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FRAME

SIBYLA TRIQUETRA

The simulator of forest biodynamics

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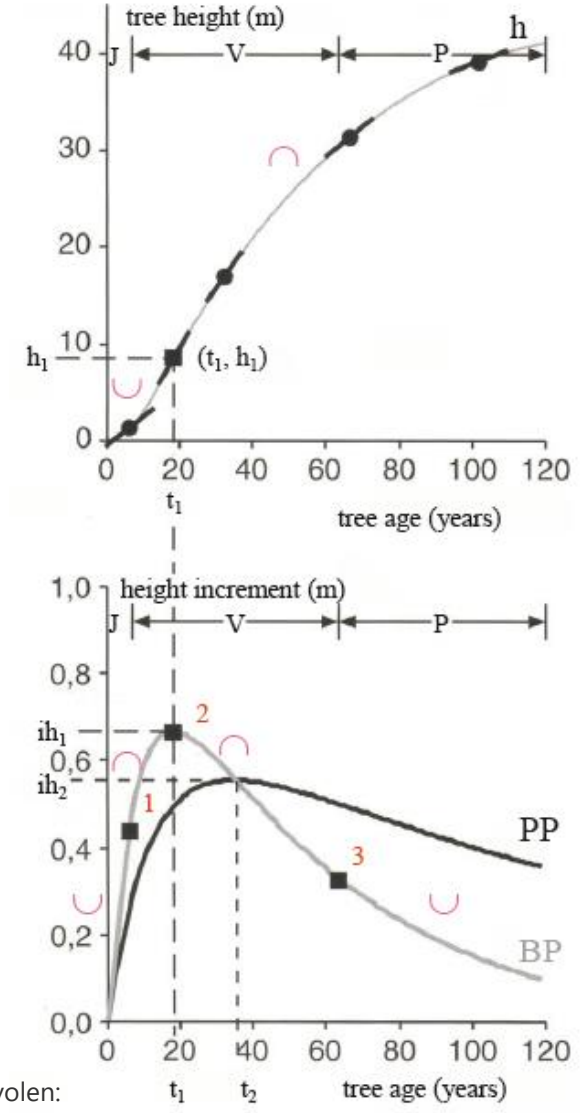
Principles and rules in forest modeling

The principle of **growth and increment**

Tree: change in tis diameter, height and volume

Stand: mean diameter, top height, basla area or stock



The **yield function** is a mathematical function expressing the relationship between growth value and the age of an individual or population. The function has a progress shape and a typical development in the shape of an 'S', which asymptotically approaches the maximum value.

The **increment function** expresses the change in the growth value of an individual or population throughout a defined time period, depending upon age. It can be expressed as the first derivation of the growth function (current increment) or may be based upon the proportion of growth value and age (mean increment).

Source: FABRIKA, Marek; PRETZSCH, Hans. 2011. *Analýza a modelovanie lesných ekosystémov*. Zvolen: Technická univerzita vo Zvolene. ISBN 978-80-228-2181-0.

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function name	growth function	increment function	expansion component	reduction component
Hossfeld IV	$y = t^c / (b + t^c / a)$	$y' = bct^{c-1} / (b + t^c / a)^2$	cy / t	cy^2 / at
Gompertz	$y = ae^{-be^{-ct}}$	$y' = abce^{-ct} e^{-be^{-ct}}$	$c \ln(a) y$	$cy \ln(y)$
logistic	$y = a / (1 + ce^{-bt})$	$y' = abce^{-bt} / (1 + ce^{-bt})^2$	by	$(b / a) y^2$
mono-molecular	$y = a(1 - ce^{-bt})$	$y' = abce^{-bt}$	ab	by
v.Bertalanffy	$y = a(1 - e^{-bt})^3$	$y' = 3abe^{-bt}(1 - e^{-bt})^2$	$3a^{1/3} b y^{2/3}$	$3by$
Chapman-Richards	$y = a(1 - e^{-bt})^c$	$y' = abce^{-bt}(1 - e^{-bt})^{c-1}$	$a^{1/c} bcy^{(c-1)/c}$	bcy
Levakovič III	$y = a(t^2 / (b + t^2))^c$	$y' = 2abc / t(b + t^2)$	$2cy / t$	$2a^{-1/c} cy^{(c+1)/c} / t$
Korf	$y = ae^{-bt^{-c}}$	$y' = abct^{-c-1} e^{-bt^{-c}}$	$c \ln(a) y / t$	$cy \ln(y) / t$

