

TREE OF LIFE THEORY

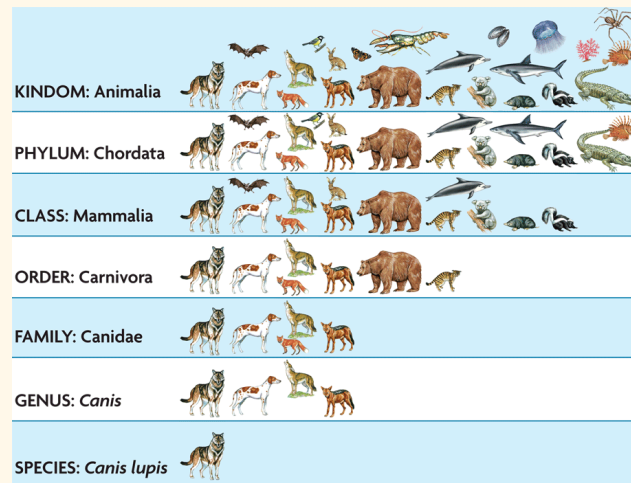
I. VISUALISATION

II. ALGORITHMS

BACHELOR RESEARCH PROJECTS; LIACS

A de Bruin, D.J. Kornet, S.G.R. Nijssen, M. Zandee

Hierarchical Classification



A	CONIDAE	TURRIDAE s.l.			TEREBRIDAE
B	CONIDAE	TURRIDAE	ST.	DR.	PS. TEREBRIDAE
C	CONIDAE	TURRIDAE?			

Linnaeus' *Systema Naturae* (1735)

EVOLUTION

Darwin

(*Origin of Species*, 1859)

Hierarchical Order by
differential birth rates
among varieties

Origin of Varieties

small heritable changes

Genetic (recombination, mutation, lateral transfer)

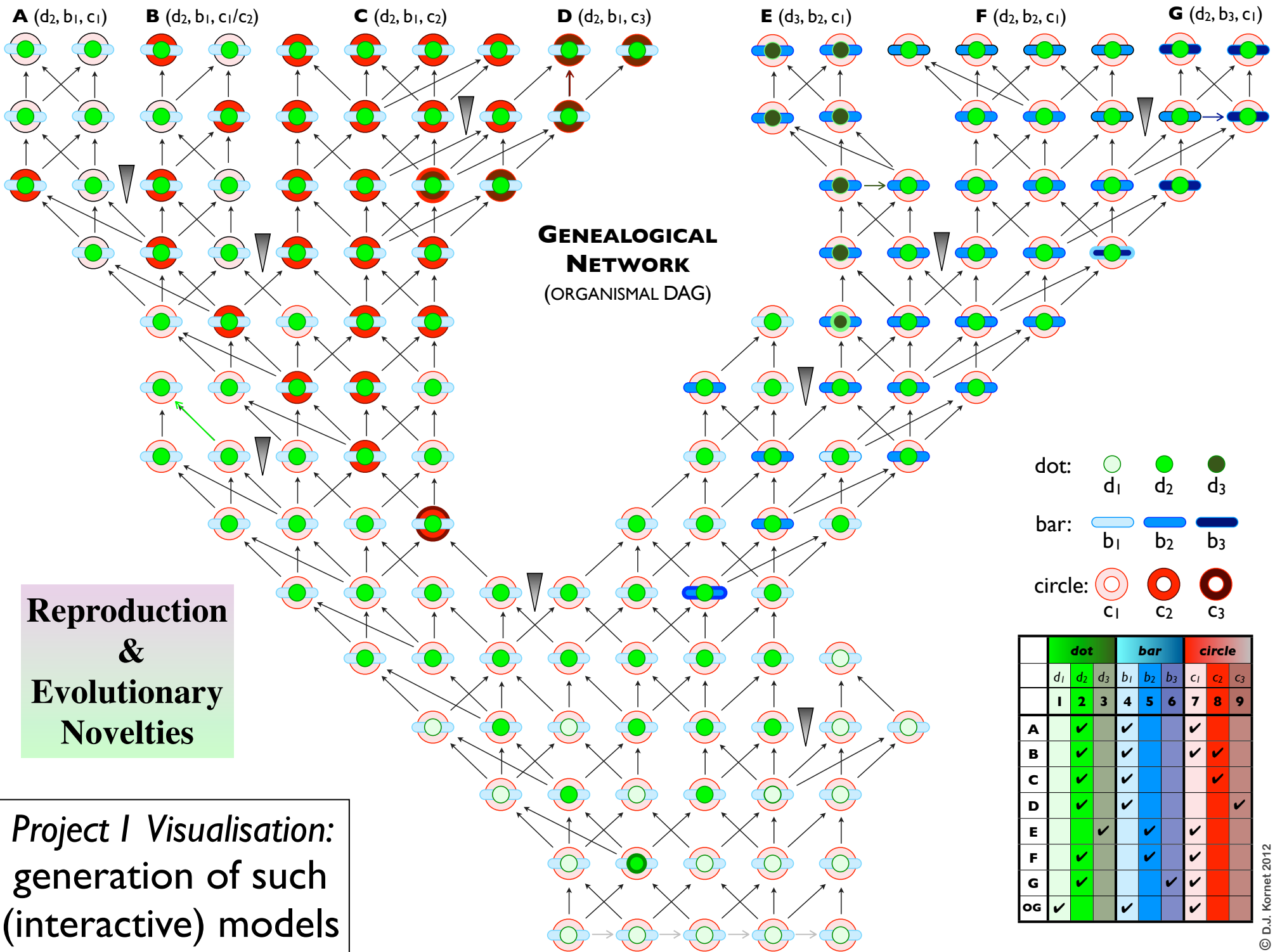
Epigenetic (in gene expression):

