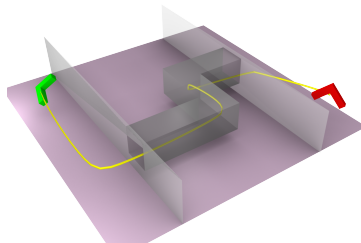
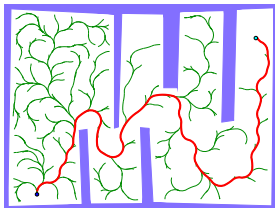
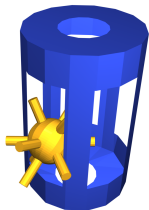


Motion planning: motivation

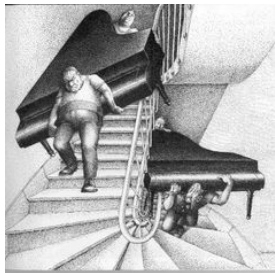
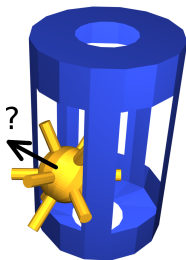
Vojtěch Vonásek

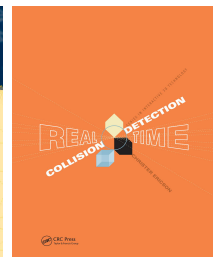
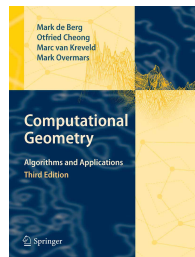
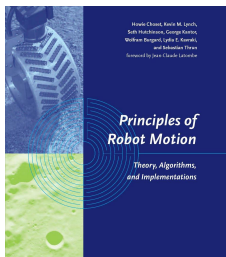
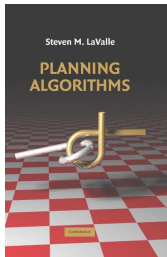
Department of Cybernetics
Faculty of Electrical Engineering
Czech Technical University in Prague



Informal definition: Motion planning is about automatic finding of ways how to move an object (robot) while avoiding obstacles (and considering other constraints).

- Classical problem of robotics
- Also Piano mover's problem
- Relation to other fields
 - Mathematics: graph theory & topology
 - Computational geometry: collision detection
 - Computer graphics: visualizations
 - Control theory: feedback controllers required to navigate along paths
- Motion planning finds application in many practical tasks

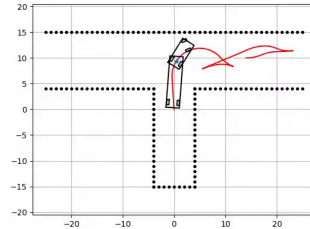




- S. M. LaValle, Planning algorithms, Cambridge, 2006, [online: planning.cs.uiuc.edu](http://online.planning.cs.uiuc.edu)
- H. Choset, K. M. Lynch et al., Principles of Robot Motion: Theory, Algorithms, and Implementations (Intelligent Robotics and Autonomous Agents series), Bradford Book, 2005
- M. de Berg, Computational Geometry: Algorithms and Applications, 1997
- C. Ericson. Real-time collision detection. CRC Press, 2004.

Robotics, automation & automotive industry

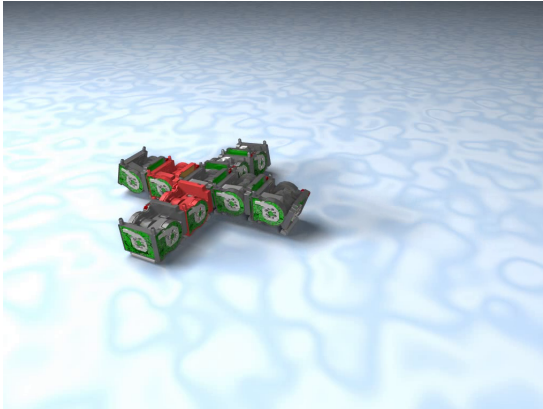
- mobile robots, manipulators, drones, modular robots, underwater, humanoids ...
- autonomous cars, parking assistant