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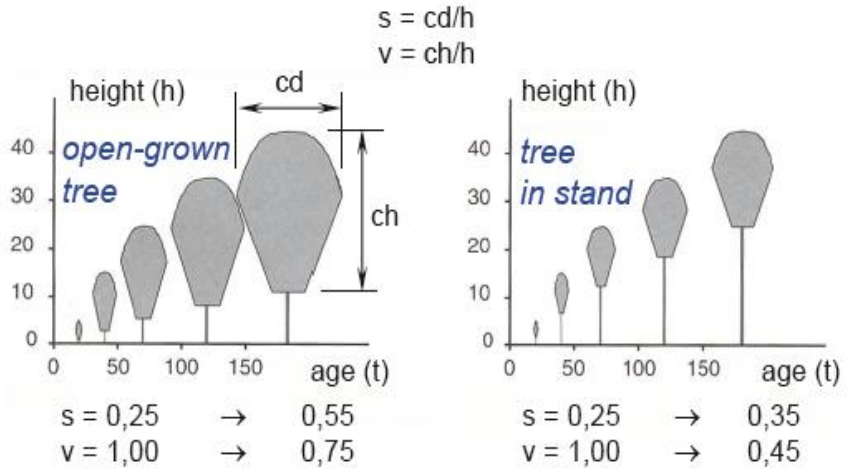
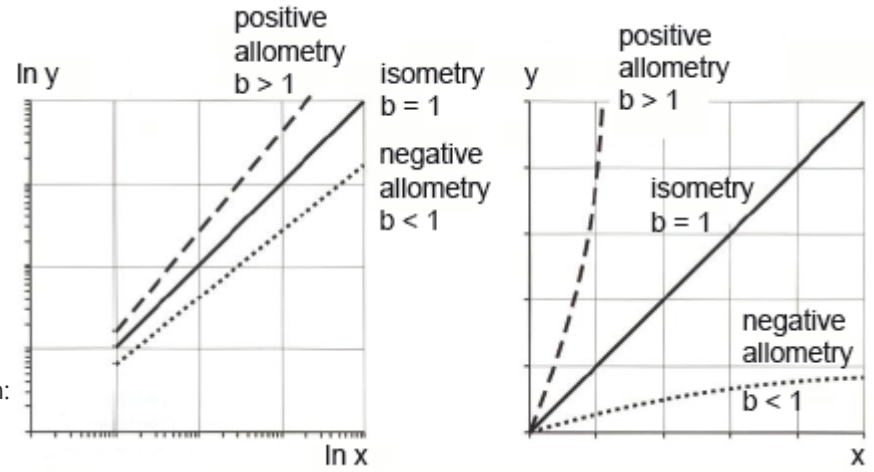
Allometric rule of shape changes

Allometry expresses changes in the proportions between individual organs of a specimen over time. Allometry is caused by various growth rates of organs which are in permanent relation to each other or to the growth rate of the entire organism.





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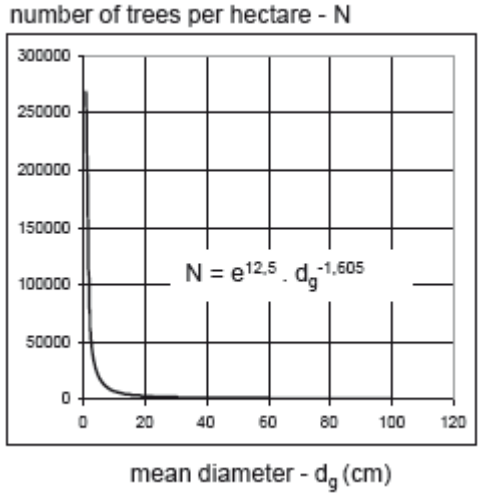
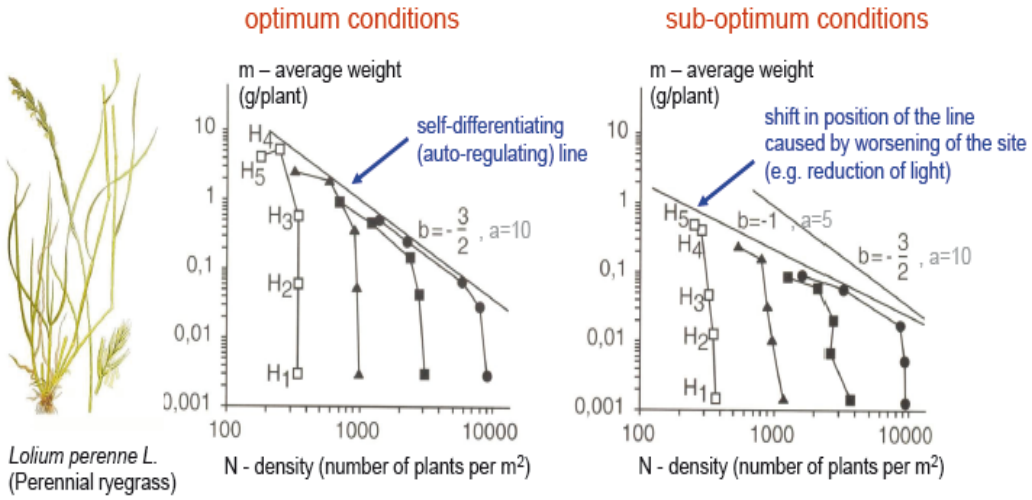
Rules of growing space

Reineke´s stand density rule



Yoda self_thinning rule



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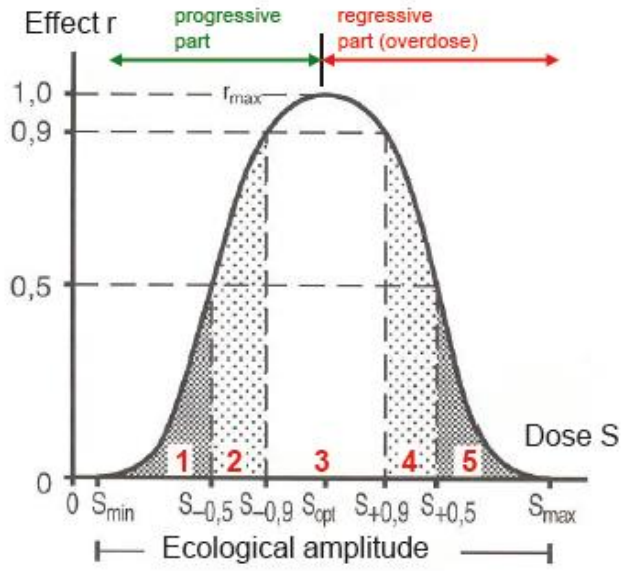
Law of dose and response



1 – lower pessimal range
2 – lower sub-optimum range
3 – optimum range
4 – upper sub-optimum range
5 – upper pessimal range

Source: FABRIKA, Marek; PRETZSCH, Hans. 2011. *Analýza a modelovanie lesných ekosystémov*. Zvolen: Technická univerzita vo Zvolene. ISBN 978-80-228-2181-0.

