Deep Learning

Conclusion

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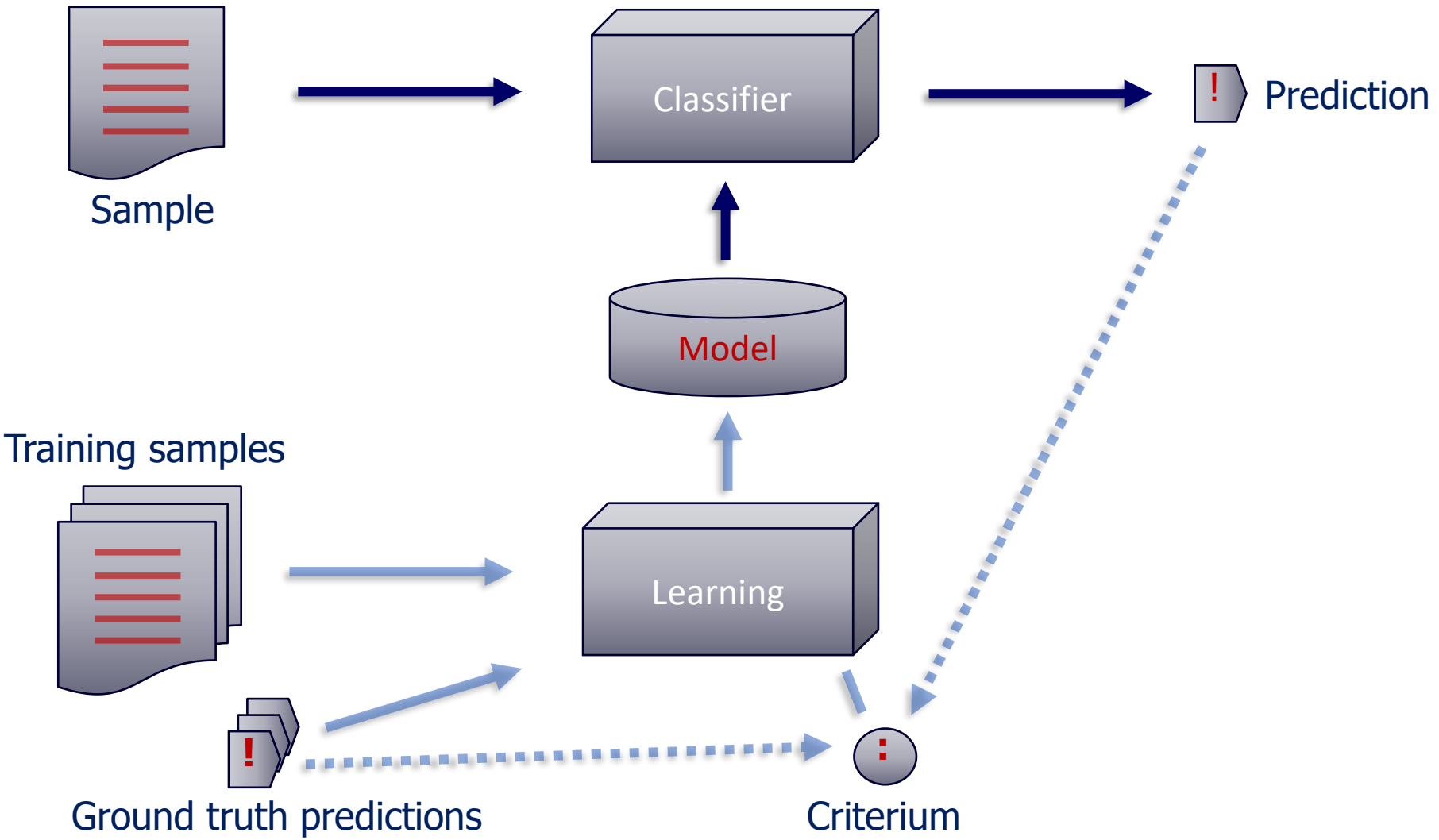
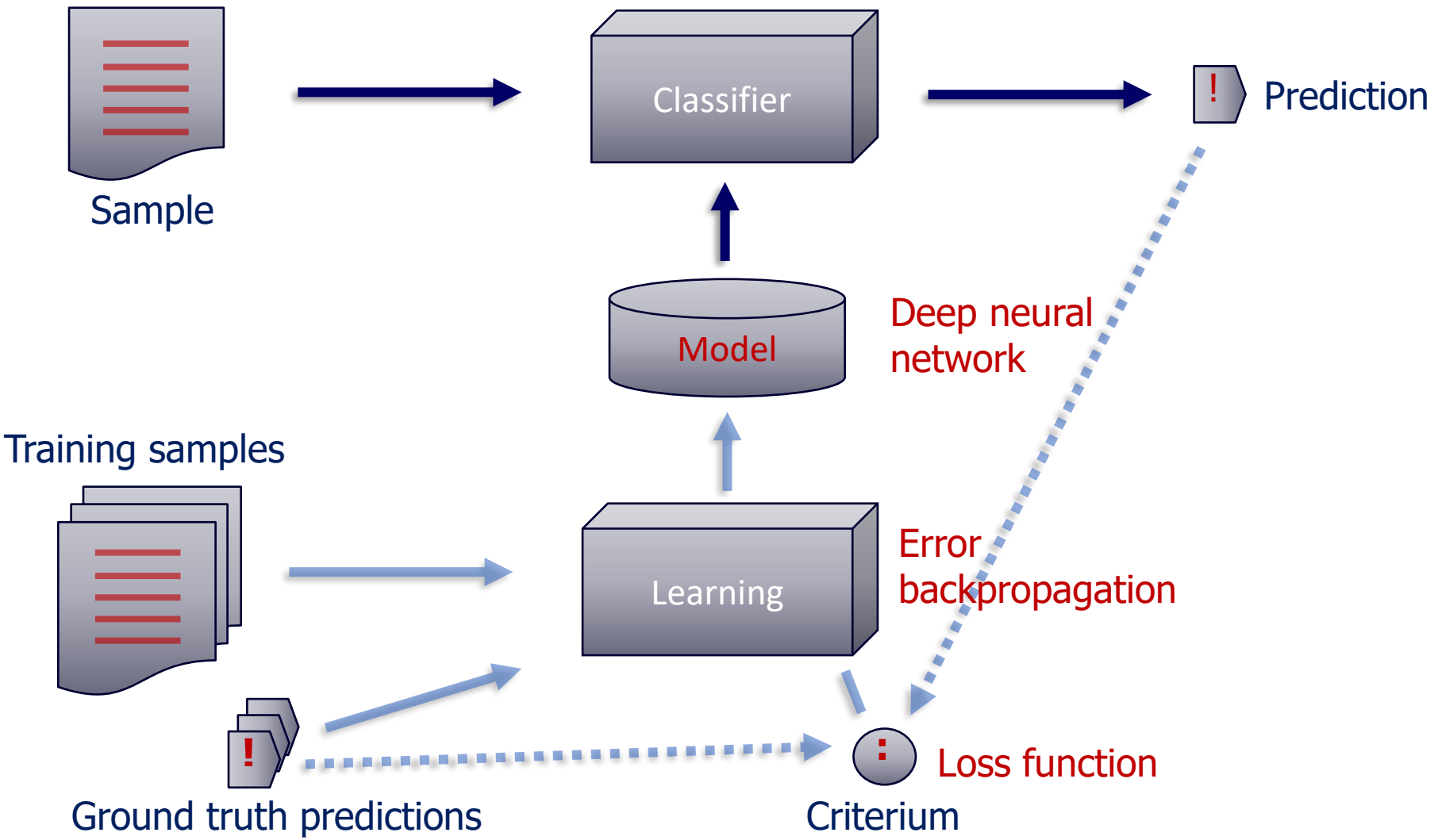
Academic year: 2022/23

