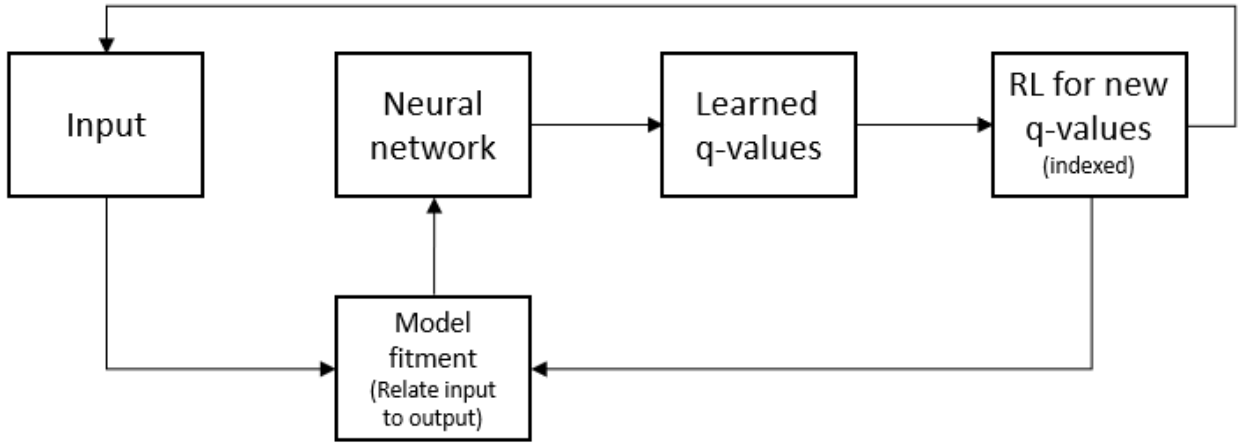
DRL, generalization, and DQN

Deep Reinforcement Learning (DRL)

- Originates from the combination of:
  - RL using a value-based technique: Q-Learning
  - A deep neural network

- It can be defined as:
  - Implementation of deep neural networks to approximate the components in RL, such as Q-values.



DRL

- With DRL:
  - Q-learning:
    - Learning is done through the approximation of Q-values instead of prediction

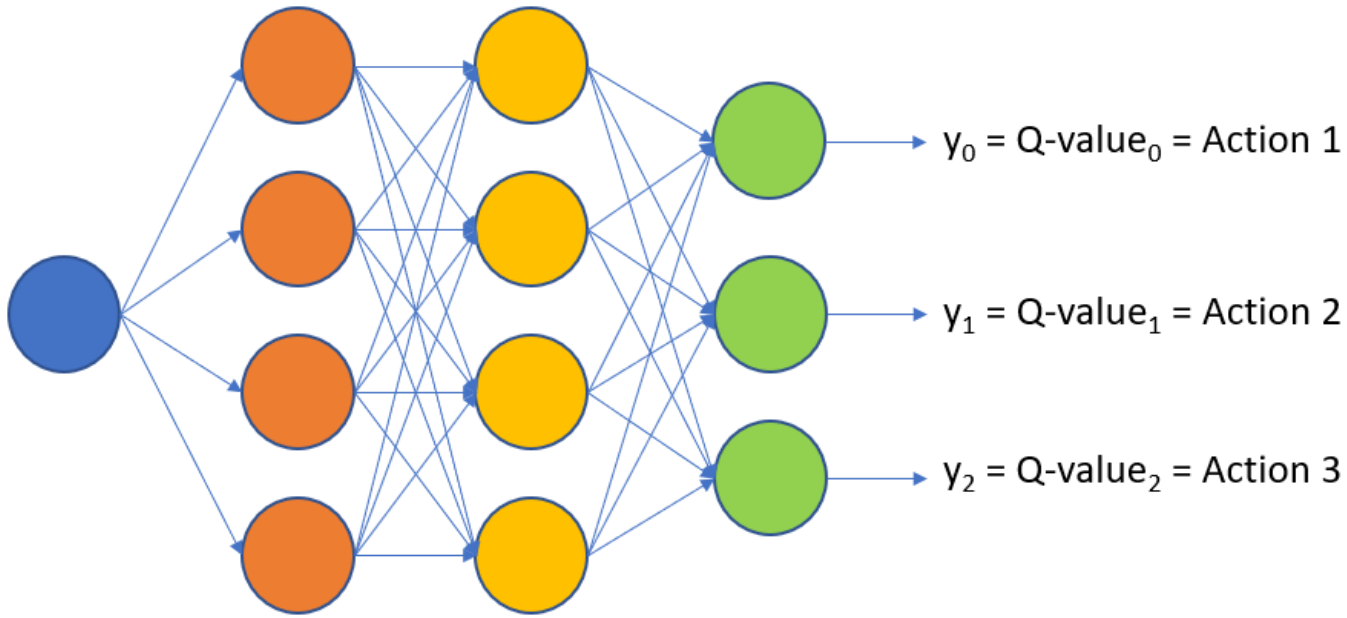
$$Q(S_t, A_t) \leftarrow Q(S_t, A_t) + \alpha\left[R_{t+1} + \gamma \max_a Q\left(S_{t+1}, a\right)\right]$$

