



# Rule-based algorithms under the AI Act

*To be or not to be* an AI system

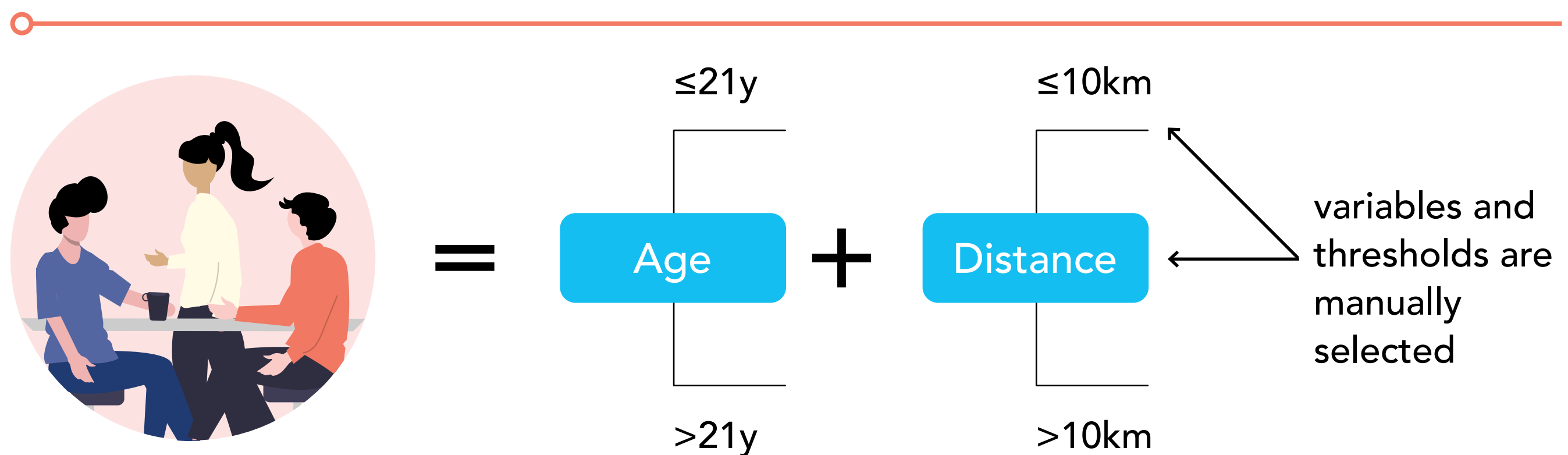


Learn more about practical implementation of the AI Act

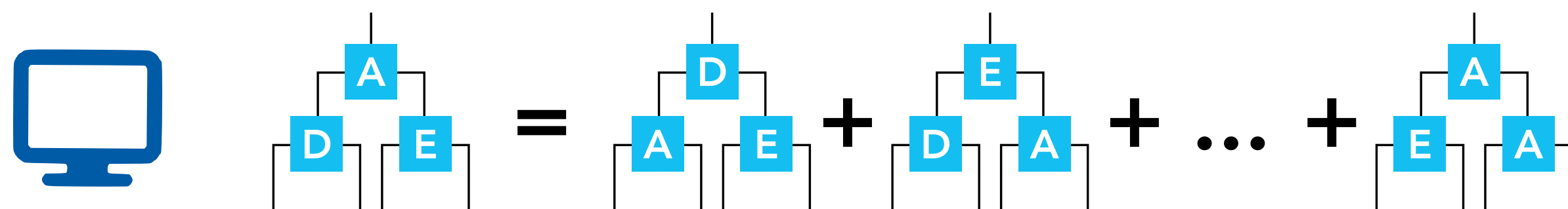


# Rule-based algorithms come in many forms, with *inference* as a key differentiator

A decision tree can be manually created, based on domain expertise...



...or is inferred by statistical methods, using optimization, ML etc.

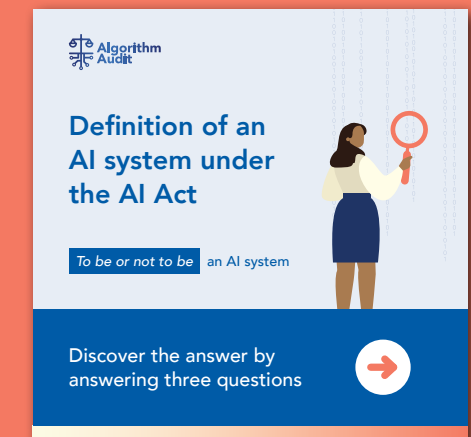


Optimization methods include tree-based learning using Gini index, entropy or mean squared error etc.

