

# UNDERSTANDING PHYLOGENY

Nikolas Reichardt,  
5<sup>th</sup> semester BoS. Business Informatics,  
Bioinformatics

## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

# Phylogeny is a common science about evolutionary history, furthermore, the process of understanding evolution

## BASICS

### Phylogeny

The evolutionary history of a species or a group of species

### Phylogenetic Tree

A diagram that describes the evolutionary relationships among various species

based on information available and gathered by systematizes

## AGENDA

- > Basics
- > **Scale of the Universe**
- > Creation of Life
- > Evolution to Human
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

The Universe itself is approximately 13,7 billion years old.  
Where are we in our Universe and what estimated scale are we in?

SCALE OF THE UNIVERSE



## AGENDA

- > Basics
- > Scale of the Universe
- > **Creation of Life**
- > Evolution to Human
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

**The evolutionary process of life starts approximately 3,9 billion years ago caused by impacts of a 20 million years long meteor shower**

CREATION OF LIFE



### Theory about Creation of Life

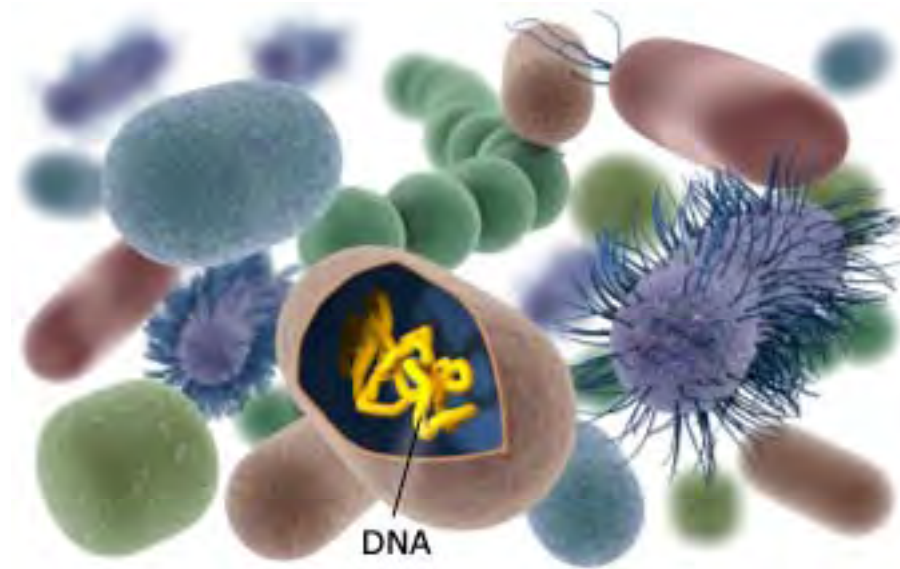
- Theory about meteor shower
- Water has been vaporized
- Chemical substances from the meteors made life possible
- 3.9 billion years old meteor has been found





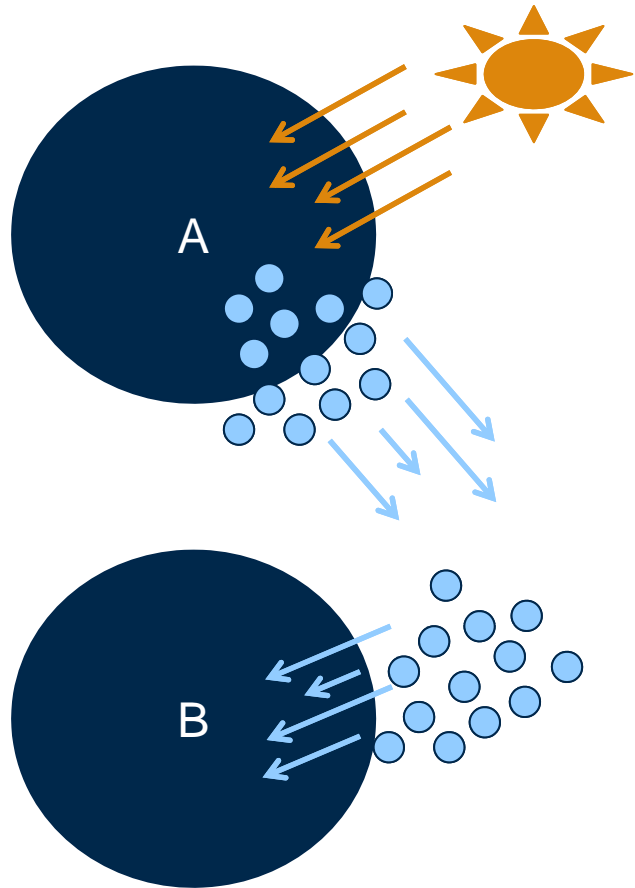
# How was life created?

## CREATION OF LIFE



**It all started with 2 bacteria, which had no nucleus and were absorbing energy out of the environment**

CREATION OF LIFE

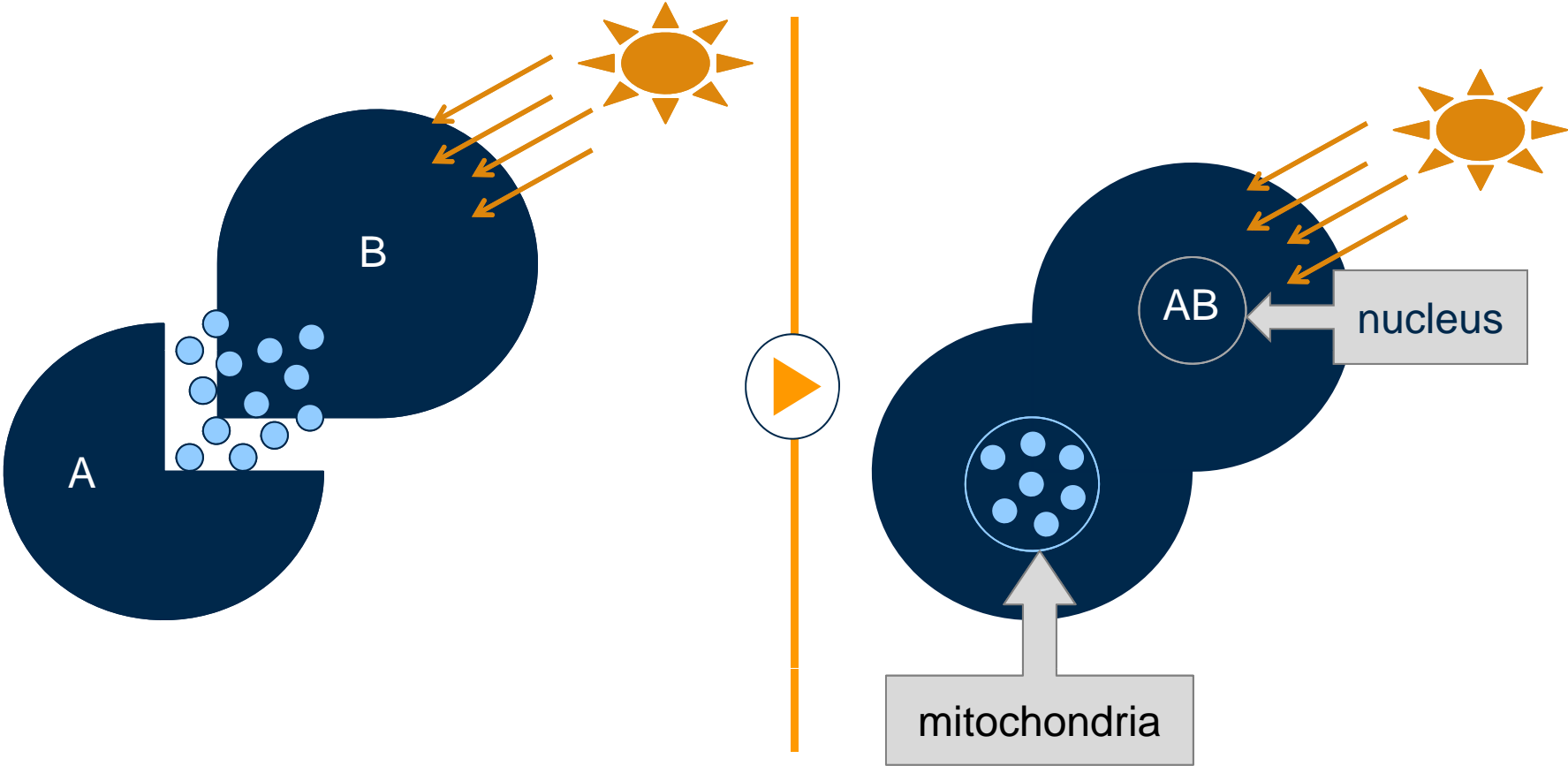


Species of Prokaryotes
<ul style="list-style-type: none"><li>• Absorbs sunshine</li><li>• Produces hydrogen and energy</li></ul>

Species of Prokaryotes
<ul style="list-style-type: none"><li>• Absorbs hydrogen</li><li>• Produces energy</li></ul>

