



$$2 + 2 = 5$$

4

~~5~~

Összeadni tanul a robot és a robotológus

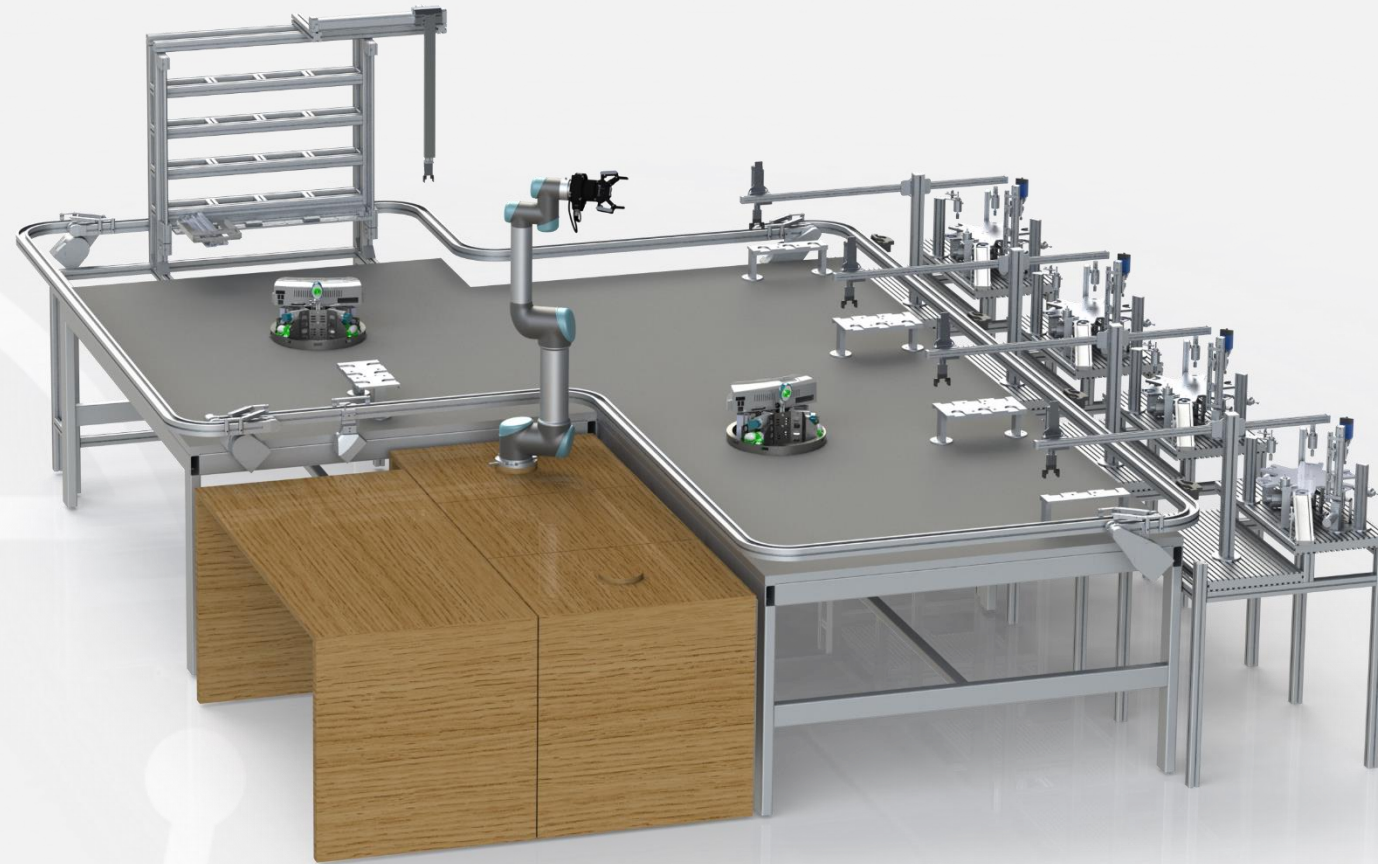
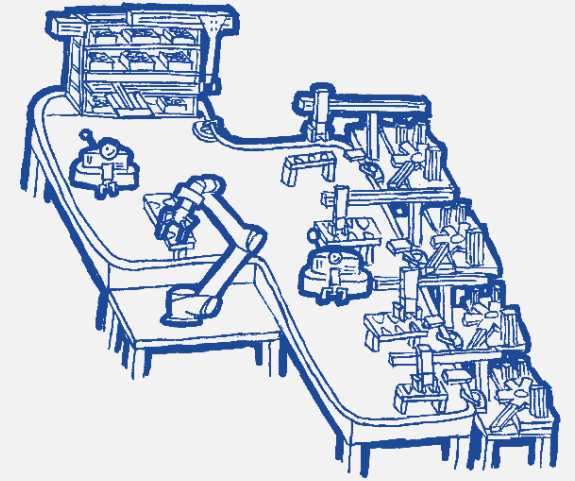
HU-MATH-IN Partnertalálkozó: Ipar 4.0

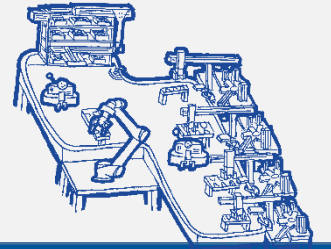
Beregi Richárd, kutatómérnök

2021.03.04.