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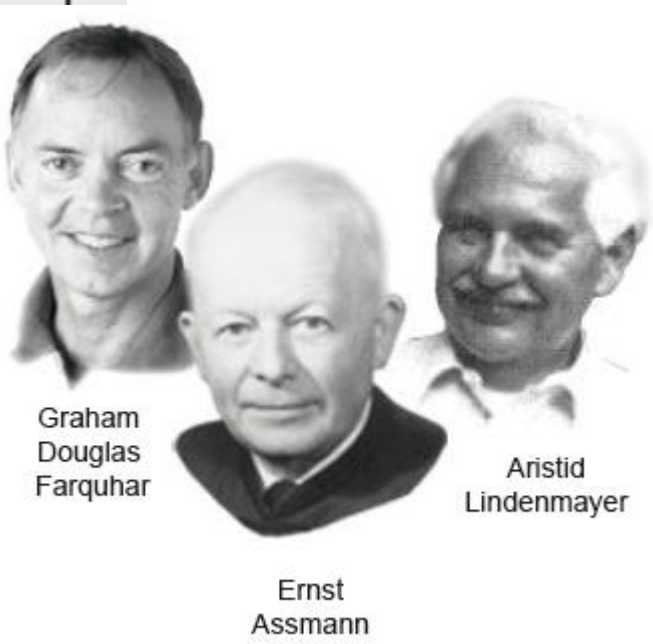
At genesis of forest modelling the three Wise men have operated :

The first has been called FORESTER	The second has been called BIOLOGIST	The third has been called MATHEMATICIAN
and searched for the answer to: „What benefit is produced by forest?“	and searched for the answer to: „Why tree organs growth?“	and searched for the answer to: „How the tree is formed in space?“
He gave to world: regression equation	He gave to world: algorithm of photosynthesis	He gave to world: fractal
Gift has been accepted in disciplines: biometry, forest mensuration, forest growth and yield science	Gift has been accepted in disciplines: bioclimatology, ecopedology, plant physiology	Gift has been accepted in disciplines: formal grammar, fractal geometry, computer graphics
Empirical models have been established.	**Process-based** models have been established.	**Structural** models have been established.



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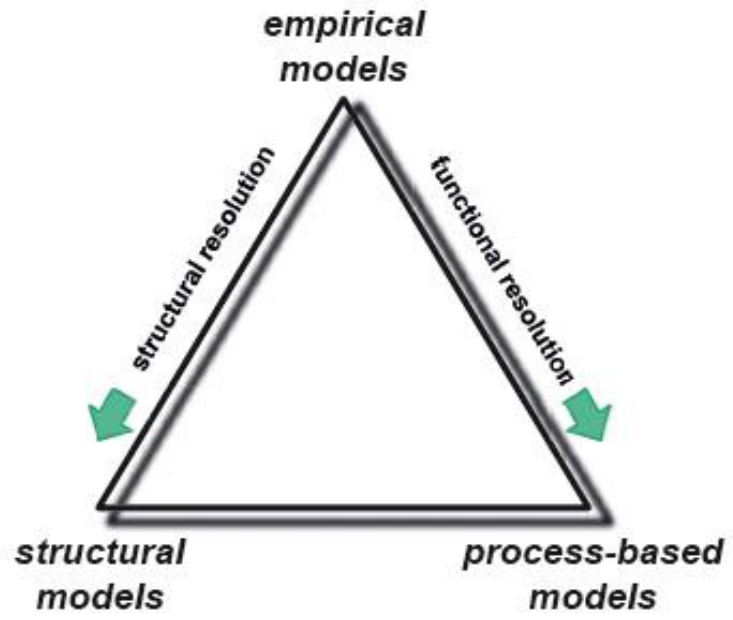
Classification of the models



Empirical models are constructed using statistical equations derived from empirical measurements. Since they are constructed based on sample data, they are valid only for a representative population.

Process-based models orientate towards modelling causal relationships. They use algorithms simulating physiological processes such as photosynthesis, respiration and allocation. Their concept is more general.

Structural models focus upon modelling tree morphology based upon the topology of organs and the architecture of the plant. They use growth grammars in the form of L-systems.

Source: FABRIKA, Marek; PRETZSCH, Hans. 2011. *Analýza a modelovanie lesných ekosystémov*. Zvolen: Technická univerzita vo Zvolene. ISBN 978-80-228-2181-0.

