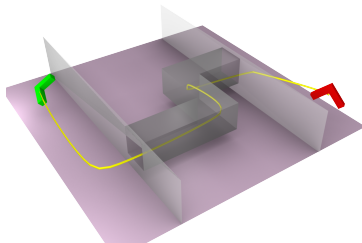
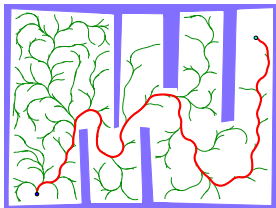


# Motion planning: motivation

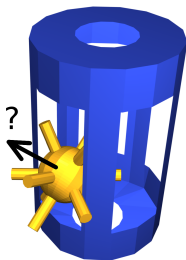
**Vojtěch Vonásek**

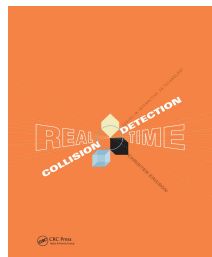
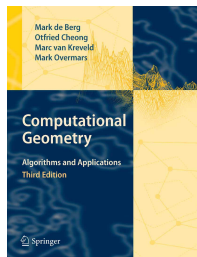
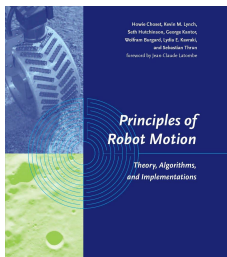
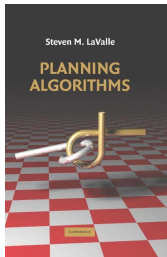
Department of Cybernetics  
Faculty of Electrical Engineering  
Czech Technical University in Prague



**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

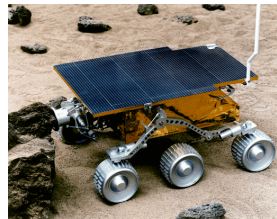




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- H. Choset, K. M. Lynch et al., Principles of Robot Motion: Theory, Algorithms, and Implementations (Intelligent Robotics and Autonomous Agents series), Bradford Book, 2005
- M. de Berg, Computational Geometry: Algorithms and Applications, 1997
- C. Ericson. Real-time collision detection. CRC Press, 2004.

## Robotics, automation & automotive industry

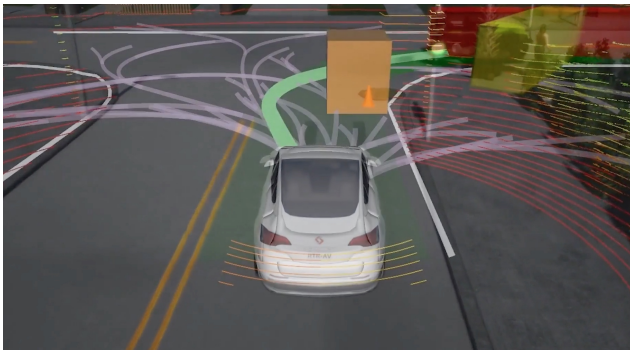
- mobile robots, manipulators, drones, modular robots, underwater, humanoids ...
- autonomous cars, parking assistant





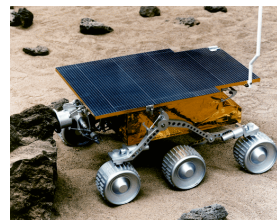
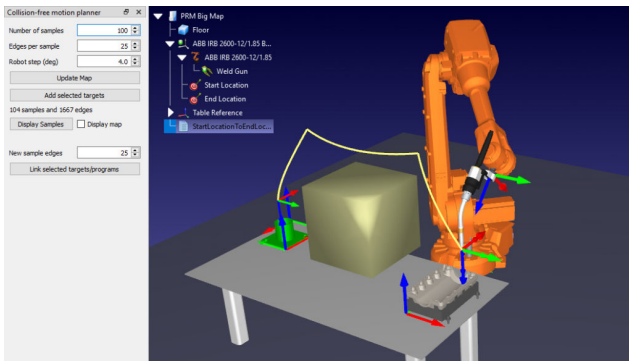
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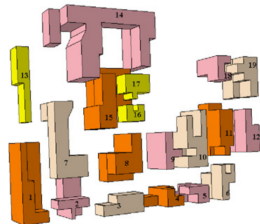
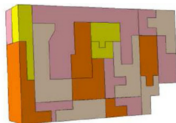
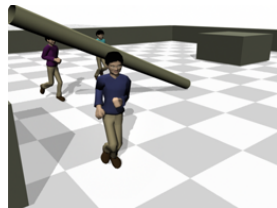
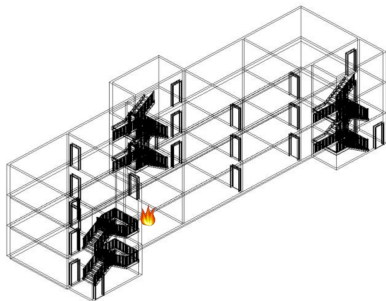
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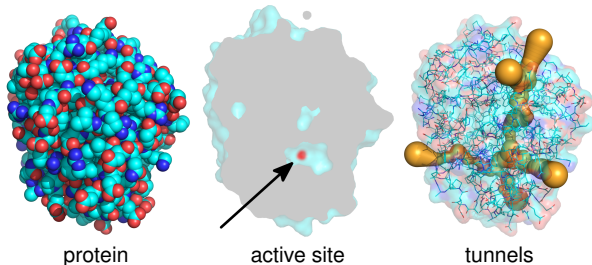
## CAD systems & computer games

