Embodied artificial intelligence through free energy minimization

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EAISI AI Café
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TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

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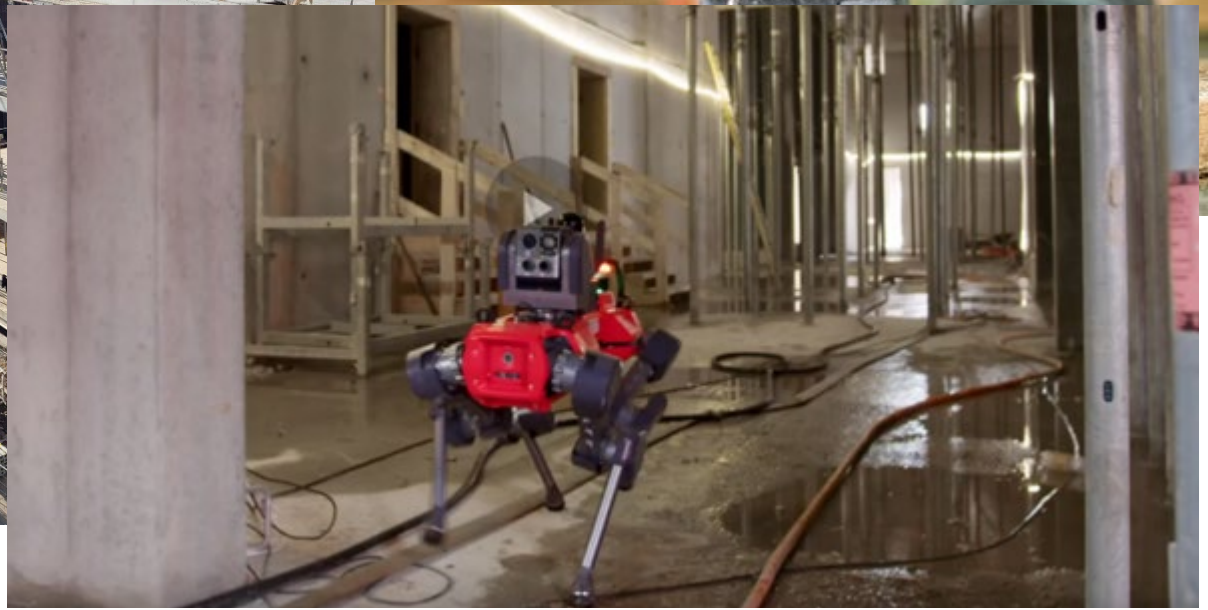
Dangerous jobs



https://www.anybotics.com/robotics/anymal/

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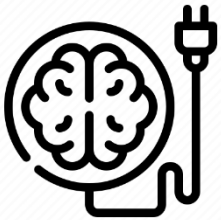
Embodied Artificial Intelligence

Hafner, DayDreamer; https://www.youtube.com/watch?v=xAXvfVTgqr0

~10-20 MegaWatt



~20 Watt

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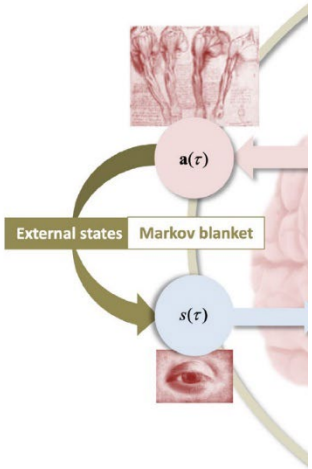
Free energy minimization