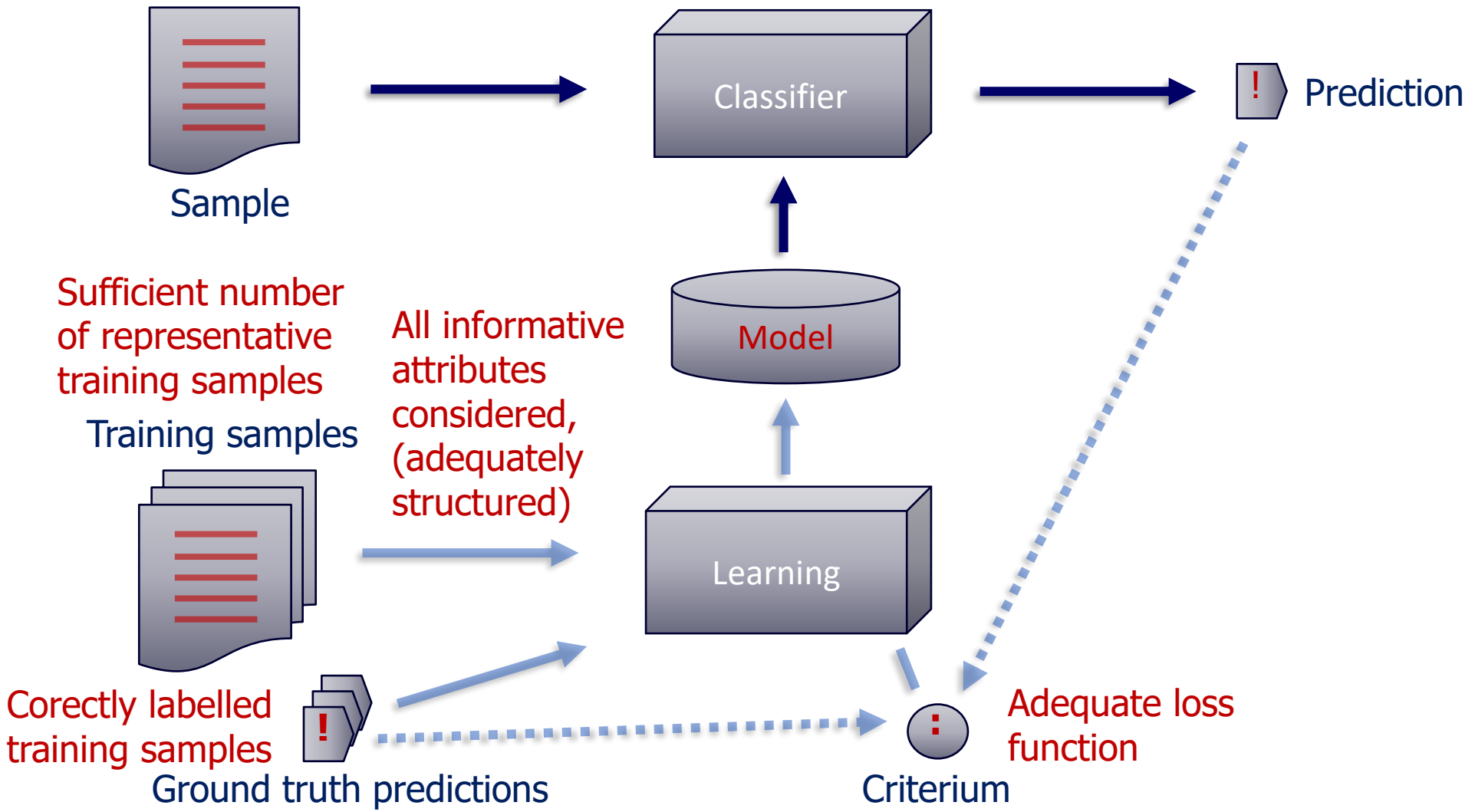
Machine learning



Deep learning

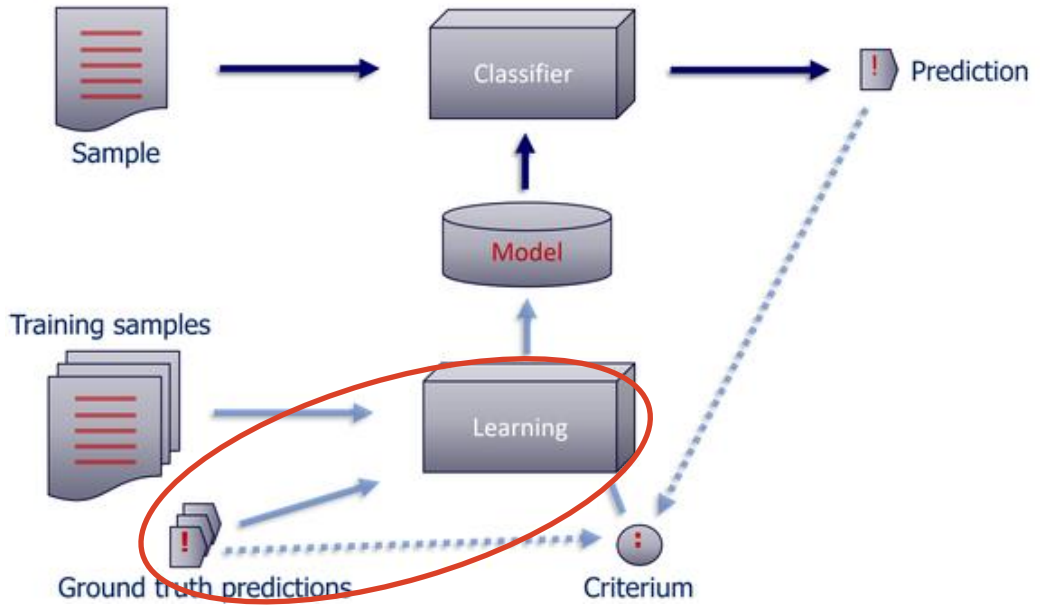


Key factors for fair decision making

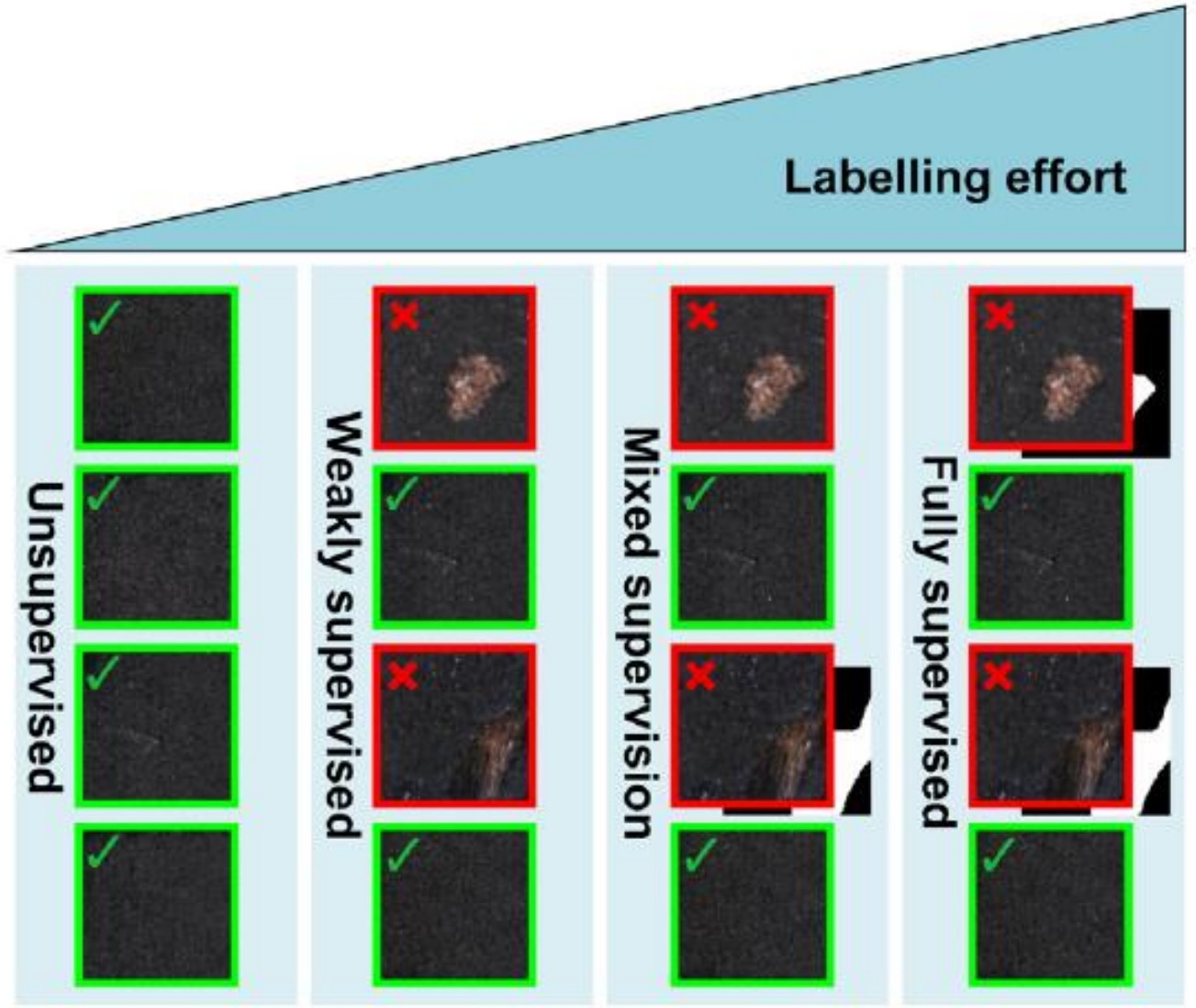


Learning regimes

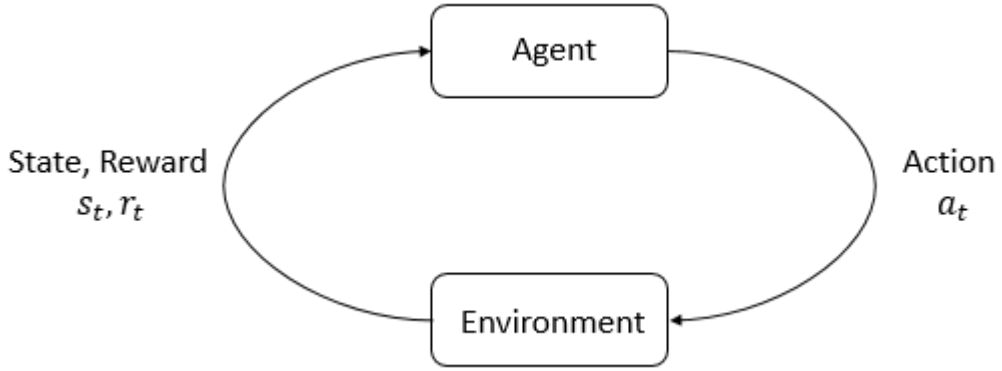
- Supervised learning
- Weakly supervised learning
- Semisupervised learning
- Unsupervised learning
- Self-supervised learning
- Reinforcement learning

