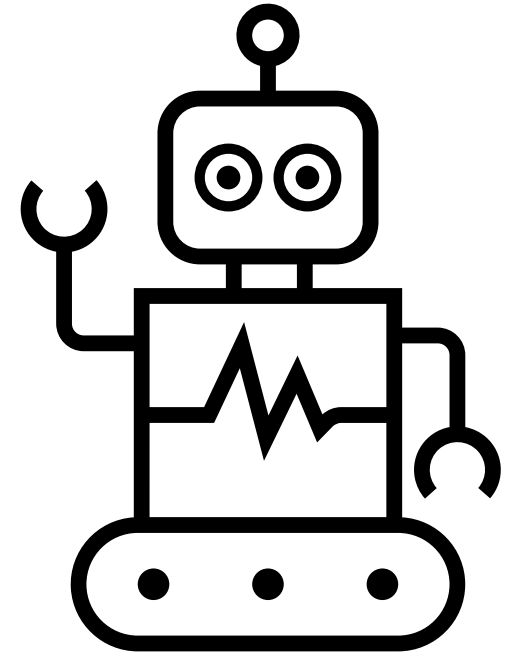


Machine Learning

...for physicists?

Teacher:

Menno Bokdam



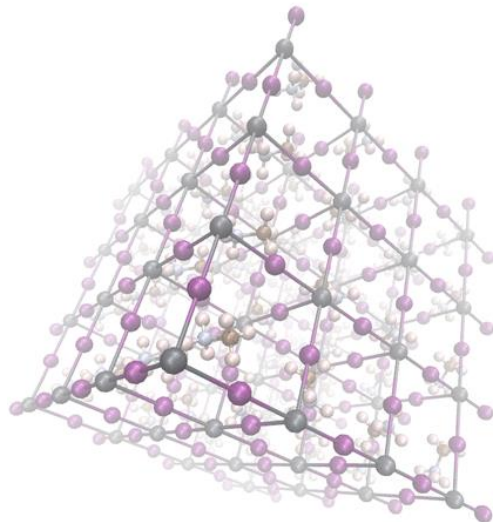
Course code	202100224			
Short name	Machine Learning			
Contact person	Bokdam, M.			
EC amount	3 or 5 EC	Instructional language	<input type="checkbox"/> NL	<input checked="" type="checkbox"/> EN

Machine Learning

...for physicists?

As physicists we love building 'toy' models:

- Ising model
- Planar capacitor model
- Incompressible flow
- The 'ideal' gas
- Cow as a point particle
- ... and so on...



This works well, but:

- Is often limited by our physical/chemical intuition
- It is not always easy to systematically improve the accuracy of the model
- Requires higher order theory

But has clear advantages as well:

- Physically intuitive model
- Often converges to the 'exact' solution in limiting situations
- Thereby solutions are bound and do not unexpectedly diverge.

Machine-Learning models can be complementary:

- A model can be constructed purely on (experimental) 'data'
- Complexity of the model beyond 'fitted' functions

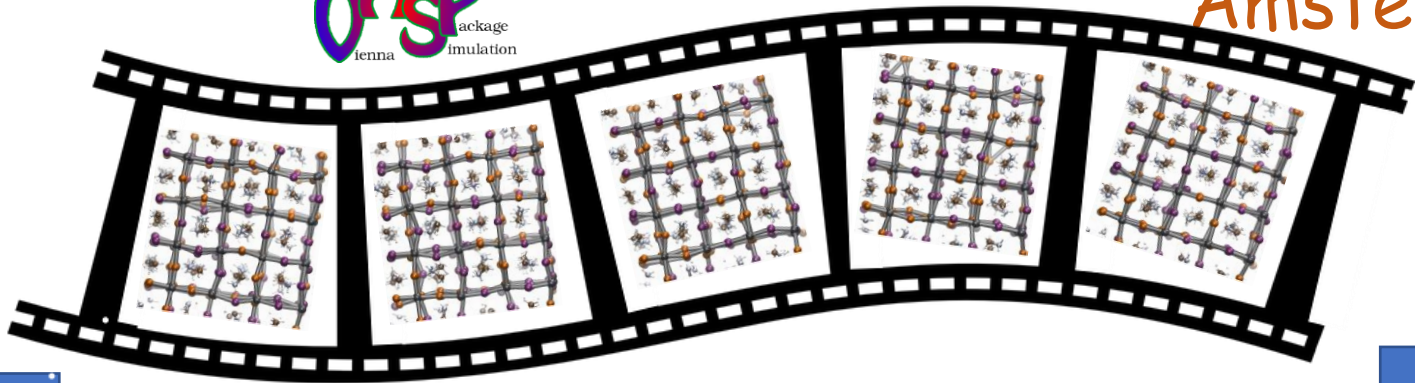
Molecular dynamics based on first principles

Start structure:
 $\{R_i, \text{Type } i\}$

Solve Schrödinger equation.