Evolutionary Novelties

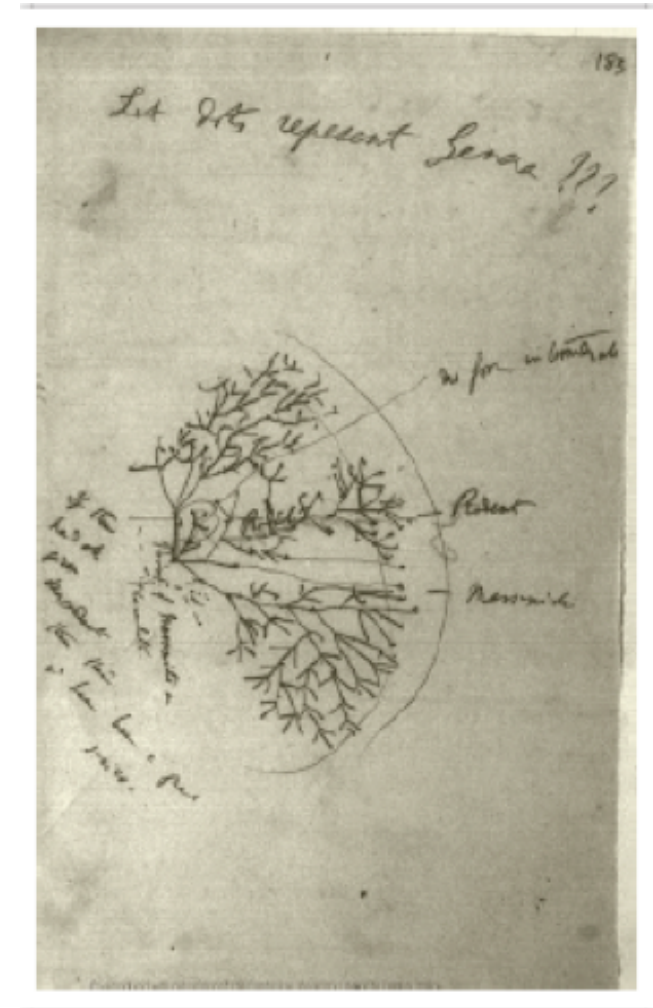
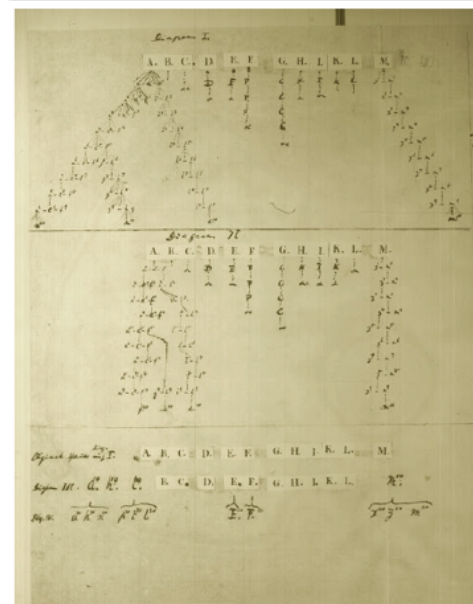
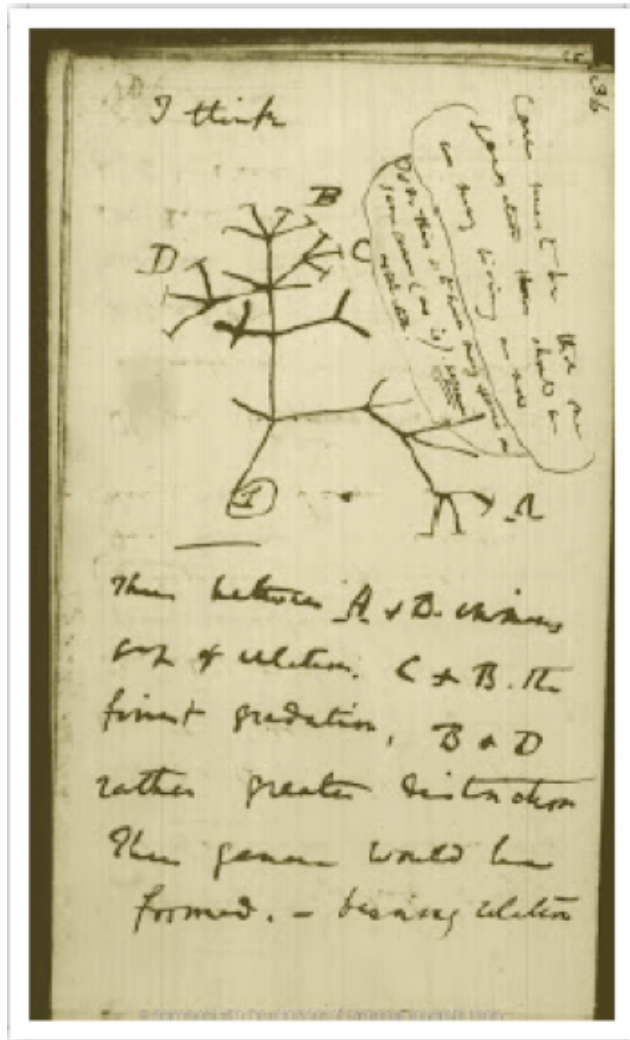
Hierarchical Order by

historical process of

**Reproduction &
Evolutionary Novelties**

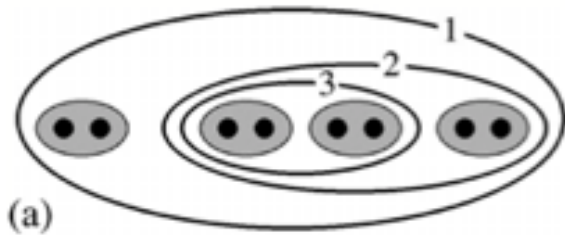


Tree of Life Theory development I (mid 19th century)