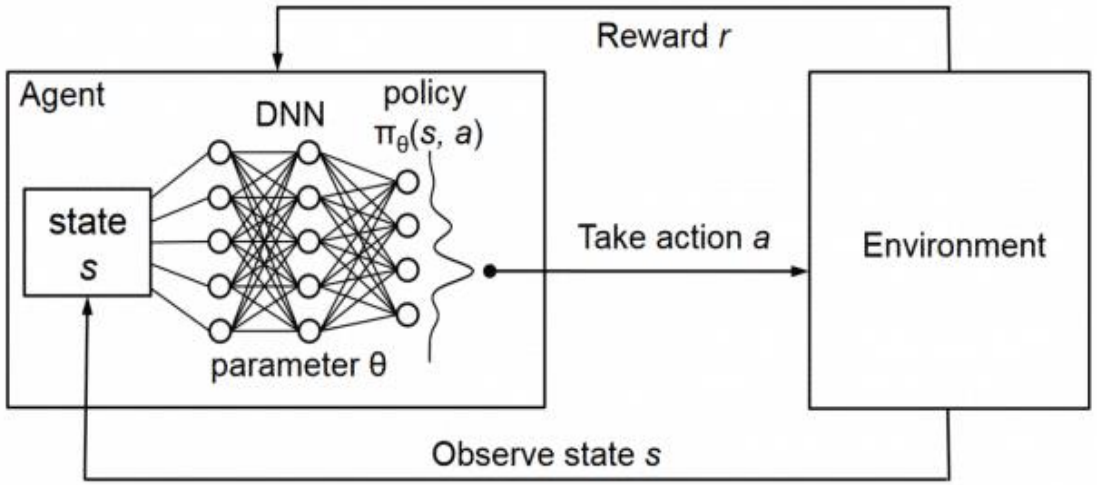


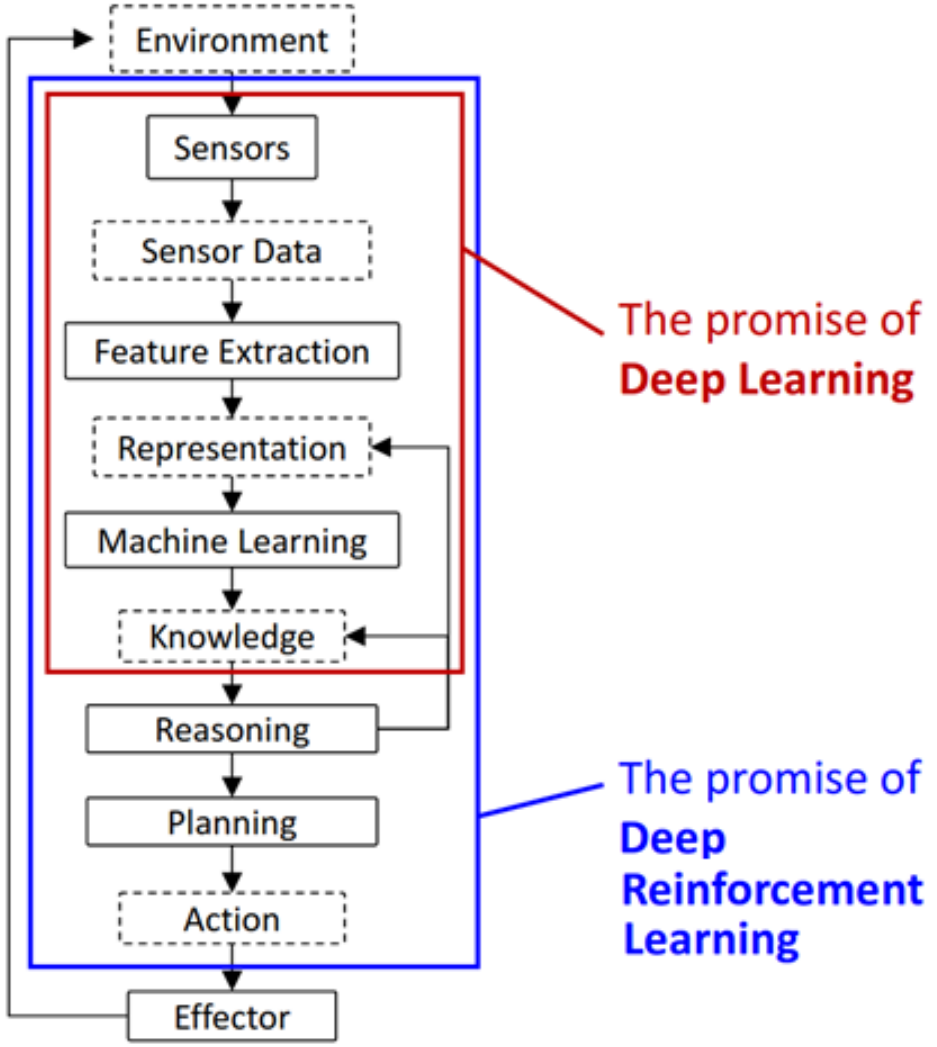
Learning regimes



Deep reinforcement learning

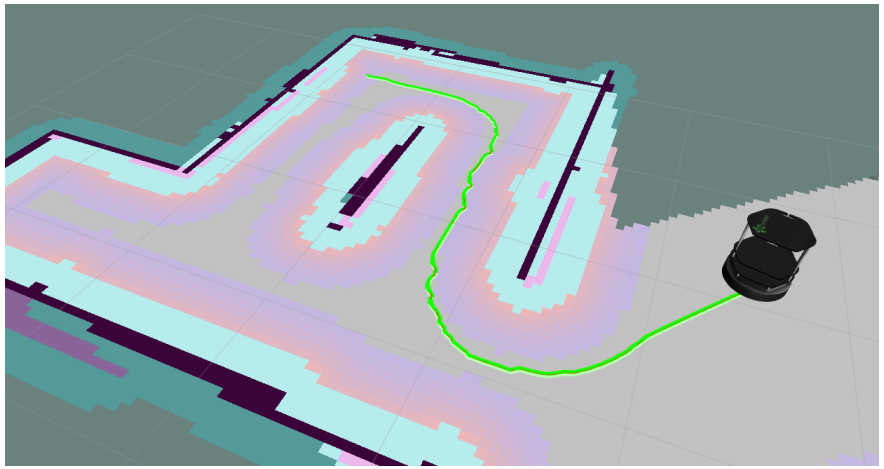


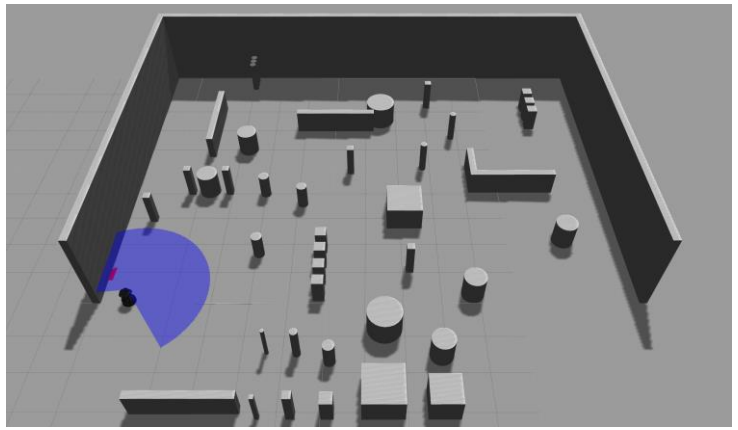


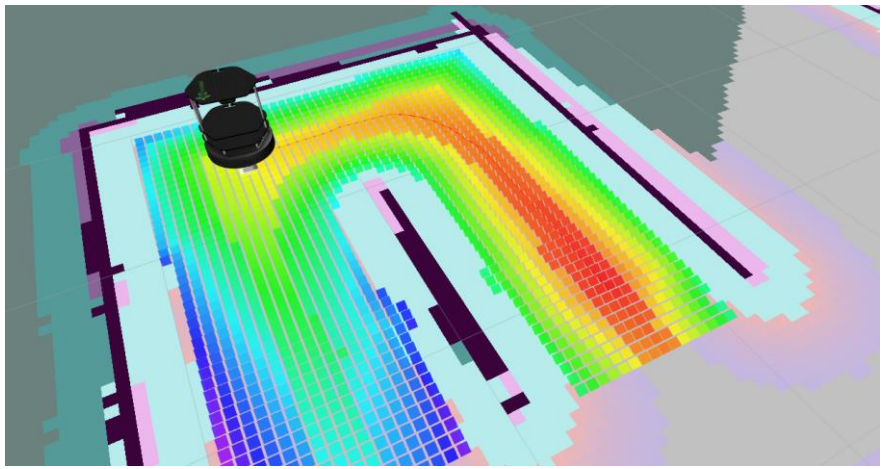


RL for goal-driven mapless navigation

- Local vs. global navigation.
  - Local navigation connects robot with global plan
  - Relying only on sensor readings
  - Dealing with unforeseen changes
  - Dynamic environment, robot in populated space
  - New environment...
- Data driven local navigation
  - Learning only
  - Learning DWA parameters