Not even the supercomputer in Amsterdam is fast enough!



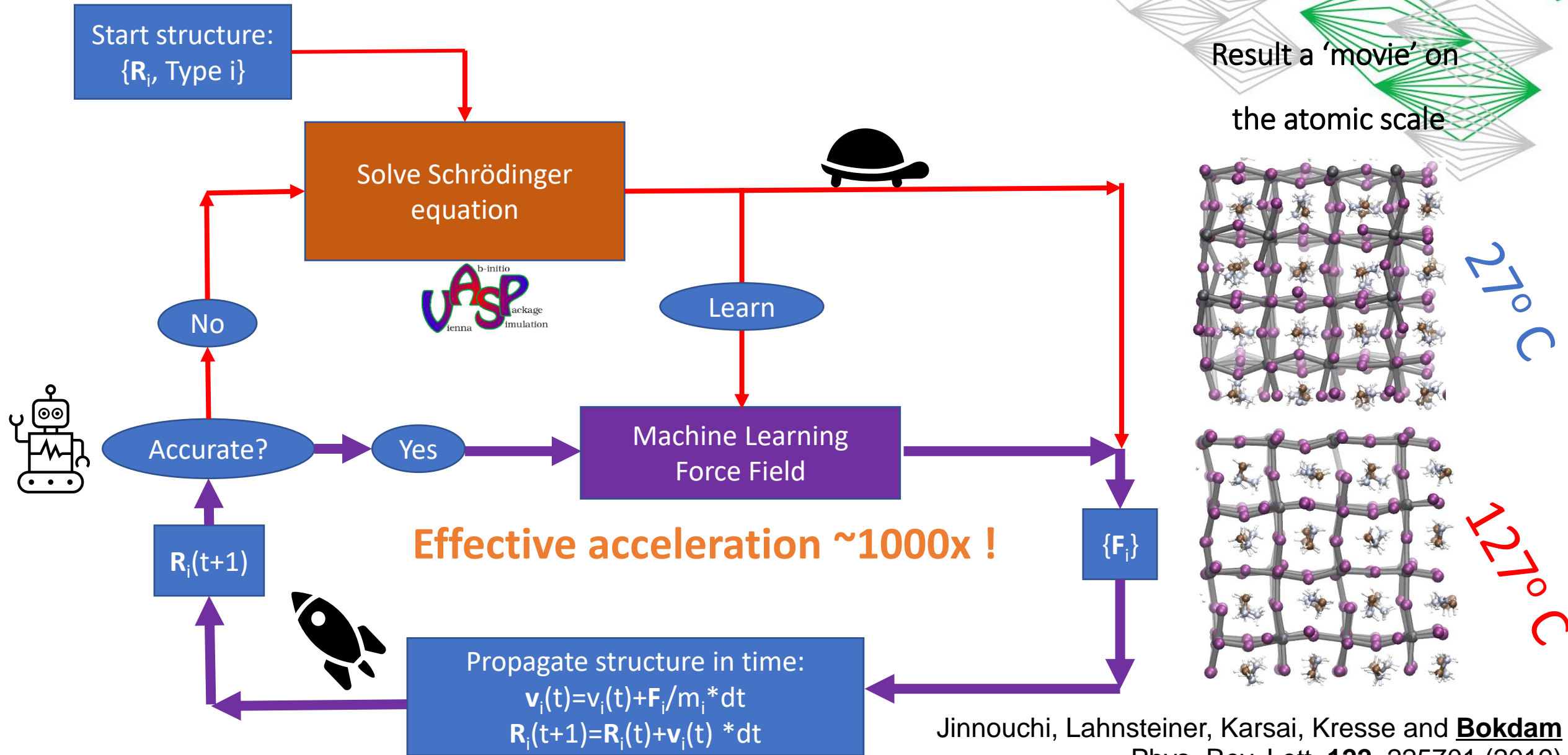
$R_i(t+1)$

$\{F_i\}$

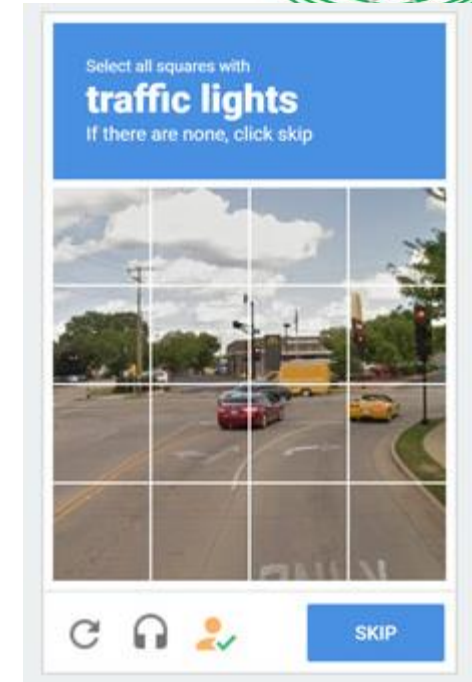
