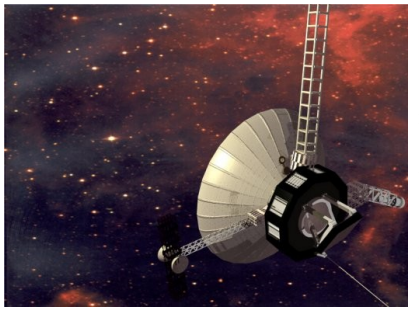
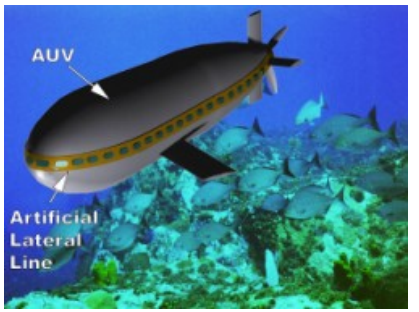
Machine Learning in Robotics

Robots in use

- Today Robots are used
  - Mainly in telematic use for
    - Open space exploration (Probes Voyager)
    - Industrial production (Automobile industry)
    - Under water work (e.g. Deep-Water-Oil-Crisis)
    - Reconnaissance, monitoring hostile places and (killing) people (it's a shame for all people who invested their life creating robots for peaceful use)
  - Rarely in autonomous use (requires machine Learning)
    - Autonomous vacuum cleaner (Staubsauger)



Voyager, 1977, Nasa



news.uiuc.edu/WebsandThumbs/Liu, Chang_and_Jones,Doug/sub_1_b.jpg

csmonitor.com/var/ezflow_site/

Irobot, Roomba

Robocup

- Was introduced after the first challenge – create a program that can win in chess - was passed
- New challenge: beat the worldchampionship masters with a robotic team
  - In comparison to chess
    - No precisely defined states and operations
    - No two situations are exactly identical [Pfeifer, Scheier 99]
  - Is aimed to be solved until 2050

Robocup Leagues

- Small-Size
- Mid-Size
- AIBO
- Humanoid
- Rescue
- Dance
- Simulation

http://www.robocup-us.org/Old/robocup-2007/images/soccermidsize.jpg

http://cdn.physorg.com/newman/gfx/news/hires/3281__0018.jpg

robocup-us.org/Old/robocup-2007/images/humanoid.jpg

http://124.146.198.189/Press/Seattle/junior_dance.jpg

robocup-us.org/Old/robocup-2007/images/fourlegged.jpg

http://www.cs.cmu.edu/~robosoccer/image-gallery/small/ssl_game.jpg

Equipment

- Omnivision
- Omniwheels
- Laser Scanner
- Bumper
- Gyroscopes
- LCD-Camera

Ultrasonic Sensor http://shop.nxt-roboter.de/

http://www.educatec.ch/thenews/ RFID sensor

http://shop.educatec.ch/images/colorsensorw1.jpg Color Sensor

http://www.nubot.com.cn/image/2512.jpg

http://blog-imgs-27.fc2.com/n/9/a/n9a/OMNIvision.jpg

http://www.aisbit.de/robocup/images/hardware/img5.jpg

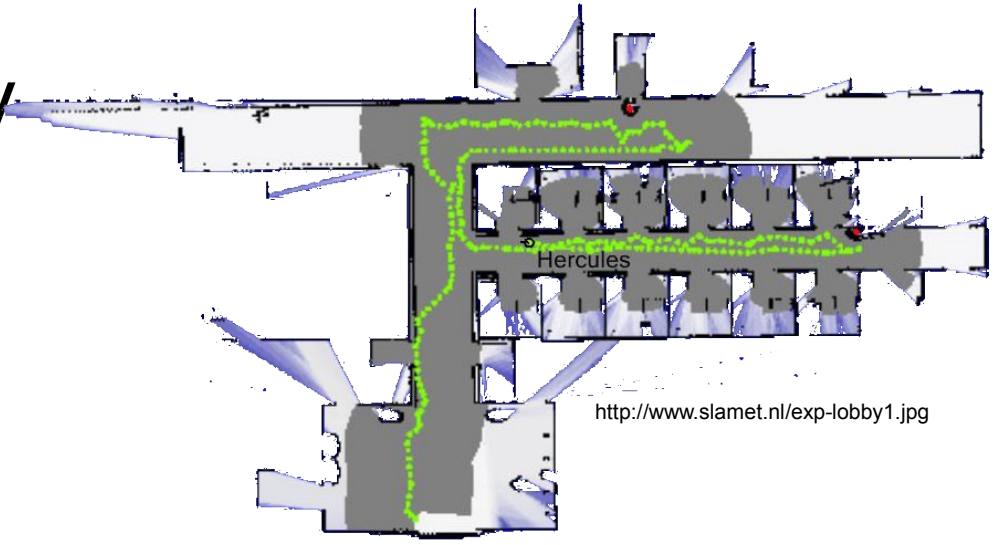
http://www.dlr.de/jobs/en/Portaldata/47/Resources//sick.jpg