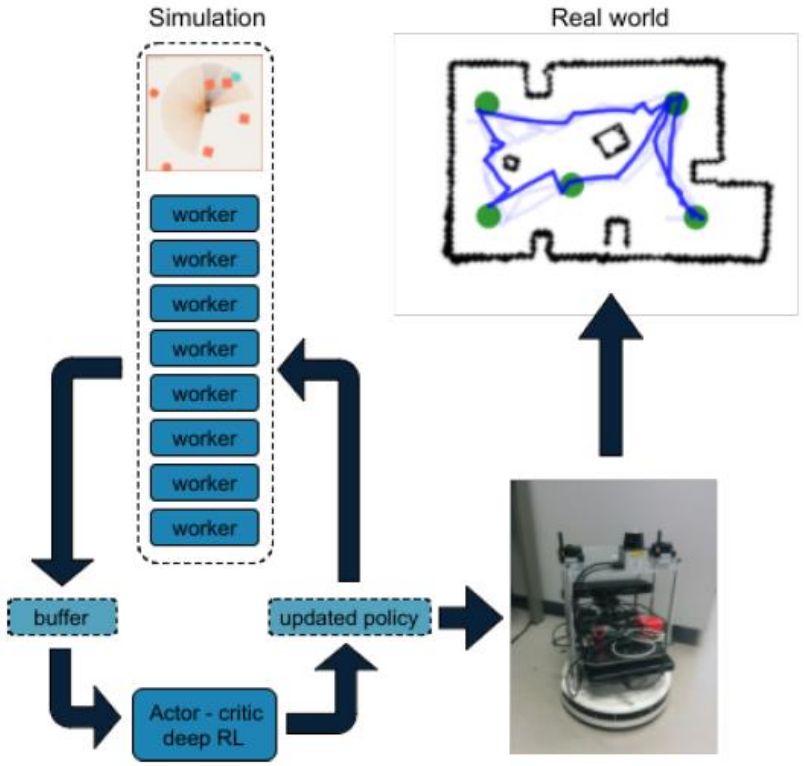


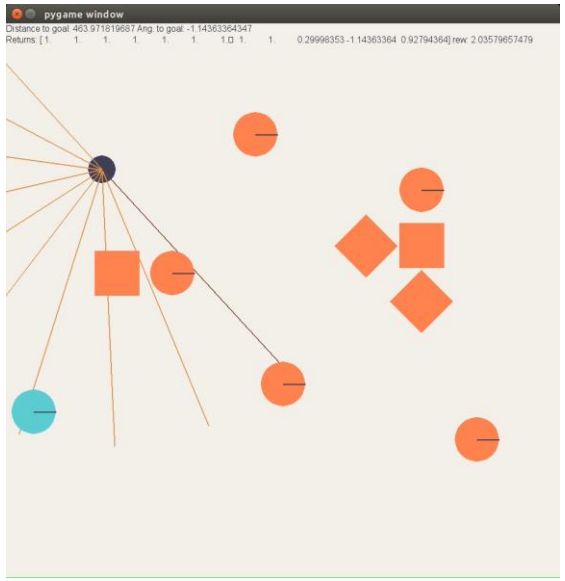


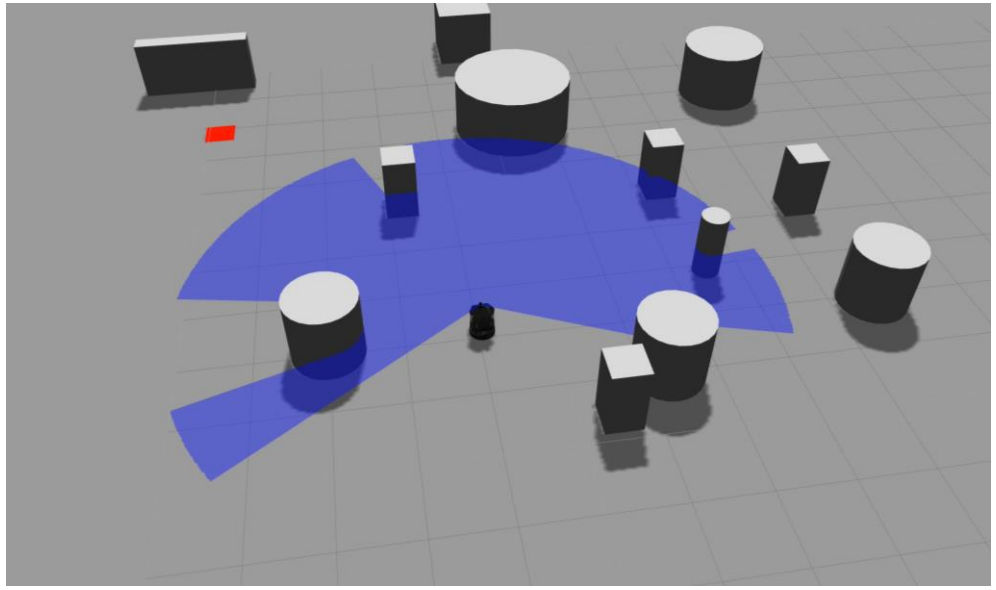


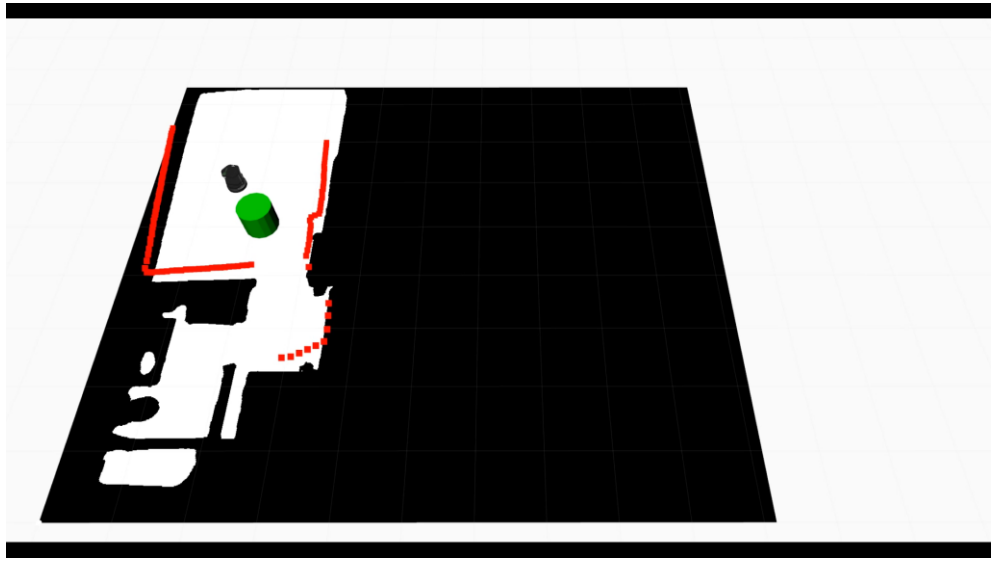
Deep reinforcement learning

- Training in simulation
  - ~ 600 epochs, 3M steps
- Learned policy transferred to the real robot





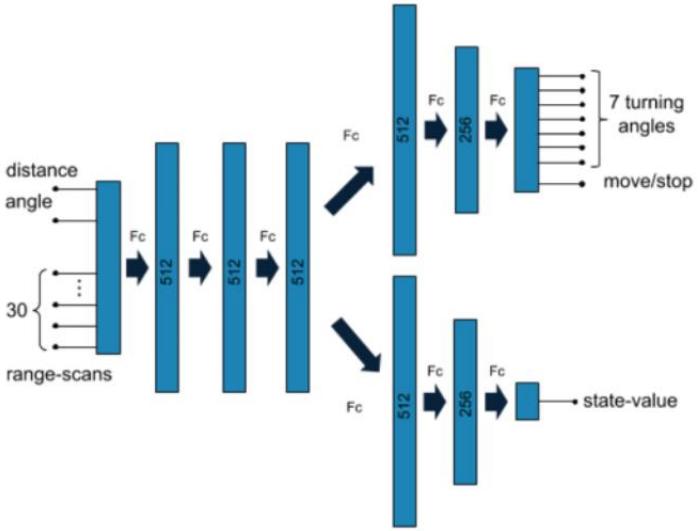


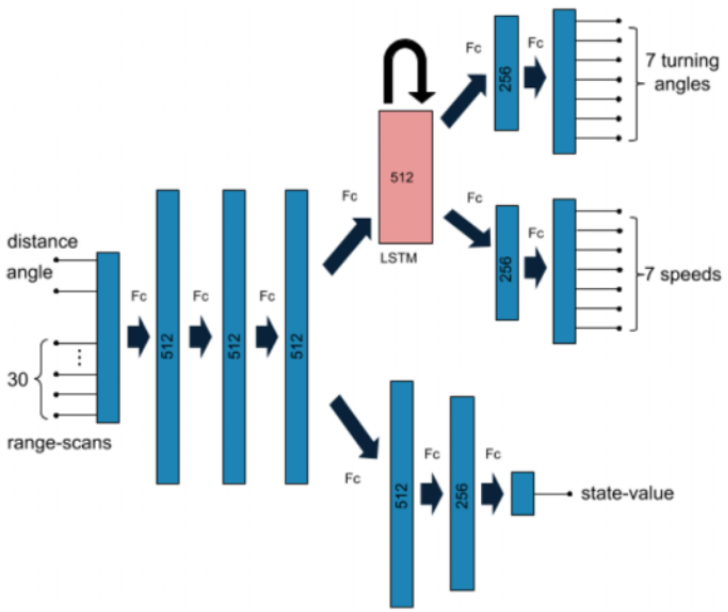


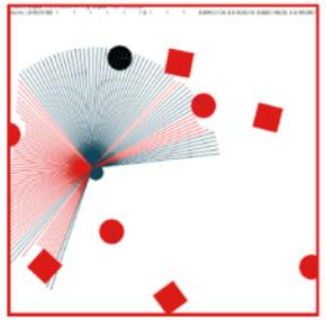
Learning only approach

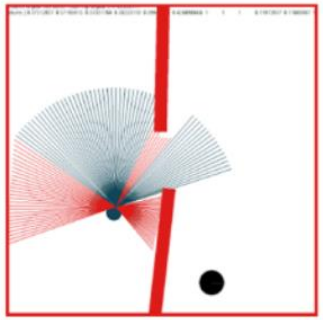
[Dobrevski & Skočaj, 2021]

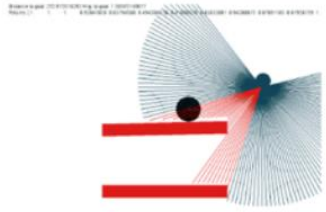
- Navigation as POMDP
- Sensor readings -> actions