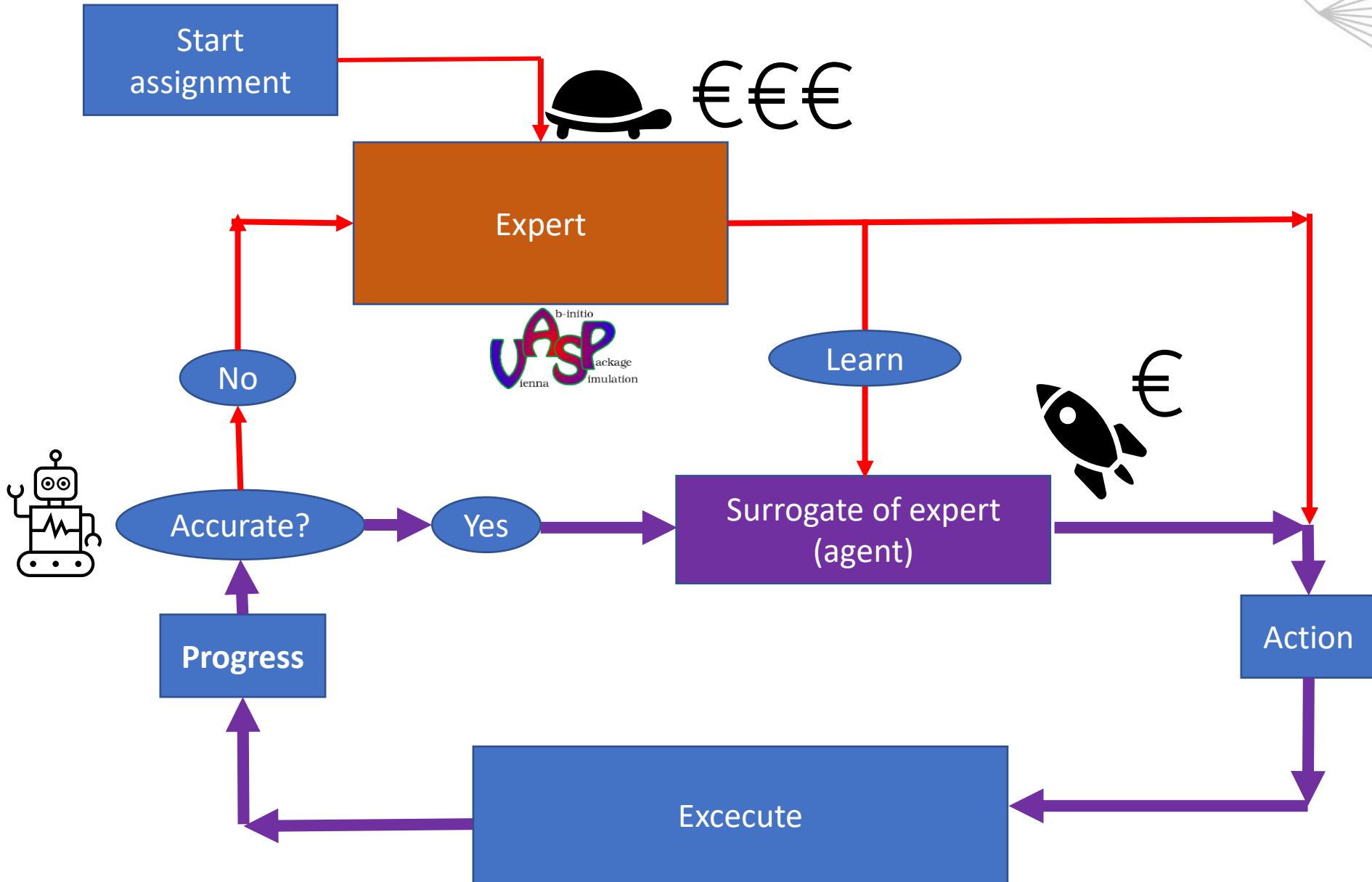
Propagate structure in time:
 $v_i(t) = v_i(t) + F_i/m_i * dt$
 $R_i(t+1) = R_i(t) + v_i(t) * dt$



Machine learning for atoms



Machine learning for ...