ML methods include tree ensemble-based learning techniques, such as bagging, boosting, and bootstrapping

# Inference and autonomy are the key terms that define the scope of the AI system definition

See also:



## Analysis of article 3 and recital 12

### Inference

Primary differentiator for AI system identification, specified as:

- > *"the process of obtaining the outputs, [...] and to a capability of AI systems to derive models or algorithms, or both, from inputs or data."*
- > *"include machine learning approaches that learn from data how to achieve certain objectives and logic- and knowledge-based approaches"*
- > *"transcends basic data processing by enabling learning, reasoning or modelling"*

### Autonomy

*"operate with varying levels of autonomy" is easily fulfilled*

# When are rule-based algorithms an AI system?

## Example rule-based algorithm

```
1 def risk_score (age,distance):
2     if age<= 21 and distance <= 10:
3         score = 1
4     elif age <= 21 and distance > 10:
5         score = 2
6     elif age > 21 and distance <= 10:
7         score = 3
8     else:
9         score = 4
10
11         return f"risk score: {score}"
12
13 risk_score(age=19, distance=5)
```

✓ 0.0s

'risk\_score: 1'

## Recital 12

*"the definition... should not cover systems that are based on the rules defined solely by natural persons to automatically execute operations"*

## Autonomy



### Autonomy

At line 13 the `risk_score` algorithm autonomously computes the risk score for a person with `age=19` and `distance=5km` and predicts risk score 1

## Inference



### Inference

If the rules are derived from data (ML, statistics, optimization etc.)



### Inference

If rules are created by humans: it depends how the rules are created and whether it's a logic or knowledge-based approach

# A simple rule-based algorithm created by humans is not a logic or knowledge-based system

## Recital 12

*“inference ... includes ... logic- and knowledge-based approaches that infer from encoded knowledge or symbolic representation of the task to be solved. [..]”*

*“The capacity of an AI system to infer transcends basic data processing by enabling learning, reasoning or modelling.”*

## What is a logic- and knowledge-based approach?

- > Logic based systems consist of proposition and connectives, such as  $\neg A$ ,  $A \wedge B$ ,  $A \vee B$ , where A and B a true or false (referred to as a ‘*propositional formula*’)
- > Knowledge-based systems have two defining components: 1) knowledge base, which explicitly encoded knowledge; 2) a reasoning system that allows to derive new knowledge
- > “*encoded knowledge*” refers specifically to encoding propositional formulas encoded in a knowledge base

See also section 5.1.1 of the standard work Artificial Intelligence, Poole & Mackworth (2010)

# So, a simple rule-based algorithm created by humans is not an AI system?

## Example rule-based algorithm

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```

✓ 0.0s

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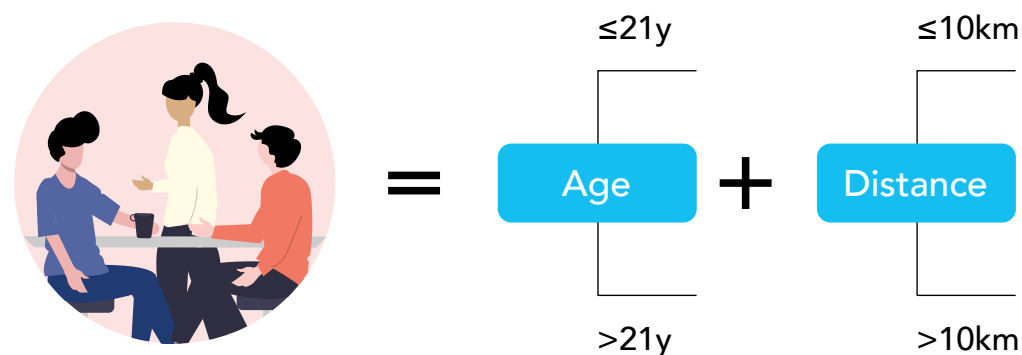
Simple rule-based algorithms are an AI system when rules are derived from data (ML, statistics, optimization etc.)



Simple rule-based algorithms are not a logic or knowledge-based system, as there is no knowledge-base or reasoning system, and are thus not an AI system

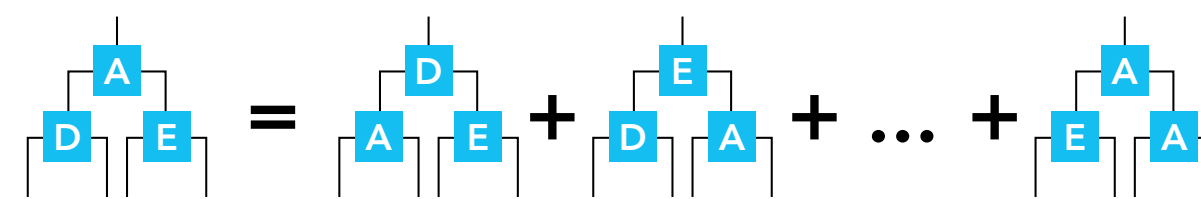
# Algorithms not covered by the AI Act still require control measures

## Manually created simple rule-based algorithms



No AI system under the AI Act, still control measures are needed

## Rules learnt using statistical methods



AI system under the AI Act

## Algorithms

Impactful algorithms

AI system according to AI Act (AIA)

High-risk AI system (AIA)

Prohibited AI system (AIA)

Building *public knowledge*

for *ethical algorithms*

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discussion!



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