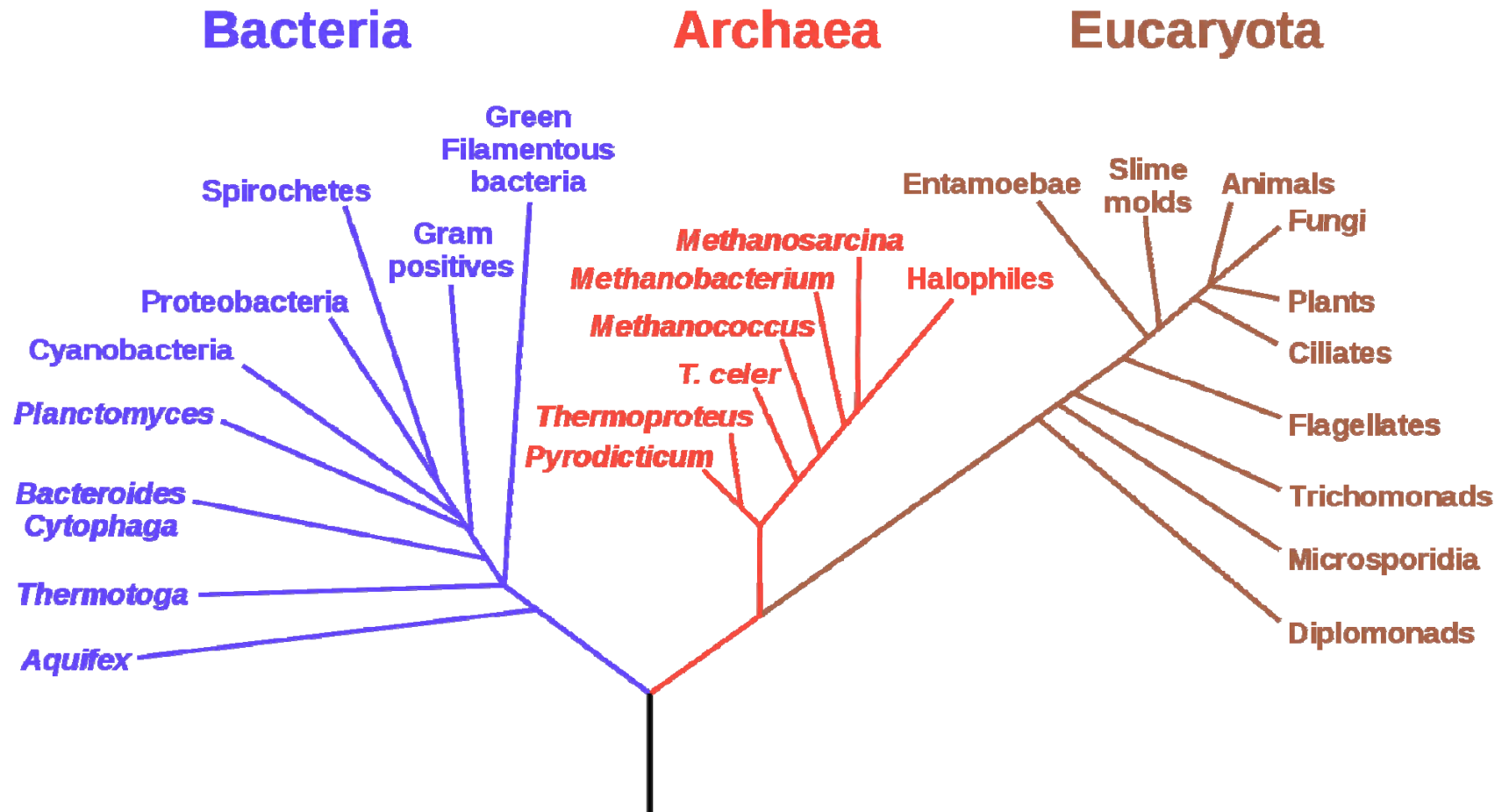
# The bacteria saw the advantage in a symbiosis and stored the other bacteria in itself

## CREATION OF LIFE



# The phylogenetic “Tree of Life” shows the very beginning of the evolution

## CREATION OF LIFE



## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > **Evolution to Human**
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

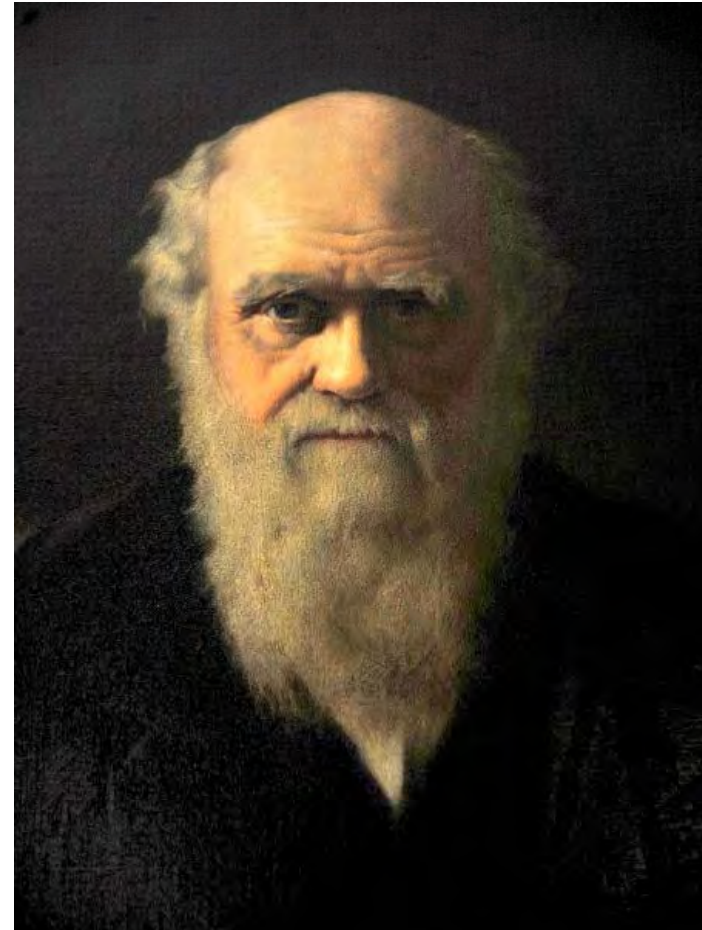
**Charles Darwin is the founder of the evolutionary theory, which has been criticized but nowadays is adopted by every scientist**

## EVOLUTION TO HUMAN

### Charles Darwin

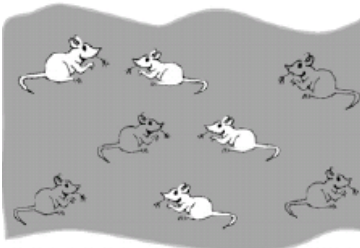

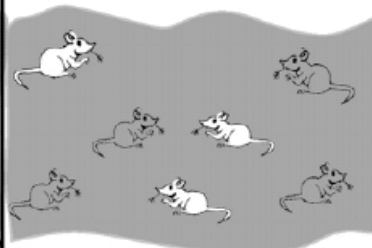
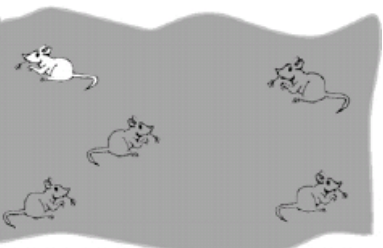
Evolutionary Scientist who:

- Specified lots of species
- Sailed 5 years around the world
- Went seasick all the time
- Wrote 2 books about evolution
- Split opinions about his theory



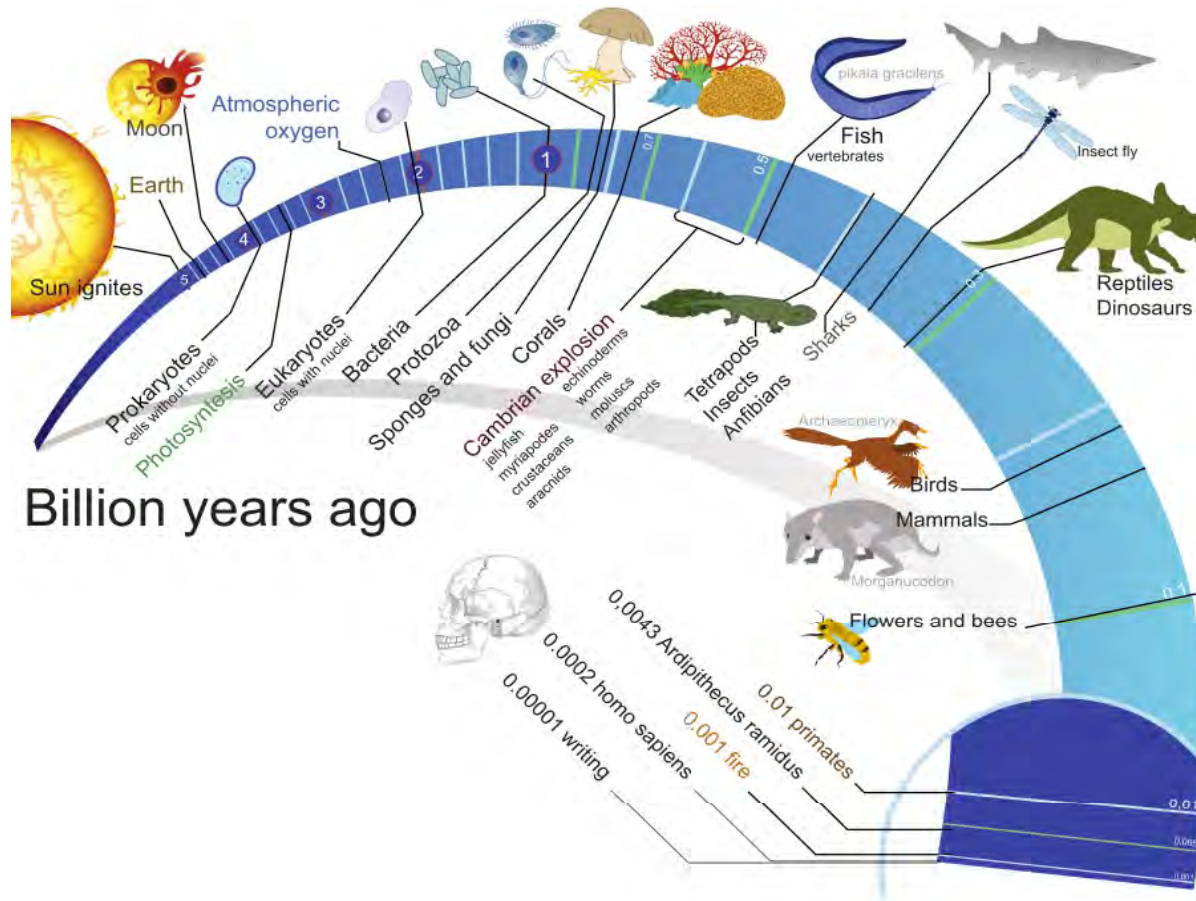
# His theory includes the natural selection that only the fittest survives

## EVOLUTION TO HUMAN

Darwins Definition	Neutral Selection		
<p>Three Key Elements:</p> <ol style="list-style-type: none"><li>1. Individuals varies for traits</li><li>2. Traits are heritable</li><li>3. Vary in survival/ reproduction</li></ol>	<p>1</p> 	<p>2</p>  	<p>3</p> 