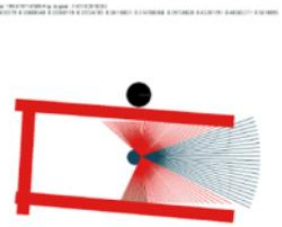


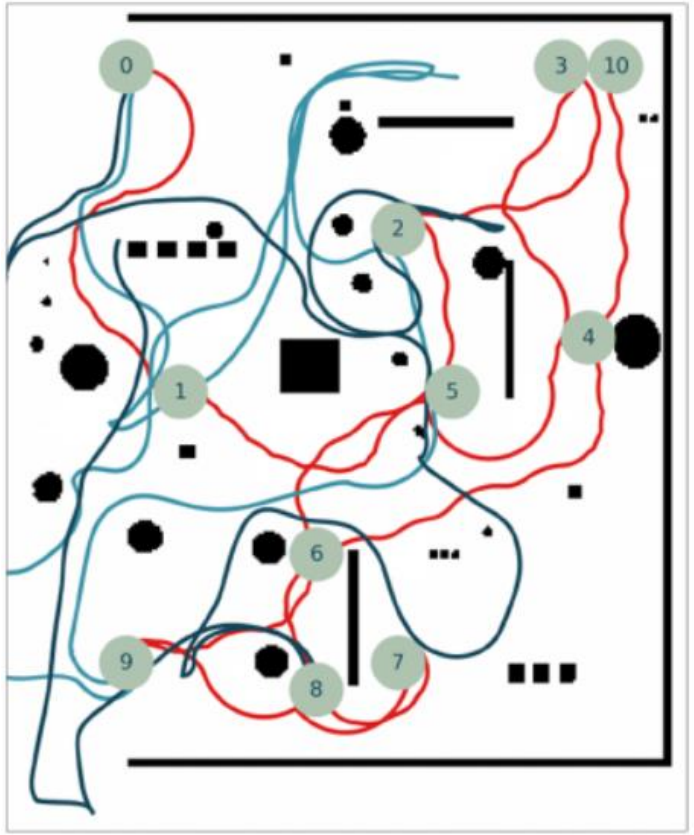








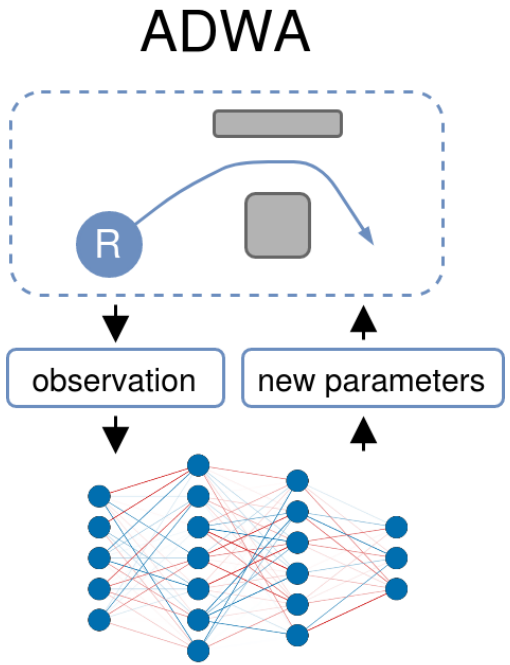


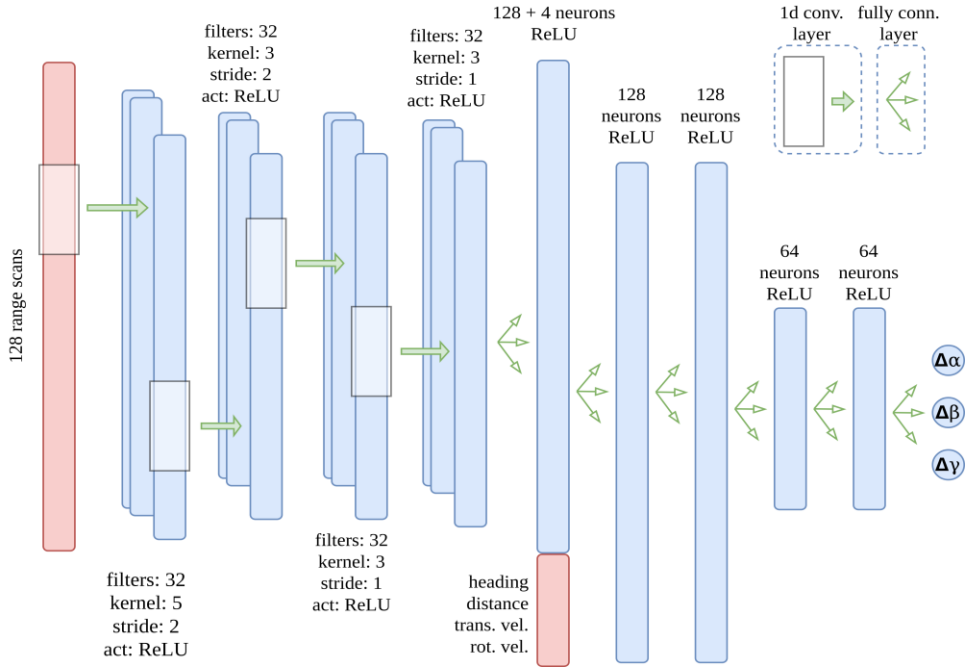


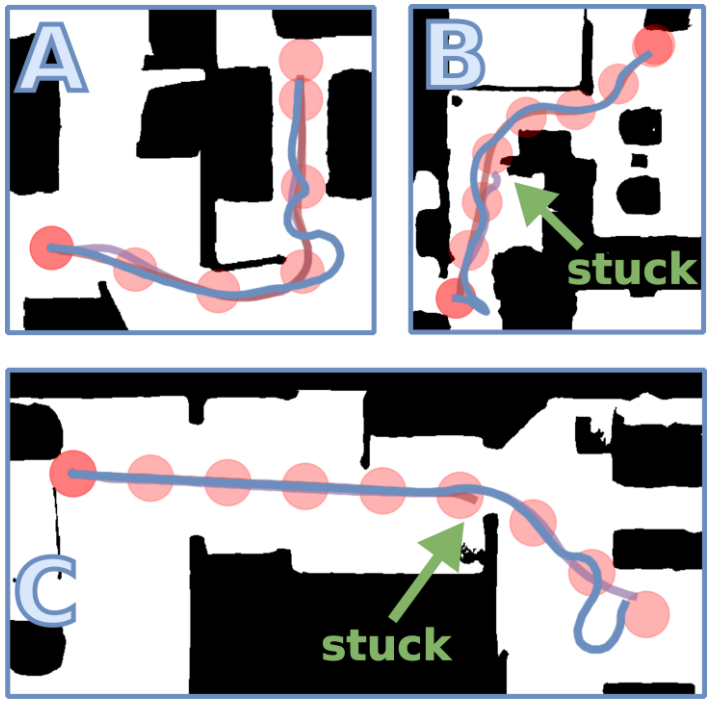
DRL for Adaptive DWA

Dobrevski & Skočaj, 2020

- Classic approaches (DWA)
  - Provide safety mechanisms, smooth trajectories
  - Are not optimised for specific situation
- Learning-based approaches
  - Require additional safety mechanisms
- => merry learning and DWA -> ADWA



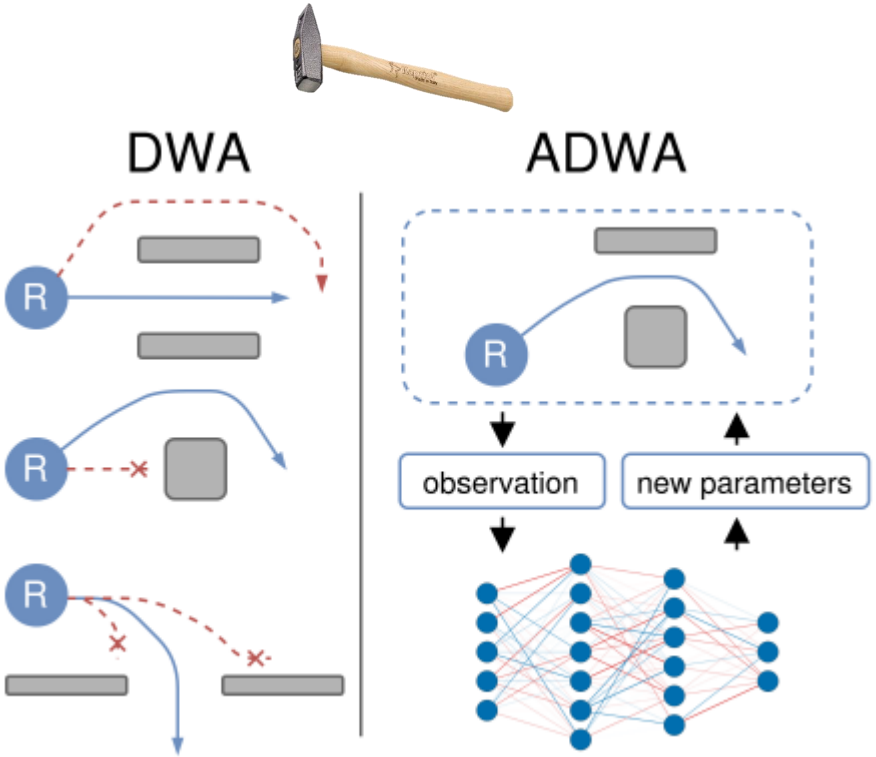


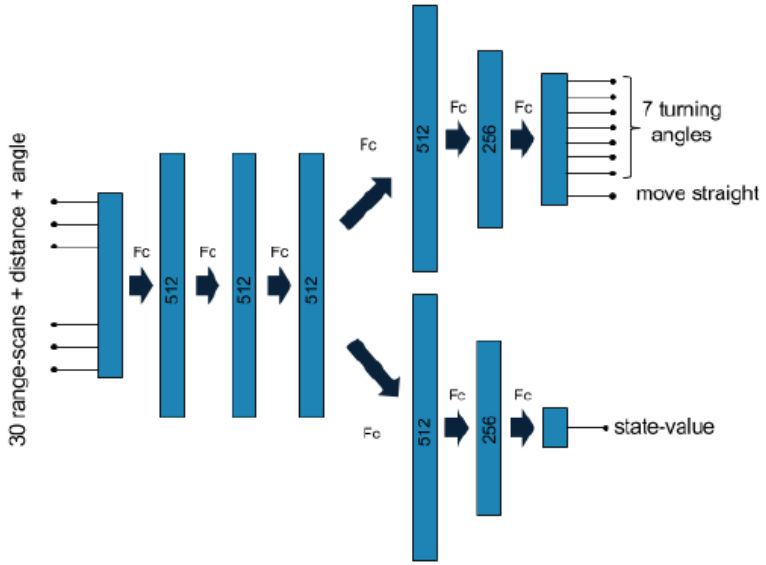


method	# completed ep.
Best DWA[7]	294
ANFIS DWA[15]	340
Ours	**520**

Built-in vs. learned

- Goal-driven mapless navgation
- Constraining the problem with background knowledge