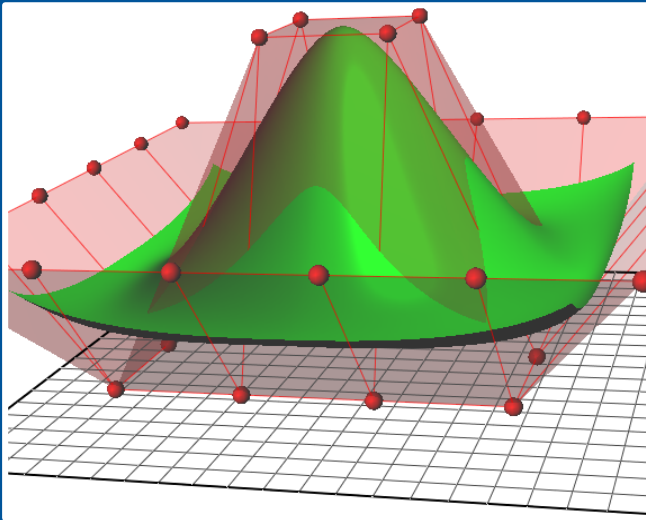
SmartFactory

Kísérleti kiber-fizikai gyártórendszer

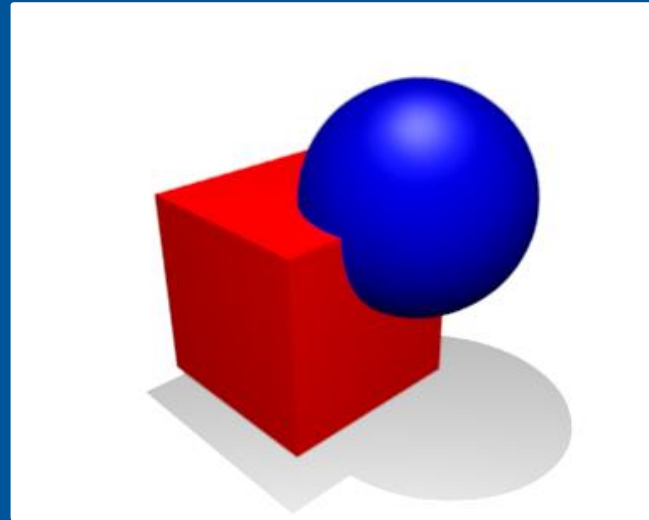




Térgeometria



Halmazelmélet

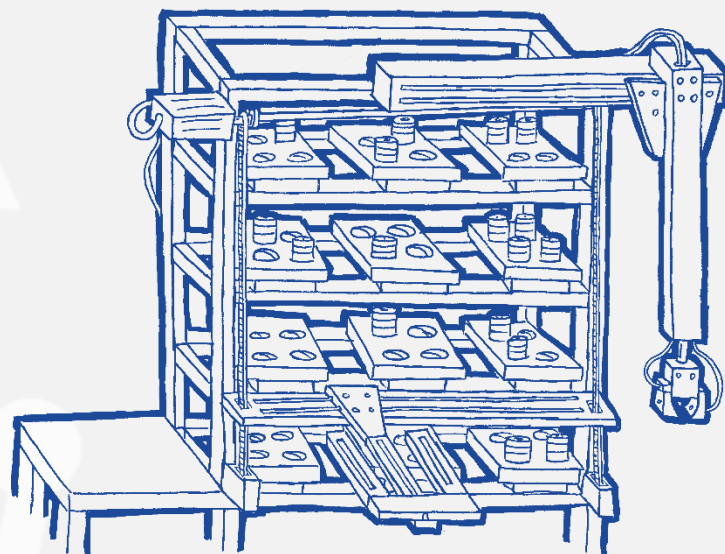


Topológia

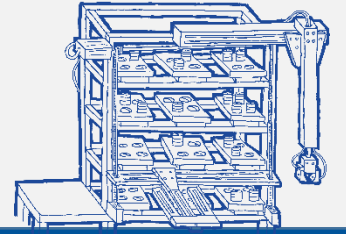


Magasraktár

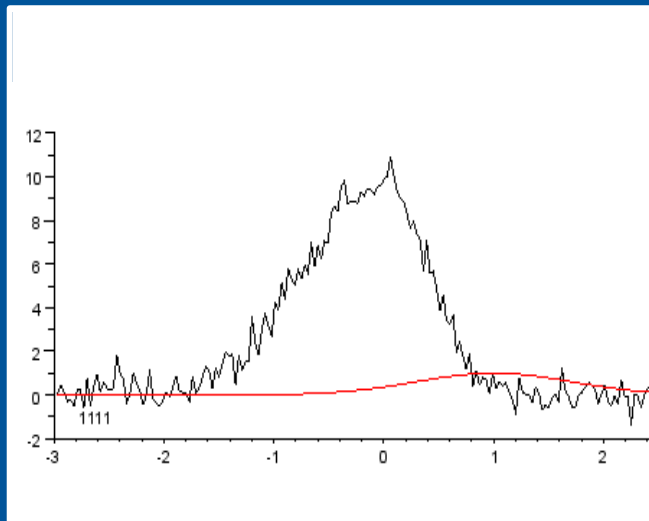
- **Raktározási feladatok**
- Raktárgazdálkodás
- Egyedi azonosítás
- Öndiagnosztika



