Intelligenza artificiale e machine learning nelle tecnologie forestali

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Research Group IUFRO 3.01.03 “**Harvesting and Processing Systems**”



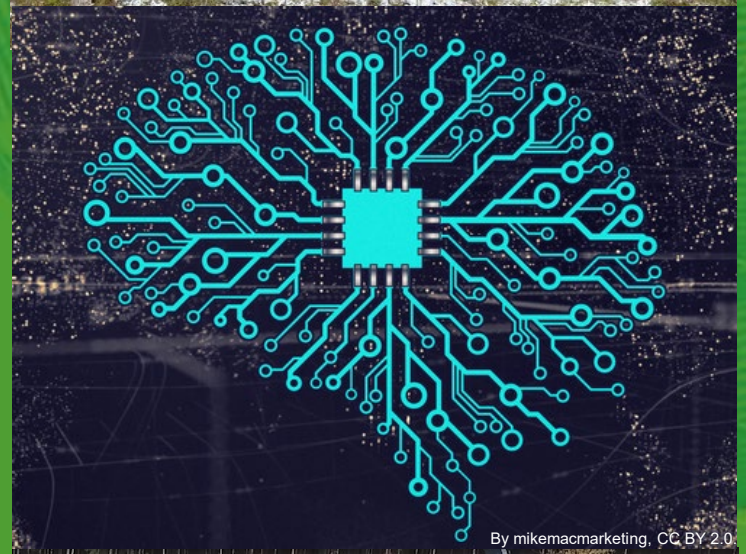

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Photo Anneli Knutsson, MAJT

Could AI harvest a forest/do forestry?

Which of these is AI?

- A camera detecting trees
- A model predicting forest growth
- A harvester optimising its crane movements
- ChatGPT writing a report



All of them - potentially.

What do we actually mean with AI?

- **AI**
  → the broad concept: machines performing tasks that normally require human intelligence

- **Machine Learning**
  → a way of building AI systems by learning patterns from data

- **Deep Learning**
  → a particular family of machine-learning methods, especially powerful for images, video, speech, etc.

