

Dilemmas of Educational Robotics

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The Science Teaching Department Celebrates 50 Years of Activity, 7 January 2019.

thymio



<https://www.thymio.org/home-en:home>

Dilemma 1: Build or Buy?

Question 1: Si tu pouvais choisir de recevoir un robot pour Noël, lequel de ces deux tu choisirais (pour le même prix):

Connais-tu déjà ce robot? Oui Non

Connais-tu déjà ce robot? Oui Non



Je choisirais celui-ci

Je choisirais celui-ci

Ce robot est plus _____

Ce robot est plus _____

What is the Educational Value of LEGO®?

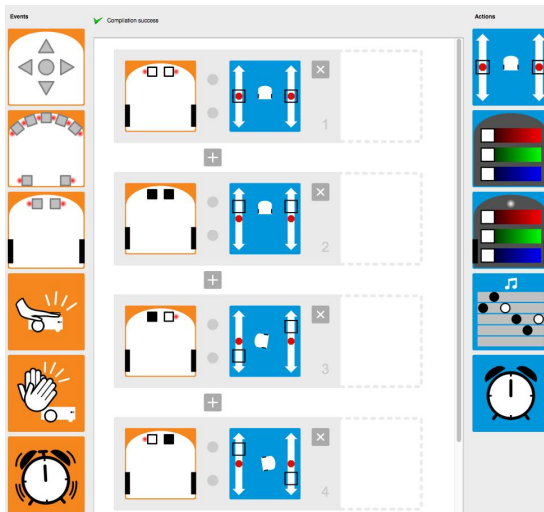


Dilemma 2: What Do the Students Learn?



Mor Friebron Yesharim, MSc thesis, WIS

Jourdain Effect? Constructs vs. plans?



Mor Friebroon Yesharim, MSc thesis, WIS

Dilemma 3: Low floor and/or high ceiling?



High ceiling: probabilistic path finding

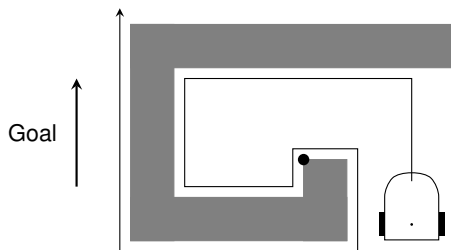
0	p	p	p	p	p	$p + \frac{1}{3}p$	$p + p$	← Nest
1	p	p	p	p	p	$p + \frac{4}{3}p$	$p + \frac{1}{3}p$	
2	p	p	p	p	$p + p$	p	p	
3	p	p	p	p	■	p	p	← Food
4	p	p	p	p	p	p	p	
5	p	p	p	p	p	p	p	
	0	1	2	3	4	5	6	7

<https://www.thymio.org/creations-en:navigation-fourni>

<https://youtu.be/V4Vlus5HWLA>

Dilemma 4: Real robots don't drive straight

Obstacle avoidance using the Pledge algorithm



[https://www.thymio.org/en:
avoiding-an-obstacle-using-the-pledge-algorithm](https://www.thymio.org/en:avoiding-an-obstacle-using-the-pledge-algorithm)

<https://youtu.be/wtGSr9fJka4>

Dash robot *can* drive straight



<https://www.makewonder.com/>

<https://youtu.be/cfmk5MLJg2M>

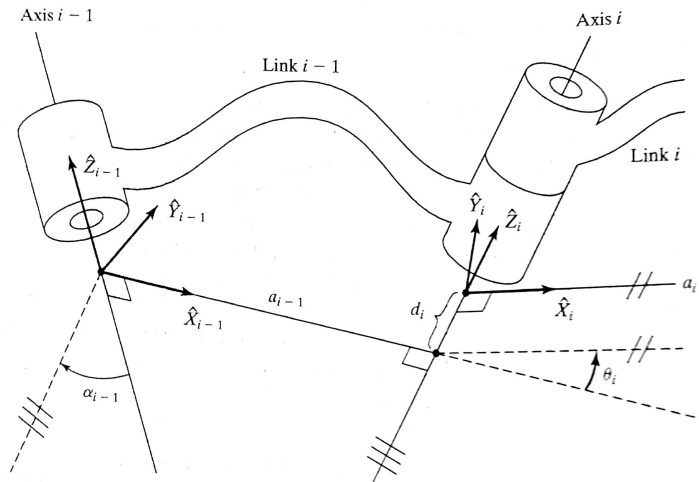
Dilemma 5: Bait and Switch

$$F_{\Delta r_l} = \nabla_{\Delta r_l} f = \left[\frac{\partial f}{\partial \Delta s_r} \quad \frac{\partial f}{\partial \Delta s_l} \right] = \dots \quad (5.12)$$