# Throughout the evolutionary process a lot of species evolved

## EVOLUTION TO HUMAN



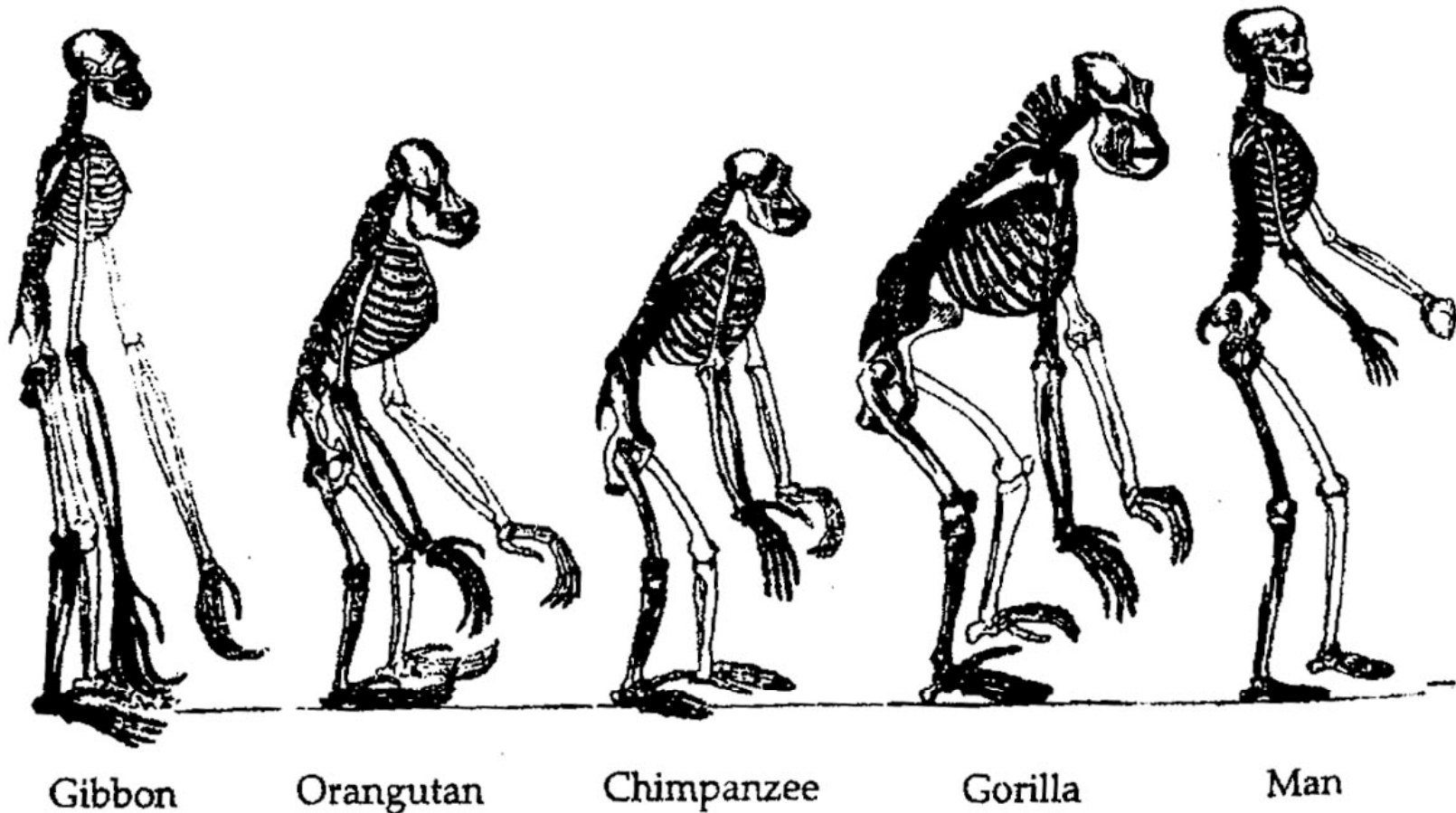
Evolutionary dates	
Eukaryote Cells	2.100
Animals	590
Vertebrates	505
Mammals	220
Primates	75
Apes	28
Great apes	15
Humans	0,5
Modern humans	0,2

Million years ago



The visuals of species may look similar. We can adopt certain structures of the skeleton to analyze relationships among them

EVOLUTION TO HUMAN



## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > **Phylogenetic Trees**
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > **Phylogenetic Trees**
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

# What are the key elements of the phylogenetic trees and what do they say about the lineage?

## PHYLOGENETIC TREES



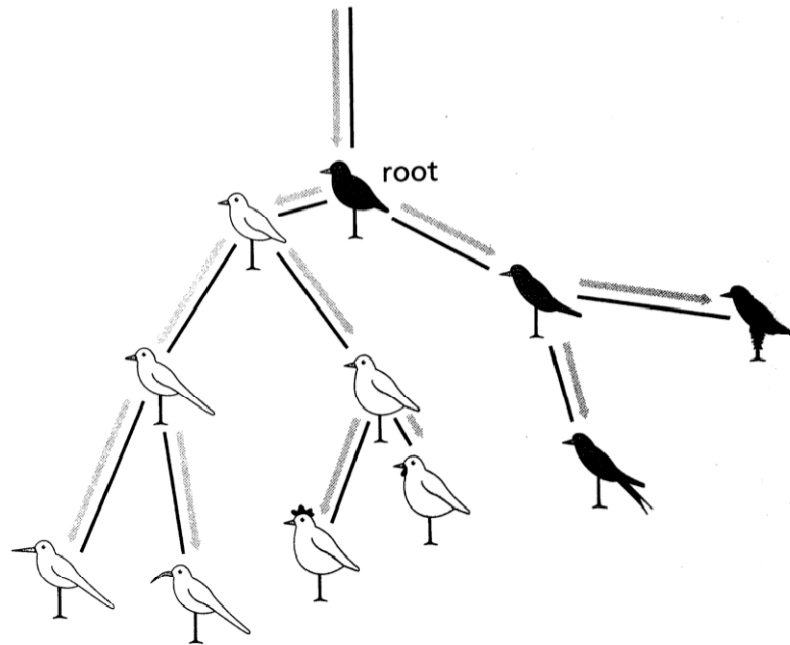
## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > **Phylogenetic Trees**
  - Explanation of the Visuals
  - **Different Kinds of Trees**
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

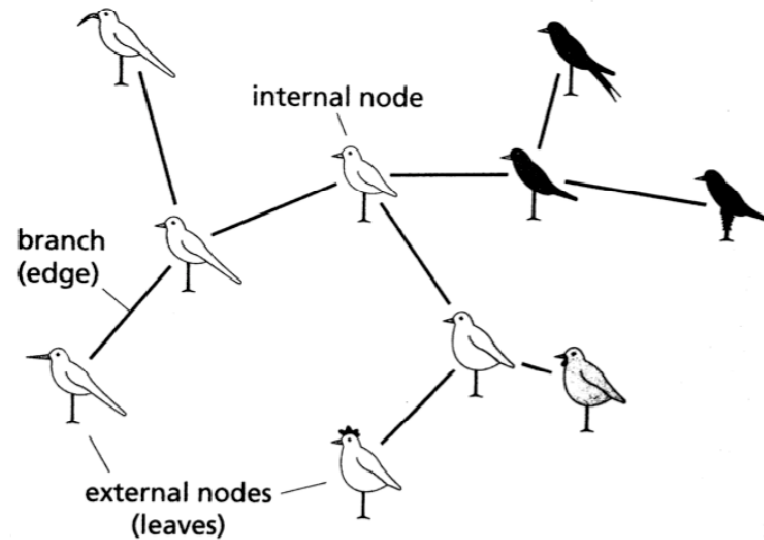
# There are different trees for different kinds of demonstrations

## PHYLOGENETIC TREES

Rooted Tree



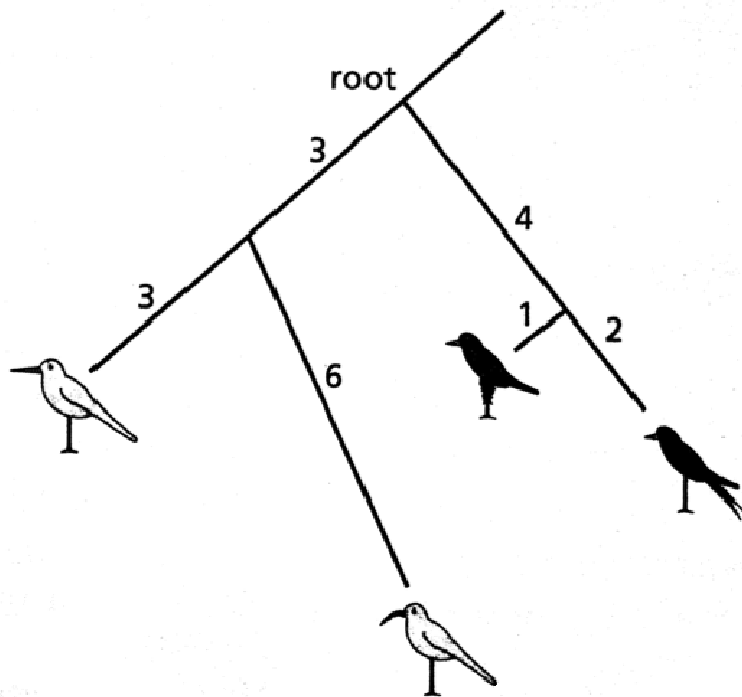
Unrooted Tree



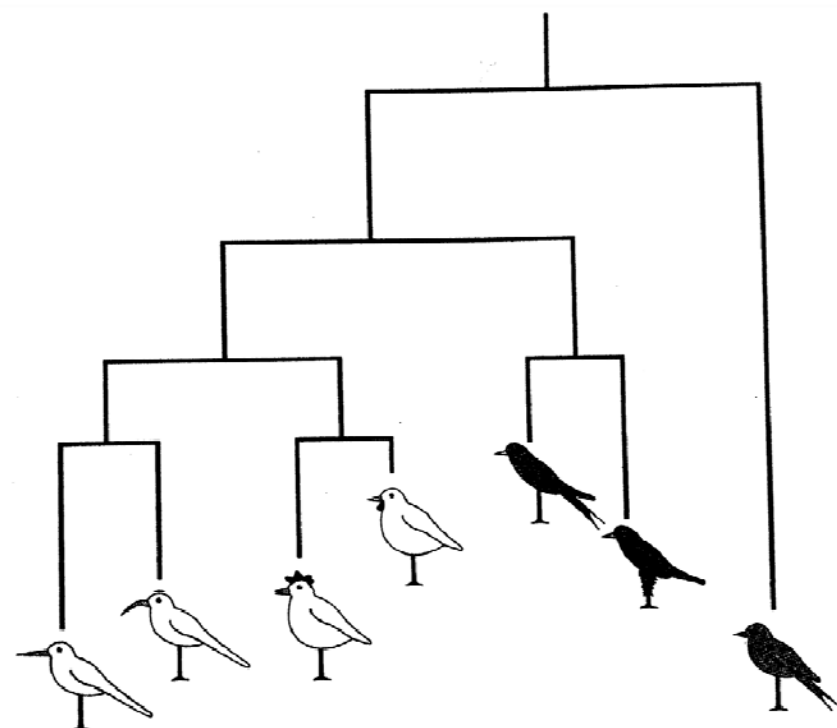
# There are different trees for different kinds of demonstrations