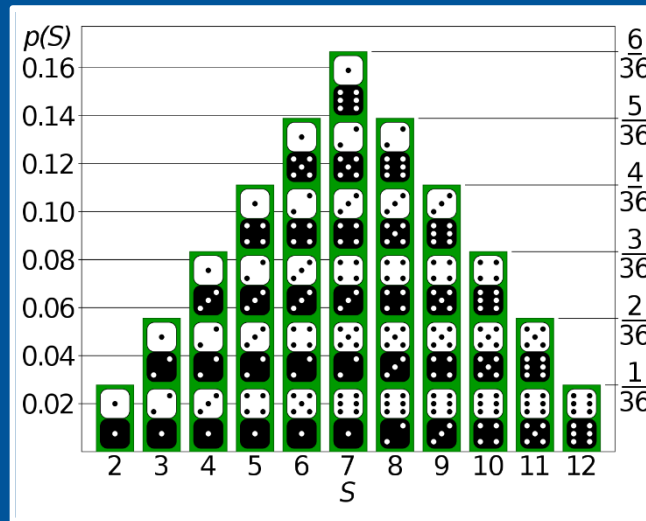
Magasraktár



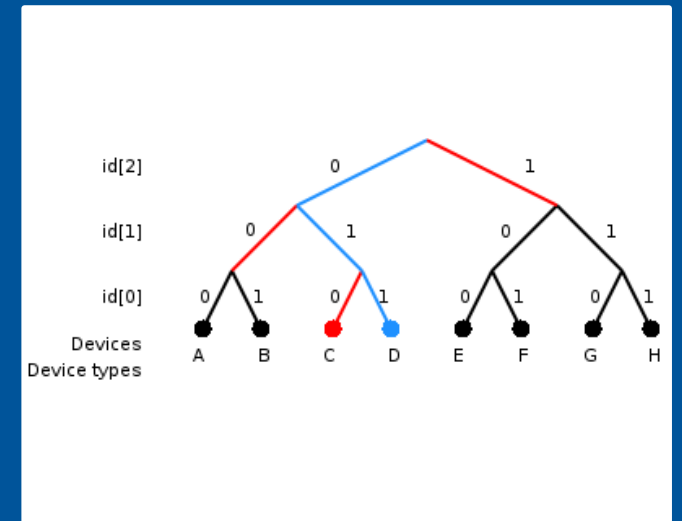
Statisztika



Valószínűség számítás

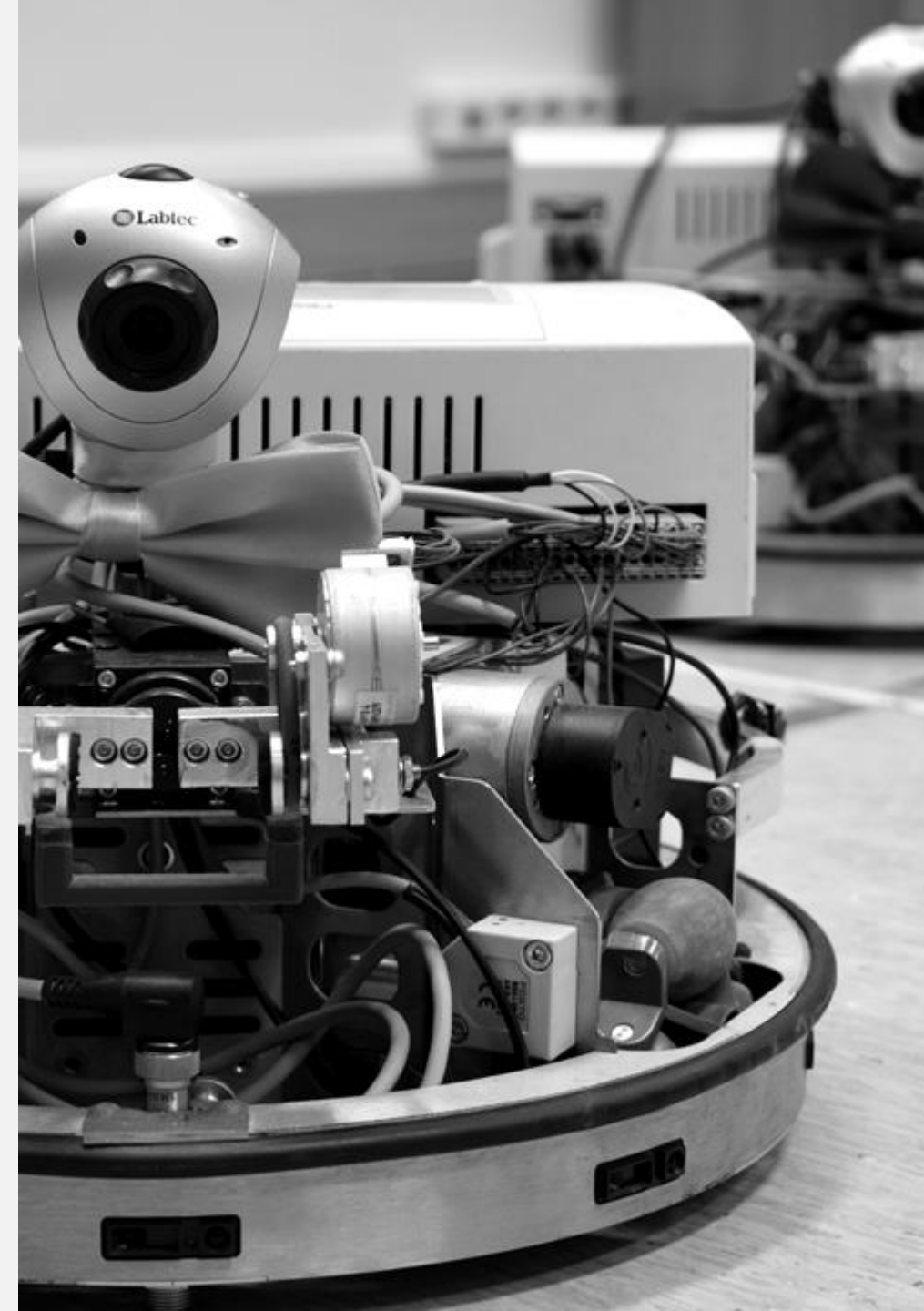
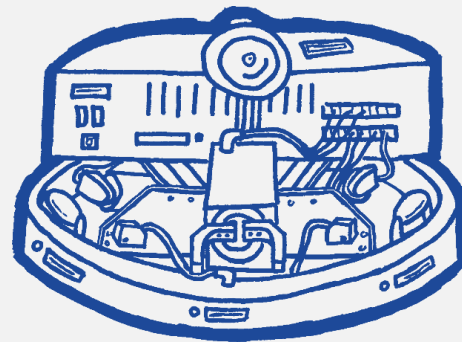