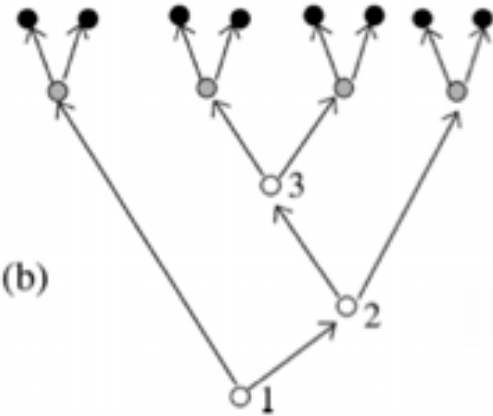


Darwin's (off the record)
Tree of Life sketches

Tree of Life Theory development 2 (mid 20th Century)



(a)



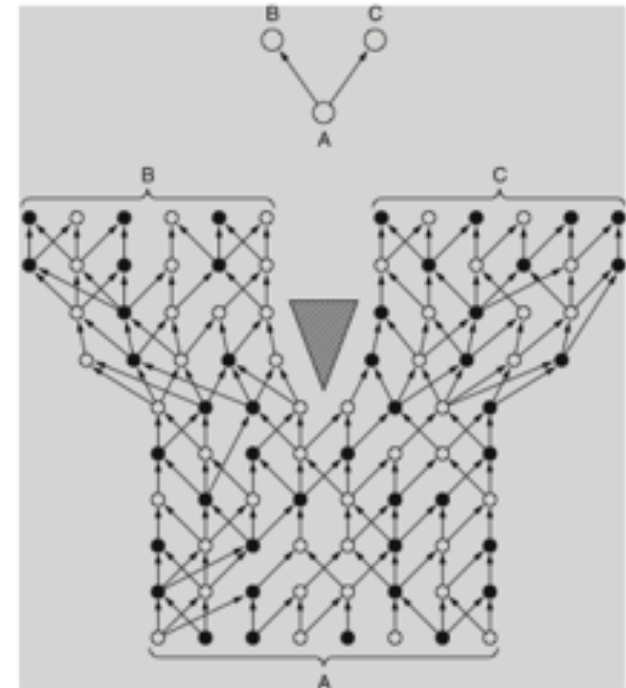
(b)

hierarchical classification

**is based on
tree structure**

(use evolutionary novelties, not overall similarity)