AI is the umbrella; Machine learning is a common way to build AI systems

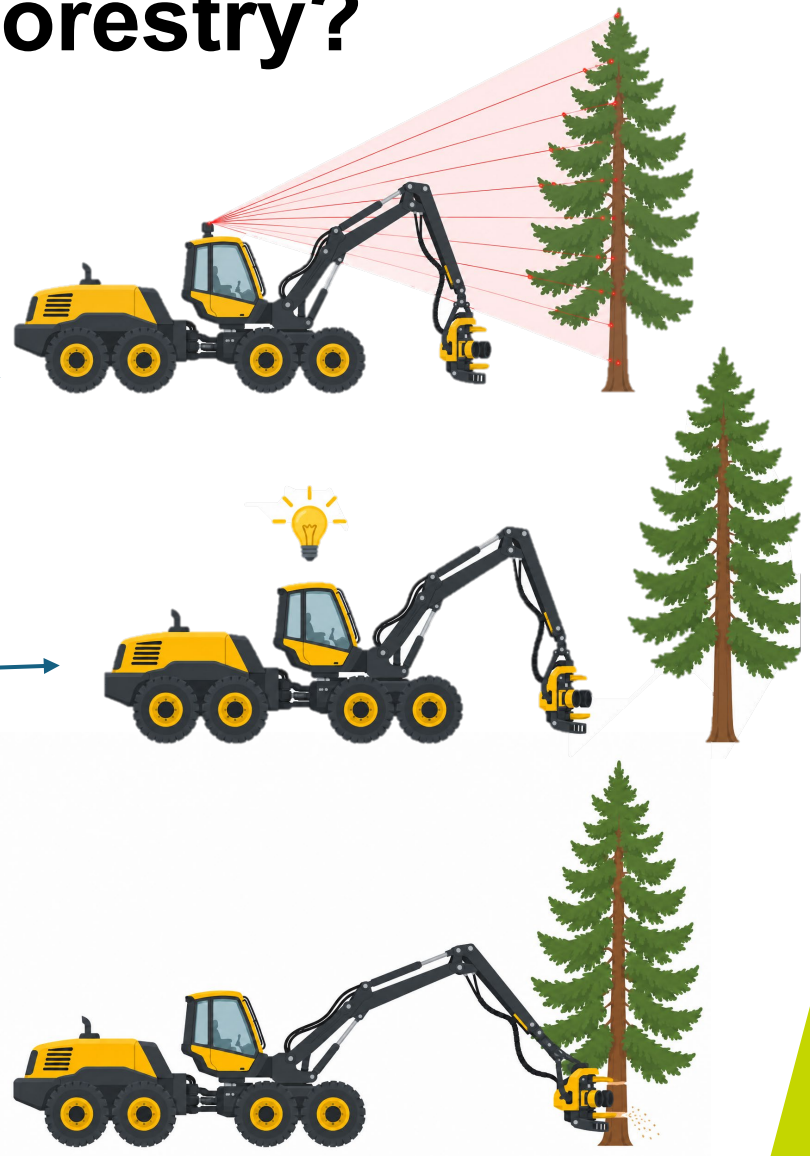


Could AI harvest a forest/do forestry?

- The interesting question is: which parts of forestry can machines learn to do?

- Can machines
  - ***See***
  - ***Think***
  - ***Act***

good enough to do forest operations?