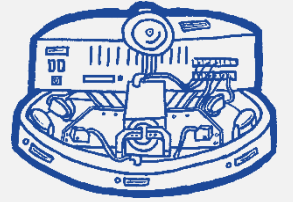
Keresési algoritmusok



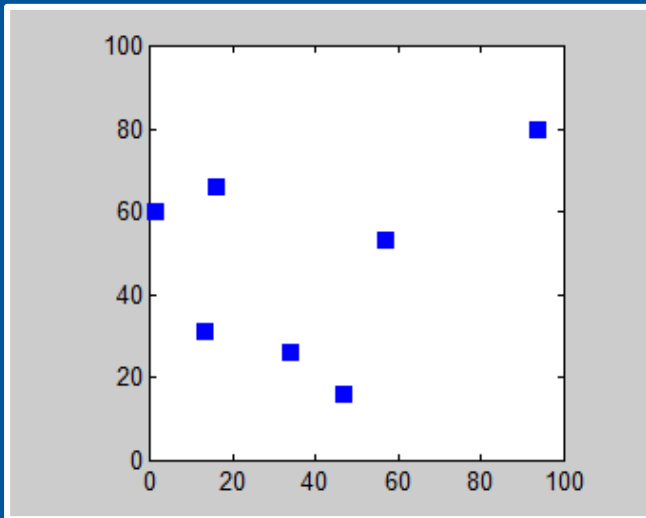
Szállító robotok

- **Anyagmozgatási feladatok**
- Helymeghatározás
- Útvonal tervezés
- Konkurens és kooperatív működés