## PHYLOGENETIC TREES

Additive Rooted Tree



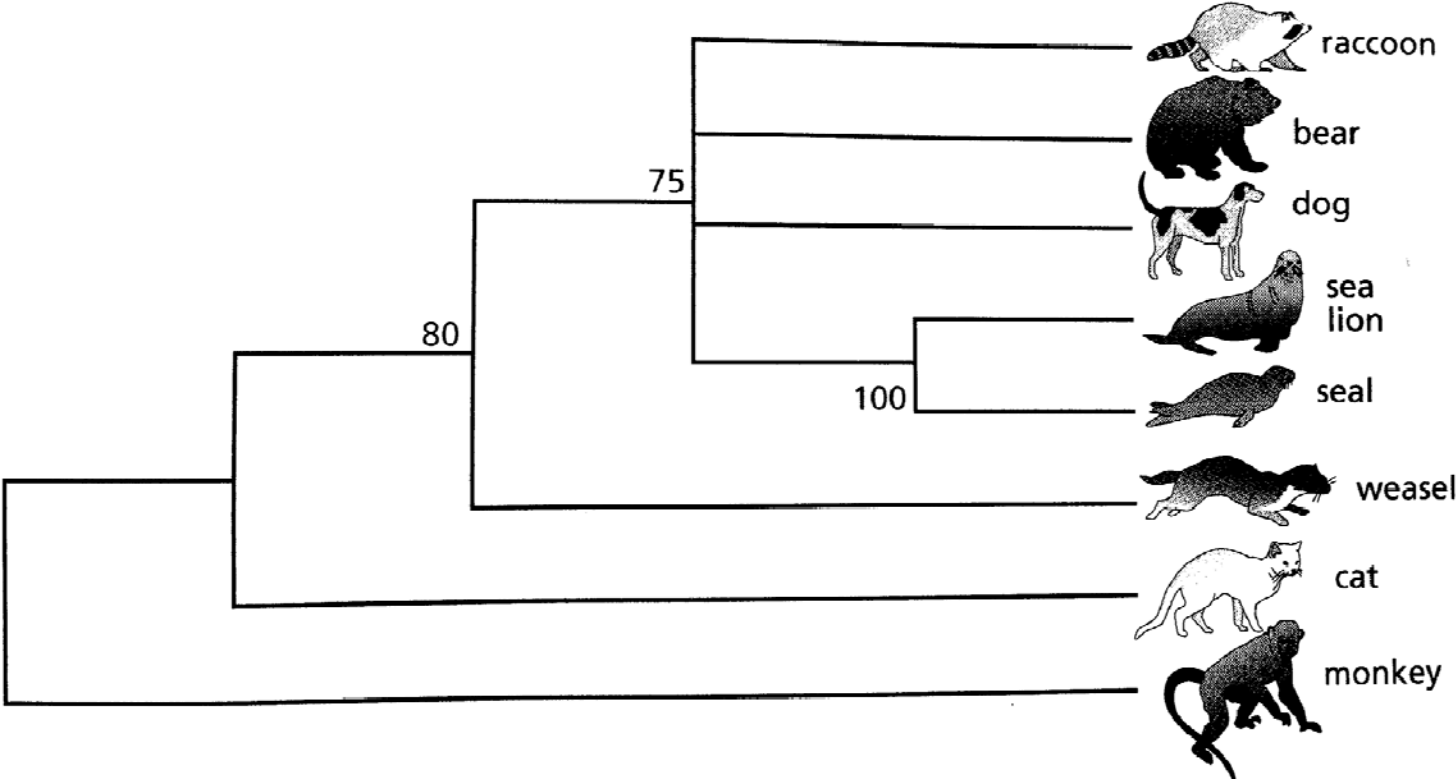
Tree by Outgroup



# There are different trees for different kinds of demonstrations

## PHYLOGENETIC TREES

### Condensed Tree

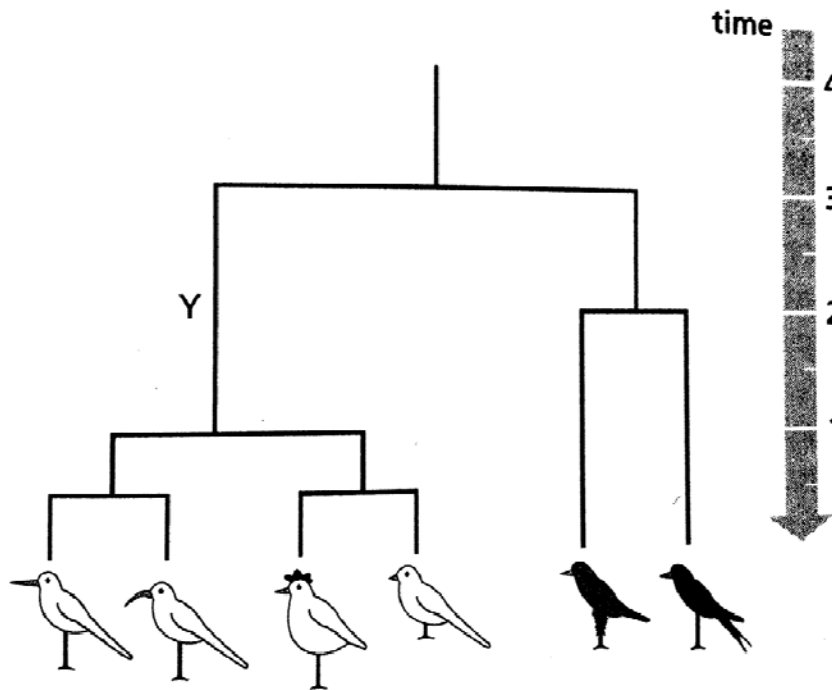




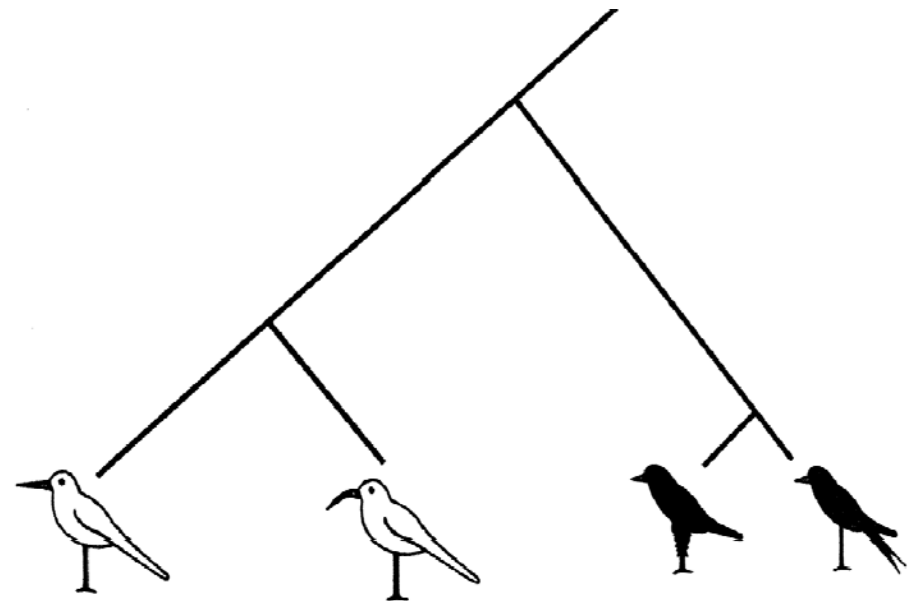
# There are different trees for different kinds of demonstrations