Species: nodes in Tree of Life



tree structure

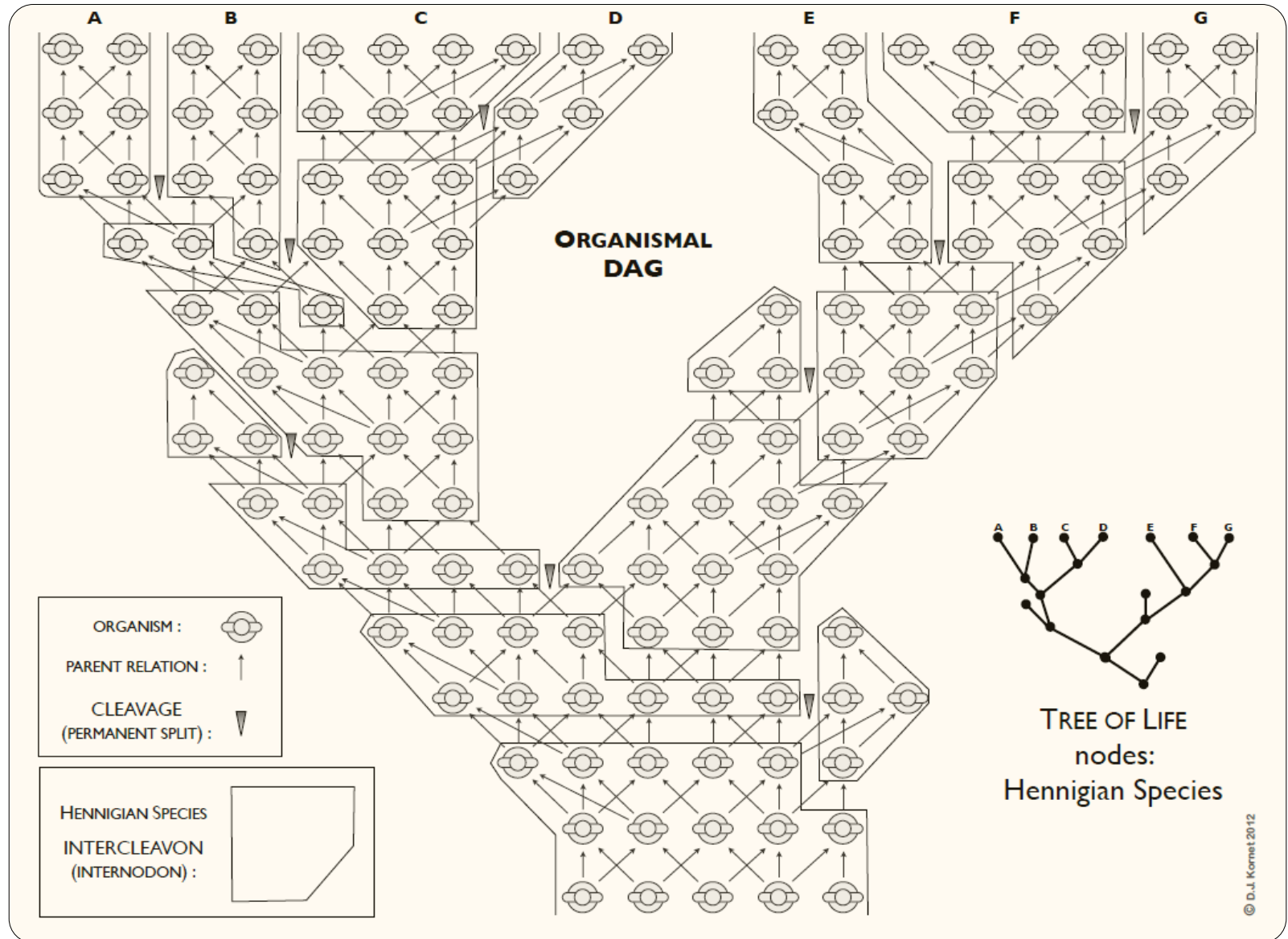
**is based on
(permanent) cleavages**

in genealogical network (organismal DAG)

Hennig's *Tree of Life* theory

Tree of Life Theory development 3a (late 20th Century)

Kornet's
Tree of Life Theory



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Internodons as equivalence classes

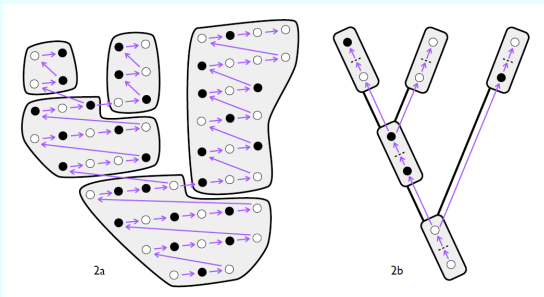
Project II Algorithms

Tree of Life Theory: development here and now

Find Tree in organismal DAG

using external information:

Topological ordering by **added Birthdate**

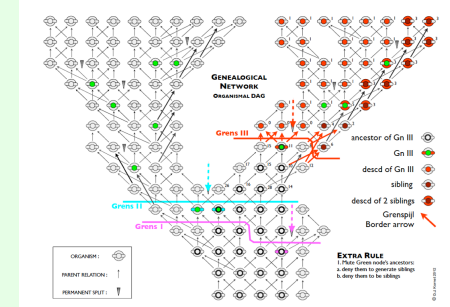


Sam Alexander (Ohio),
Arie de Bruin, Diedel Kornet:
Organismal Tree construction
by *Undir-Parent relation*

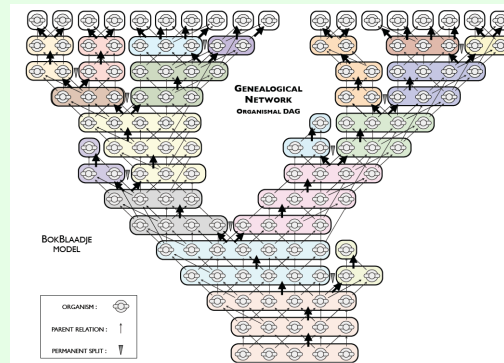
almost linear algorithm available
(Arie de Bruin, Sam Alexander)

Holy Grail **not using** external information:

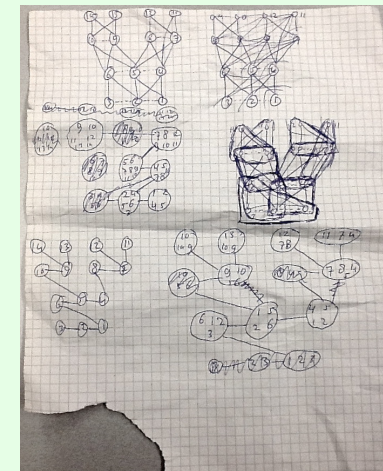
Joost Kok: *Green Node Bordering*



Canonical? Topological ordering by **intrinsic Generation Number**



Arie de Bruin: *Generation Stripping*

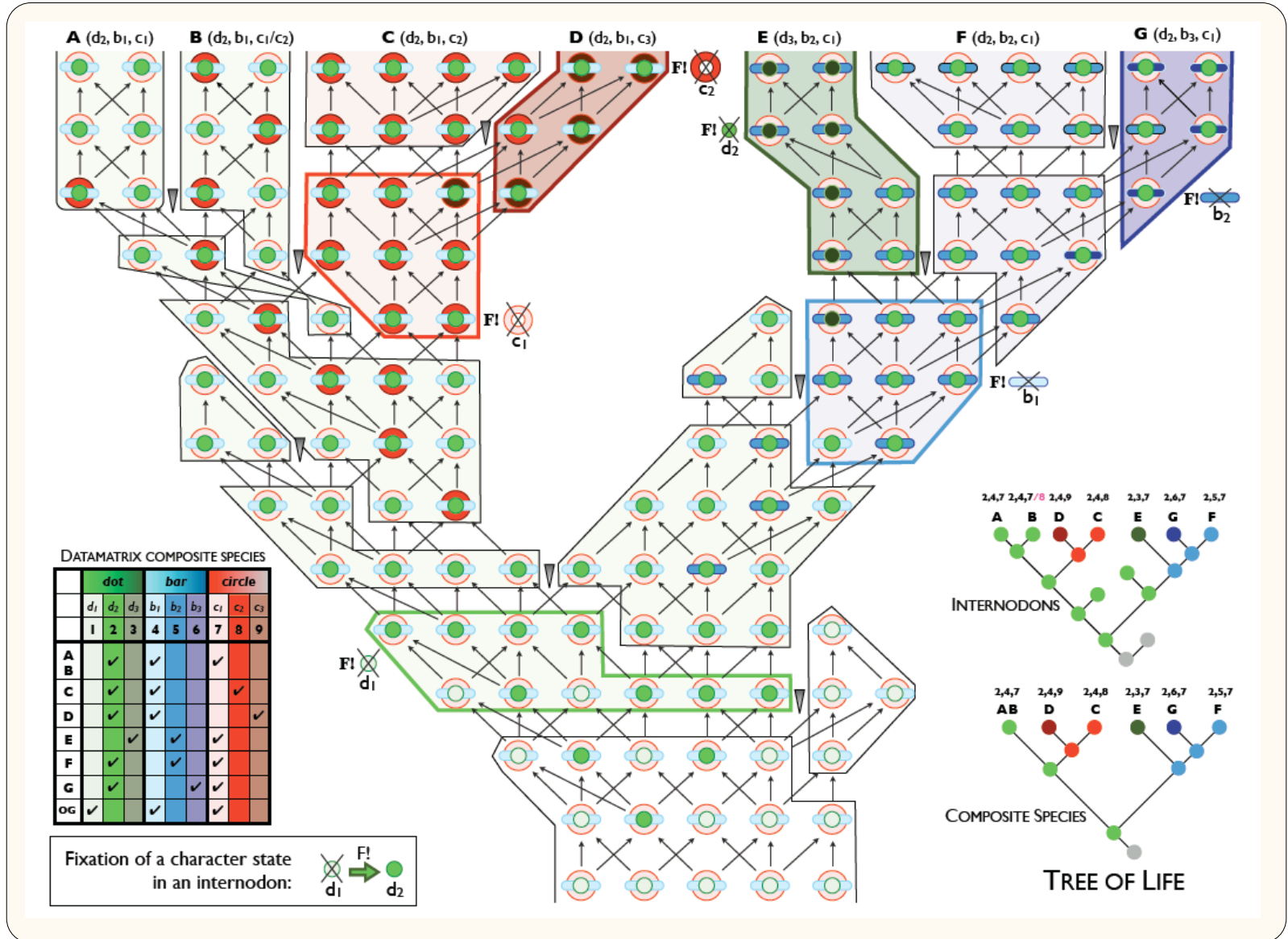


Siegfried Nijssen: *Tree Decomposition*

almost linear algorithm available
(Arie de Bruin, Hendrik Jan Hoogeboom, Siegfried Nijssen)

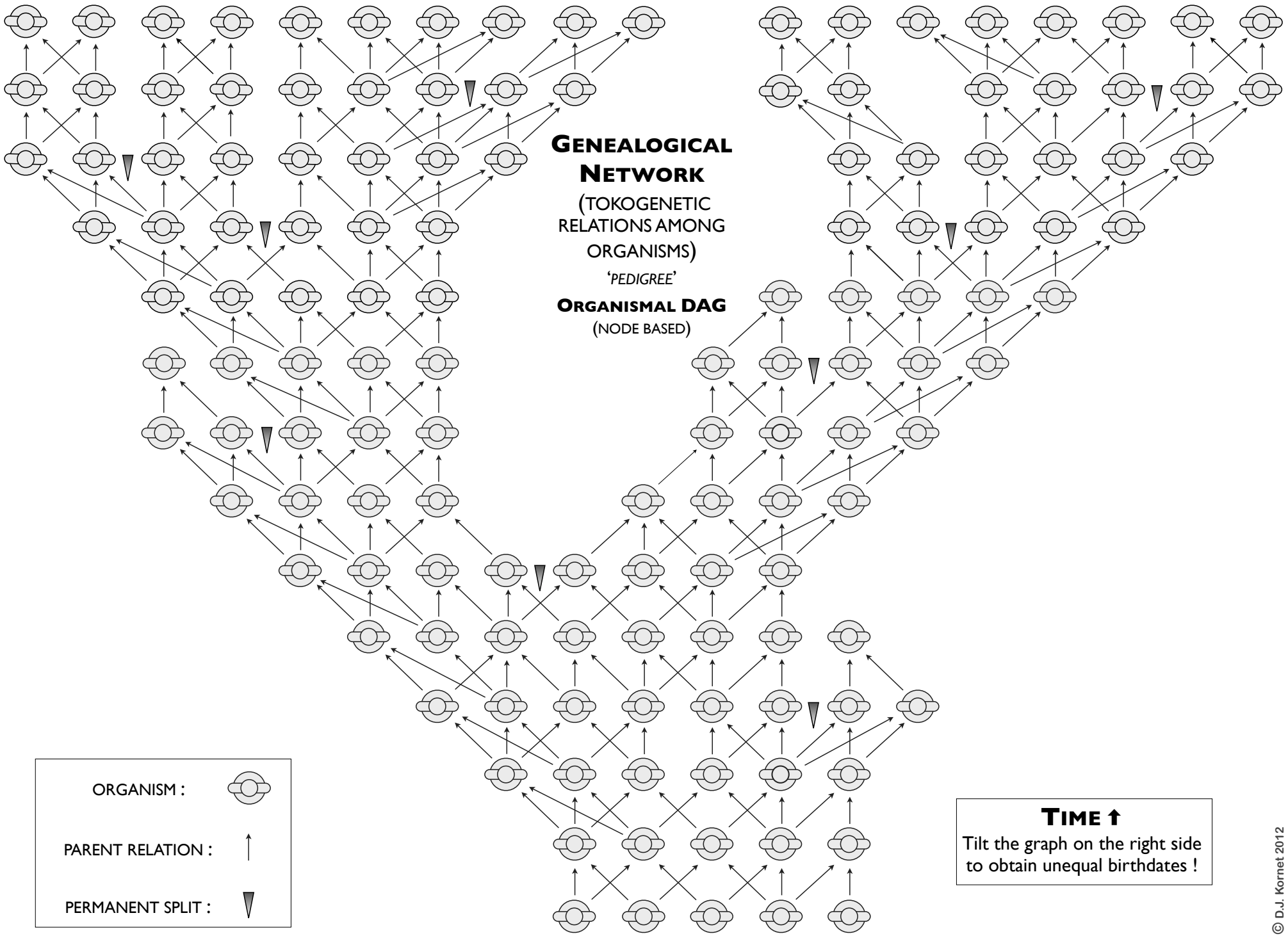
Tree of Life Theory development 3b (late 20th Century)