Robotics for your home

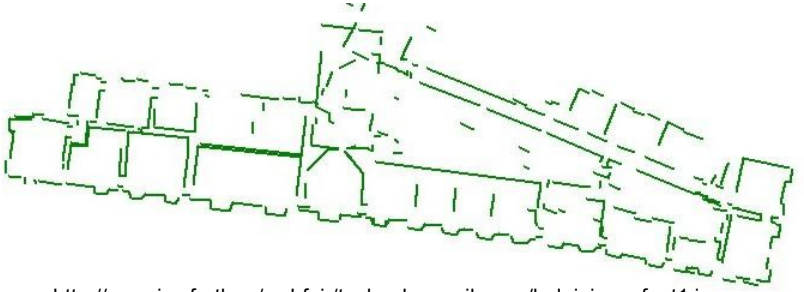
- AIBO (discontinued)
  - 18 motors, 3 per leg
  - Two stero microphones
  - Two heat sensors
  - Infra-red finder
  - 4 accelaration sensors
- QRIO
  - Stereo vision
  - Speech and face recognition
  - 5 finger manipulators, walking biped

Localization using Odometry

- Determine the robots position without knowing it
- Use sensoric inputs from wheels
  - From revolution of two wheels the distance can be measured
- Increasing uncertainty
  - Because of schlupf
  - Friction
  - noise
- Must be “guided” using other sensor-readings or domain knowledge