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



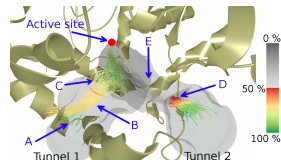
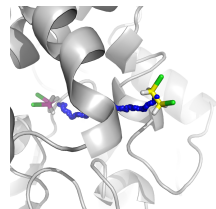
## Bioinformatics

- protein folding
- analysis of protein tunnels



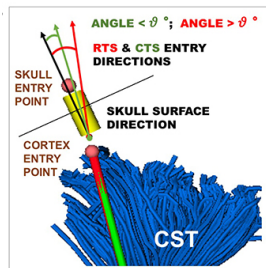
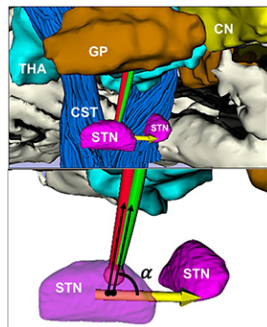
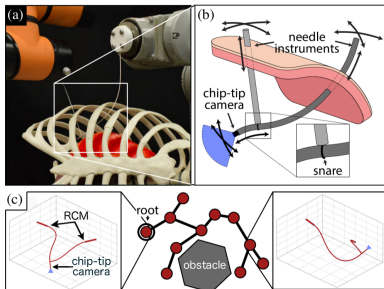
Can a ligand reach the active site?

- Existence of a path indicates “promising” candidate
- Faster than in vitro or Molecular dynamics simulations



## Surgery

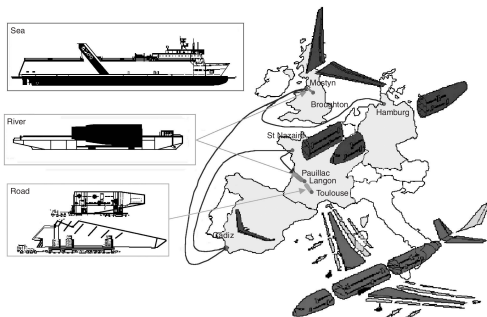
- Paths for needles & other tools
- Robotic manipulators



• A. Kuntz et al. "Motion planning for continuum reconfigurable incisionless surgical parallel robots", IEEE/RSJ IROS, 2017

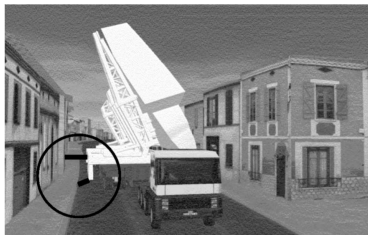
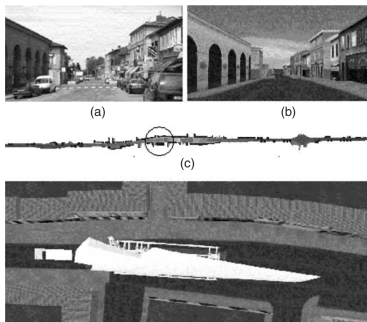
• A. Segato, V. Pieri et al. "Automated Steerable Path Planning for Deep Brain Stimulation Safeguarding Fiber Tracts and Deep Gray Matter Nuclei"

- 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



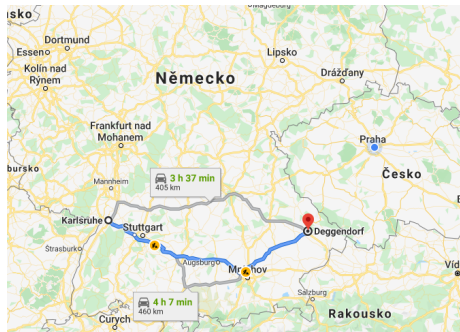
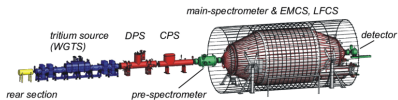
- Lamiroux, F. et al. "Trailer truck trajectory optimization: the transportation of components for the Airbus A380", IEEE Robotics & Automation Magazine, 12, 2005
- VanGeem, C., and C. A. M. Kineo. "Trailer-truck trajectory optimization for Airbus A380 component transportation."

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- The core was constructed in Deggendorf (~ 400 km from KIT)





- KATRIN — neutrino detector in Karlsruhe Institute of Technology, Karlsruhe, Germany
- The core was constructed in Deggendorf ( $\sim 400$  km from KIT)
- Transport around Europe ( $\sim 8600$  km)