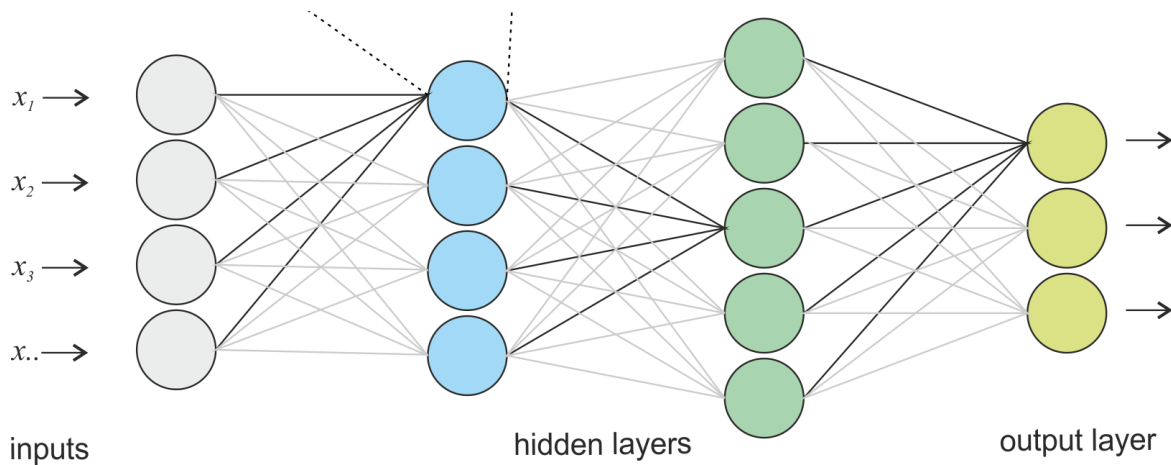


You are expert for Google

Databases are essential



ImageNet



Cat or Dog?

1 of 0 ?

Dr. Fei-Fei Li

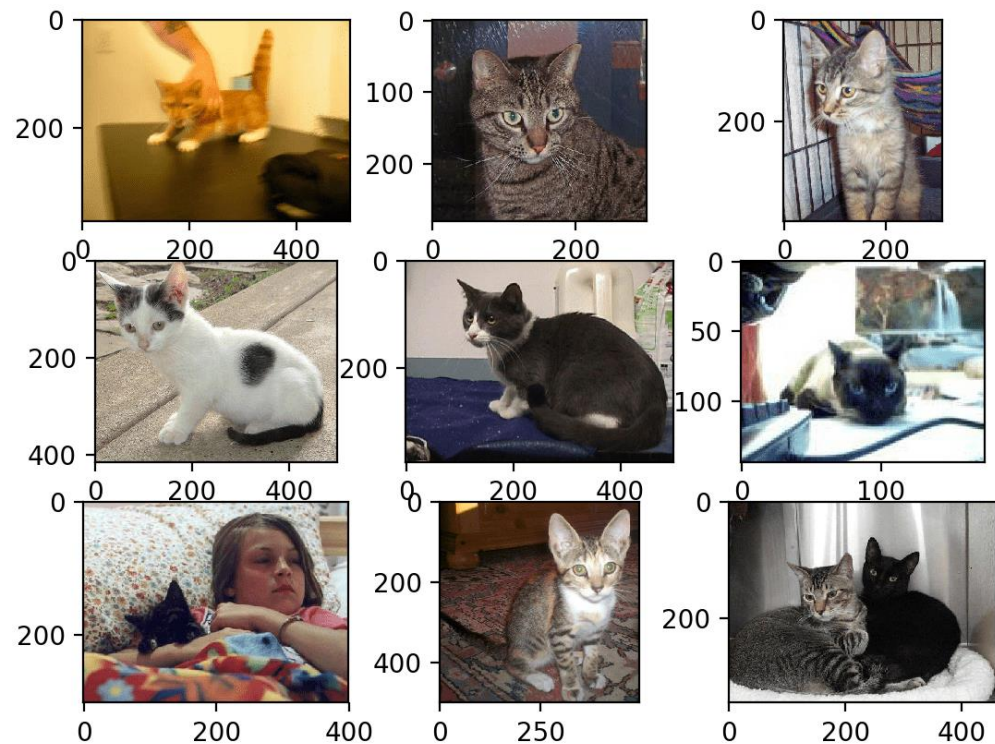
Founder ImageNet
Professor Princeton
University