## PHYLOGENETIC TREES

Phylogram  
Tree

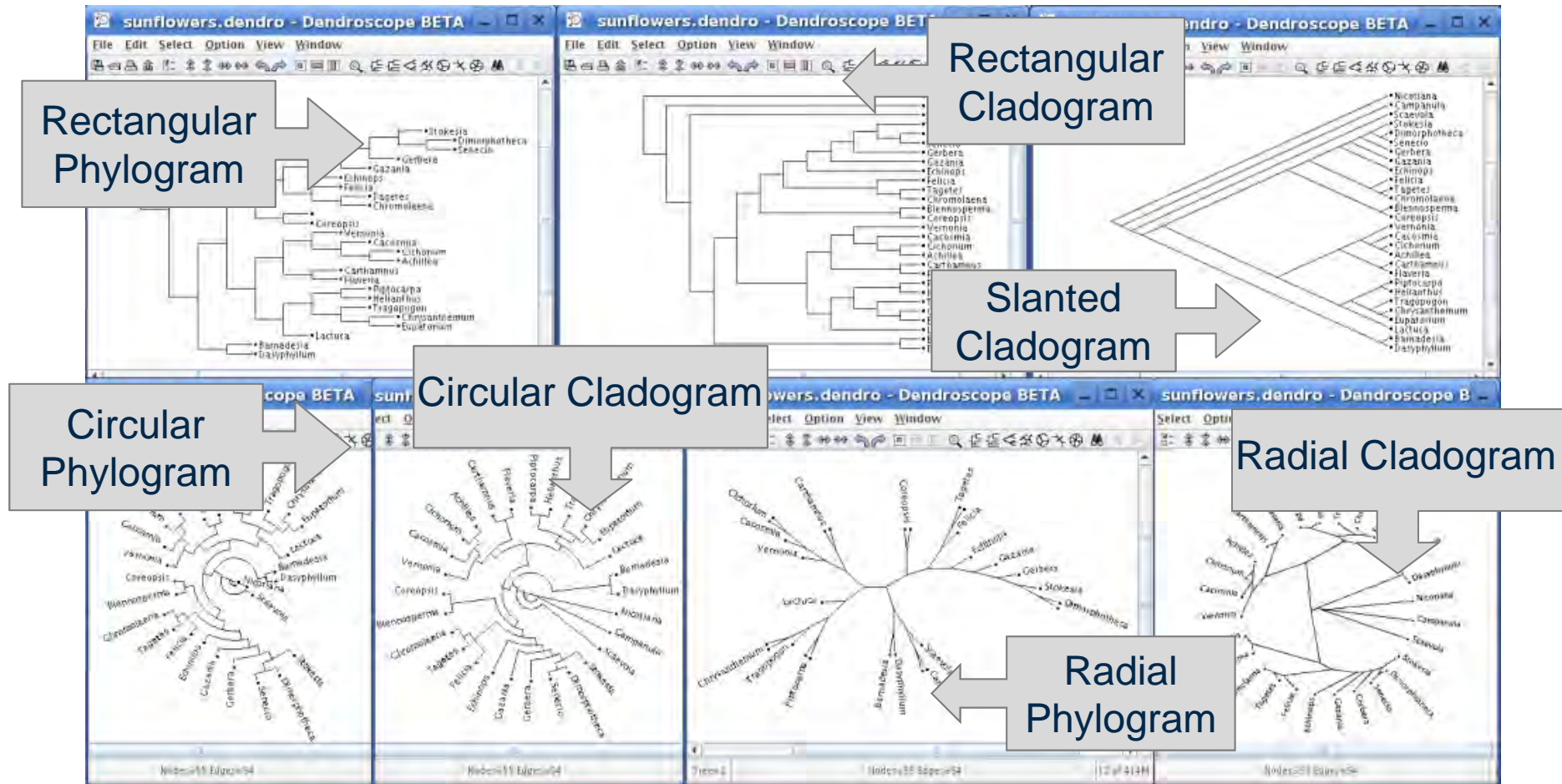


Cladogram  
Tree



# There has been used different trees for different kinds of demonstrations

## PHYLOGENETIC TREES



## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > **Phylogenetic Trees**
  - Explanation of the Visuals
  - Different Kinds of Trees
  - **Groups of Species**
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

# There are different groups of species which can be clustered together to help visualize certain similarities

## PHYLOGENETIC TREES

### Monophyly

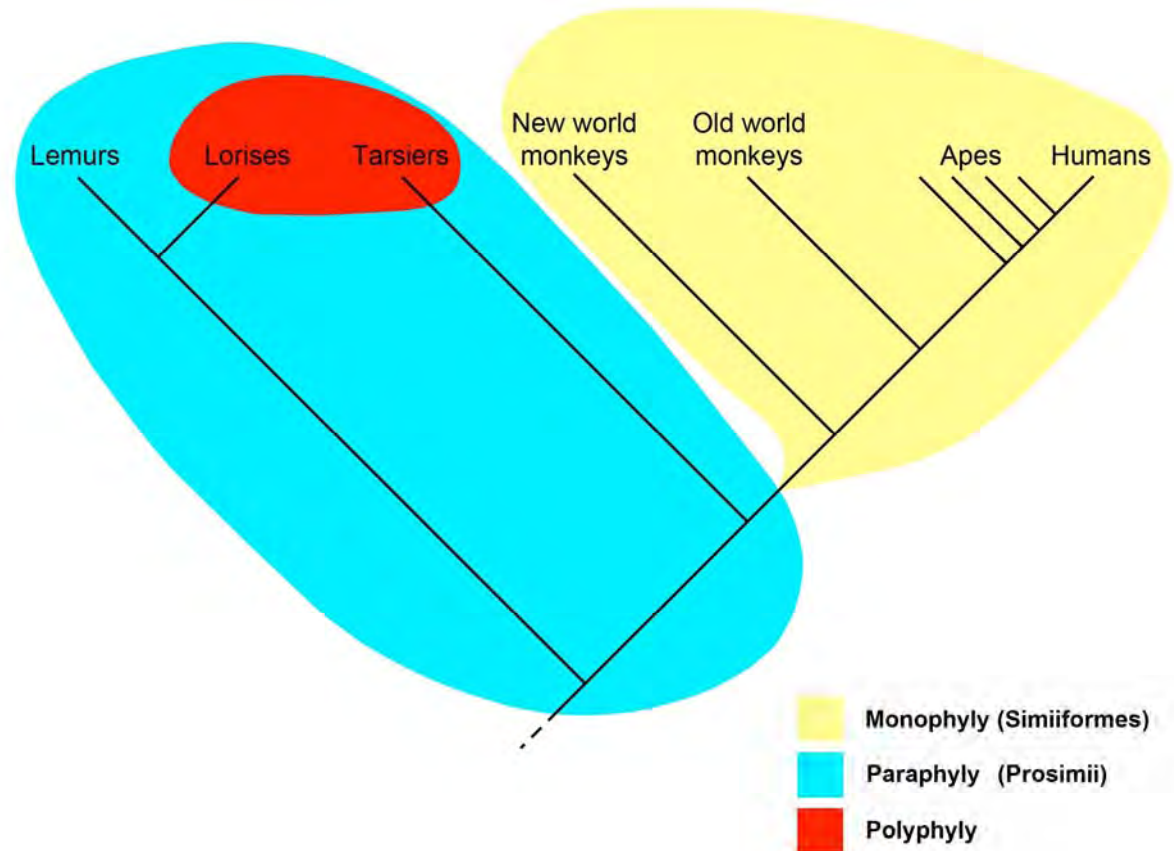
All living descendants of that group from a common ancestor

### Paraphyly

Not all living descendants of that group but a common ancestor

### Polyphyly

Certain different species that share something



## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > **Phylogenetic Trees**
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - **Evidence of the Tree**
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