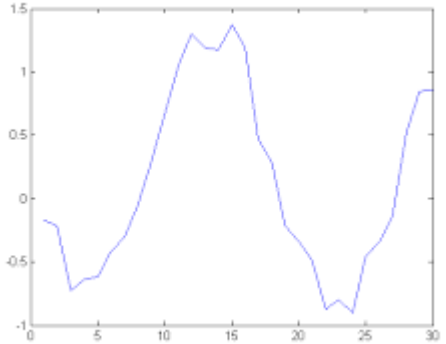
Engineering approach

Engineering approach+ deep learning

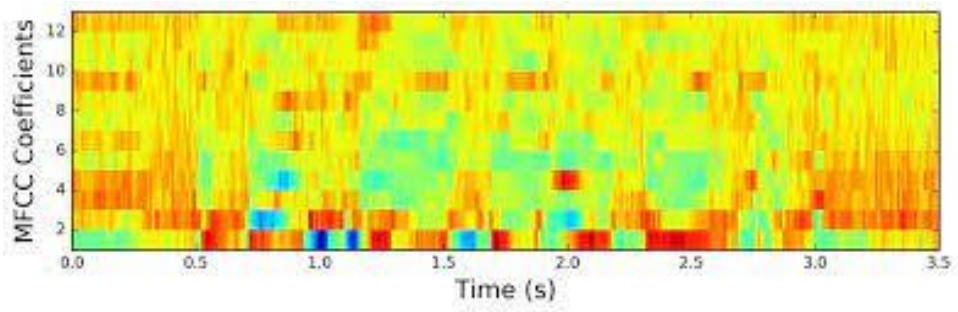
Learning only

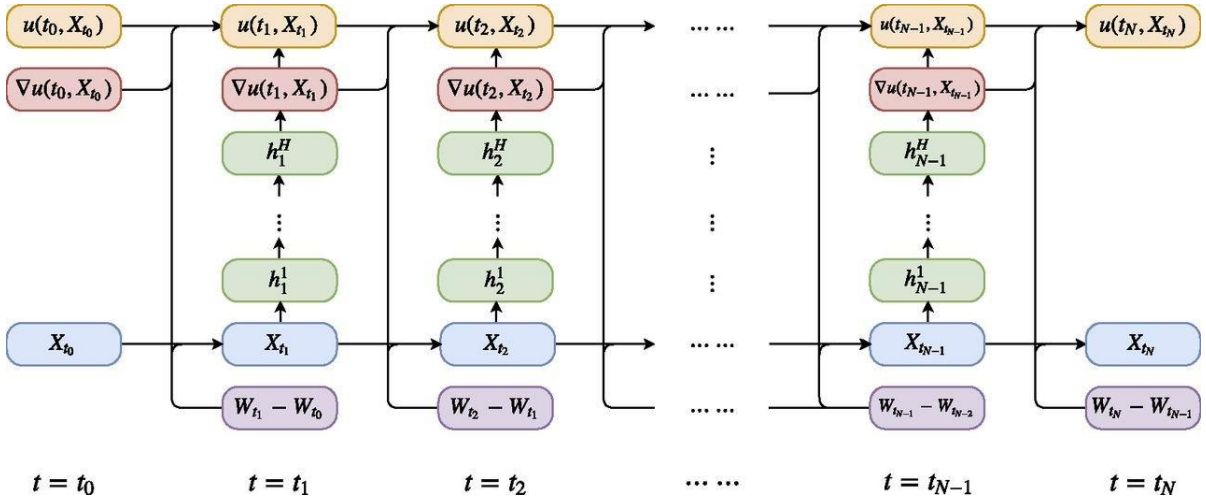
Beyond CV and NLP

- Use CV methods to detect specific patterns, or segment images, or track objects in other domains
- Transform data from other modalities in image-like data and use CV methods



- Use deep learning as a primary tool for problem solving
- Use deep learning for efficient optimisation
- Use deep models as efficient function approximators



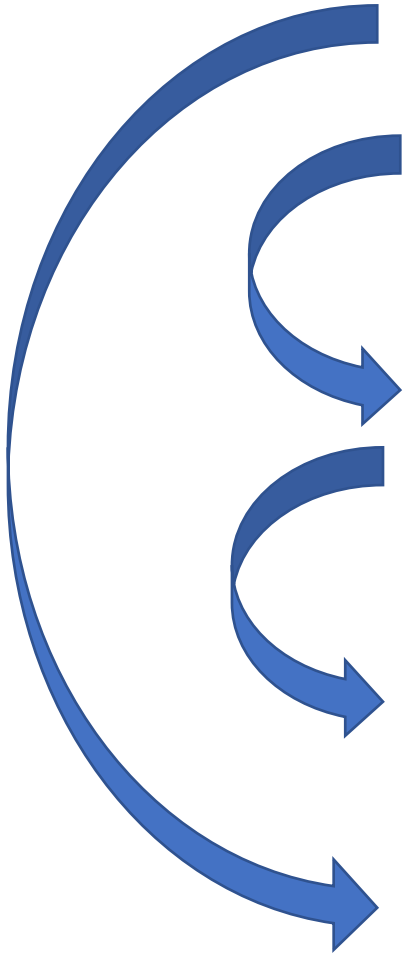


Function approximator

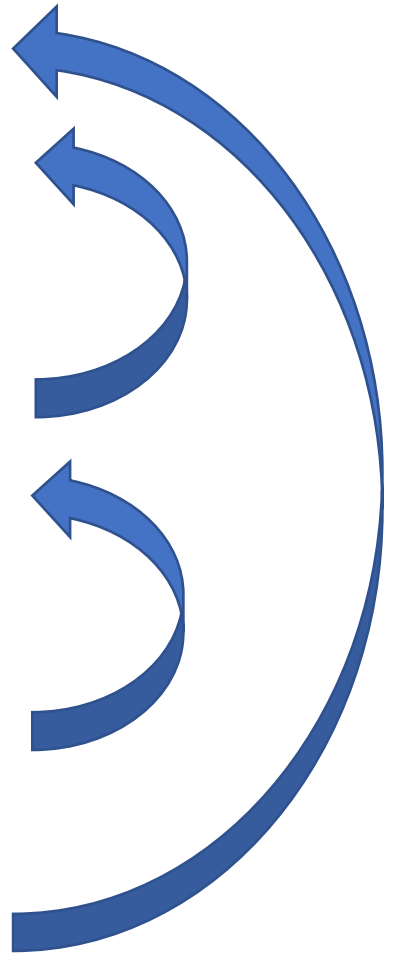
- Deep model as a function approximator
- Different training possibilities:

function	known	unknown
$f(x) \doteq y$	x_{tr}, y_{tr}	f
$f(x)$	x_{tr}	f
$f(x) \doteq \hat{f}(x)$	$x_{tr}, \hat{f}$	f
$f(f^{-1}(y)) \doteq y$	y_{tr}, f^{-1}	f
$f(g(x)) \doteq y$	g, x_{tr}, y_{tr}	f
$g(f(x)) \doteq y$	g, x_{tr}, y_{tr}	f