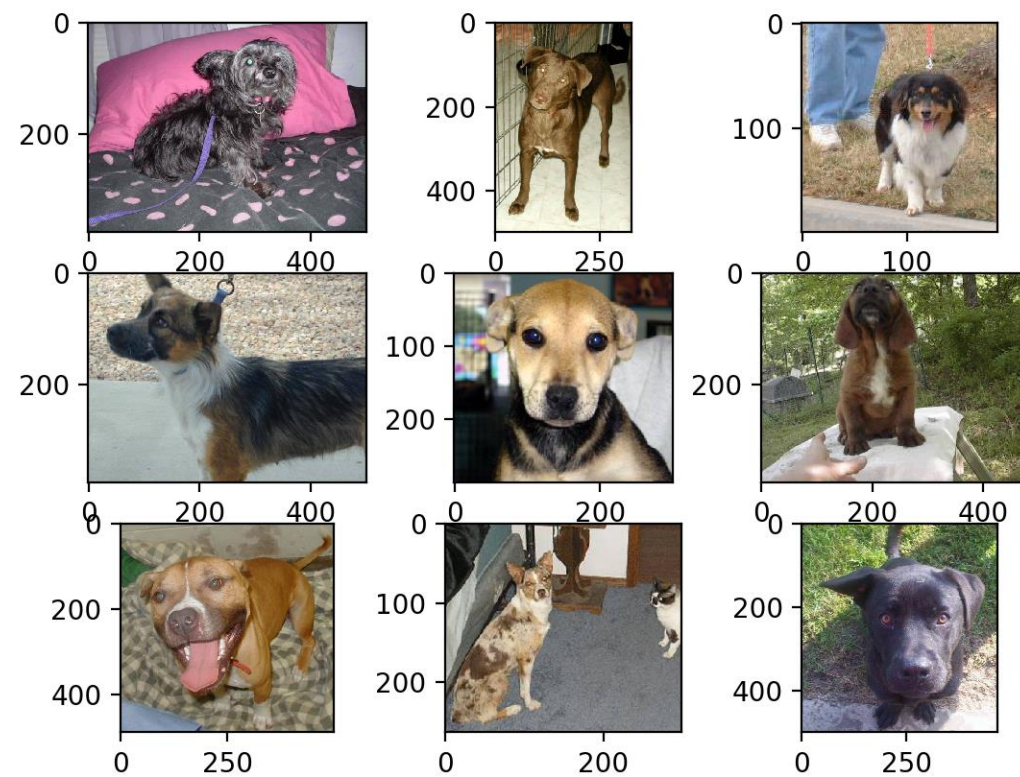
UNIVERSITY
OF TWENTE.

Menno Bokdam (2023)