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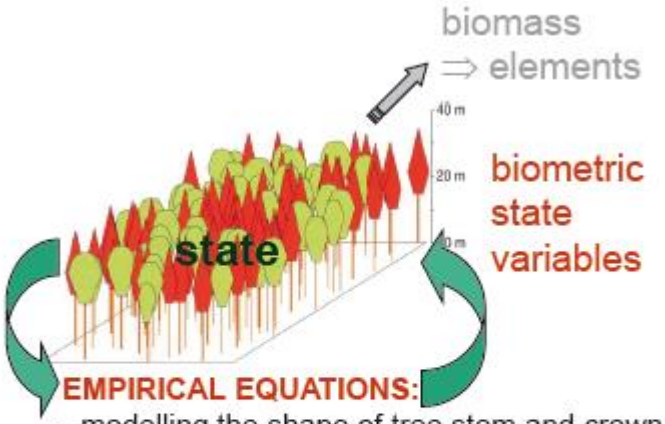
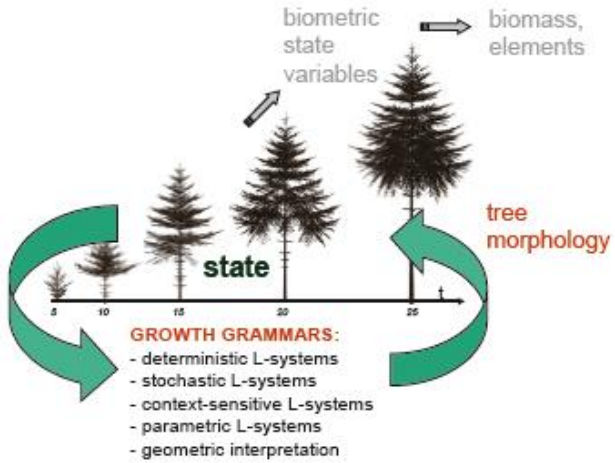
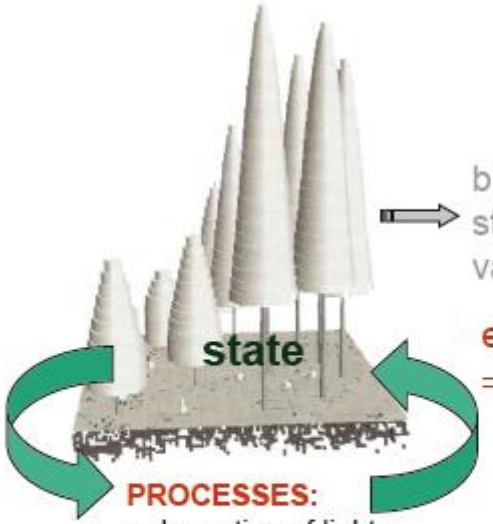


EMPIRICAL EQUATIONS:
- modelling the shape of tree stem and crown
- modelling the diameter, height and spatial structure
- modelling competition
- modelling mortality
- modelling thinning
- modelling growth



GROWTH GRAMMARS:
- deterministic L-systems
- stochastic L-systems
- context-sensitive L-systems
- parametric L-systems
- geometric interpretation



PROCESSES:
- absorption of light
- interception
- evapotranspiration
- photosynthesis
- respiration
- allocation
- senescence

Source: FABRIKA, Marek; PRETZSCH, Hans. 2011. *Analýza a modelovanie lesných ekosystémov*. Zvolen: Technická univerzita vo Zvolene. ISBN 978-80-228-2181-0.

Sibyla

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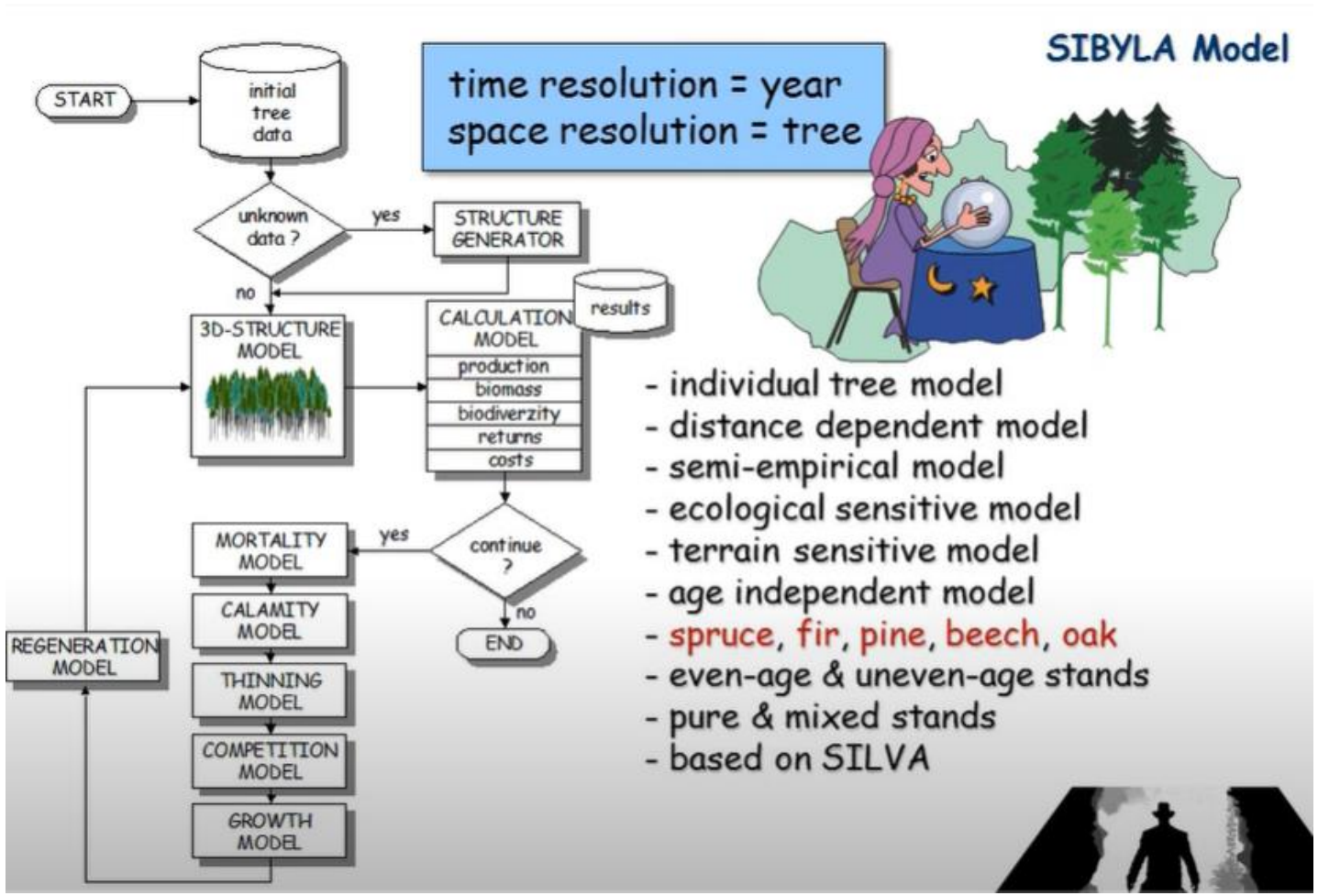

