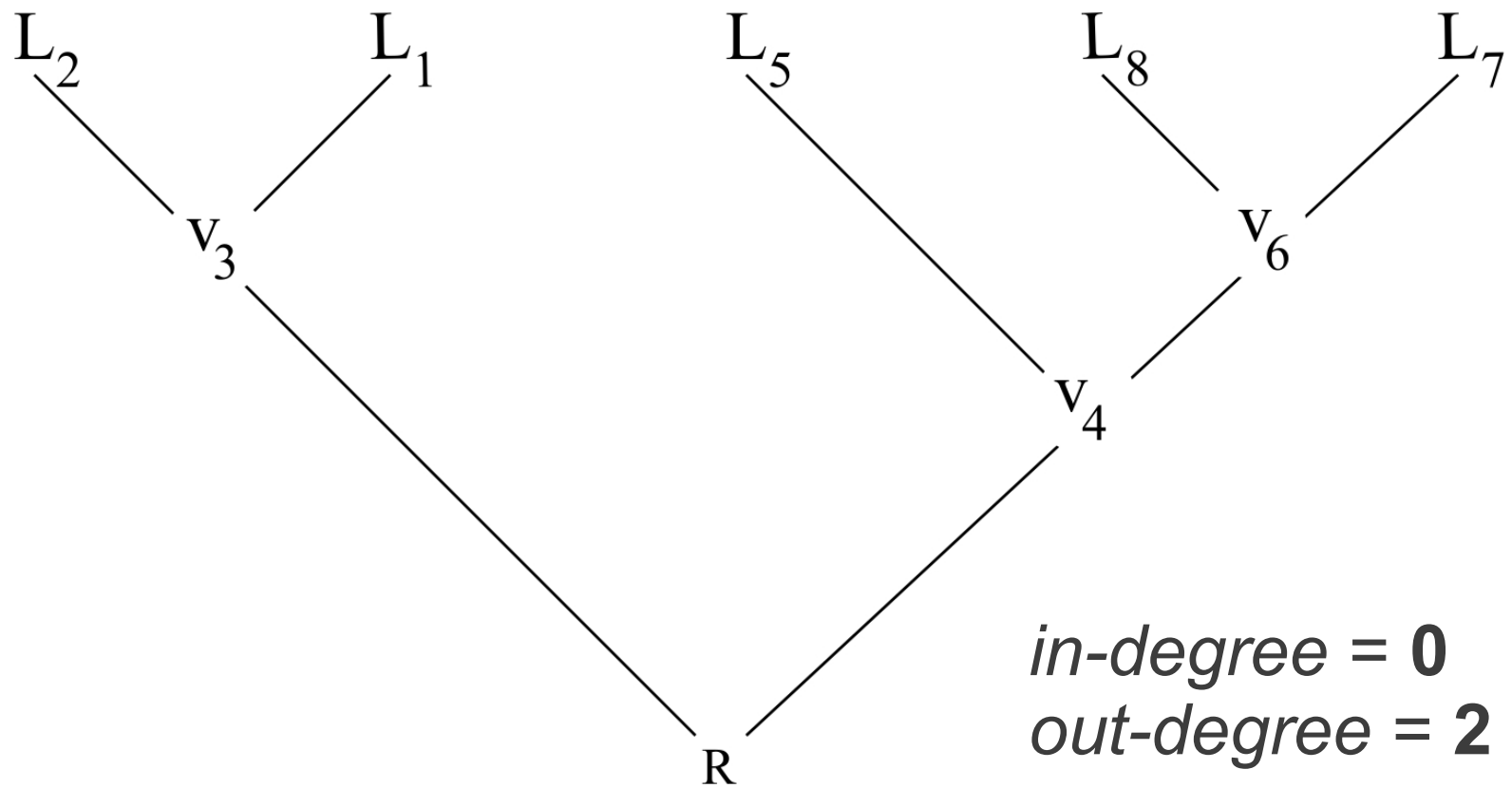


$|L| - 2$ nós internos.