$$\left[\begin{array}{cc} \frac{\partial \Delta s}{\partial \Delta s_r} \cos\left(\theta + \frac{\Delta\theta}{2}\right) + \frac{\Delta s}{2} - \sin\left(\theta + \frac{\Delta\theta}{2}\right) \frac{\partial \Delta\theta}{\partial \Delta s_r} & , \frac{\partial \Delta s}{\partial \Delta s_l} \cos\left(\theta + \frac{\Delta\theta}{2}\right) + \frac{\Delta s}{2} - \sin\left(\theta + \frac{\Delta\theta}{2}\right) \frac{\partial \Delta\theta}{\partial \Delta s_l} \\ \frac{\partial \Delta s}{\partial \Delta s_r} \sin\left(\theta + \frac{\Delta\theta}{2}\right) + \frac{\Delta s}{2} \cos\left(\theta + \frac{\Delta\theta}{2}\right) \frac{\partial \Delta\theta}{\partial \Delta s_r} & , \frac{\partial \Delta s}{\partial \Delta s_l} \sin\left(\theta + \frac{\Delta\theta}{2}\right) + \frac{\Delta s}{2} \cos\left(\theta + \frac{\Delta\theta}{2}\right) \frac{\partial \Delta\theta}{\partial \Delta s_l} \\ & \frac{\partial \Delta\theta}{\partial \Delta s_r} & & \frac{\partial \Delta\theta}{\partial \Delta s_l} \end{array} \right] \quad (5.13)$$

From Siegwart et al.

Kinematics: Denavit-Hartenberg Convention



From Craig.

Machine Learning: Linear Discriminant Analysis

$$\mathbf{w} = \mathbf{S}^{-1} (\boldsymbol{\mu}_{light} - \boldsymbol{\mu}_{dark}), \quad (14.4)$$

where:

$$\boldsymbol{\mu}_{light} = \begin{bmatrix} \mu_{light}^{left} \\ \mu_{light}^{right} \end{bmatrix}, \quad \boldsymbol{\mu}_{dark} = \begin{bmatrix} \mu_{dark}^{left} \\ \mu_{dark}^{right} \end{bmatrix}$$

are the mean vectors of the two classes and \mathbf{S}^{-1} is the inverse of the average of the covariance matrices of the two classes⁶:

$$\mathbf{S} = \frac{1}{2} \left(\begin{bmatrix} s^2(\mathbf{x}_{light}^{left}) & cov(\mathbf{x}_{light}^{left}, \mathbf{x}_{light}^{right}) \\ cov(\mathbf{x}_{light}^{right}, \mathbf{x}_{light}^{left}) & s^2(\mathbf{x}_{light}^{right}) \end{bmatrix} + \begin{bmatrix} s^2(\mathbf{x}_{dark}^{left}) & cov(\mathbf{x}_{dark}^{left}, \mathbf{x}_{dark}^{right}) \\ cov(\mathbf{x}_{dark}^{right}, \mathbf{x}_{dark}^{left}) & s^2(\mathbf{x}_{dark}^{right}) \end{bmatrix} \right).$$

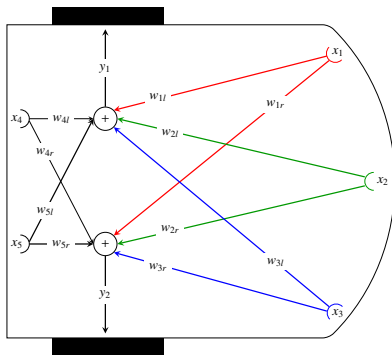
From Ben-Ari and Mondada.

Neural Networks: Hebbian Rule

$$\Delta w_{i,j} \sim \eta o_i a_j \quad (4.5)$$

with $\Delta w_{i,j}$ being the *change in weight* from i to j , which is proportional to the following factors:

- ▷ the output o_i of the predecessor neuron i , as well as,
- ▷ the activation a_j of the successor neuron j ,
- ▷ a constant η , i.e. the learning rate, which will be discussed in section [5.4.3](#).



From Ben-Ari and Mondada.

Summary of the Dilemmas

- Build or Buy?
- What Do Students Learn?
- Low floor and/or high ceiling.
- Real robots don't drive straight.
- Bait and switch.

References

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