Kornet's
Tree of Life Theory





Project I Visualisation
Project II Algorithms


Composite Species as equivalence classes (Kornet, McAllister)



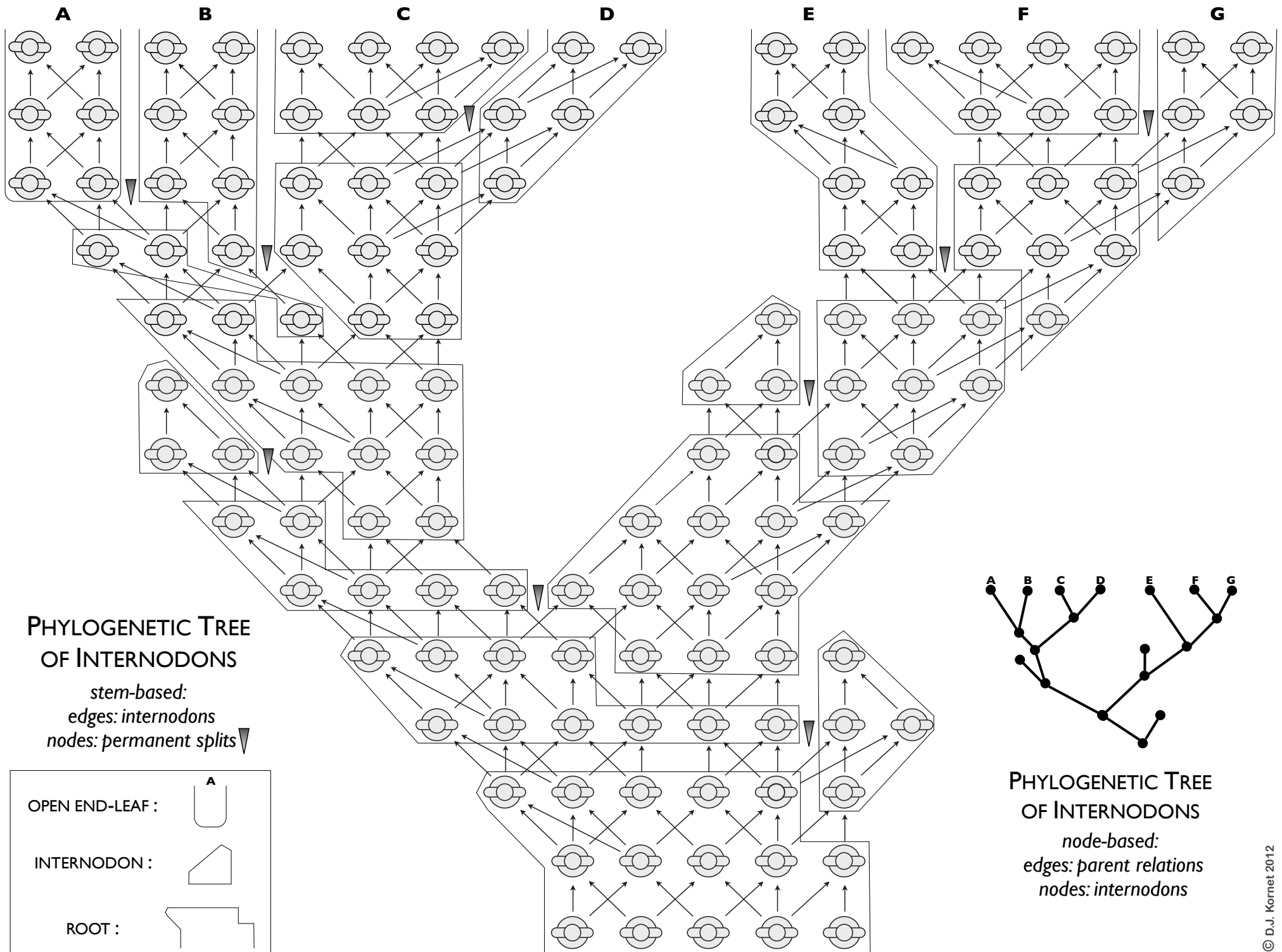
GENEALOGICAL NETWORK
 (TOKOGENETIC RELATIONS AMONG ORGANISMS)
 'PEDIGREE'
ORGANISMAL DAG
 (NODE BASED)