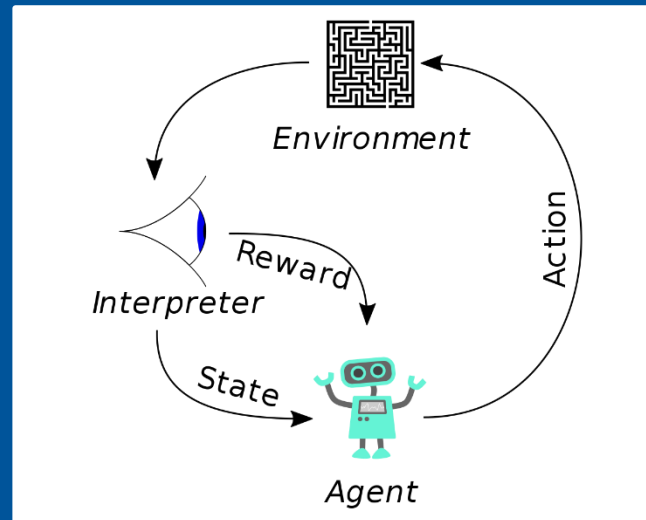




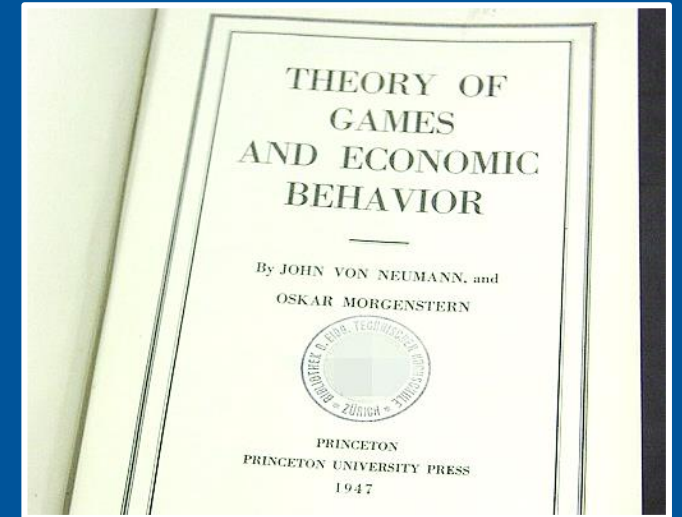
Kombinatorikus optimalizálás



Ágens-alapú modellezés

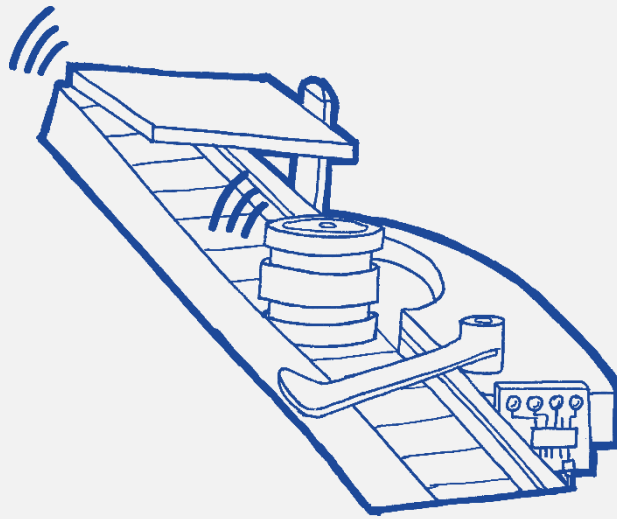


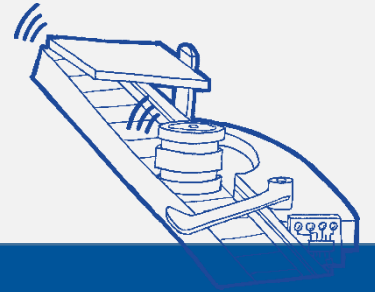
Játékelmélet



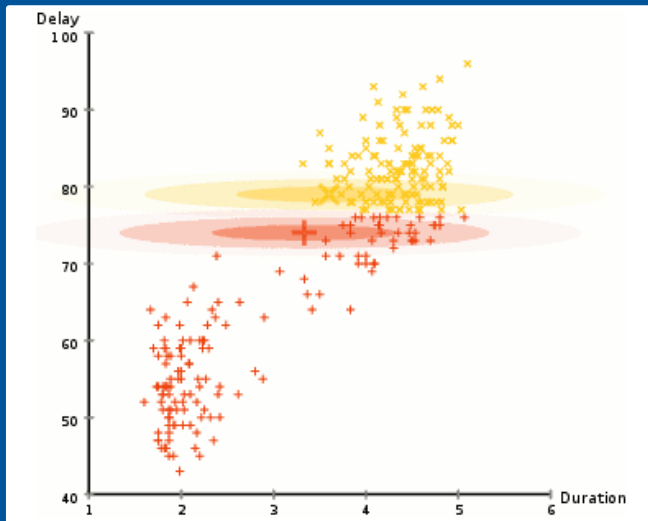
Szállítószalag

- **Szállítási feladatok**
- Blokkolási és torlaszolási problémák
- Sorkiegyenlítés
- Szortírozás

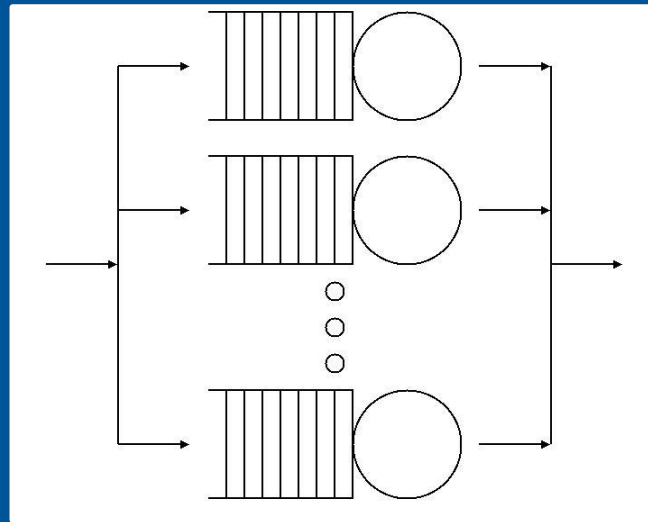




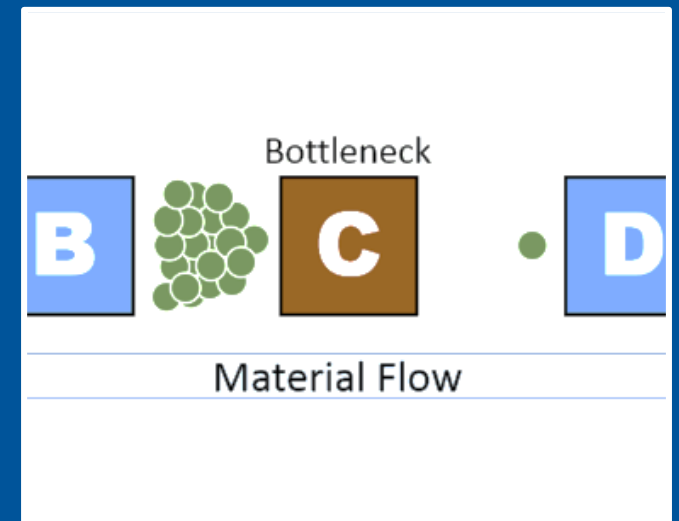
Klasszifikáció



Sorbanállás

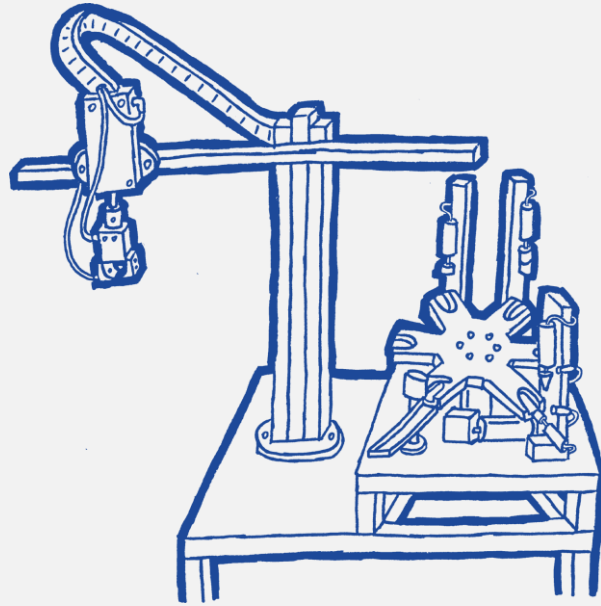


Diszkrét esemény szim.