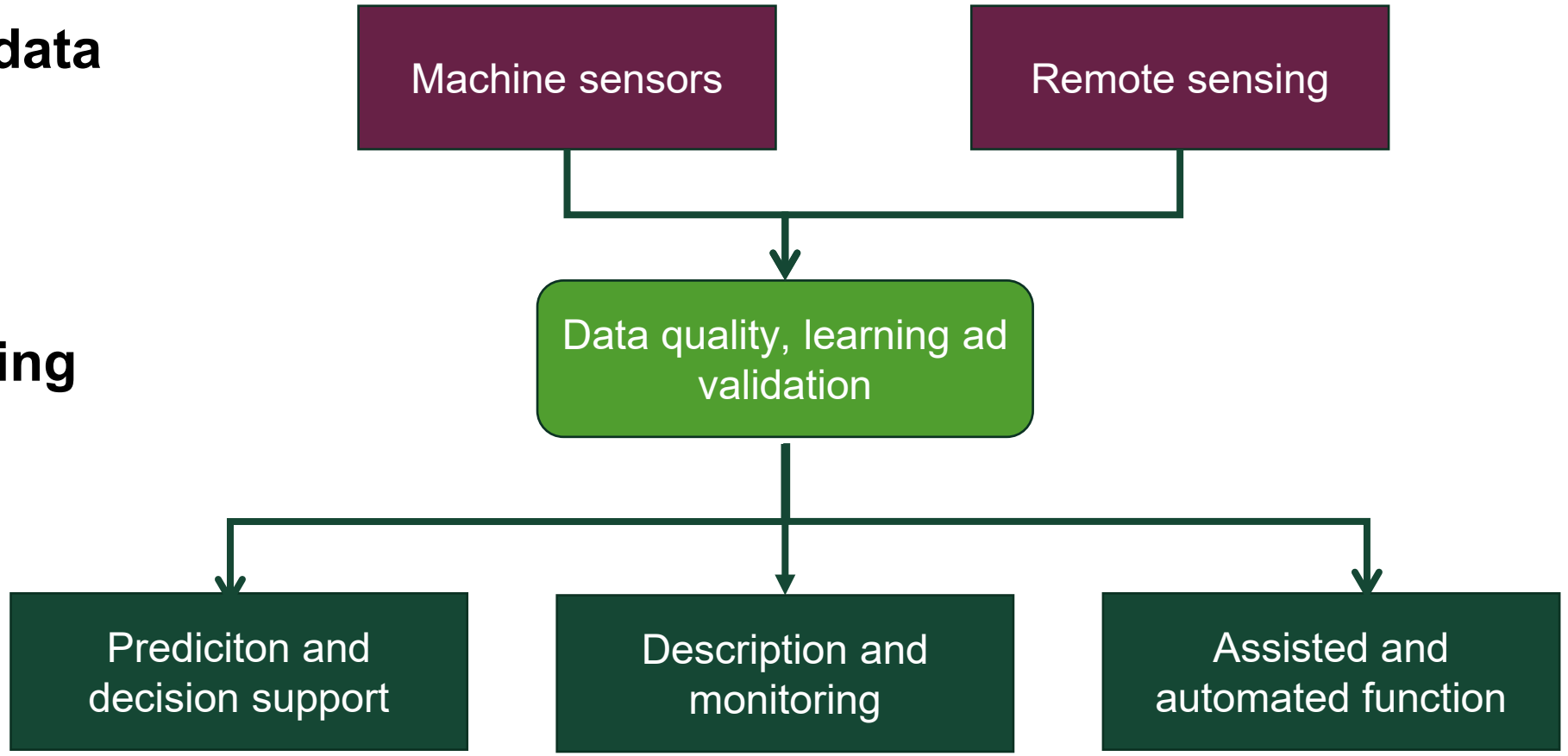


AI starts with observations of the real forest

Available raw data
See