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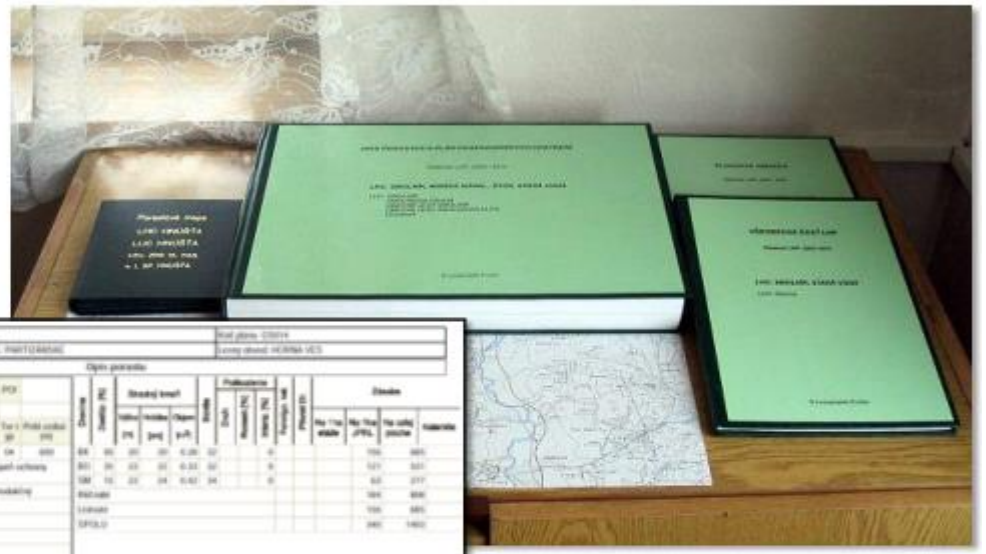
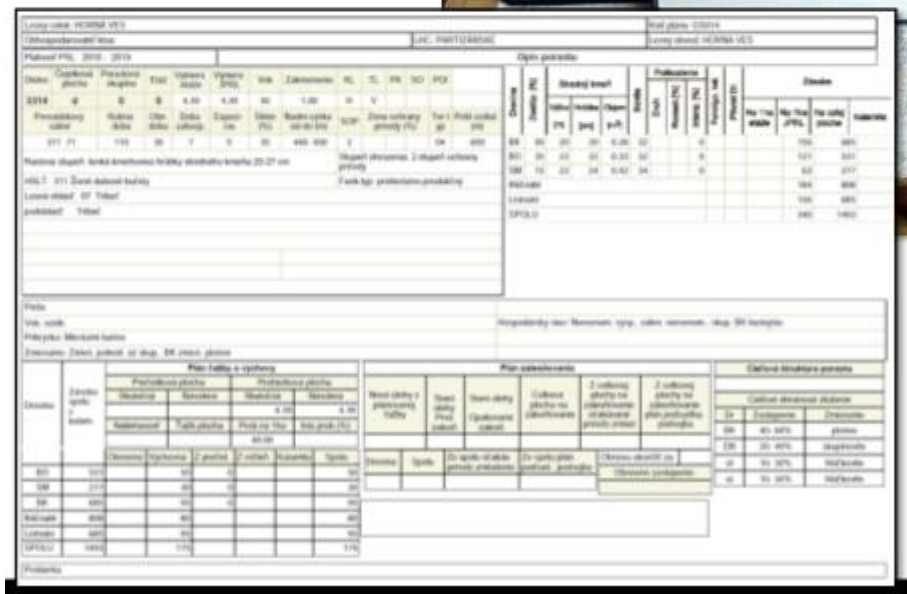
1th level of difficulty: tourist