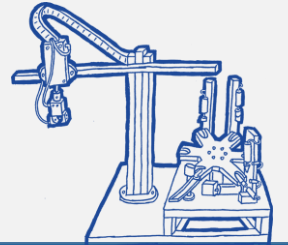


Megmunkálóállomások

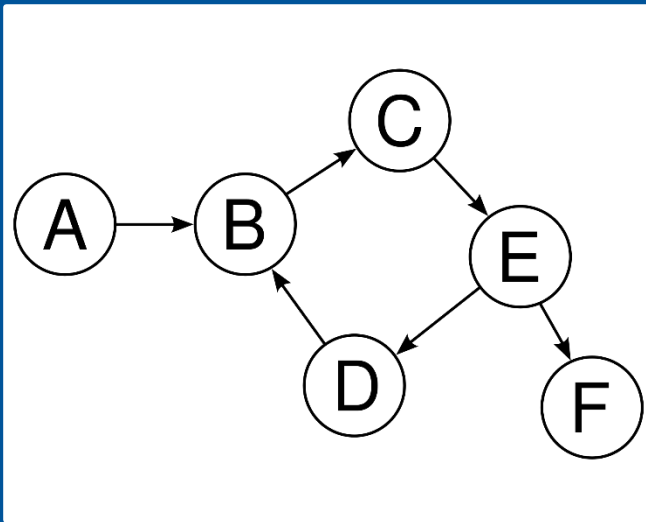
- **Megmunkálási feladatok**
- Folyamatszervezés- és ütemezés
- Hibakezelés
- Minőség ellenőrzés