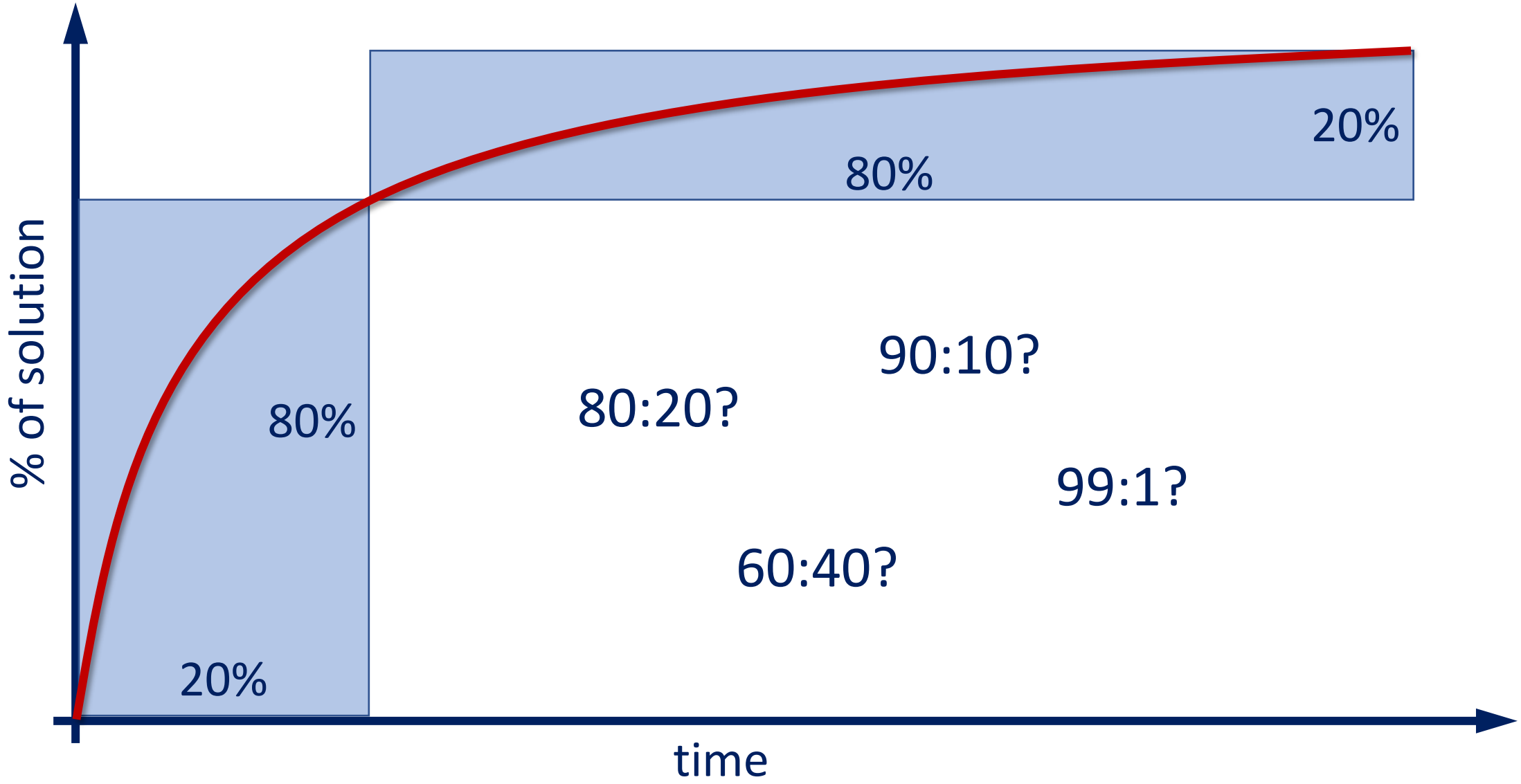
Development, deployment and maintenance



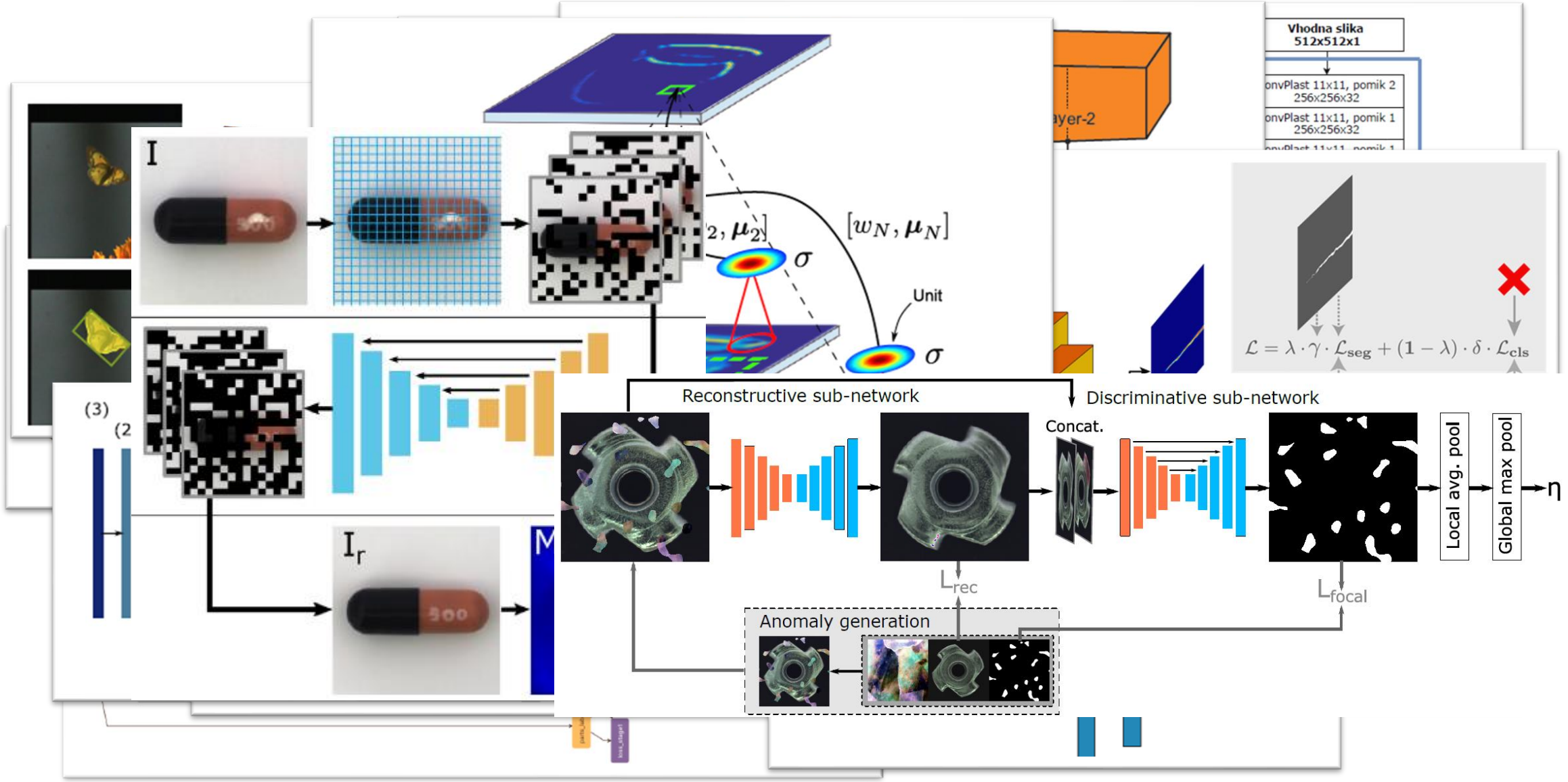
- Data, data, data!
  - Enough data, representative data
  - Correctly annotated data
- Appropriate deep architecture design
  - Proper backbone, architecture, loss function, …
  - Learning, parameter optimisation
- Efficient implementation
  - Execution speed
  - Integration
- Maintenance
  - Incremental improvement of the learned model
  - Reflecting to changes in the environment