Approximated through NN

- Now, the RL agent queries the NN for Q-values so that an action can be executed
- Output of the NN are indexed

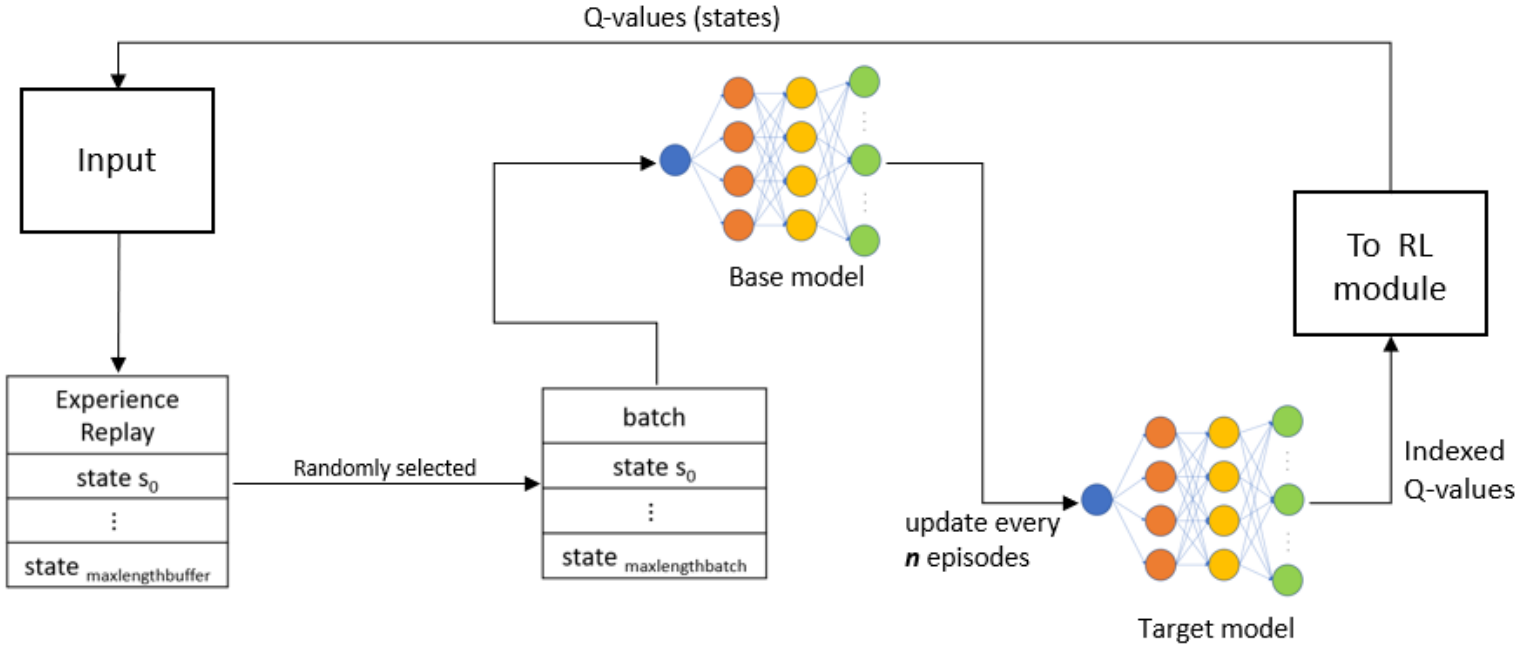
DRL

- Indexed NN output:
  - The output with the highest output value is passed to the RL agent