www.youtube.com/watch?v=z8LzkvH64aE

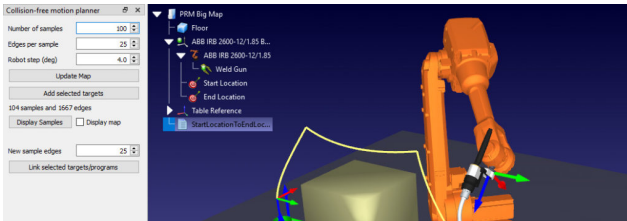
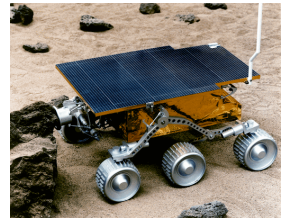
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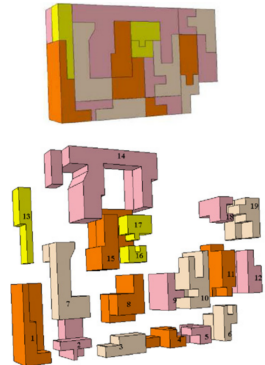
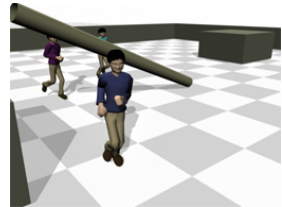
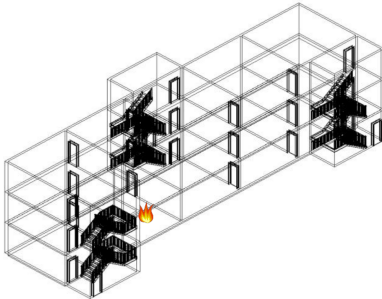
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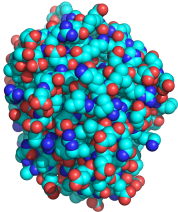
CAD systems & computer games

- (dis)assembly planning, maintainability studies
- evacuation & accessibility simulation
- motions of characters in computer games

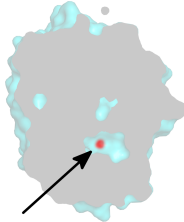


Bioinformatics: protein folding, protein docking

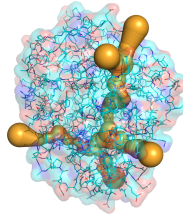
protein



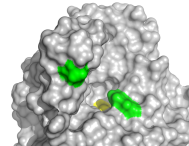
active site



tunnels



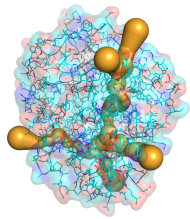
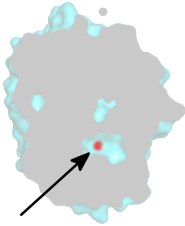
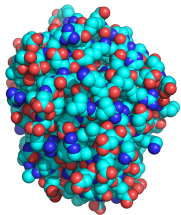
dynamics



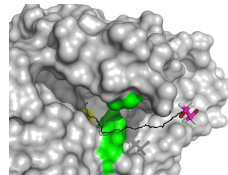
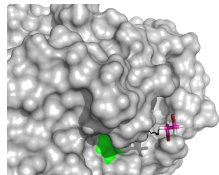
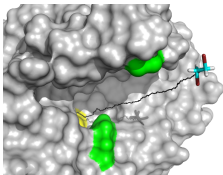
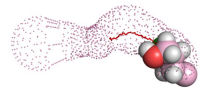
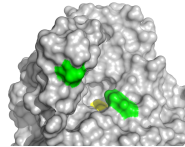
- Docking: can two molecules interact?
 - Existence of a path indicates “promising” candidate
 - Faster than in vitro or Molecular dynamics simulations