INFORMATION ADAPTING





stand description from
forest inventory

LECTURES BY MAREK FABRIKA

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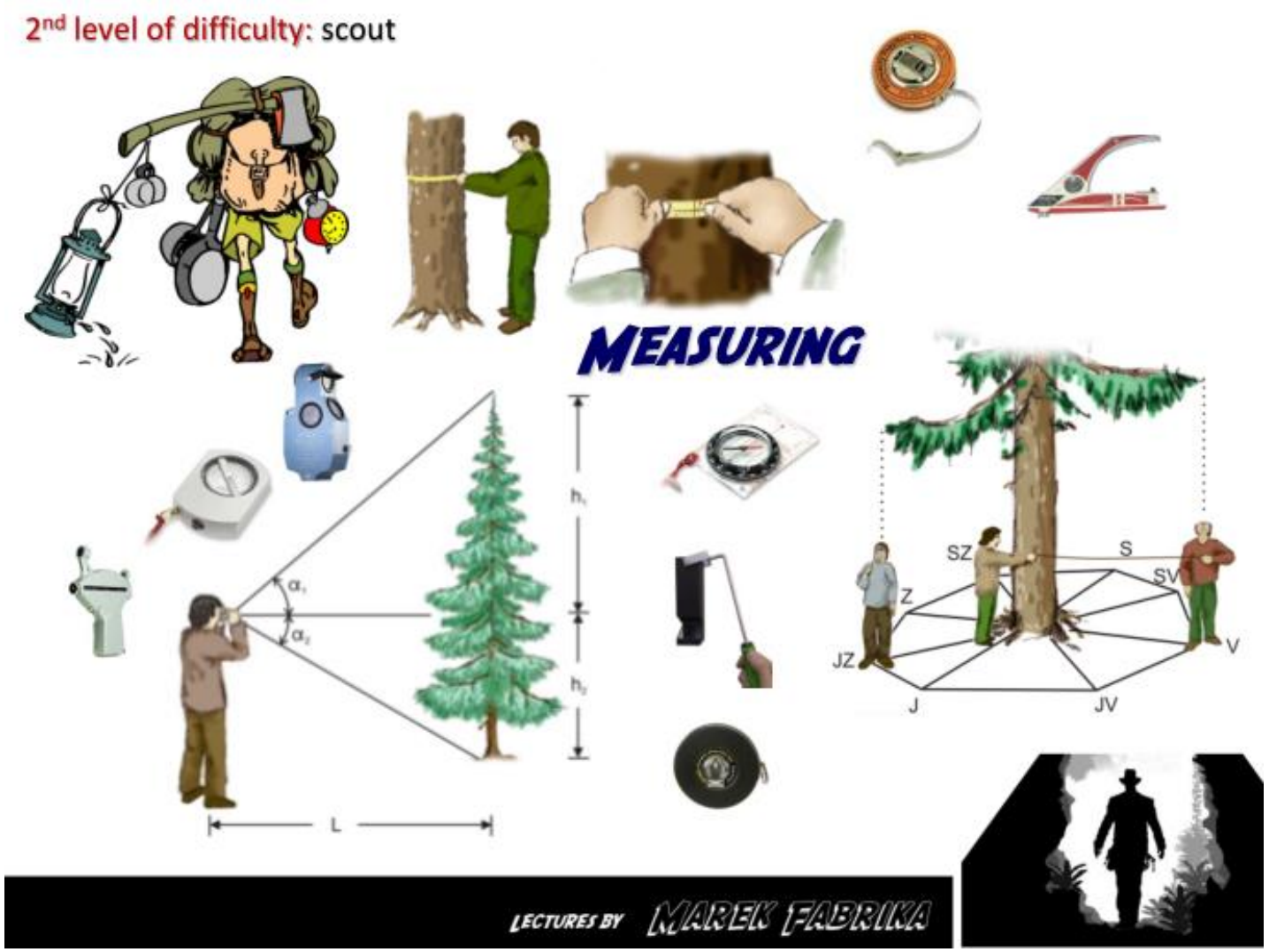

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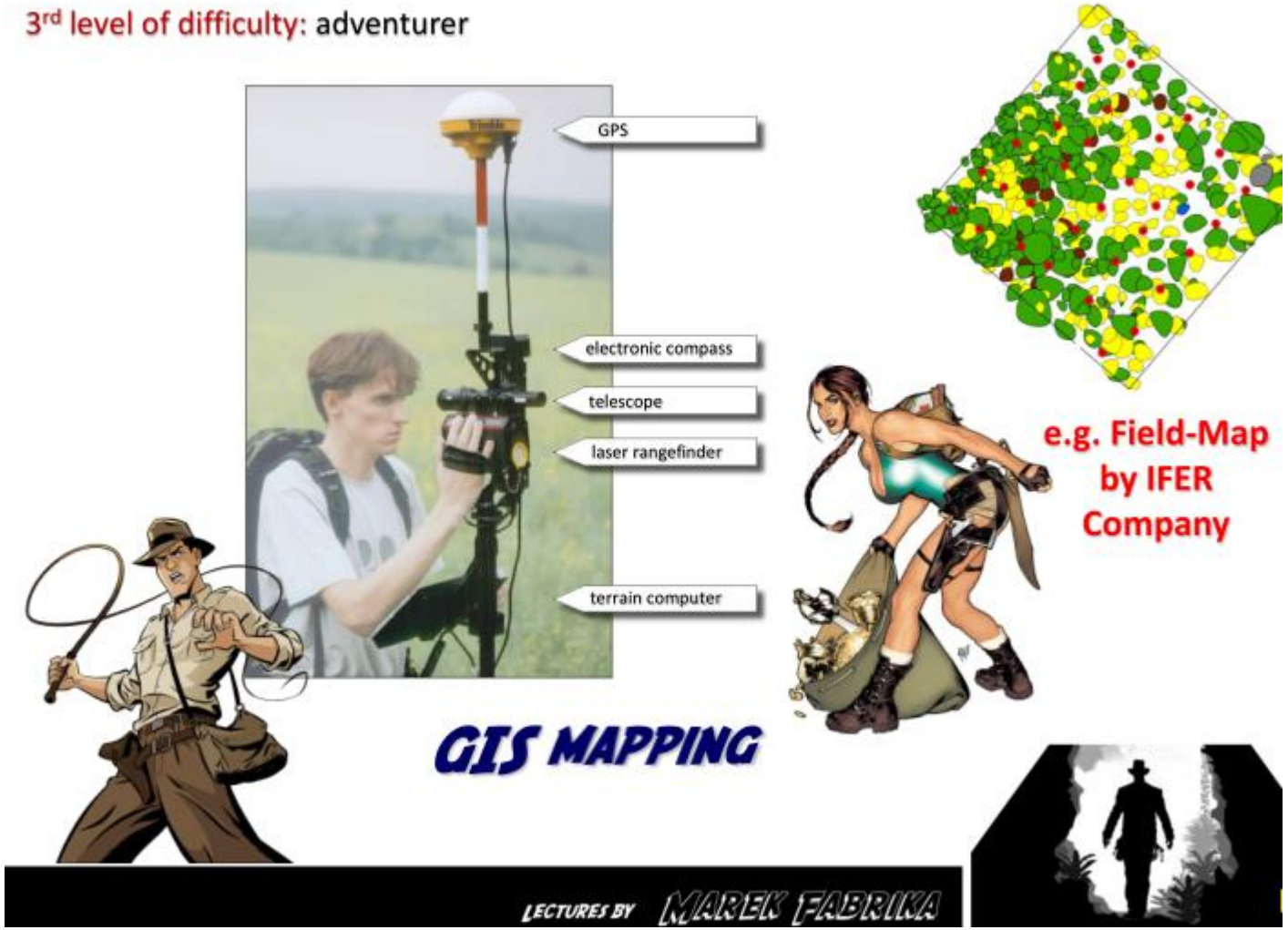