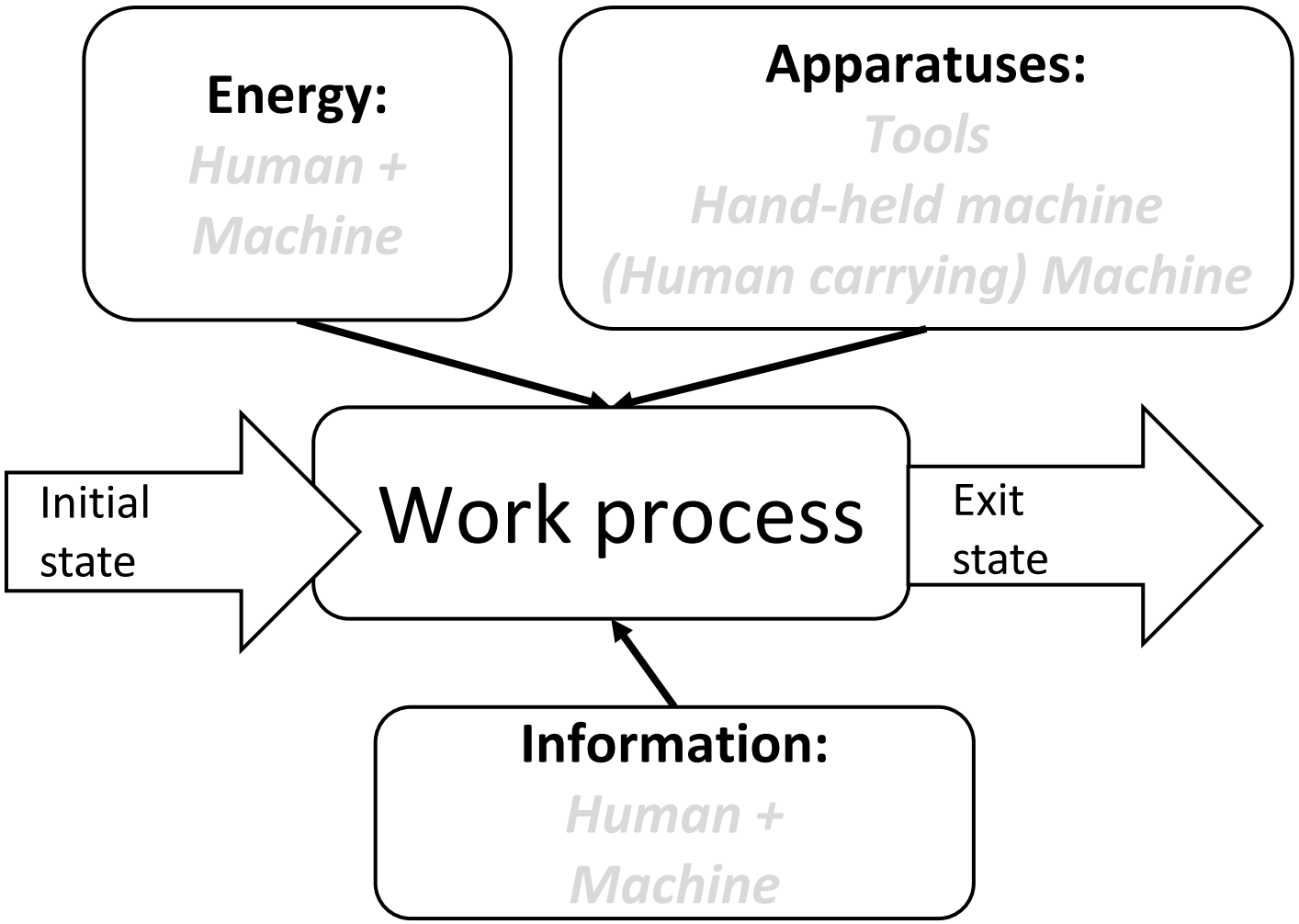
Data processing
Thing

Function
Act



Reliable AI requires relevant, representative and validated data.