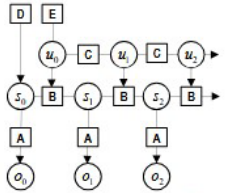


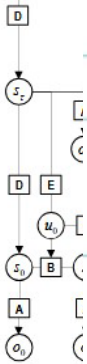
Parametric depth

$$P(o_\tau \mid s_\tau, a) = Cat(\mathbf{A})$$
$$P(s_{\tau+1} \mid s_\tau, u_\tau, b) = Cat(\mathbf{B})$$
$$P(u_{\tau+1} \mid u_\tau, c) = Cat(\mathbf{C})$$
$$P(s_0 \mid d) = Cat(\mathbf{D})$$
$$P(u_0 \mid e) = Cat(\mathbf{E})$$

$$P(\mathbf{A}) = Dir(a), \ \ldots$$
$$\mathbb{E}[P(\mathbf{A})] =: \mu(a) = a/a_0 : a_0 = \textstyle\sum_i a_i$$
$$\mathbb{E}[\ln P(\mathbf{A})] =: \varphi(a) = \psi(a) - \psi(a_0)$$
$$\ell(a) =: \ln(a)$$
$$\sigma(a) =: \mu(e^a)$$

$$P(u_{\tau+1} \mid u_\tau) = Cat(\mathbf{C})$$
$$P(u_{\tau+1} \mid c) = Cat(\mathbf{C})$$
$$\mathbf{C} = \pi \odot \sigma(-$$
$$G_k = \textstyle\sum_\tau \mathbf{o}_{\tau+1}^{\pi,k}$$
$$\mathbf{o}_{\tau+1}^{\pi,k} = \mu(\mathbf{a}^\pi) \odot$$
$$\mathbf{s}_{\tau+1}^{k} = \mu(\mathbf{b} \odot s$$
$$\mathbf{H}^\pi = \mathbf{1} \odot (\mu($$





Temporal depth

Hierarchical depth

Factorial depth

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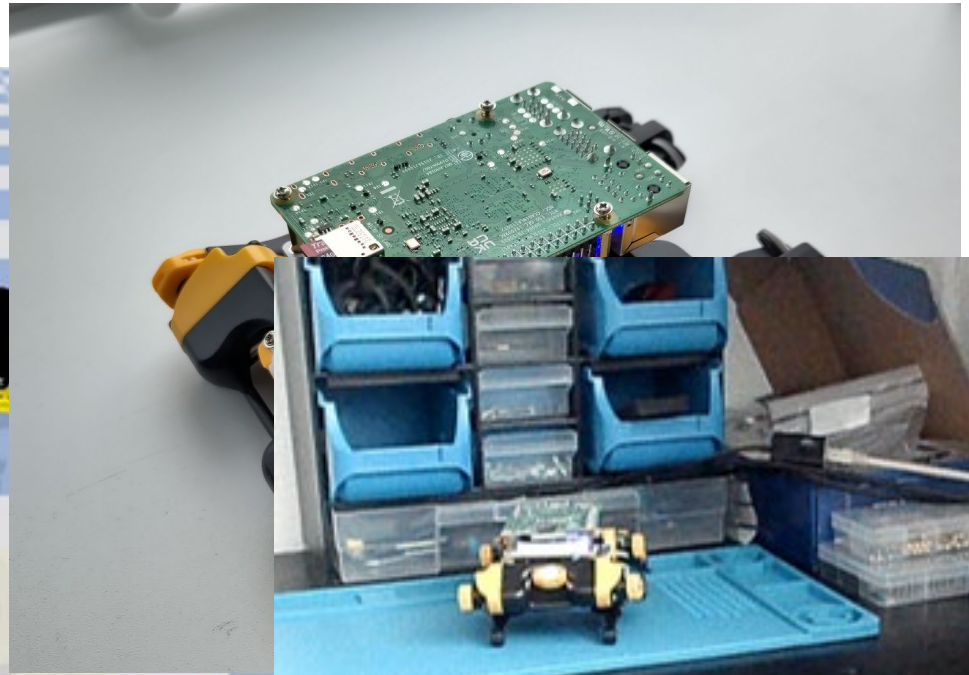
Free energy minimizing agents

$$\begin{pmatrix} \mu_{k-1} \\ \Lambda_{k-1} \\ \alpha_{k-1} \\ \beta_{k-1} \end{pmatrix}$$



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