$2x|L| - 3$ ramos.

Grafos:

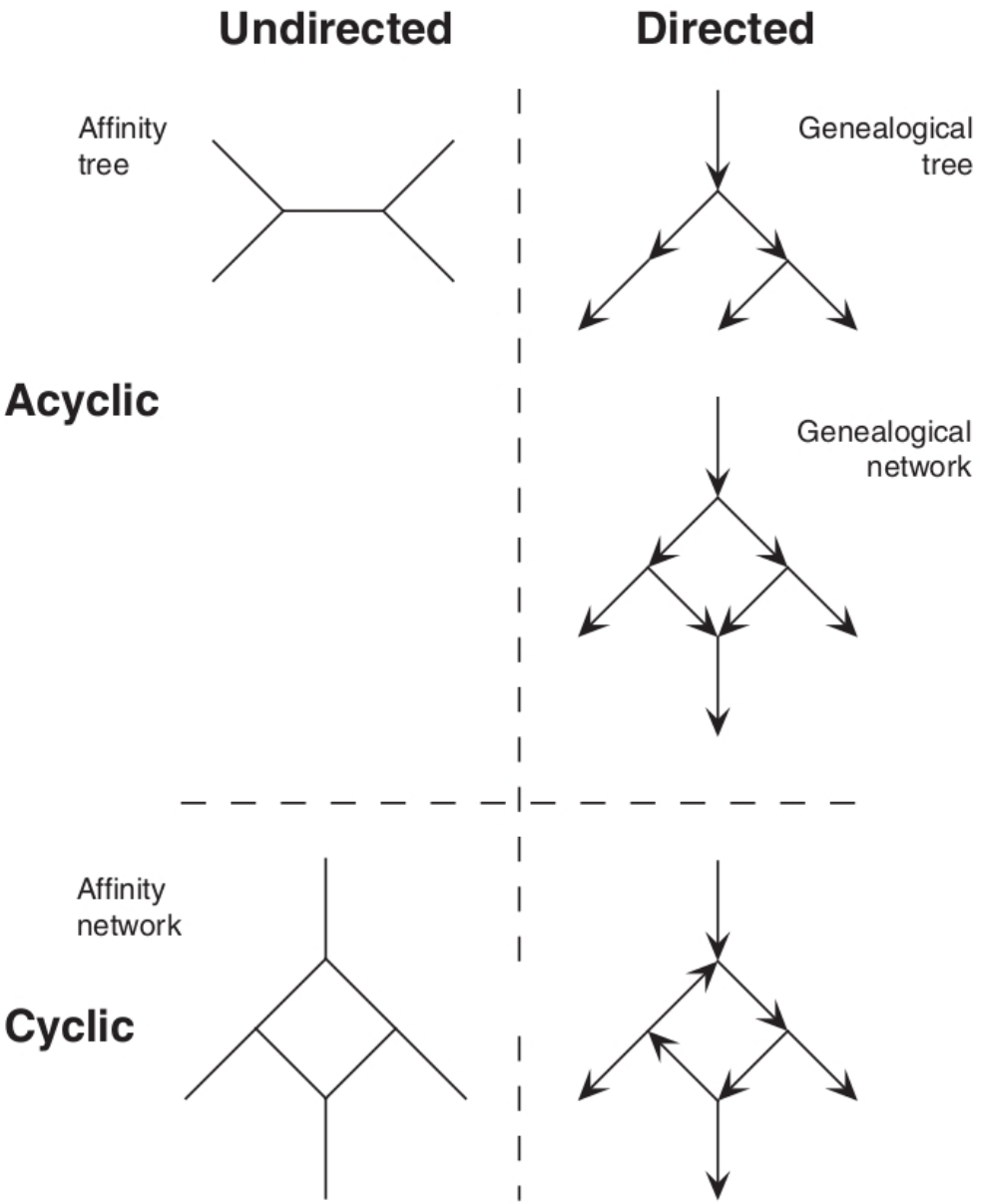
Grafos direcionados, enraizados, possui um nó e um ramo adicional.