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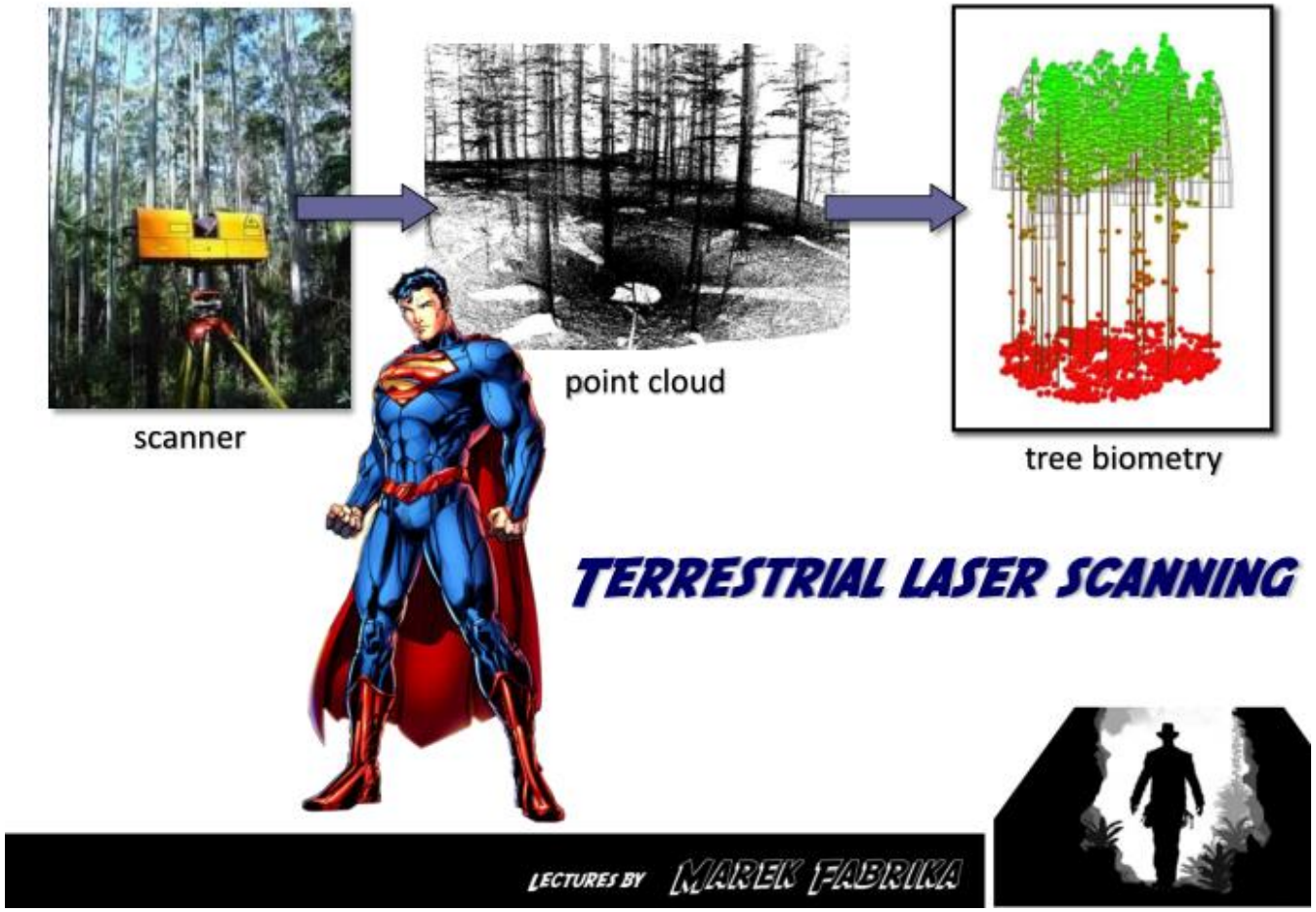
4th level of difficulty: superman



