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Efficient decision-making process for robot navigation

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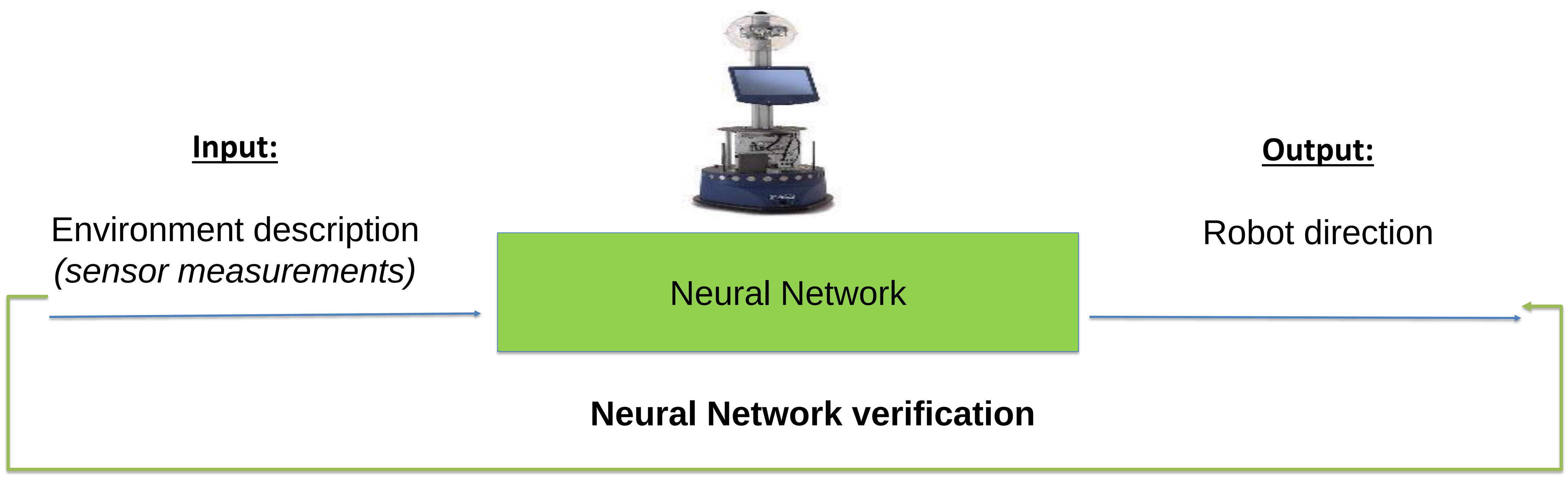
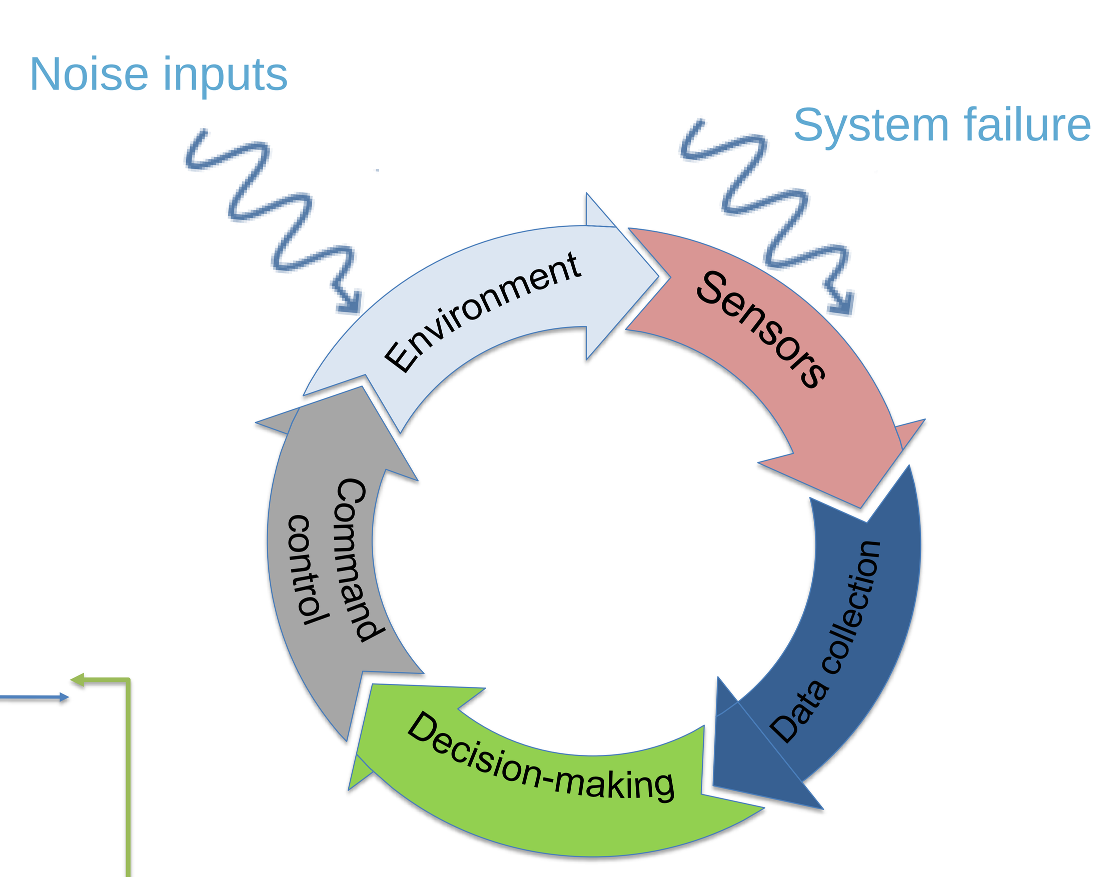
Context