A raiz é o único nó com grau 2.

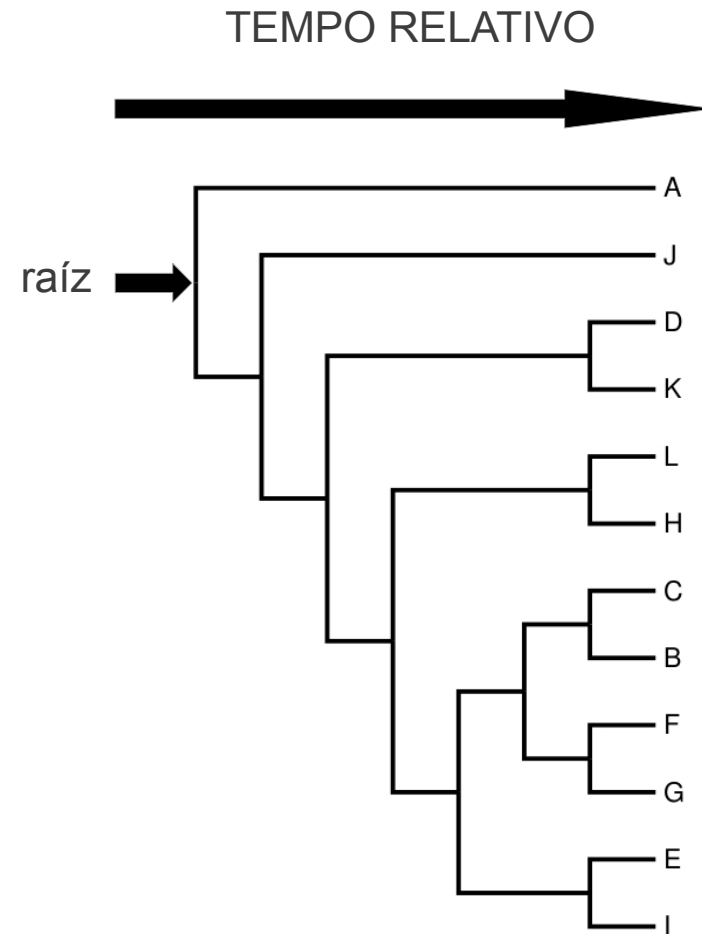
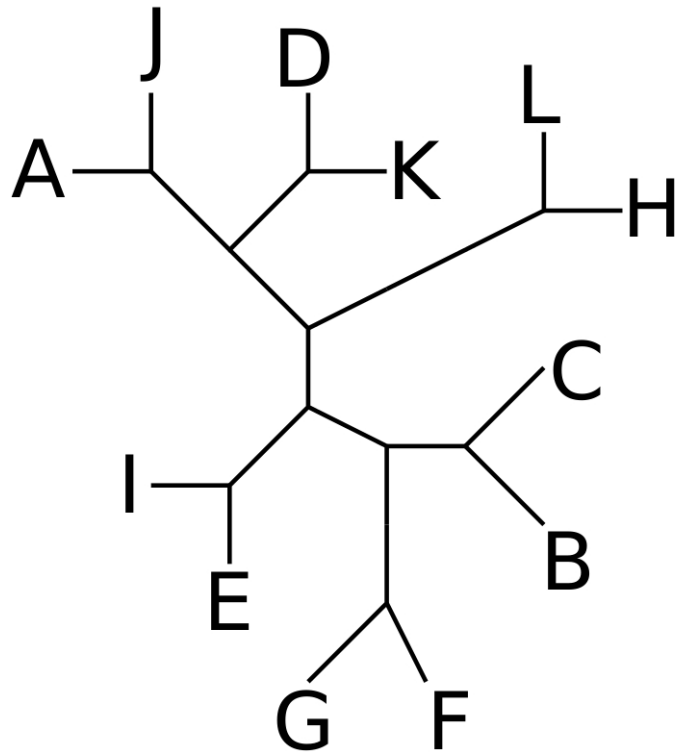
Grafos:

trees vs. networks



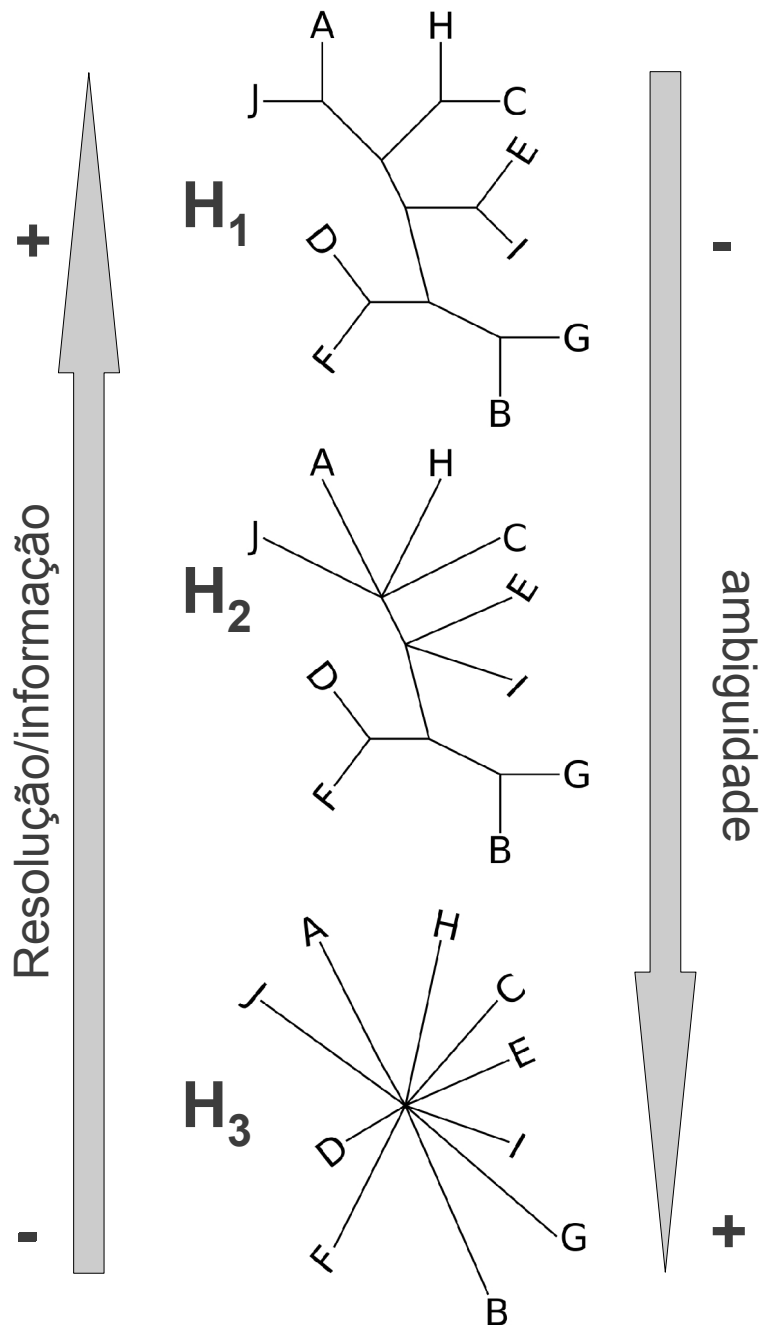
Grafos:

Raíz: vetor temporal



Racional:

Hipóteses, “*Explanatory power*”, ambiguidade, erro e testabilidade



Hipótese: *uma explicação para um fenômeno observável ou uma proposição racional prevendo uma possível correlação causal entre múltiplos fenômenos.*

H₁ → H₃: decresce o conteúdo informativo (o que a hipótese explica)

Diagramas totalmente dicotômicos estão mais relacionados com o conteúdo informativo da hipótese do que com a suposição de que todo ancestral hipotético daria origem a somente duas linhagens por cladogênese.