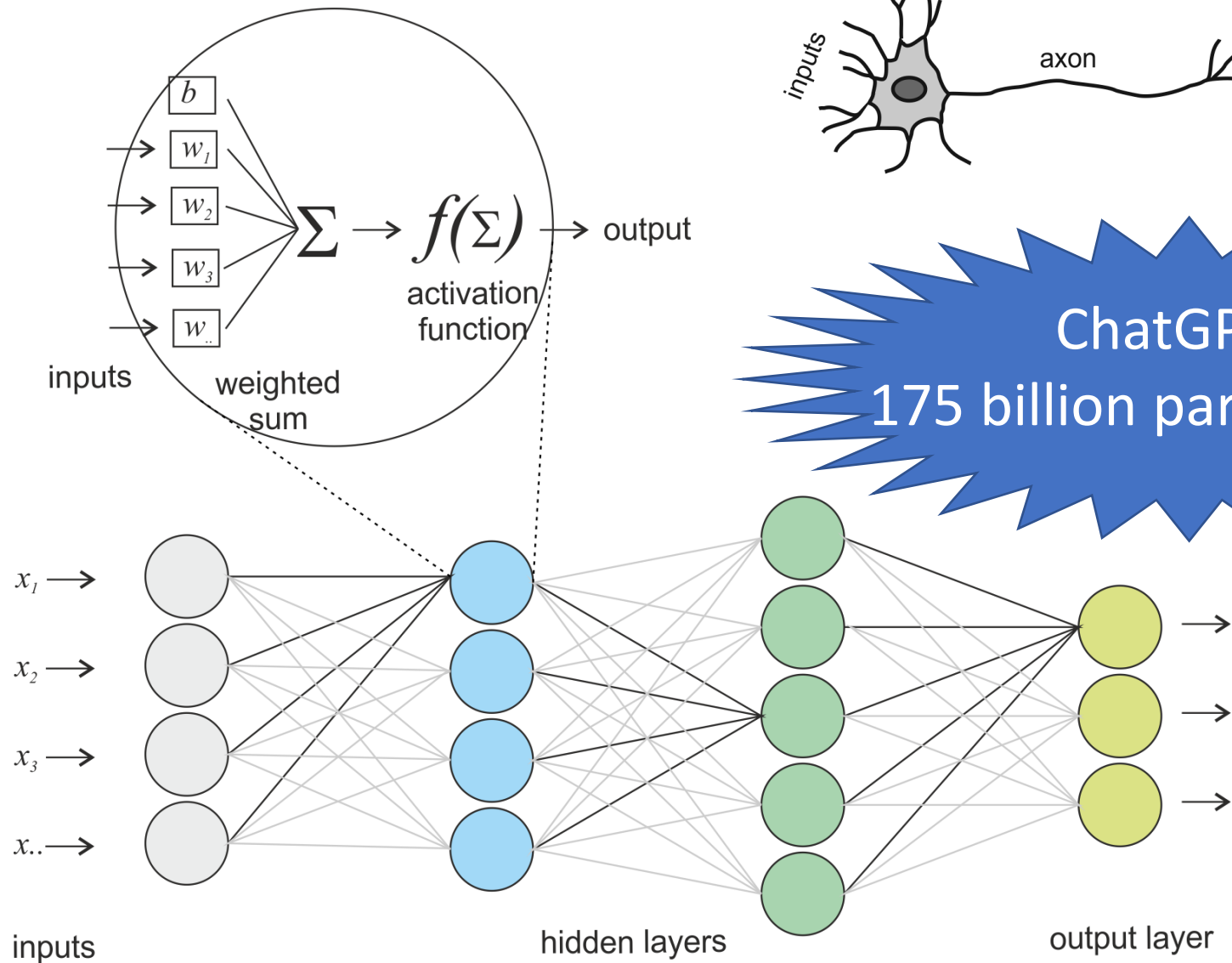
Databases are essential



Comparable variety?



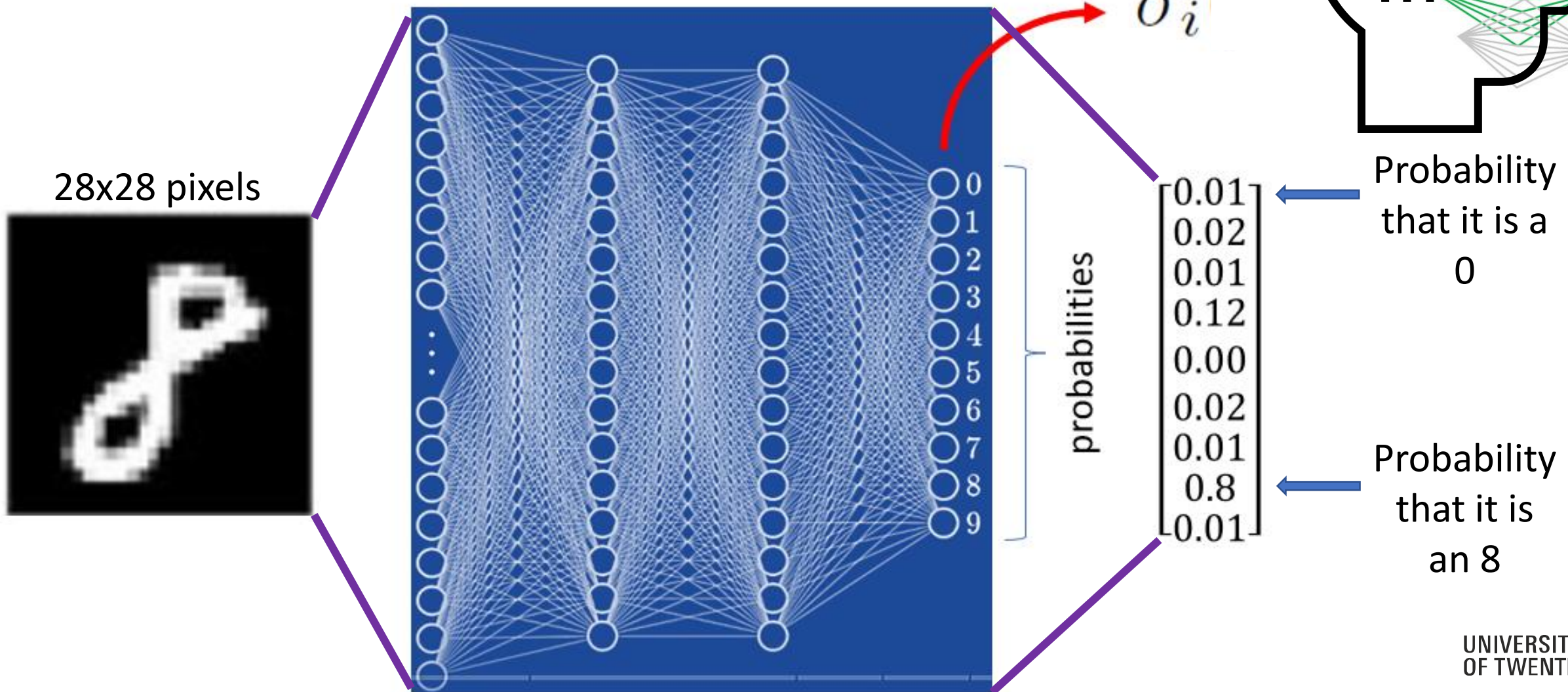
Deep learning: the neural net



ChatGPT :
175 billion parameters!!!