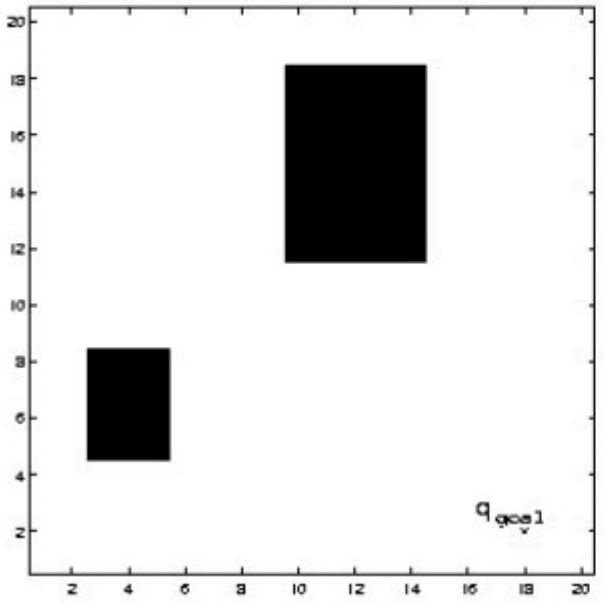


http://www.slamet.nl/exp-lobby1.jpg

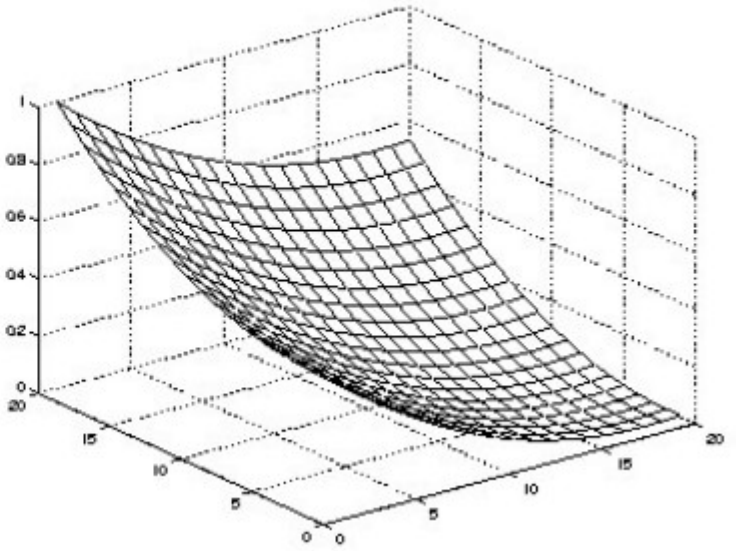


http://www.ics.forth.gr/webfair/technology_eikones/belgioioso_feat1.jpg

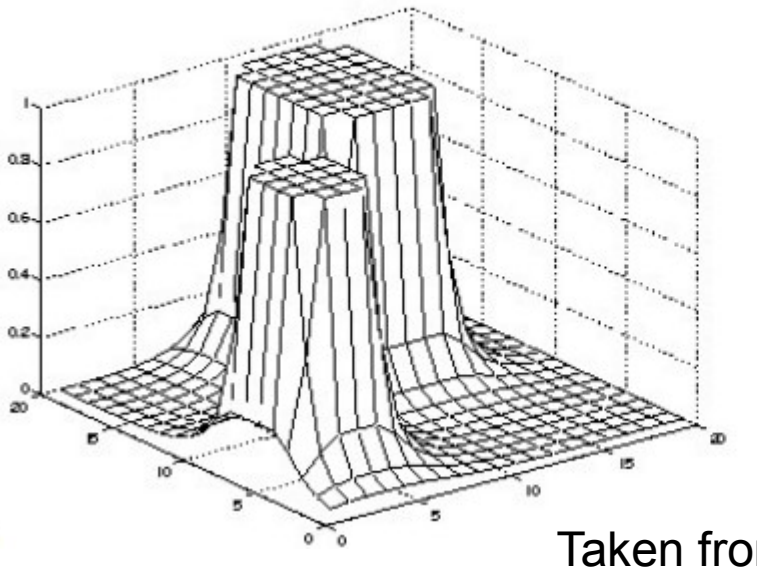
Obstacle Avoidance

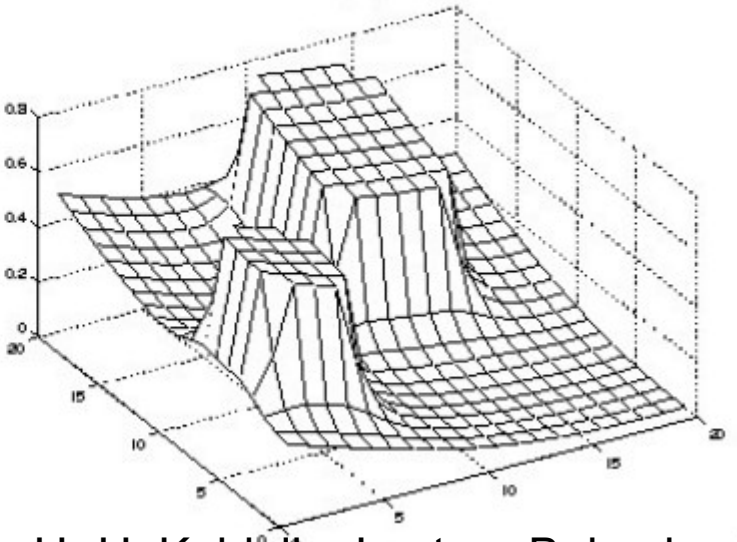


(a)



(b)