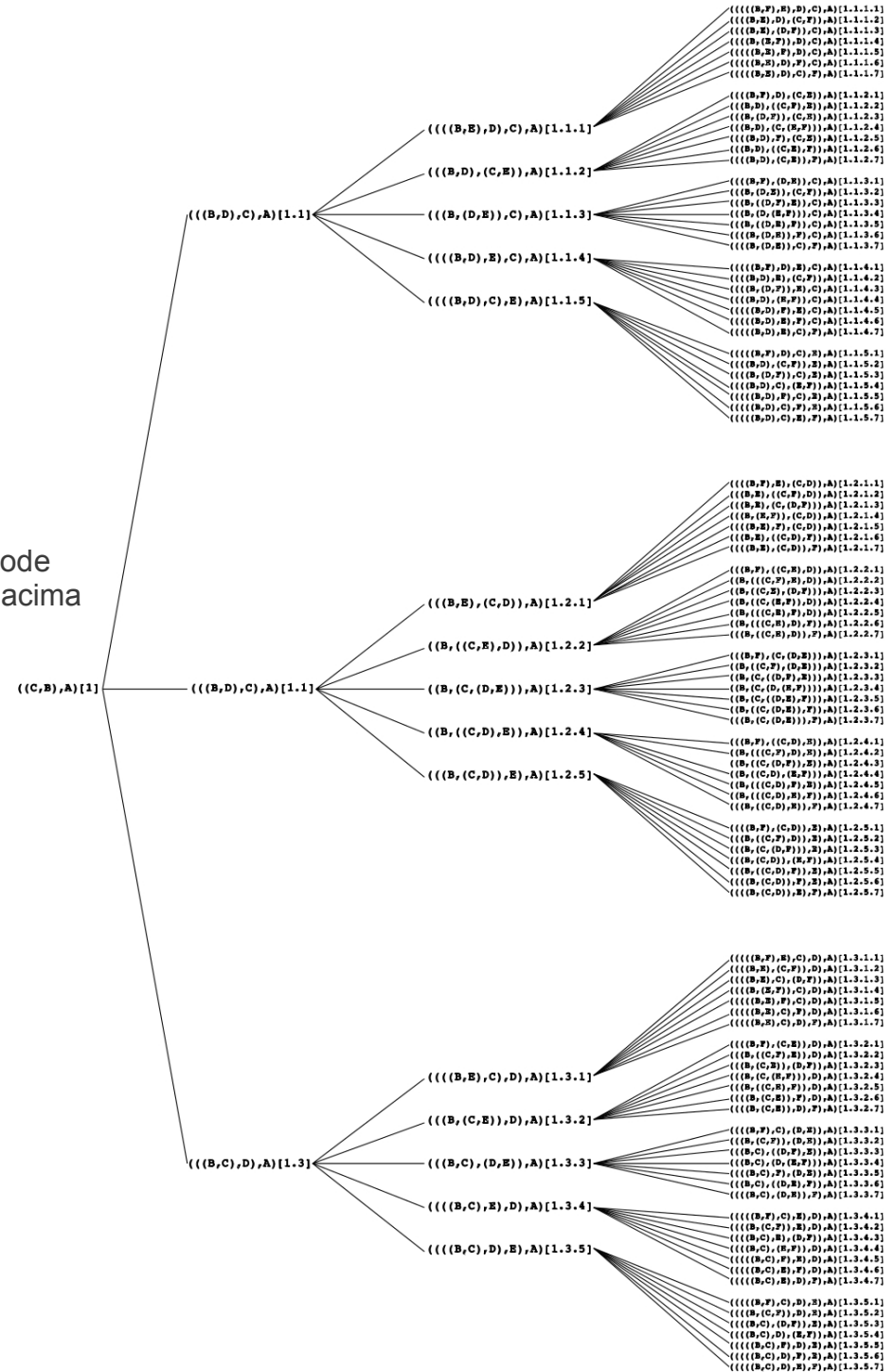
Enumeração:

Para topologias não direcionadas e $n \geq$

- 3 1
- 4 3
- 5 15
- 6 105
- 7 945
- 8 10395
- 9 135135
- 10 2027025
- 11 34459425
- 12 654729075
- 13 13749310575
- 14 316234143225
- 15 7905853580625
- 16 213458046676875
- 17 6190283353629375
- 18 191898783962510625
- 19 6332659870762850625
- 20 221643095476699771875
- 21 8200794532637891559375
- 22 319830986772877770815625
- 23 13113070457687988603440625
- 24 563862029680583509947946875
- 25 25373791335626257947657609375
- 26 1192568192774434123539907640625
- 27 58435841445947272053455474390625
- 28 2980227913743310874726229193921875
- 29 157952079428395476360490147277859375
- 30 8687364368561751199826958100282265625
- 31 495179769008019818390136611716089140625
- 32 29215606371473169285018060091249259296875
- 33 1782151988659863326386101665566204817109375
- 34 112275575285571389562324404930670903477890625
- 35 7297912393562140321551086320493608726062890625
- 36 488960130368663401543922783473071784646213671875
- 37 33738248995437774706530672059641953140588743359375
- 38 2395415678676082004163677716234578672981800778515625
- 39 174865344543353986303948473285124243127671456831640625
- 40 13114900840751548972796135496384318234575359262373046875

$$\frac{(2n - 4)!}{(n - 2)! 2^{n-2}}$$

O número de topologias enraizadas pode ser calculado multiplicando a fórmula acima pelo número de ramos $(2n-3)$ ou incrementando $+1$ à n .



Distância entre topologias: “tree-shaped-objects”

Métrica de Robinson & Foulds (1981): número mínimo de operações necessárias para converter T_1 and T_2 , denotada por $d(T_1, T_2)$.

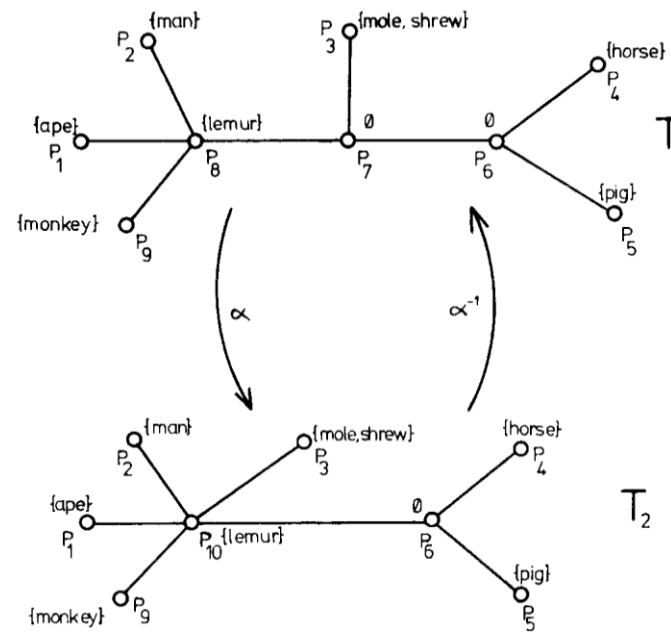


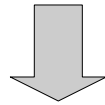
FIG. 1. The application of operations α and α^{-1} .

Optimality:

Grande debate centrado em cálculos específicos de otimização.

Definição e topologias como hipóteses:

Teste → Avaliação → Determinação de qualidade relativa



Índices de mérito comparativos

Independente do índice: requer função objetiva

$$C = f(D, T)$$

'Without such a cost, these objects are mere pictures — “tree-shaped-objects” of no use in science'
(Wheeler et al., 2006: Cladistics 12:1-9)

Distância entre topologias: teste de hipóteses

Dados para 105 topologias (6 terminais):