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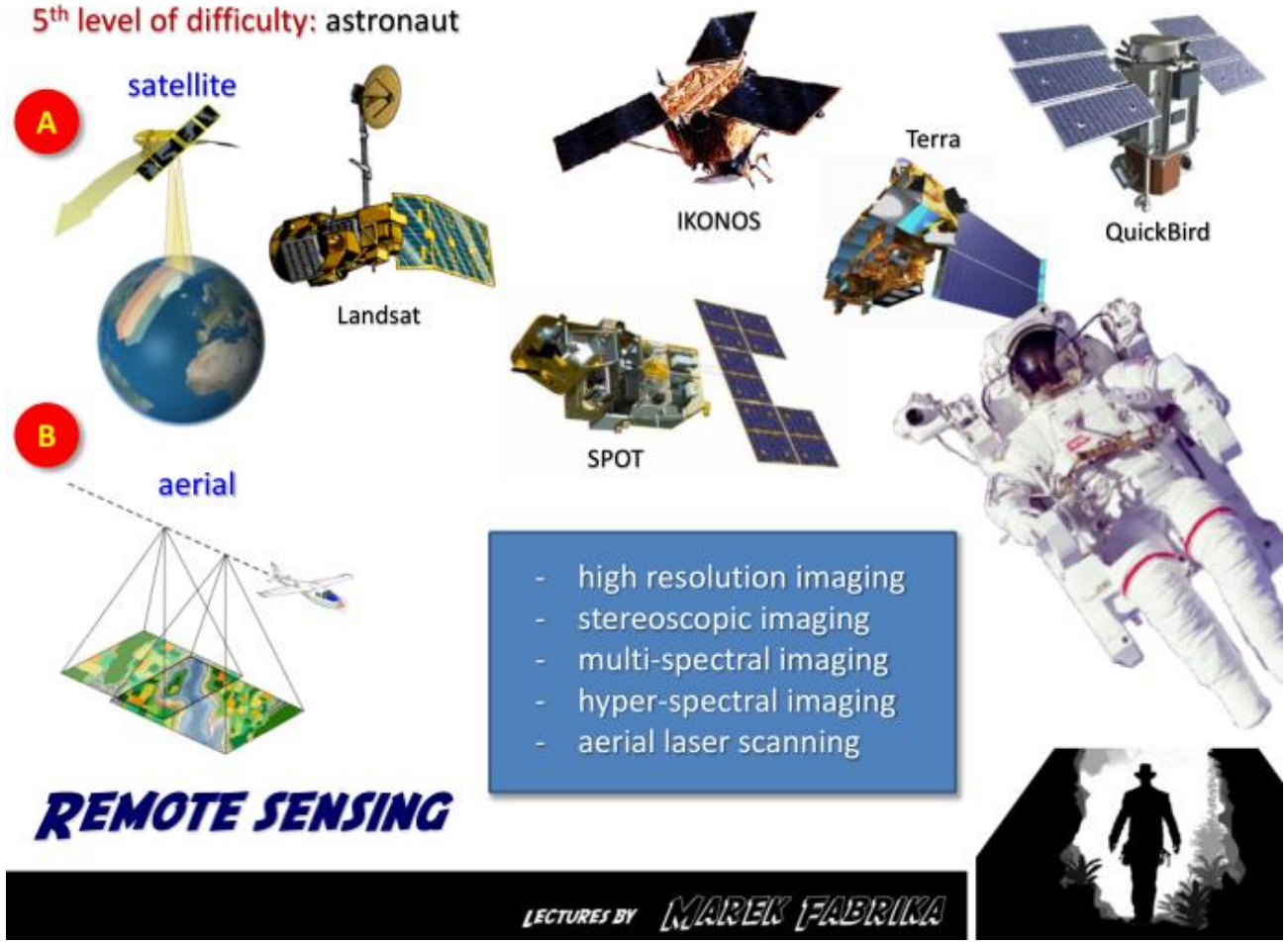

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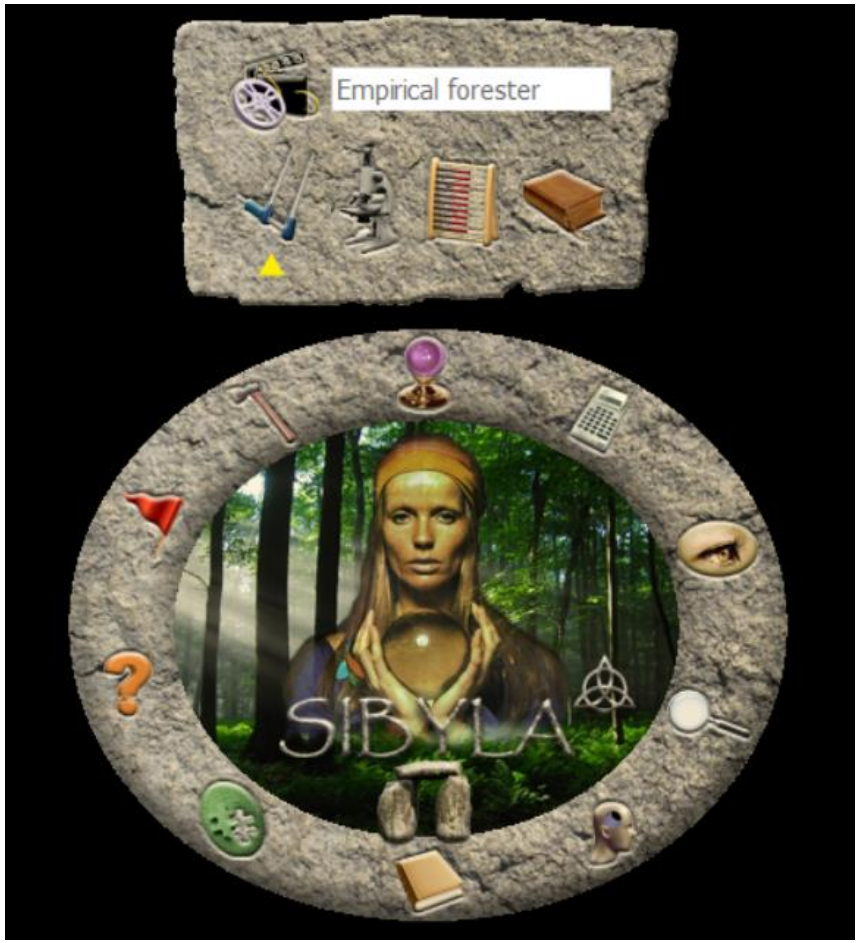
https://etools.tuzvo.sk/cave/



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