# Where is the evidence coming from?

## PHYLOGENETIC TREES



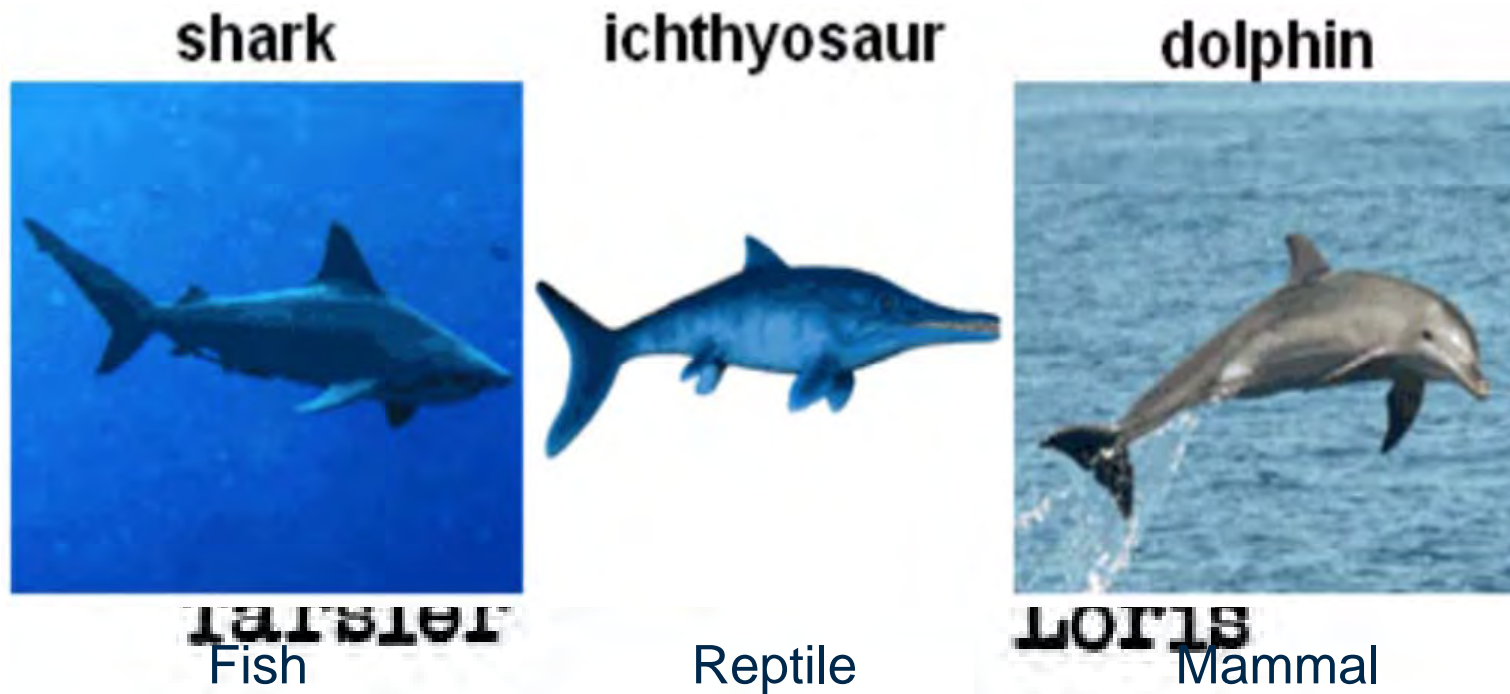
Fossil



Extant

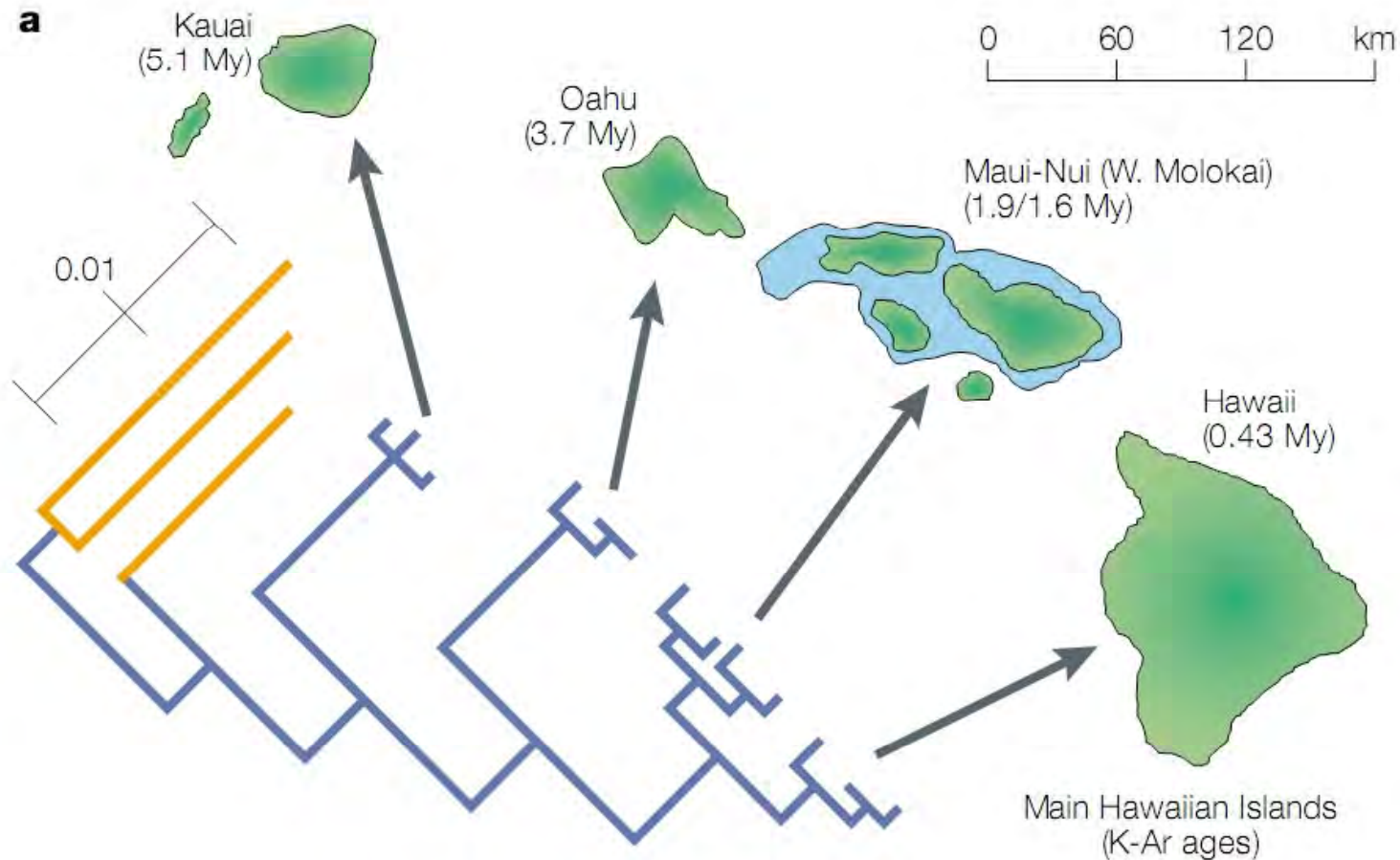
**Morphology is a difficult evidence to take. It can help cluster the species together but can also conclude to wrong relations**

PHYLOGENETIC TREES



Environment gives us details about species. If the gene pool e.g. do not mix, it has to be a new species

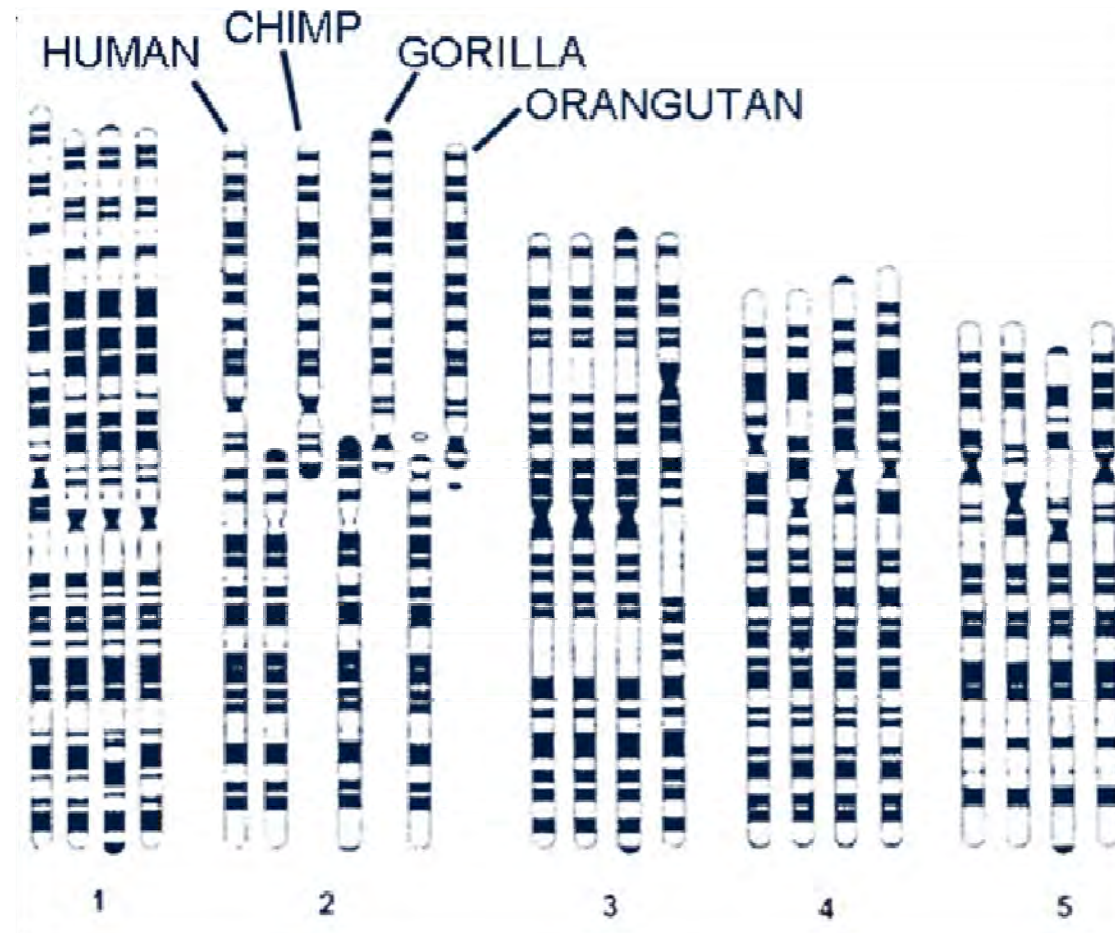
### PHYLOGENETIC TREES





The most efficient method to determine a relationship is by comparing the dna of the species

## PHYLOGENETIC TREES

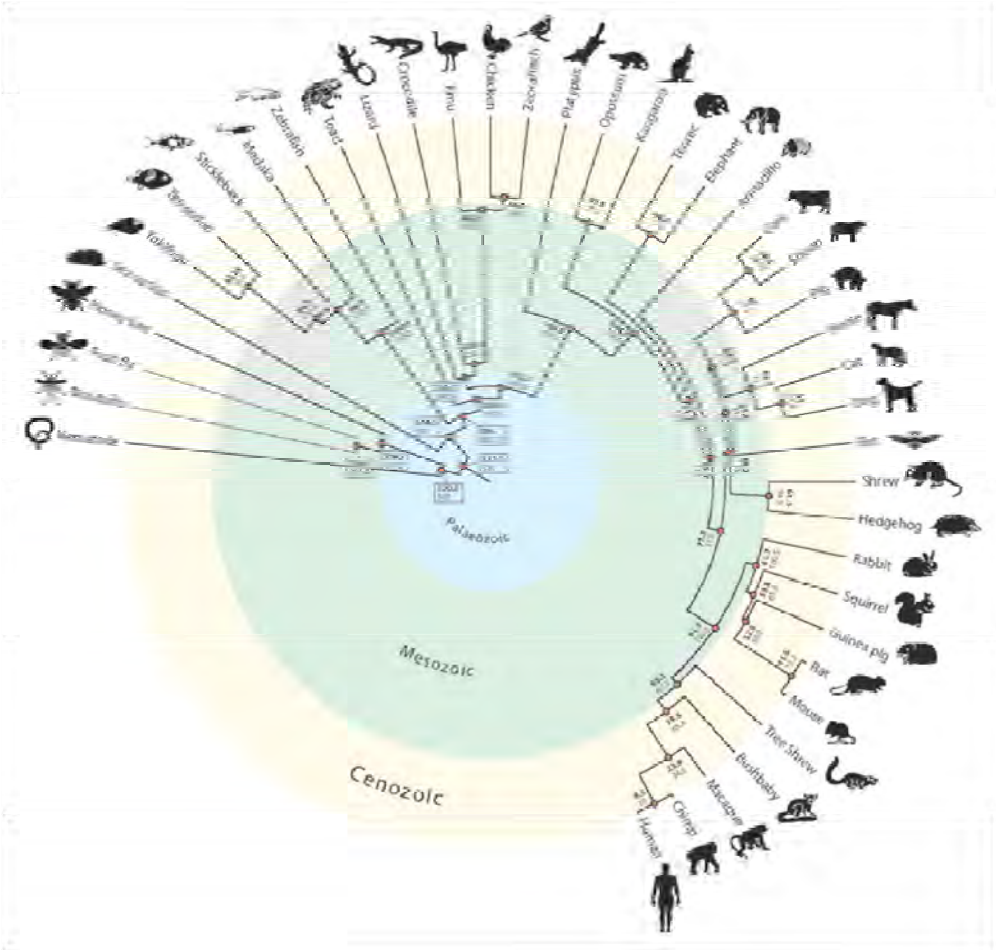


## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > **Phylogenetic Trees**
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - **Time Calculation**
- > Evolution Today?
- > Future of Phylogenetic Trees