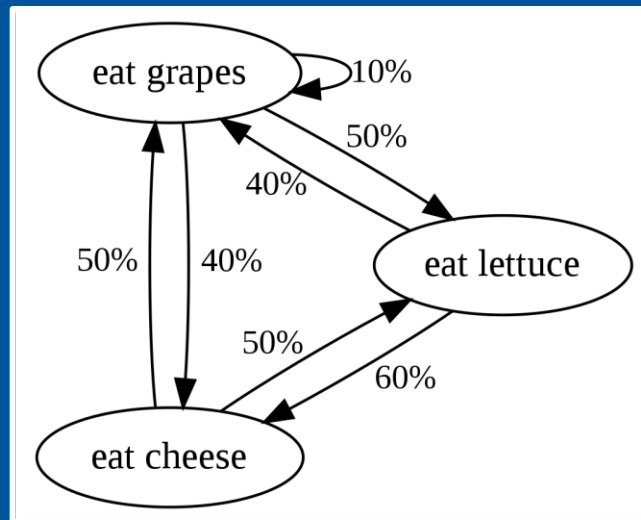
Megmunkálóállomások



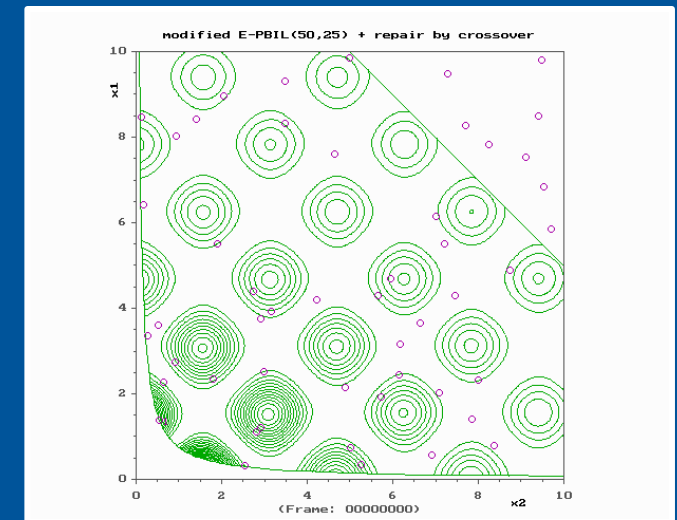
Gráfelmélet



Automataelmélet

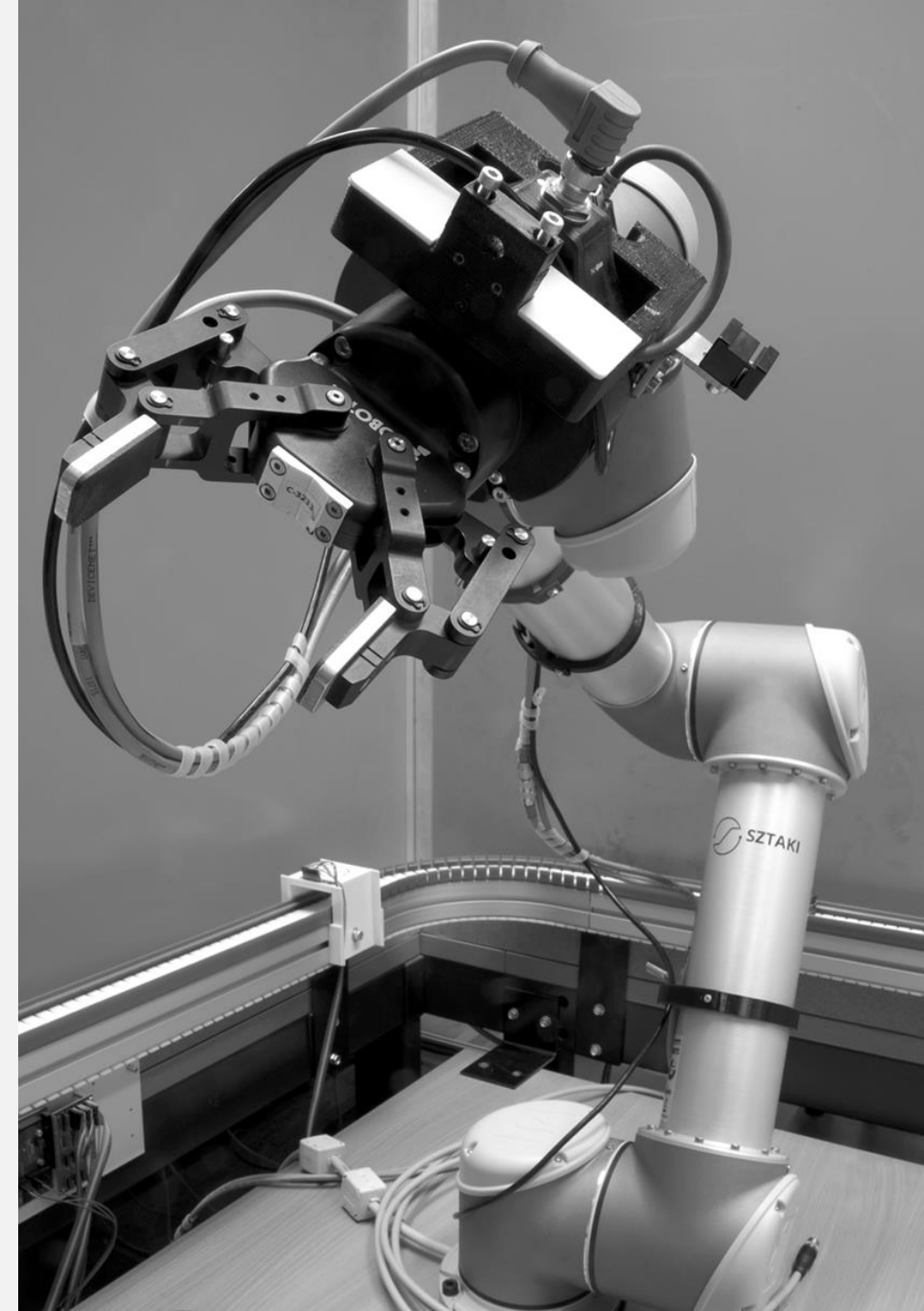
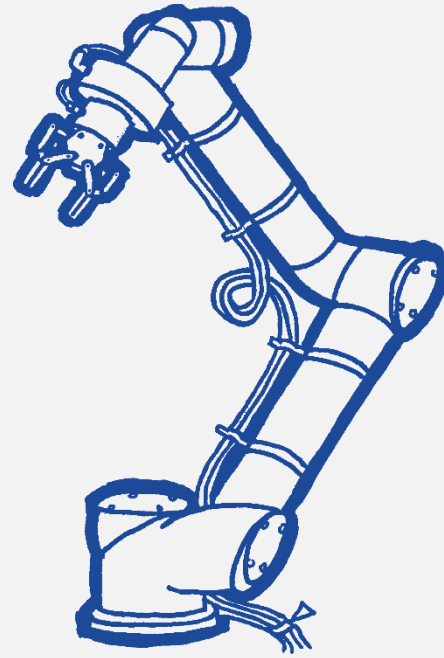


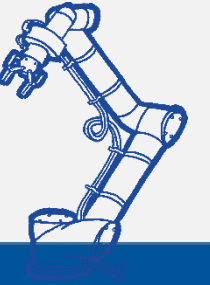
Evolúciós algoritmusok



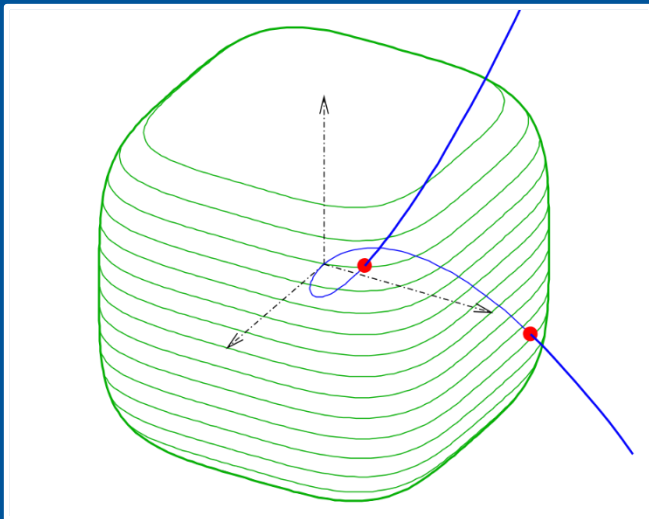
Kollaboratív robotkar

- Szerelési feladatok
- Útvonal tervezés
- Ütközésselkerülés
- Megfogás tervezés erővisszacsatolással