Generalized view on the operations







Generalized view on the operations

Manual operations

Energy:
Human +
Machine

Apparatuses:
Tools
Hand-held machine
(Human carrying) Machine

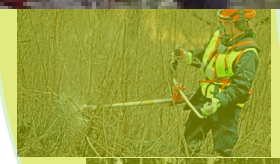
Initial state

Work process

Exit state

Information:
Human +
Machine







Generalized view on the operations

Motor-manual operations

Energy:
Human +
Machine

Apparatuses:
Tools
Hand-held machine
(Human carrying) Machine

Initial state

Work process

Exit state

Information:
Human +
Machine



Generalized view on the operations

Mechanized operations

Energy:
Human +
Machine

Apparatuses:
Tools
Hand-held machine
(Human carrying) Machine

Initial state

Work process

Exit state

Information:
Human +
(Machine)



Generalized view on the operations

Semi-autonomous mechanized operations

Energy:
Human +
Machine

Apparatuses:
Tools
Hand-held machine
(Human carrying) Machine

Initial state

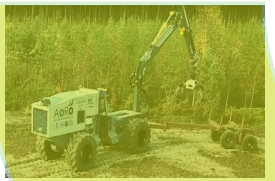
Work process

Exit state

Information:
Human +
Machine







Generalized view on the operations

Autonomous mechanized operations

Energy:
Human +
Machine

Assistive devices:
Machine

Initial state

Work process

Exit state

Information:
Human +
Machine

See+Think+Act





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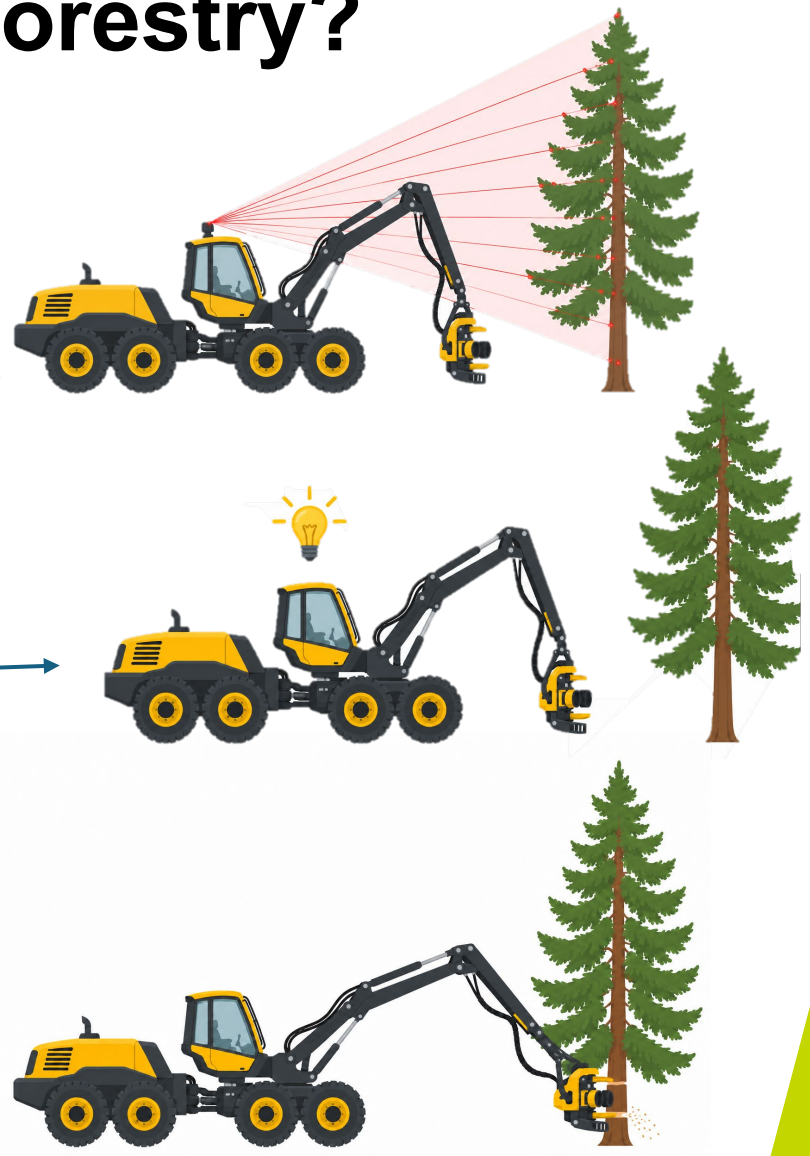
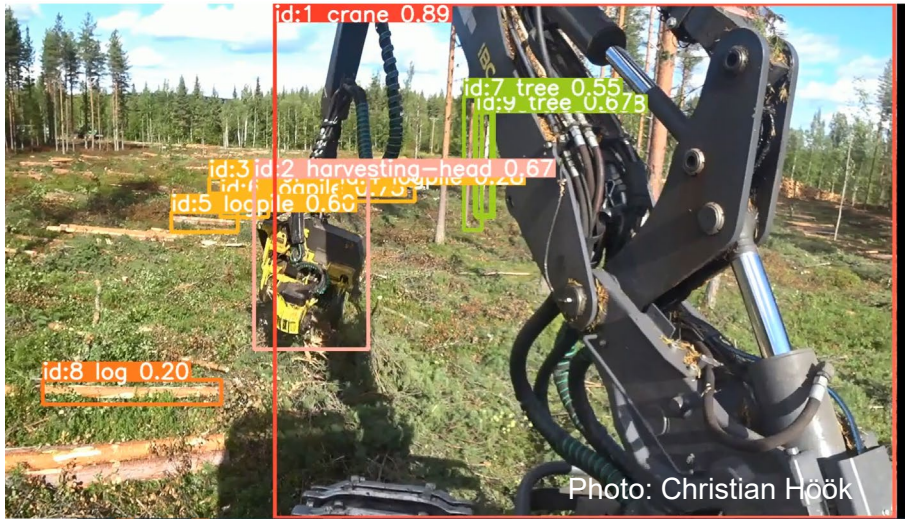
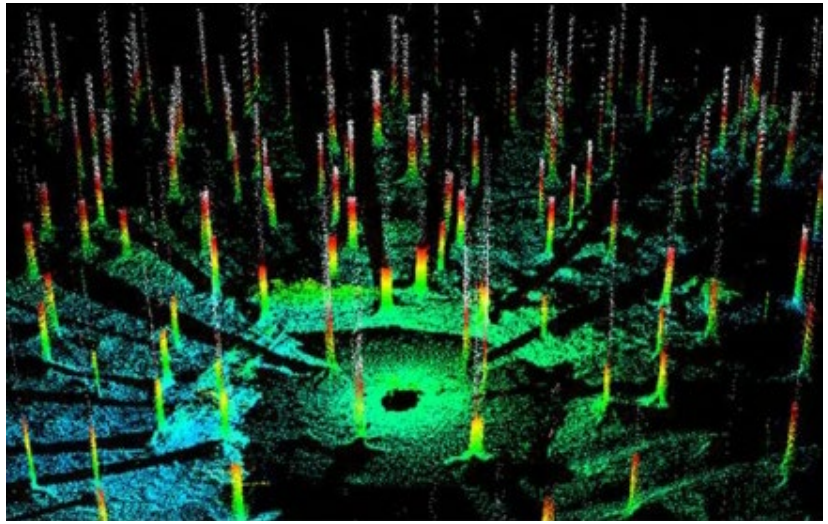


SEE – Think - Act

AI can turn images and sensor data into information about the forest

- individual trees
- tree height and diameter
- canopy structure
- tree species
- forest damage
- roads and terrain
- harvested areas
- regeneration