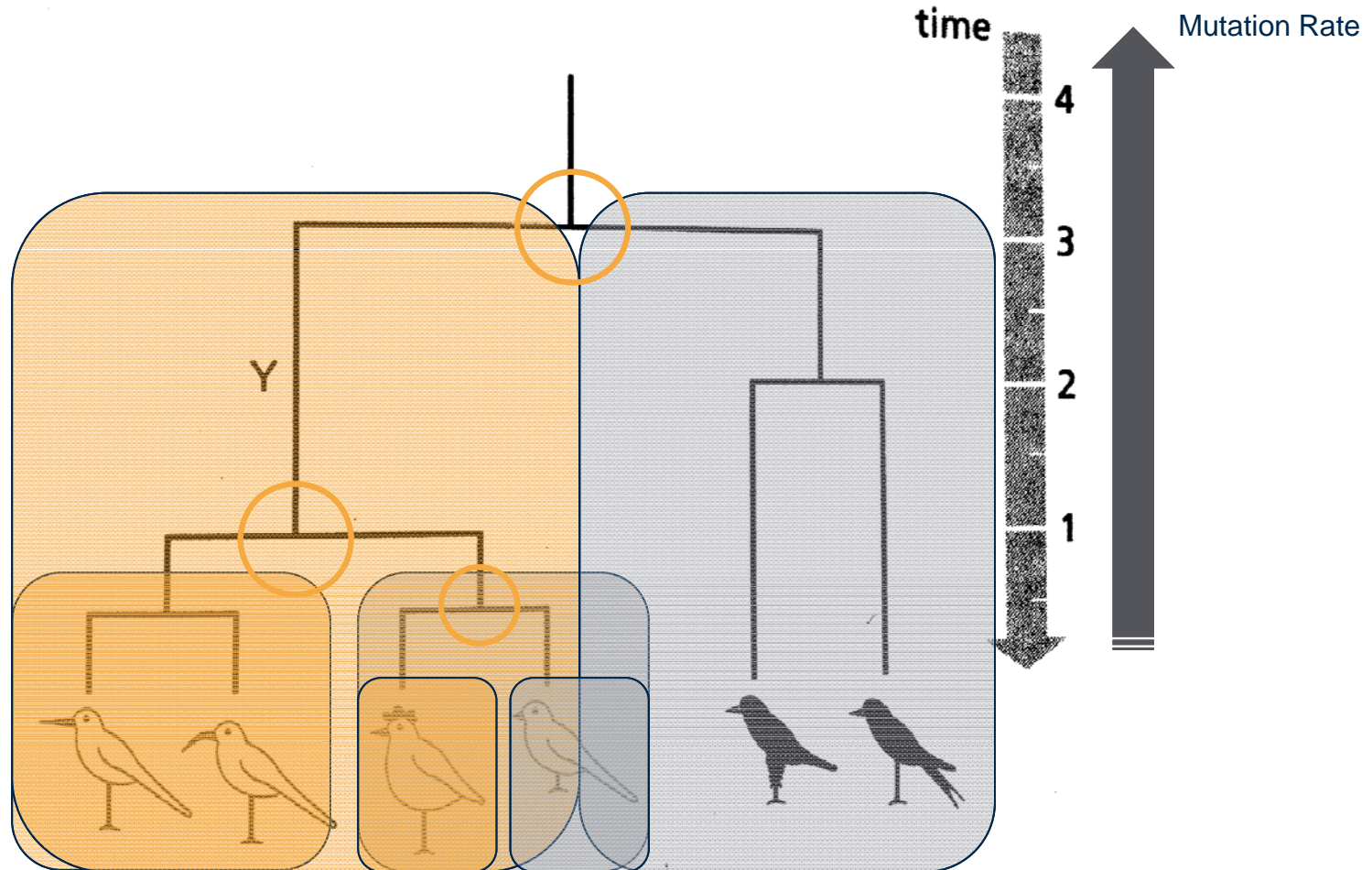
The Molecular Clock is calculated with a certain fossil. With constant mutation rates of an organism you can estimate the evolution time

PHYLOGENETIC TREES



The Molecular Clock is calculated with a certain fossil. With constant mutation rates of an organism you can estimate the evolution time

### PHYLOGENETIC TREES



## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

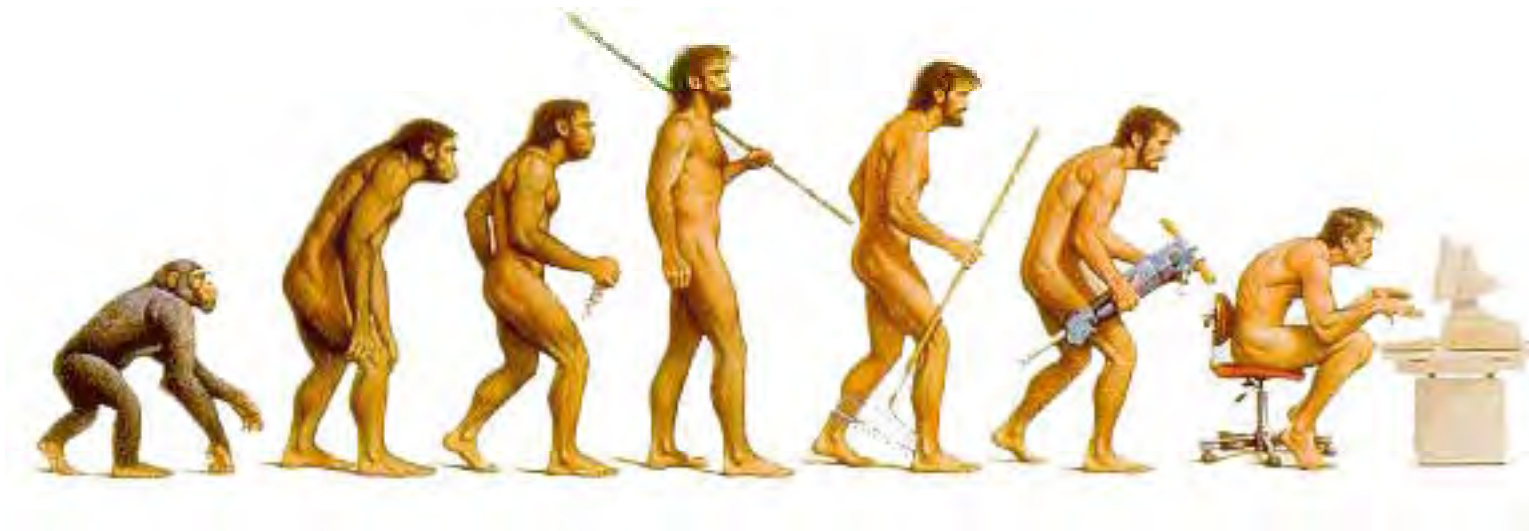
# Do animals still evolve nowadays?

## CAUSE OF MUTATION



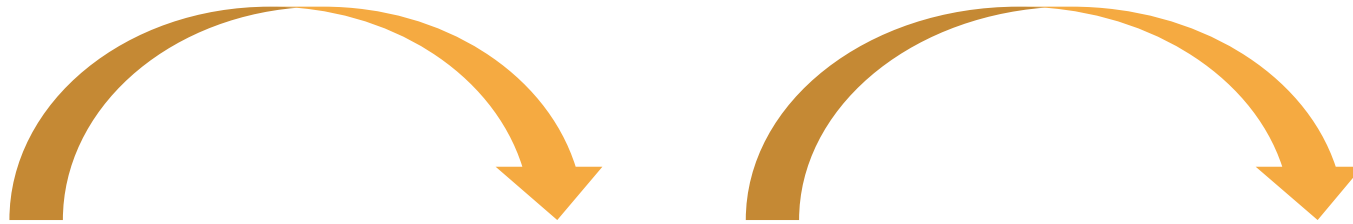
**Natural selection is about species having to cope with their environmental circumstances and procreate against them further**

**EVOLUTION TODAY?**



# Is the human species able to evolve new abilities or into a better species?

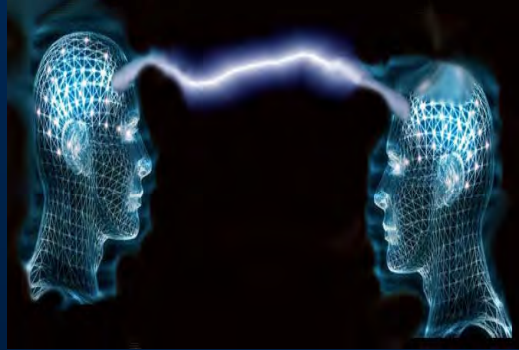
EVOLUTION TODAY?





**There are two opinions about evolution today. Scientists are coming up with new theories about it but there has been found no proof yet**

**EVOLUTION TODAY?**



**Can the human species evolve into a new species?  
Yes, but the gene pool has to stay pure**

EVOLUTION TODAY?