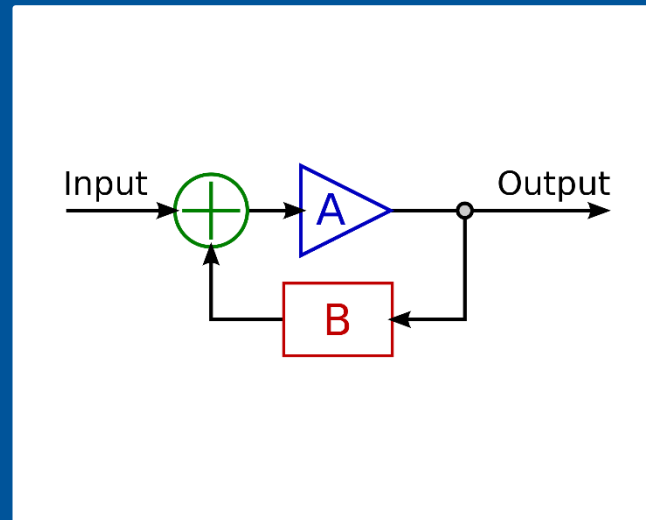




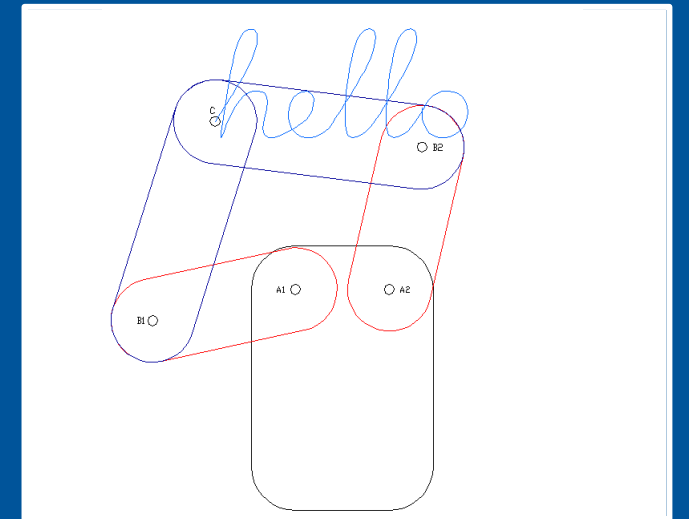
Számítógépes geometria



Szabályozáselmélet

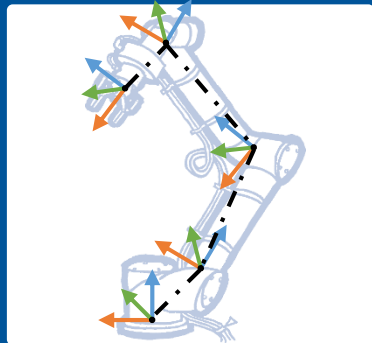
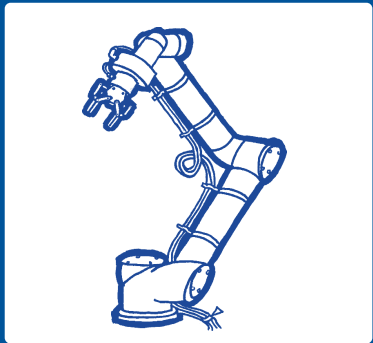


Inverz kinematika



Robotológia

- Matematikus
- Robotológus
- Mérnök



$${}^{n-1}T_n = \text{Trans}_{z_{n-1}}(d_n) \cdot \text{Rot}_{z_{n-1}}(\theta_n) \cdot \text{Trans}_{z_n}(r_n) \cdot \text{Rot}_{z_n}(\alpha_n)$$
$$\text{Rot}_{z_n}(\alpha_n) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \alpha_n & -\sin \alpha_n & 0 \\ 0 & \sin \alpha_n & \cos \alpha_n & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$
$${}^{n-1}T_n = \begin{bmatrix} \cos \theta_n & -\sin \theta_n \cos \alpha_n & \sin \theta_n \sin \alpha_n & r_n \cos \theta_n \\ \sin \theta_n & \cos \theta_n \cos \alpha_n & -\cos \theta_n \sin \alpha_n & r_n \sin \theta_n \\ 0 & \sin \alpha_n & \cos \alpha_n & d_n \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



- ❖ A NURBS surface:
https://en.wikipedia.org/wiki/Non-uniform_rational_B-spline
 - ❖ Union Merger of two objects into one:
https://en.wikipedia.org/wiki/Constructive_solid_geometry
 - ❖ Mug and Torus morph:
<https://en.wikipedia.org/wiki/Topology>

 - ❖ Asymmetrical peak model: https://en.wikipedia.org/wiki/Curve_fitting
 - ❖ The probability mass function:
https://en.wikipedia.org/wiki/Probability_distribution
 - ❖ Binary tree method:
https://en.wikipedia.org/wiki/Radio-frequency_identification

 - ❖ Solution to a symmetric TSP:
https://en.wikipedia.org/wiki/Travelling_salesman_problem
 - ❖ Reinforcement Learning (RL) scenario:
https://en.wikipedia.org/wiki/Reinforcement_learning
 - ❖ A játékelméletet megalapozó egyik mű:
<https://hu.wikipedia.org/wiki/J%C3%A1t%C3%A9kelm%C3%A9let>
- ❖ Queue networks:
https://en.wikipedia.org/wiki/Queueing_theory
 - ❖ EM clustering:
https://en.wikipedia.org/wiki/Expectation%E2%80%93maximization_algorithm
 - ❖ Bottleneck in material flow:
[https://en.wikipedia.org/wiki/Bottleneck_\(production\)](https://en.wikipedia.org/wiki/Bottleneck_(production))

 - ❖ Euclid's algorithm structured blocks: <https://en.wikipedia.org/wiki/Algorithm>
 - ❖ Irányított gráf: <https://hu.wikipedia.org/wiki/Gr%C3%A1felm%C3%A9let>
 - ❖ Keane's function: https://en.wikipedia.org/wiki/Evolutionary_algorithm

 - ❖ Intersection of curve with surface:
[https://en.wikipedia.org/wiki/Intersection_\(Euclidean_geometry\)](https://en.wikipedia.org/wiki/Intersection_(Euclidean_geometry))
 - ❖ A basic feedback loop: https://en.wikipedia.org/wiki/Control_system
 - ❖ Inverse kinematics: https://en.wikipedia.org/wiki/Robot_kinematics

 - ❖ Inverse kinematics matrices:
https://en.wikipedia.org/wiki/Denavit%E2%80%93Hartenberg_parameters

SmartFactory videó





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