Study the efficiency of a decision-making model for robot navigation under uncertain environment *i.e.*, robot sensors may generate disturbed measures, affecting the decision [1]

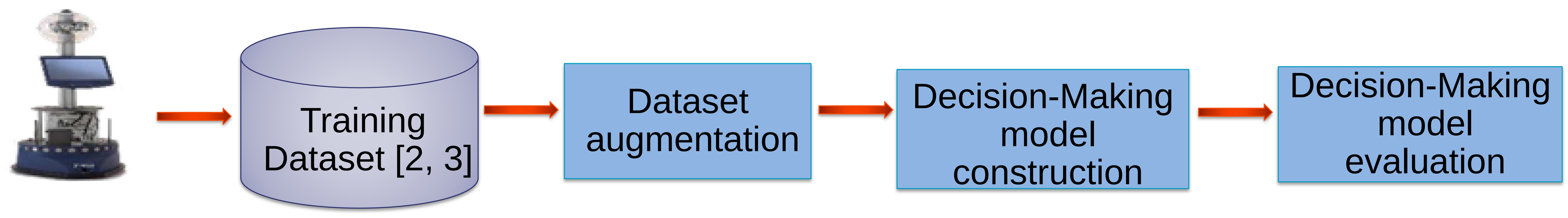




Our approach flowchart

Our approach consists basically of three stages:

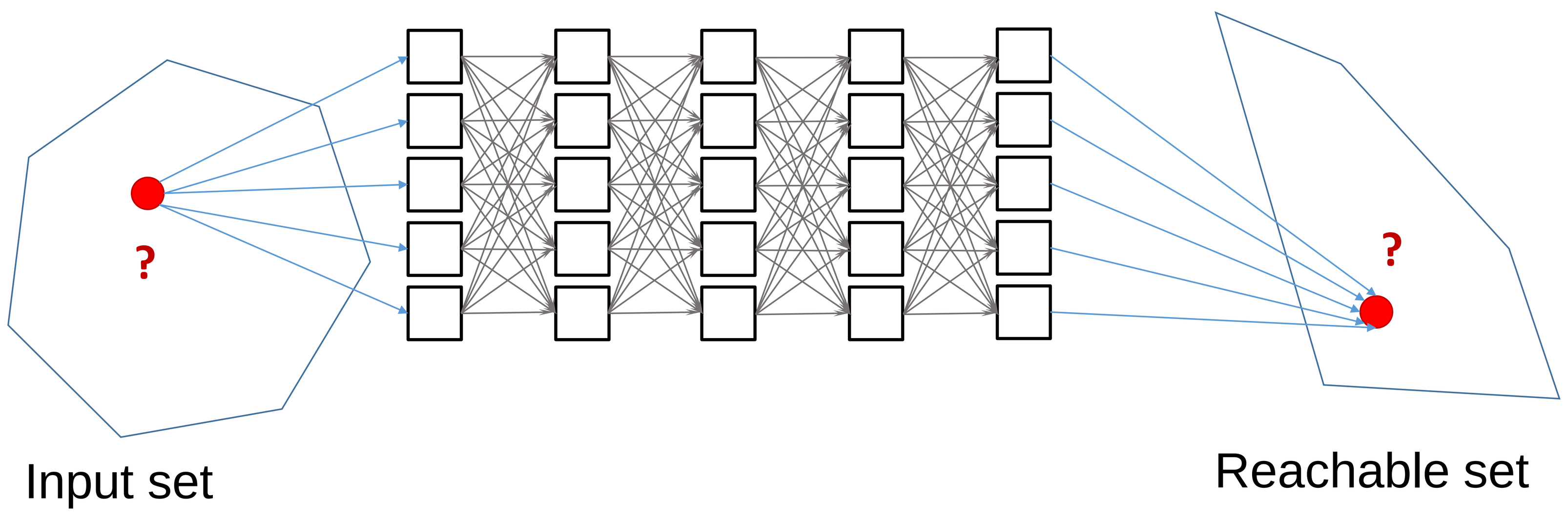
1. Training data set augmentation
2. Decision-Making model construction
3. Decision-Making model efficiency evaluation

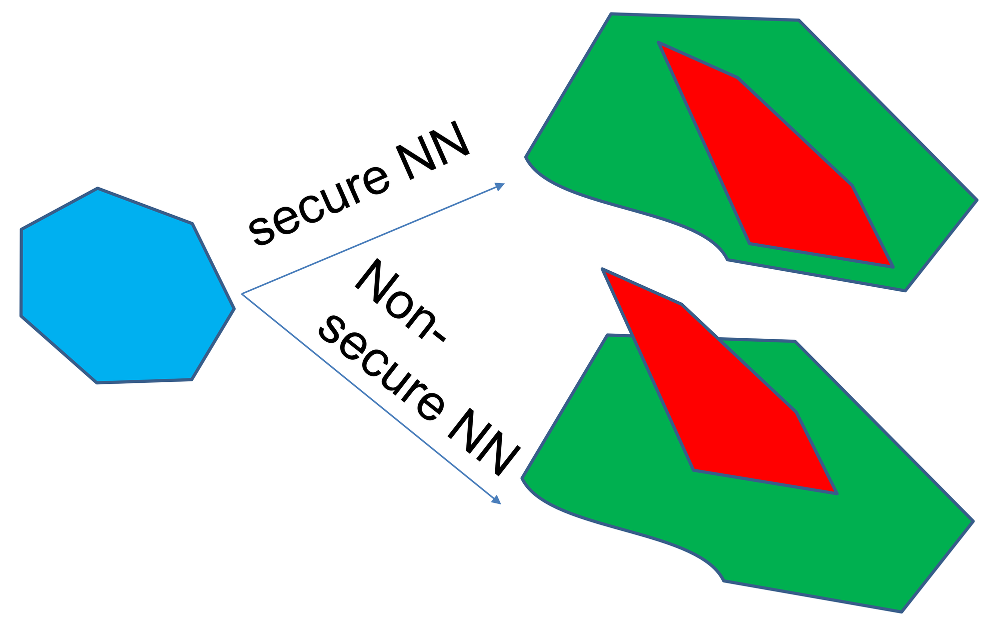


Data augmentation algorithm is applied to increase the variety of the training dataset. Each selected training sample x_{init} is augmented as following:

$$x_{noise} = x_{init} \pm \varepsilon \quad \text{where:} \quad \varepsilon \in [-(\Delta X), (\Delta X)], \quad \Delta X = \sqrt{\frac{1}{N-1} \sum_{j=1}^{N} (x_j - x)^2}$$

Neural network verification: Given x_I an input and x_N formed from x_I following a perturbation A:
Condition to check $R(x_I, A)$ **:** «The neural network outputs the same label for x_N and x_I *i.e.* x_N and x_I belong to the same class ».