ORGANISM : 

PARENT RELATION : 

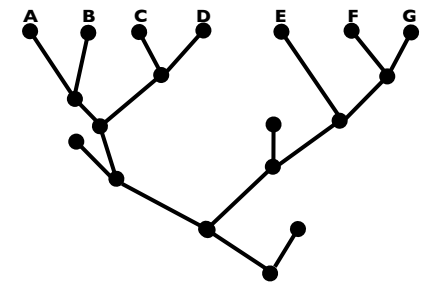
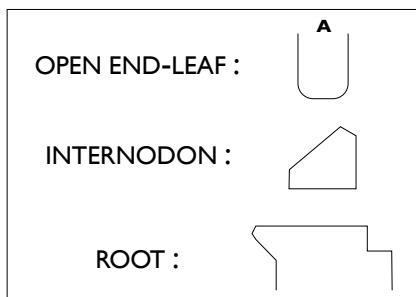
PERMANENT SPLIT : 

TIME ↑
 Tilt the graph on the right side
 to obtain unequal birthdates !



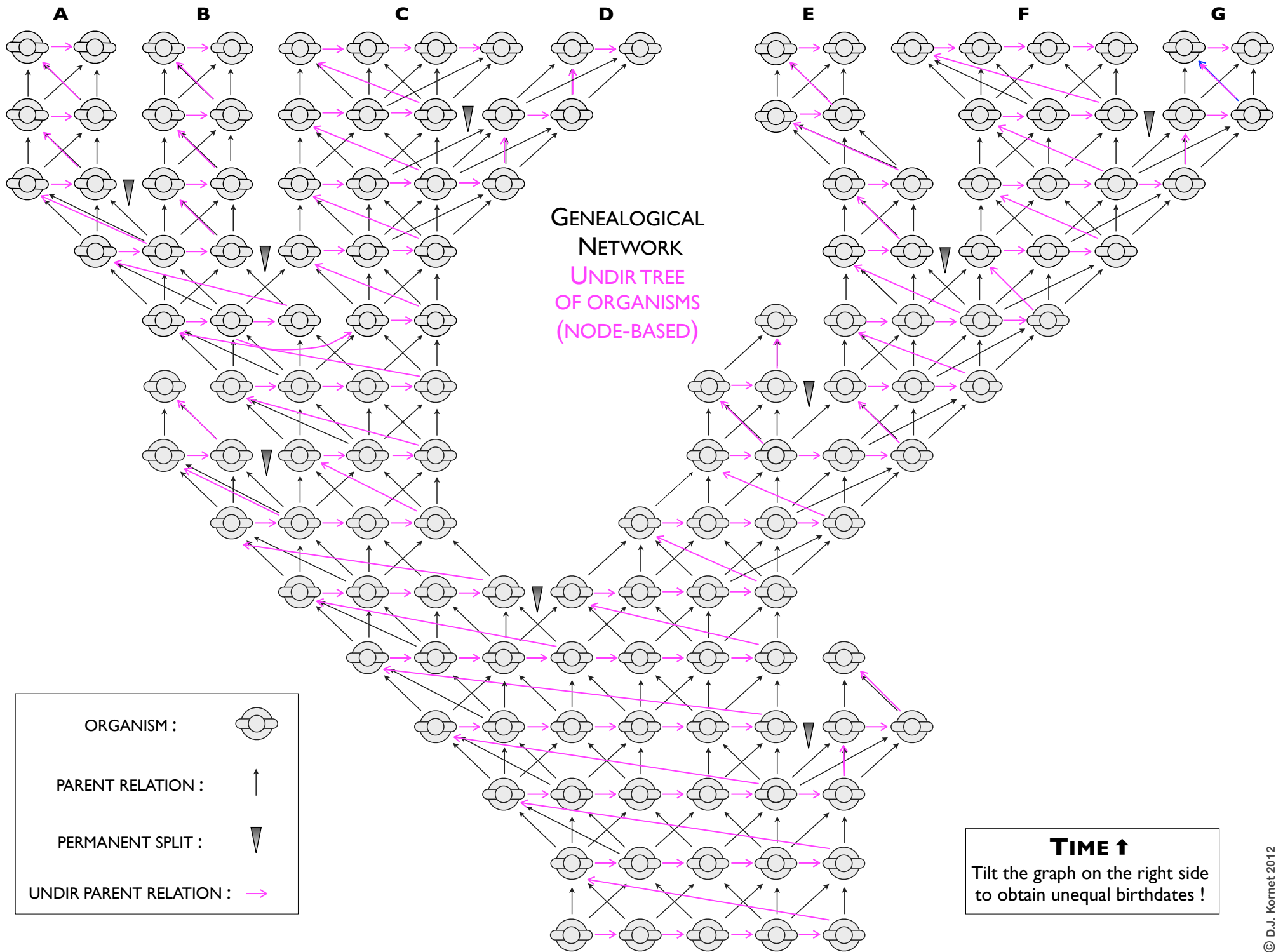
**PHYLOGENETIC TREE
OF INTERNODONS**

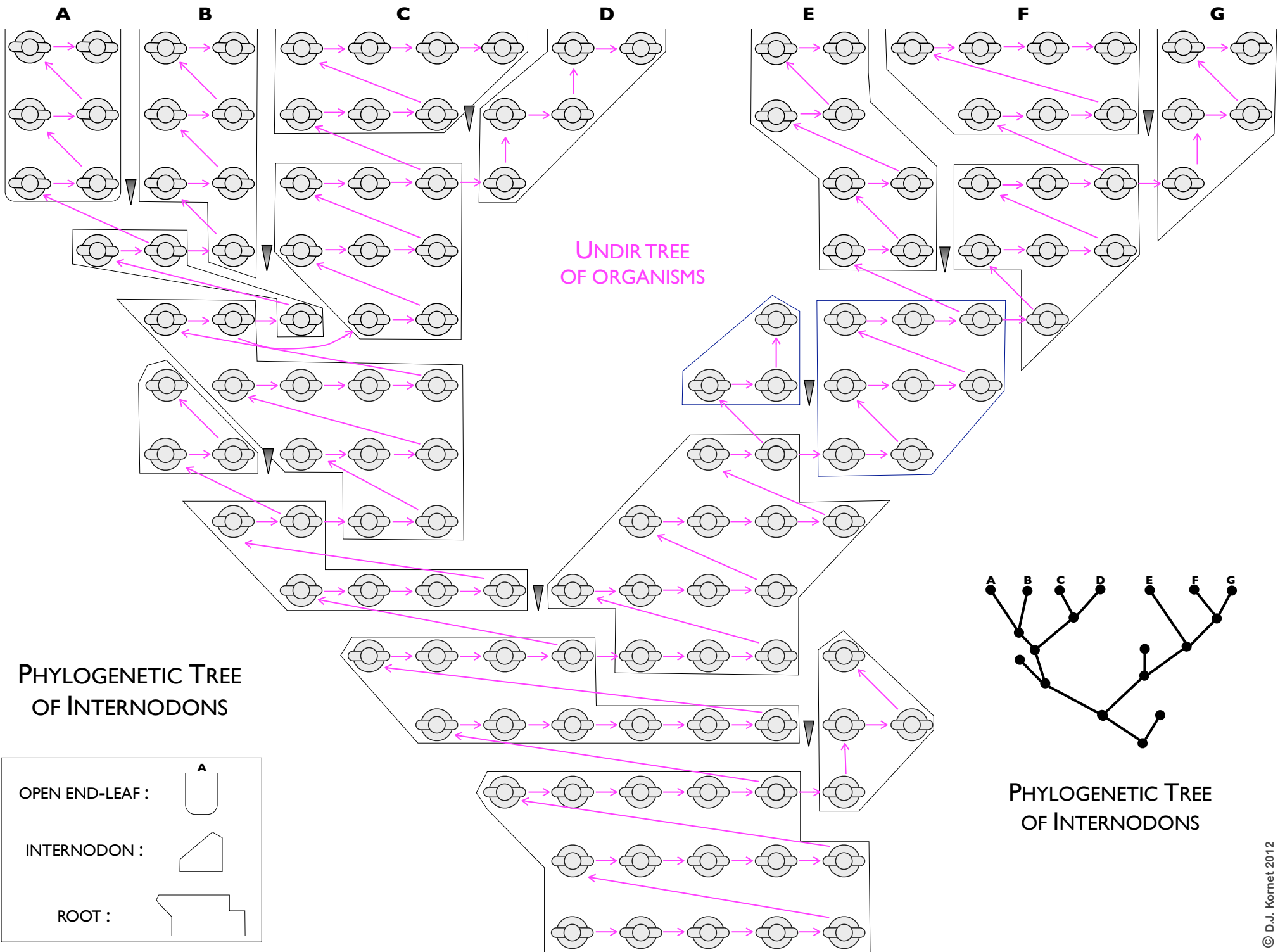
stem-based:
 edges: internodons
 nodes: permanent splits ▾



**PHYLOGENETIC TREE
OF INTERNODONS**

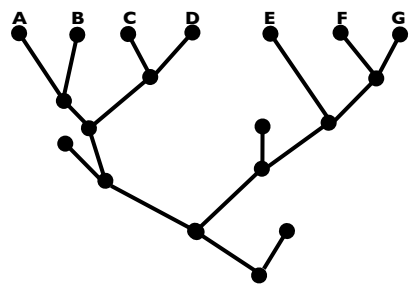
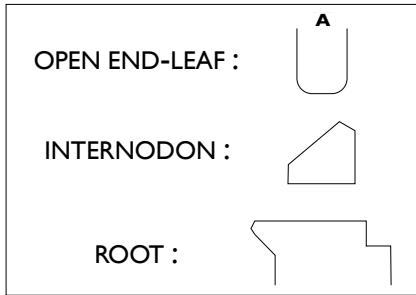
node-based:
 edges: parent relations
 nodes: internodons





UNDIR TREE OF ORGANISMS

PHYLOGENETIC TREE OF INTERNODONS



PHYLOGENETIC TREE OF INTERNODONS

Do you recognize yourself as ...

[regarding both projects]

- independent worker, as well as a teamplayer (theory under construction: interaction vital)
- talented designer, as well as skilled programmer
- flexible, rapid prototyper (adjusting specifications to emerging needs of users)
- attracted to multidisciplinary work with biologists (exchanging theories, concepts, results)

[regarding project I. Visualisation]

- loving Beauty as much as Truth
- kind to the users of your (interactive!) interface
 - 1) academic researchers exploring and testing theories and algorithms
 - 2) didactive users (classroom & public education)
- thinking BIG
 - 1) visualisation for academic purposes: small size (printable) will do
 - 2) but for classroom & public education: megasize (walls) will do better



[regarding project II. Algorithms]

- possessing adequate graph theoretical knowledge
- not afraid to formulate and prove theorems
- experienced player with graph algorithms

... you are invited !