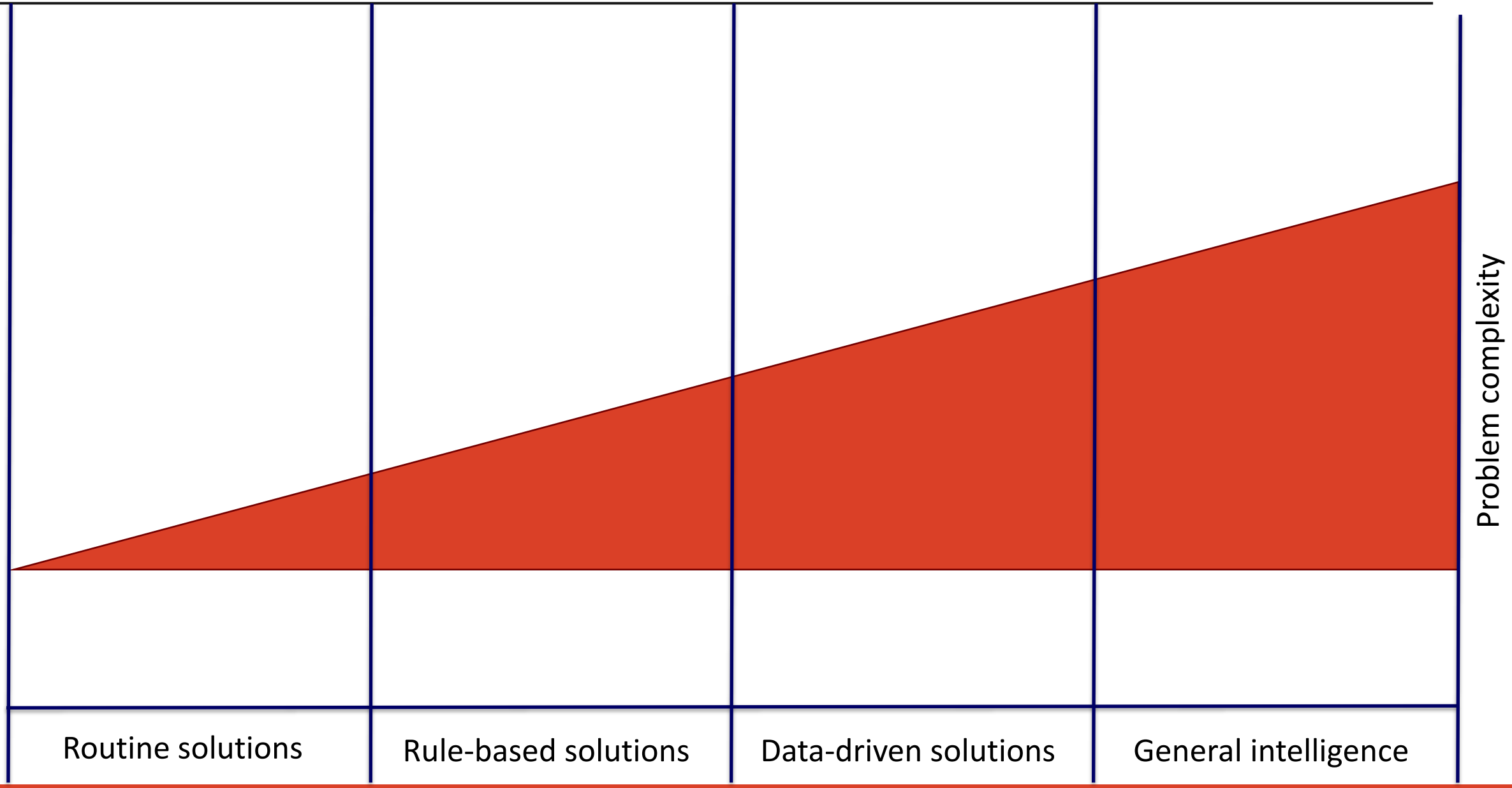
Development of deep learning solutions



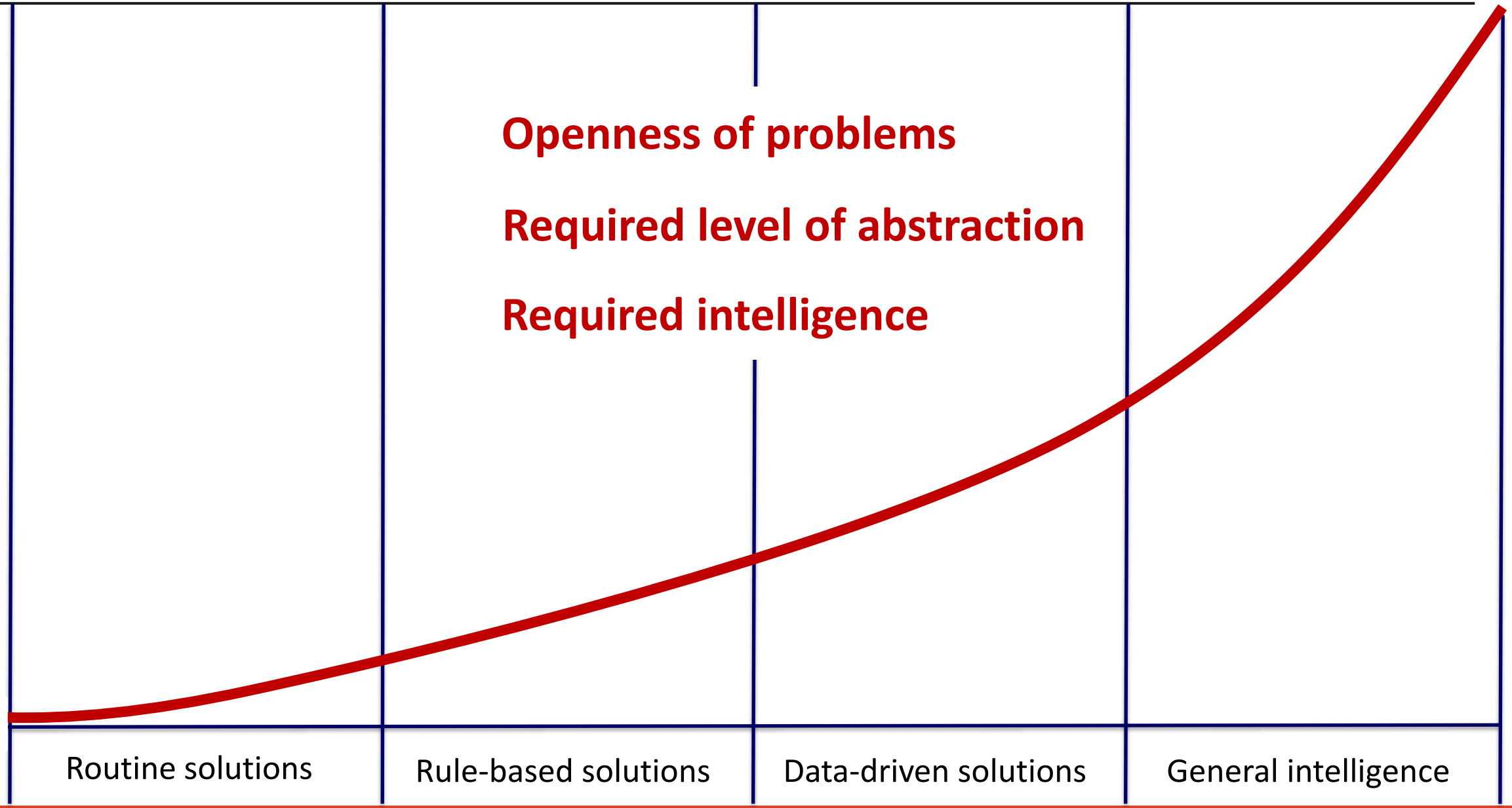
Knowledge and experience count



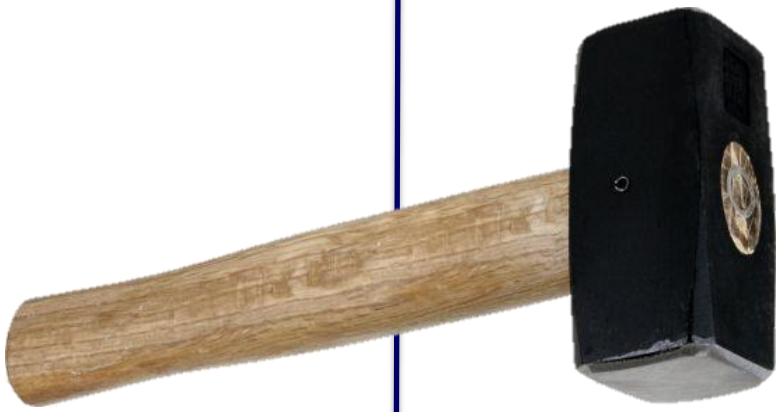
Problem solving



Problem complexity



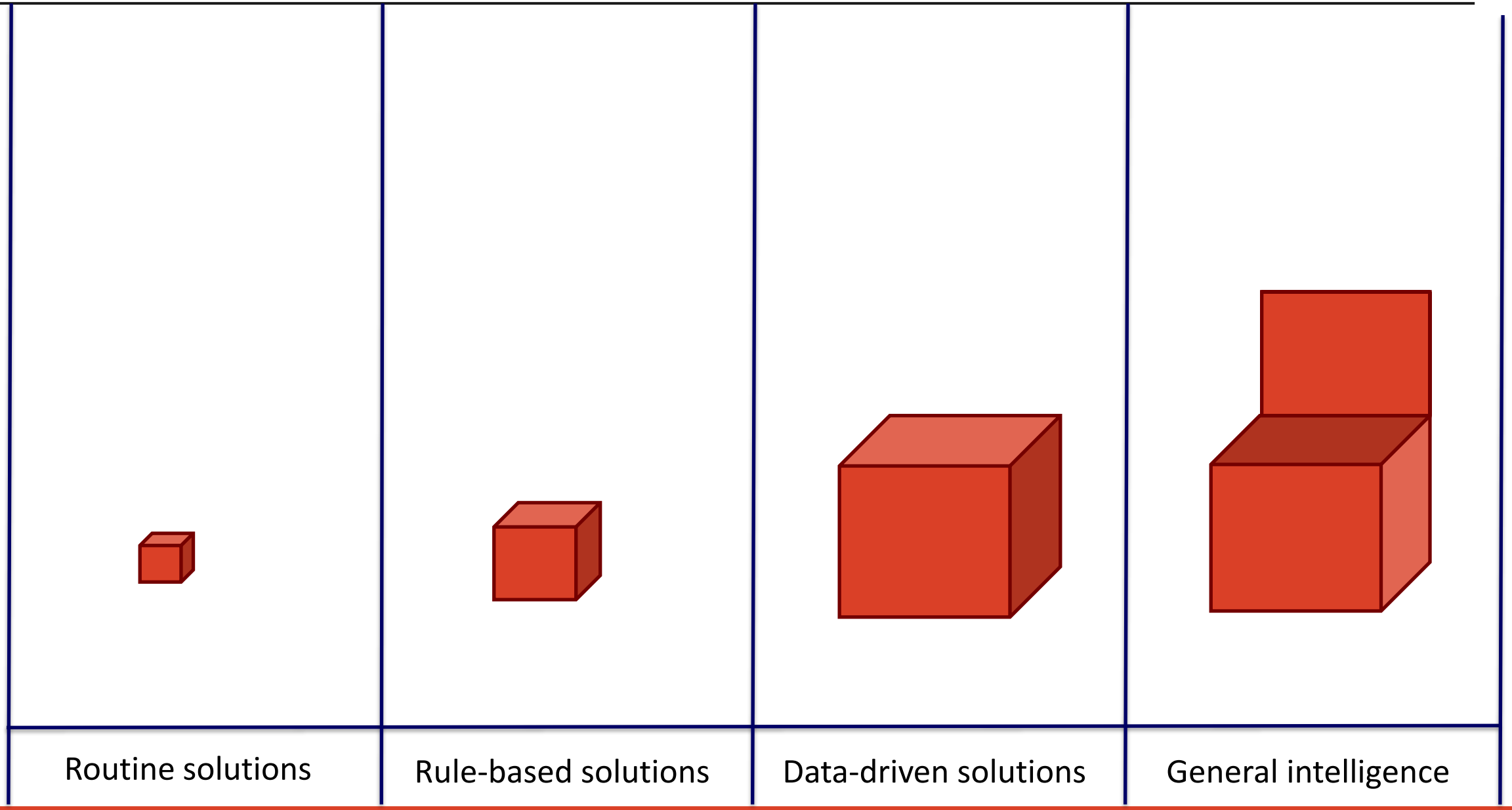
Adequate tools



Deep learning

Routine solutions	Rule-based solutions	Data-driven solutions	General intelligence

Openness of problems



Advancement of artificial intelligence