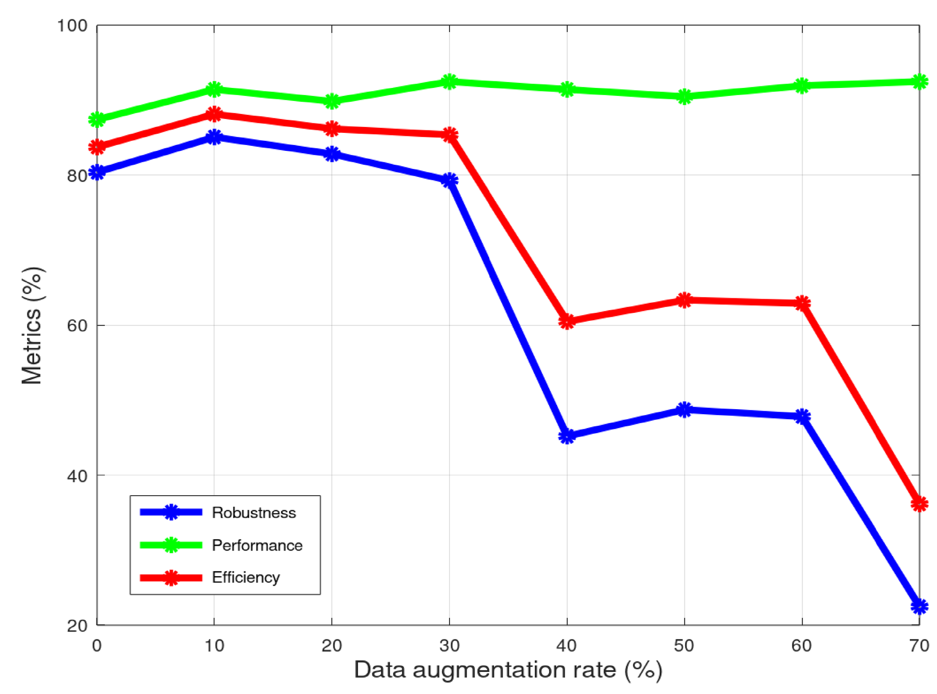
Results

Performance (*P*) = Rate of correct decisions.
Robustness (*R*) = Rate of samples keeping their original labels after perturbation.
Efficiency (*E*) = $f(P, R)$

$$E = 2 * \frac{P * R}{P + R} \qquad P = \frac{1}{N}\sum_{i=1}^{N}(Pred_i == GT_i)$$

$$R = \frac{1}{N}\sum_{i=1}^{N} \text{verified}(Net, A, s_i)$$

Data augmentation rate (%)	Performance (%)	Robustness (%)	Efficiency (%)
No augmentation	87,41	80,39	83,75
10	91,44	**85,09**	**88,15**
20	89,85	82,83	86,19
30	**92,48**	79,29	85,37
40	91,44	45,20	60,49



Results show conflicting behaviors of robustness and performance according to the data augmentation rate

Bibliography:
[1] Ibn Khedher et al., Efficient decision-making process for robot navigation based on data augmentation, submitted in 2019
[2] Ananda L. Freire, Guilherme A. Barreto, Marcus Veloso and Antonio T. Varela (2009), Short-Term Memory Mechanisms in Neural Network Learning of Robot Navigation Tasks: A Case Study'. Proceedings of the 6th Latin American Robotics Symposium
[3] Dua, D. and Graff, C., UCI Machine Learning Repository [http://archive.ics.uci.edu/ml]. Irvine, CA: University of California, School of Information and Computer Science, 2019

This work is one result of the project **EPI** "AI-based Decision Making Systems' Performance Evaluation". Its main challenge is to evaluate and optimize the performance of AI-based decision systems in automotive and marine transportation systems

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