Deep learning: the neural net

7 2 1 0 4 1 4 9 5 9 MNIST-database



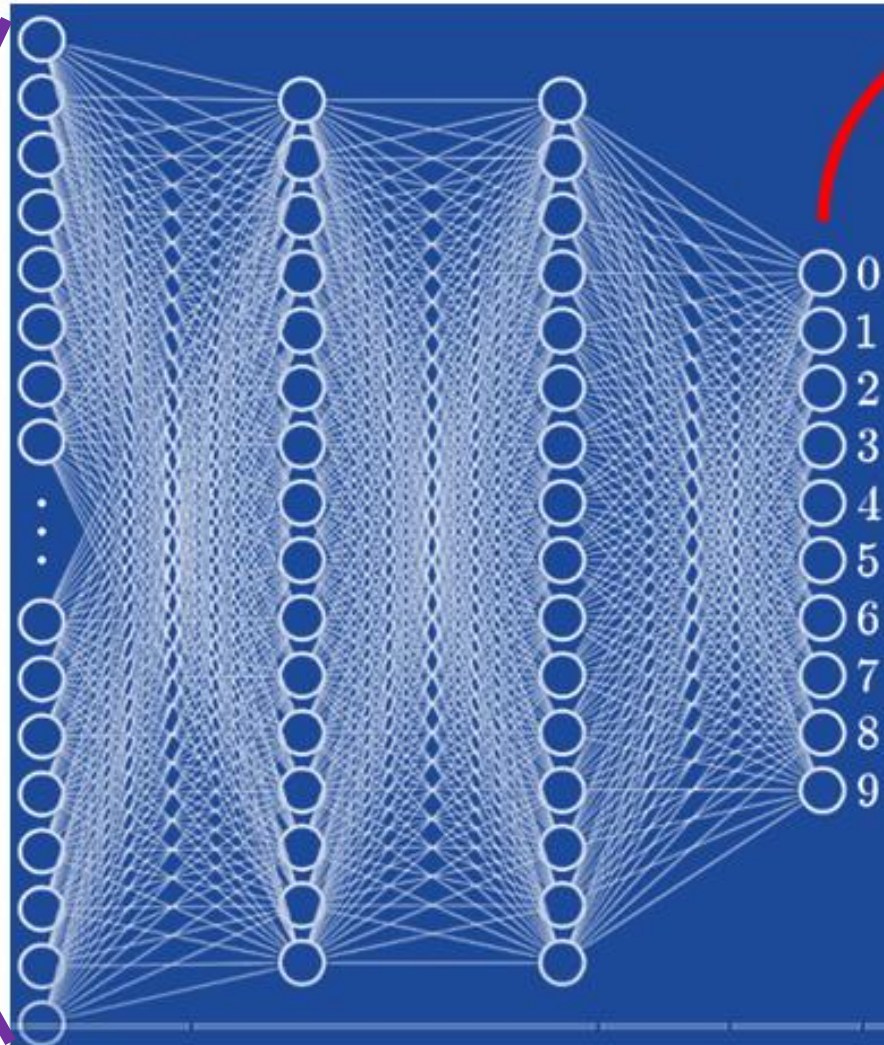
Deep learning: the neural net

Training:

Optimize the
**cost/loss
function**



The creator
picks!



* Model **Optimization**

prediction

probabilities

0.01
0.02
0.01
0.12
0.00
0.02
0.01
0.8
0.01

Correct
answer

0
0
0
0
0
0
0
0
0
1
0

Machine Learning

the course

Requirements:

- ❖ Data
- ❖ Encouragement
- ❖ Training
- ❖ Validation

'Learning' can happen in (at least) four ways:

- (1) Supervised learning;
- (2) Unsupervised learning;
- (3) Reinforcement learning
- (4) Deep learning

} Kunstmatige Intelligentie (AI)

For 3EC: You will get acquainted with the first two; supervised learning will be dominant.

For 5EC: You will get acquainted with all four; supervised learning and reinforcement learning will be dominant.

Machine Learning

the course

First part:

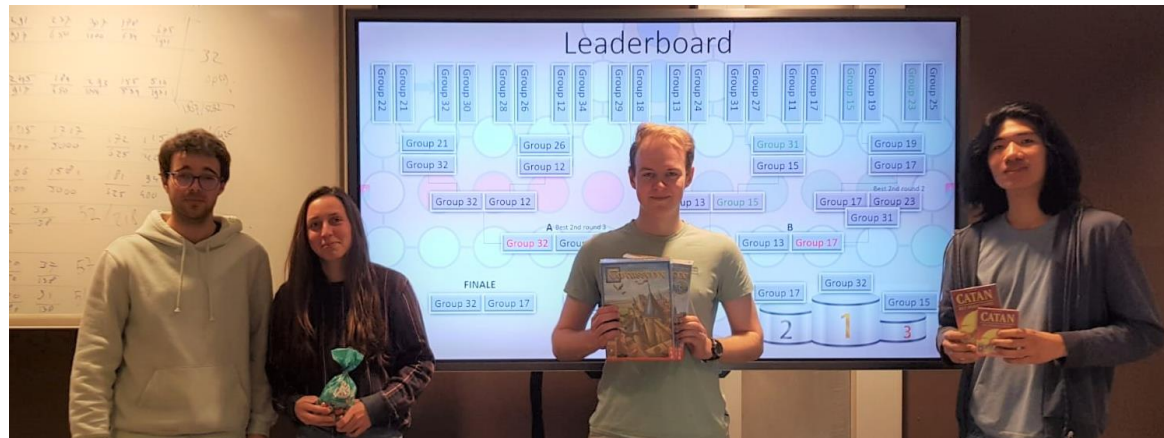
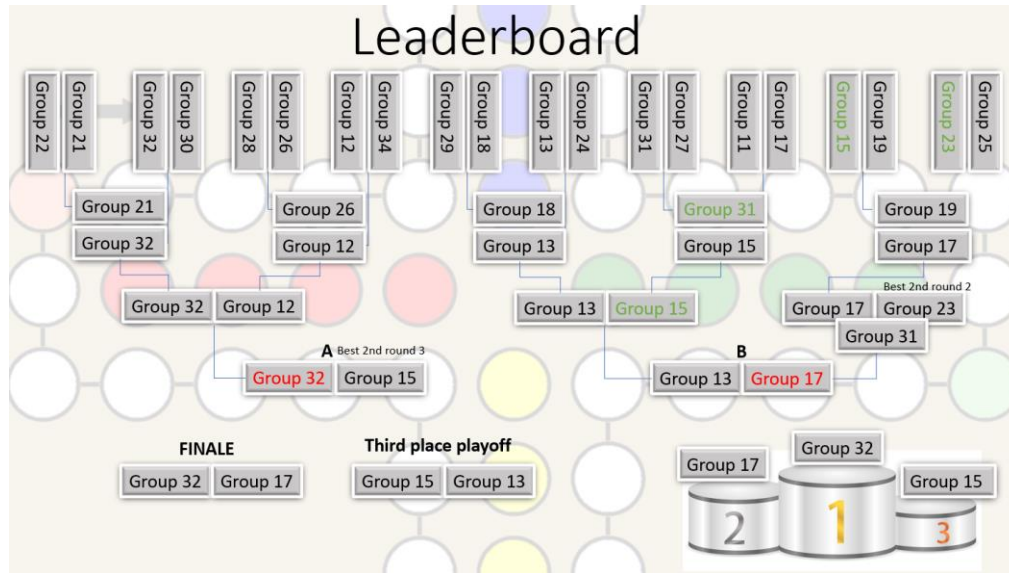
- Weekly lectorial, converting theory in working ML models
- Hand in assignment, graded pass/fail

Second part:

- (5EC) Final project, work in pairs on a larger challenging problem
- (3EC) Final assignment, work individually on an extended assignment in which you combine your acquired skills.

Project Machine Learning (5EC)

- Final assignment of 2022: **Mens erger je niet**



Assignment: Build a self-learning model of the player which is statistically significant better than a first order strategy and compete in the class competition.

- Final assignment of 2021: **Tiny Toons**



Project Machine Learning (5EC)



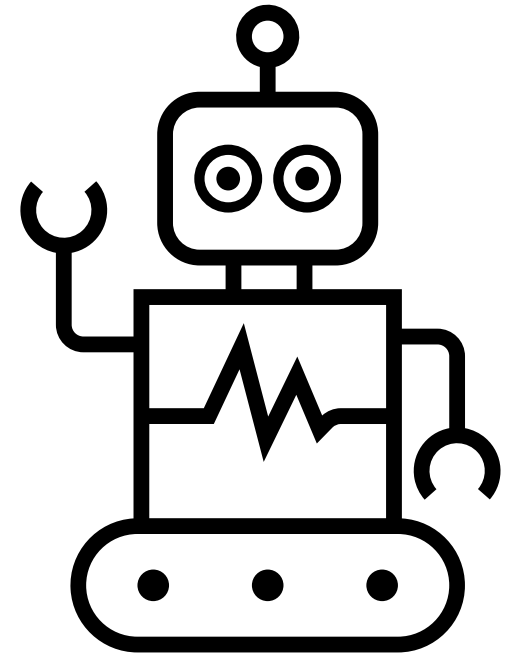
Assignment: Build a self-learning model of the player which maximizes the total score.

Machine Learning

...for you!

Questions?

m.bokdam@utwente.nl



course philosophy:

Can Do

Hands-on

Have fun!



Menno Bokdam