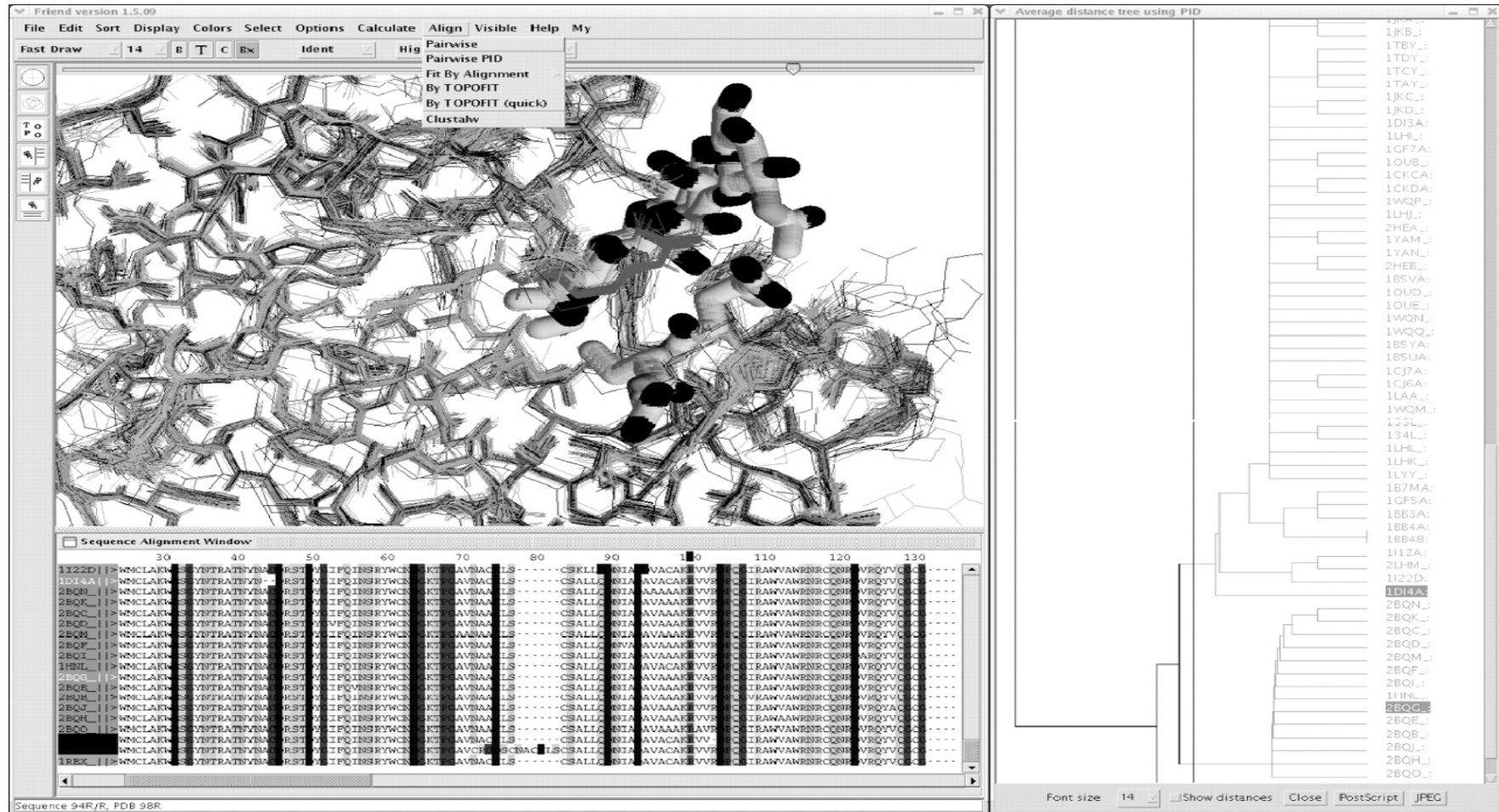


## AGENDA

- > Basics
- > Scale of the Universe
- > Creation of Life
- > Evolution to Human
- > Phylogenetic Trees
  - Explanation of the Visuals
  - Different Kinds of Trees
  - Groups of Species
  - Evidence of the Tree
  - Time Calculation
- > Evolution Today?
- > Future of Phylogenetic Trees

# What is the connection to informatics?

## FUTURE OF PHYLOGENETIC TREES



# The phylogeny needs help of informatics systems to cope with the data

## FUTURE OF PHYLOGENETIC TREES

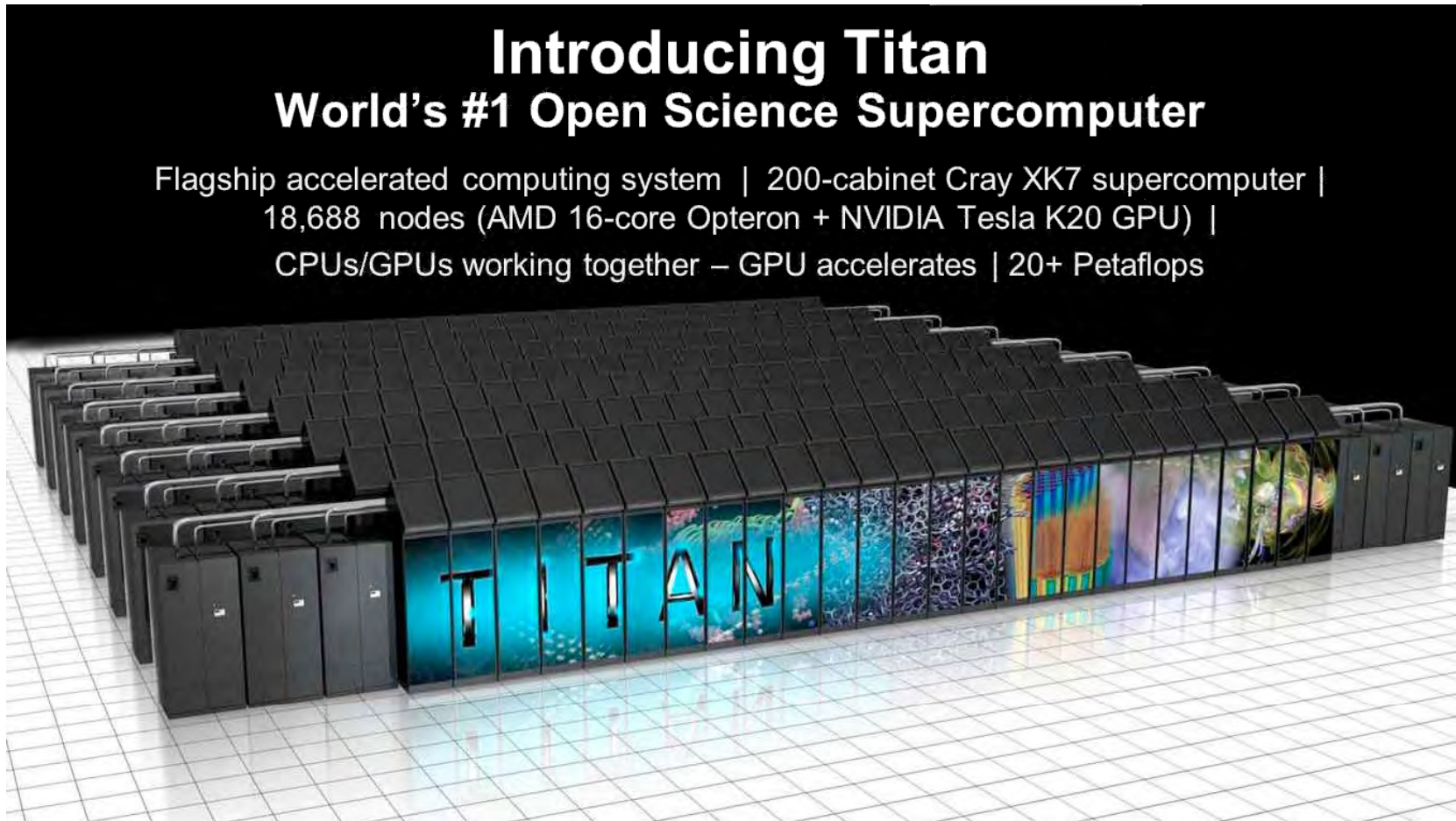
4 species	–	3 trees	(unrooted)
5 species	–	15 trees	
6 species	–	105 trees	
7 species	–	945 trees	
8 species	–	10395 trees	
9 species	–	135135 trees	
10 species	–	2027025 trees	
11 species	–	~34million trees	
100 species	–	more possible trees than electrons in the universe	$10^{70}$

Species-Tree-algorithm:  
 $A(n+1) = A(n) * [n*2+1]$

Hint:  $1*3*5*7*9*11\dots$

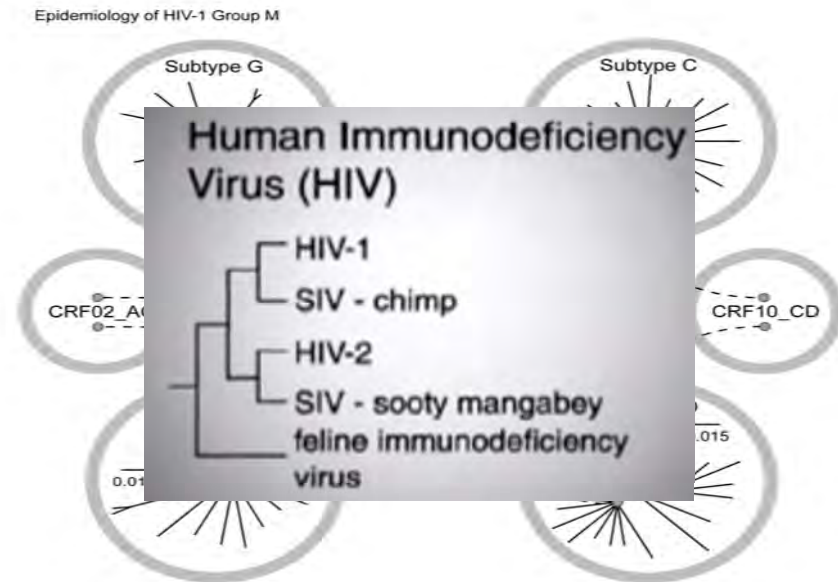
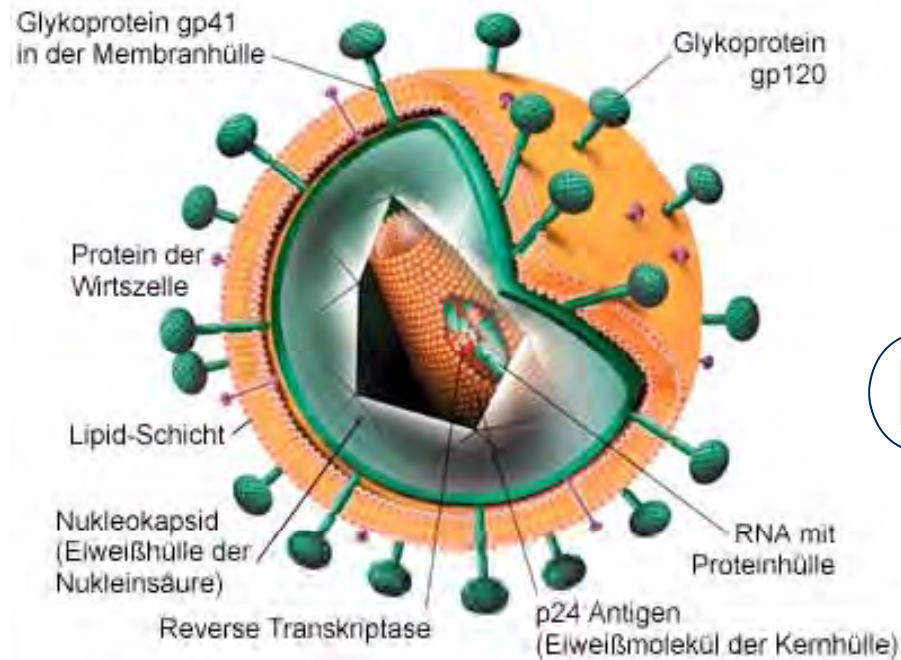
# New supercomputer are constantly created to analyze data for science

## FUTURE OF PHYLOGENETIC TREES



# With the help of bioinformatics diseases can be prevented and species can be preserved

## USAGE OF PHYLOGENETIC TREES



**Thank you for your attention!**

FEEL FREE TO ASK QUESTIONS

Nikolas Reichardt

winf9996@fh-wedel.de

5<sup>th</sup> term BoS. Business informatics