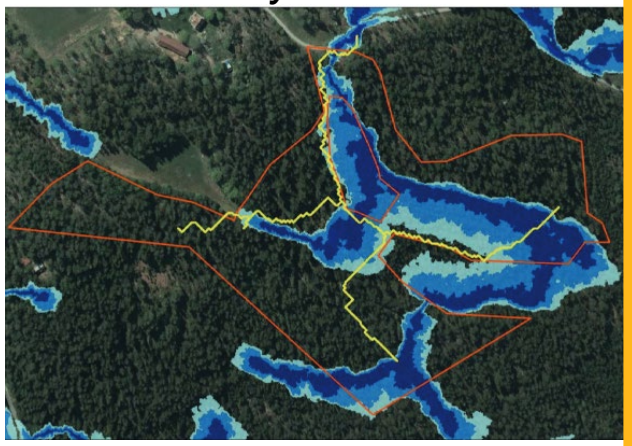
See – **THINK** – Act

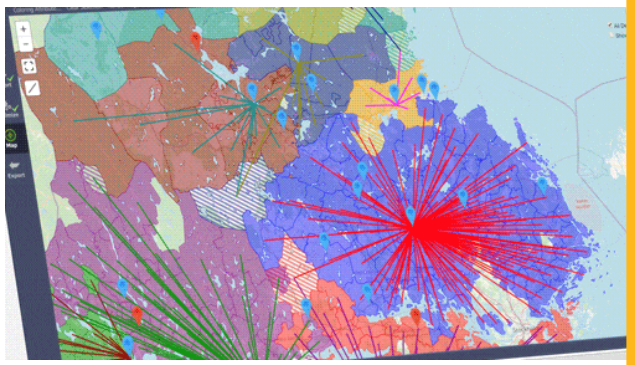
Once machines can describe the forest, we can ask them to predict what will happen next.

- growth prediction
- timber quality
- machine productivity
- trafficability
- harvest timing
- operational planning
- optimisation of routes / logistics

Operator decides: huge real-time information

Depth-toWater maps; BestWay/Timbertrail



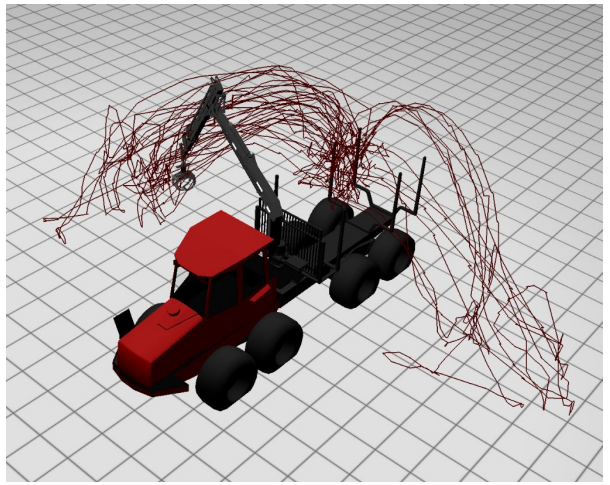


Calibrated route finder; Flowopt/Woodflow

Helping/interacting with operators

See – Think – **ACT**

The final step is not understanding or predicting the forest - it is acting in the physical world.



Autonomous movement *(proof of concept)*

- automated crane/boom movements
- autonomous locomotion







See – Think – **ACT**

The final step is not understanding or predicting the forest - it is acting in the physical world.

***Autonomous work** (few operators)*

- *automated bucking*
- autonomous harvest
- autonomous transport
- autonomous regeneration



AoRo
Arctic Off-Road Robotics Lab


Photo Anneli Knutsson, MAJT


www.sodra.se, BraSatt01

Why forestry remains a difficult test for AI

- Environmental variability
- Limited and costly reference data
- Transferability
- Safety and responsibility (digital training)

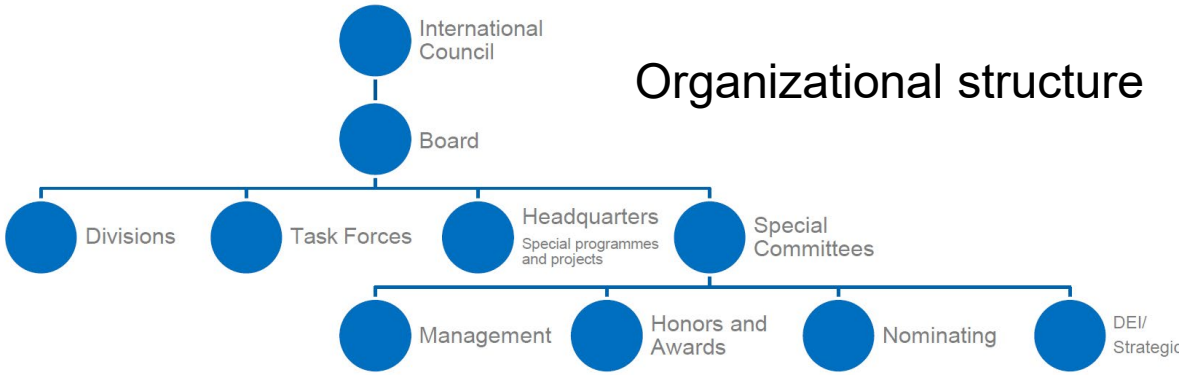








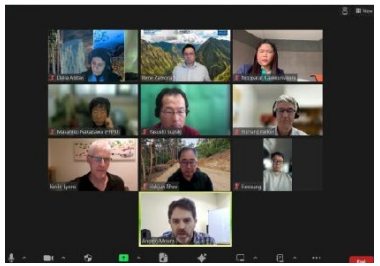
IUFRO: International Union of Forest Research Organizations