Motion planning: applications

Bioinformatics: protein folding, protein docking
protein active site tunnels

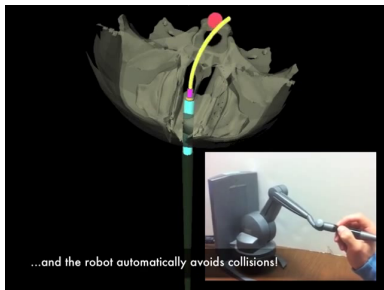


dynamics



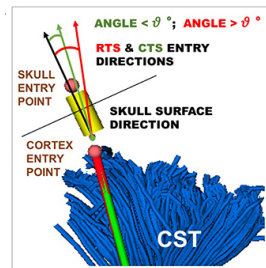
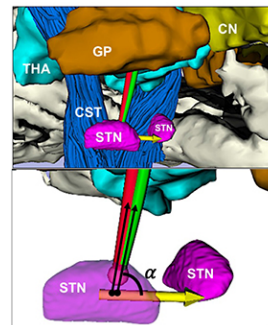
Surgery

- Paths for needles & other tools
- Robotic manipulators



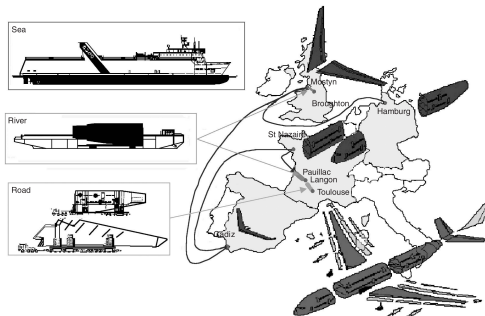
www.youtube.com/watch?v=eSc7OVN1s1c

- A. Kuntz et al. "Motion planning for continuum reconfigurable incisionless surgical parallel robots", IEEE/RSJ IROS, 2017
- A. Segato, V. Pieri et al. "Automated Steerable Path Planning for Deep Brain Stimulation Safeguarding Fiber Tracts and Deep Gray Matter Nuclei"



Large object transportation

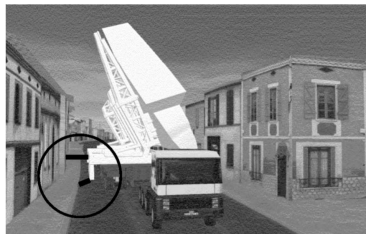
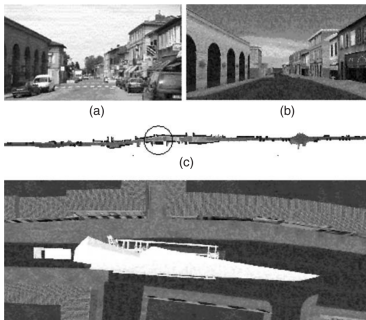
- Components for Airbus airplanes are made in distinct regions
- Transportation of large pieces (e.g. wings) through narrow streets
- Motion planning is used to design and/or verify routes



- Lamiroux, F. et al. "Trailer truck trajectory optimization: the transportation of components for the Airbus A380", IEEE Robotics & Automation Magazine, 12, 2005
- VanGeem, C., and C. A. M. Kineo. "Trailer-truck trajectory optimization for Airbus A380 component transportation."

Large object transportation

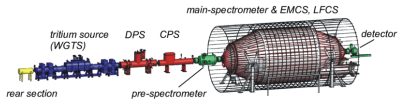
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Large object transportation: KATRIN neutrino detector, KIT, Karlsruhe

- The core was constructed in Deggendorf (~ 400 km from KIT)
- Transport around Europe (~ 8600 km)



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www.youtube.com/watch?v=ODu3GVpqD1M