DRL -> DQN

- With NN approximation, a Q-table can be disregarded
  - Everything is now coming from the NN
  - **This is a Deep Q-network**
- However, a “warm-up” period is or can be needed to discard unnecessary experience



DQN

- Some cautions with DQN:
  - Since we are working with large state spaces:
    - Dimensionality: the number of states is very large
  - To address this:
    - Use Experience Replay
      - Prioritized experience replay
      - Importance factor

DRL

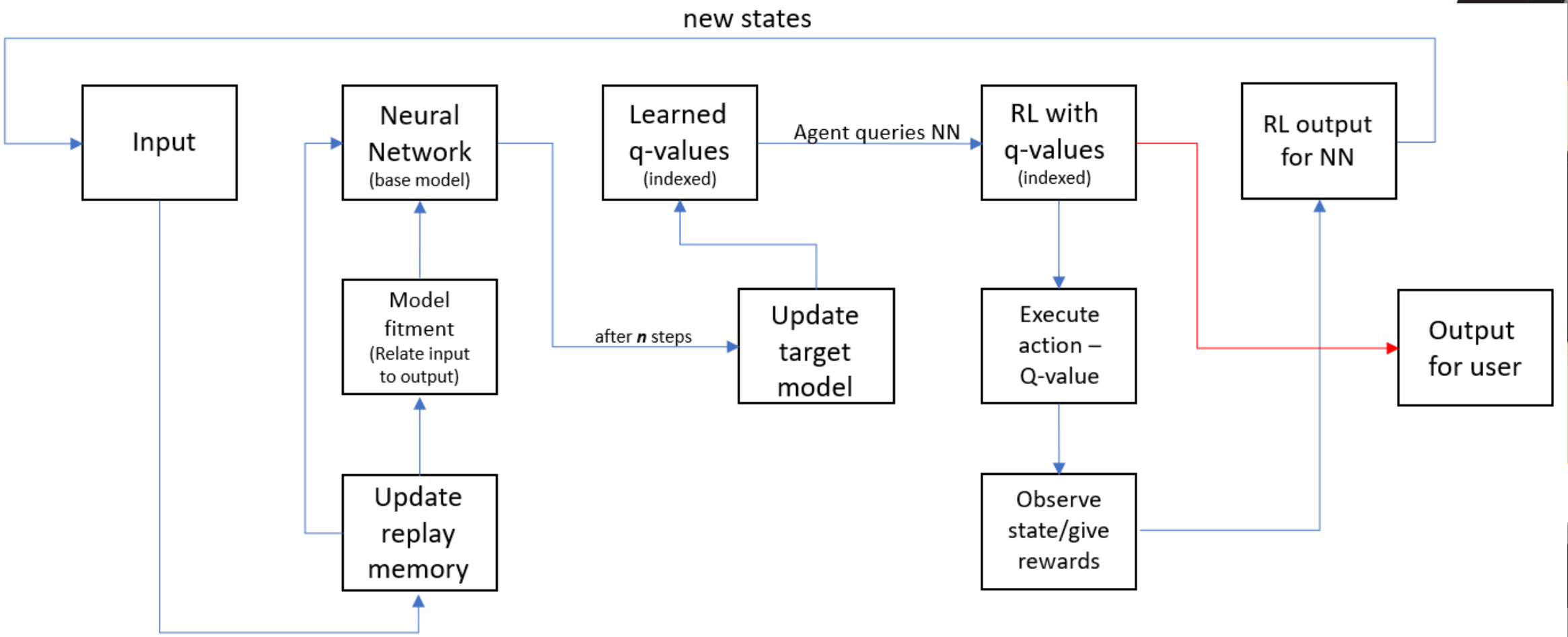
- Generalization:
  - Two definitions:
    - The “problem” of generalization
    - A generalized model
  - The “problem” of generalization:
    - When a model is not able to approximate (or classify) because of **overfitted** values:
    - Overfitted values:
      - False values for Accuracy and Loss:
        - Very high accuracy reached, very fast
        - Very low loss reached, very fast

DRL

- A generalized model:
  - A single model that can be implemented in different environments:
    - This means:
      - No overfitting
      - Good accuracy and loss
  - A generalized model can still output good values even when the input state was never seen before (or during training)

- The main goal of a DRL model is to be able to generalize

DQN flowchart simplified with ER



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