Organizational structure

Business Meetings

Asia-pacific time zones

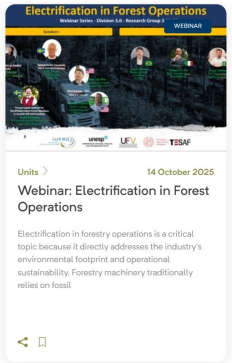


Africa-Europé-Americas



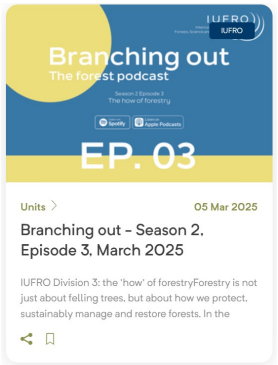


Multiple events





3 Podcast



Division 3

DIVISION 3

Forest Operations Engineering and Management

AREAS OF ACTIVITY: Forest engineering; operations in forest nurseries; operations related to silvicultural activities; operational planning, management, modelling, information systems, and control; work study, ergonomics, health and safety; small-scale forestry; interface between human, forest operations and environments.

There ***will*** be more AI/robot/human interactions – but will the operations be very different?

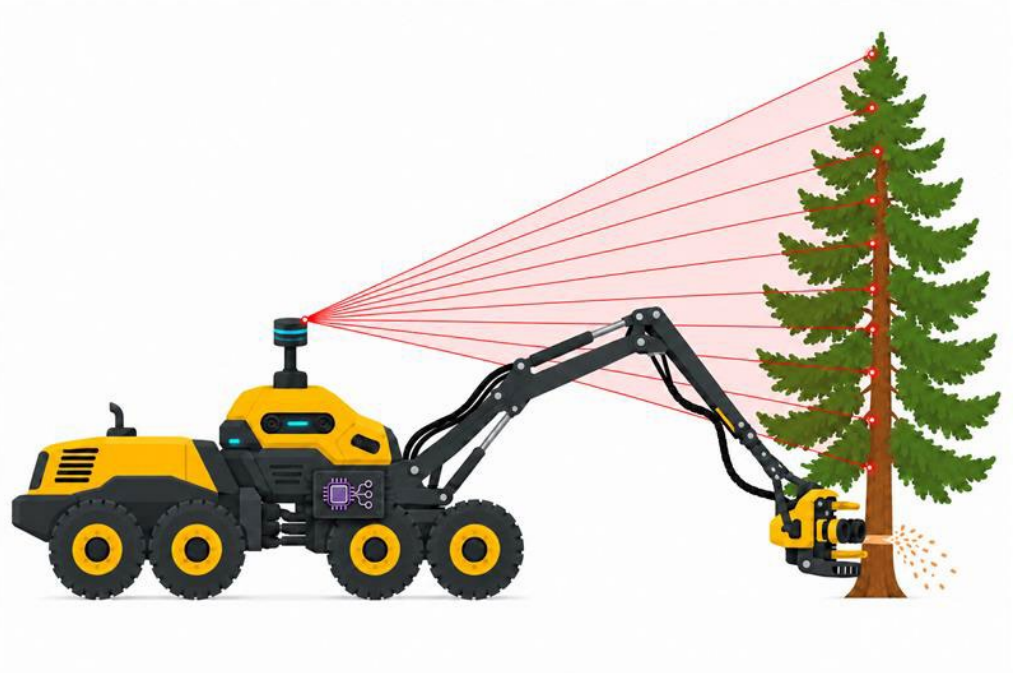
And if so, how – and ***why***?!

Could AI harvest a forest/do forestry?

Not yet

But we're moving:

- to/from machines that see the forest
- to machines that think about the forest
- to machines that act in the forest



Safety, efficiency, sustainability.

Thank you for your attention!

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