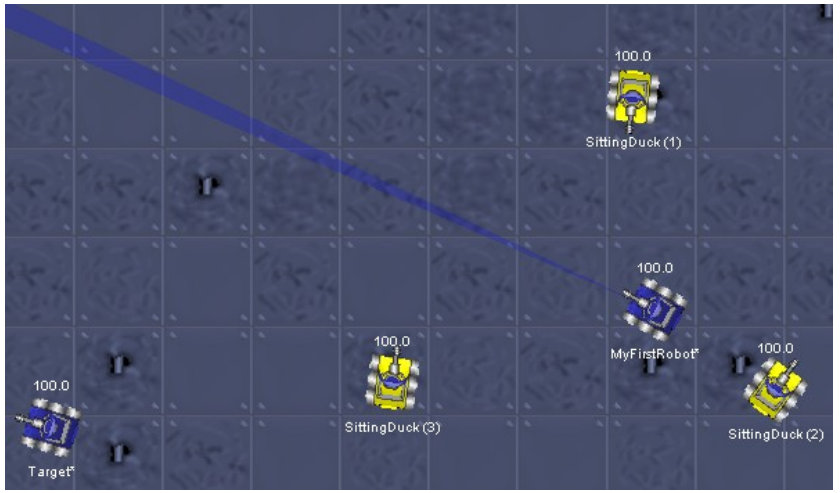




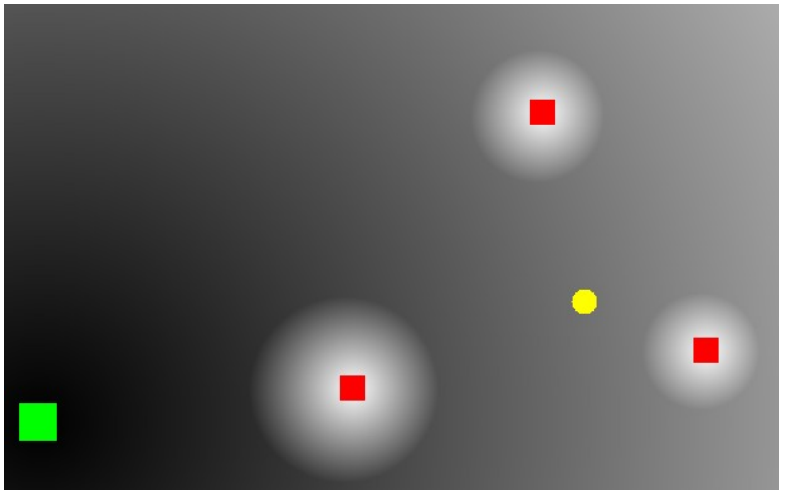
Taken from H.-U. Kobialka Lecture Behavior, 2002

Navigation and Potential fields

- Navigation exploting Robocode
  - Sensing and Knowledge about environment
  - Navigation Map building



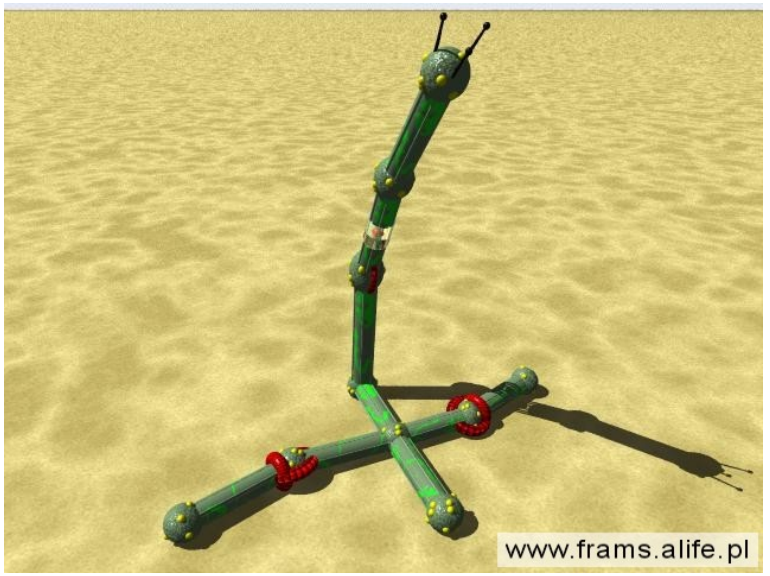
Robocode “Test”-Area

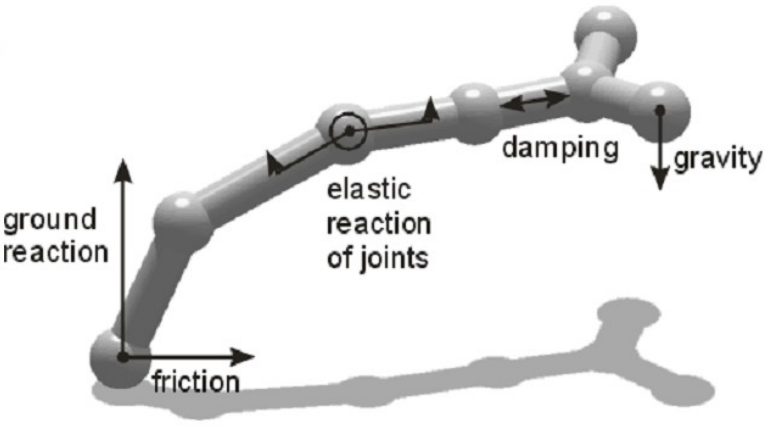


Potential Field with Obstacles and Target

Artificial Life

- FrameStikcs
  - mechanical struc-tures (bodies) and control systems (brains) of crea-tures are modeled
    - Are discribed by genotype (/*4*/CLL,aiLLRMc<f<rX>#MIF>X>,iRRLFmLc<c<sss<<X>N>L<X#2>><XwLw>FLLIL<XM>srXw>XrE>LAiXCw)
  - Development by means of evolution

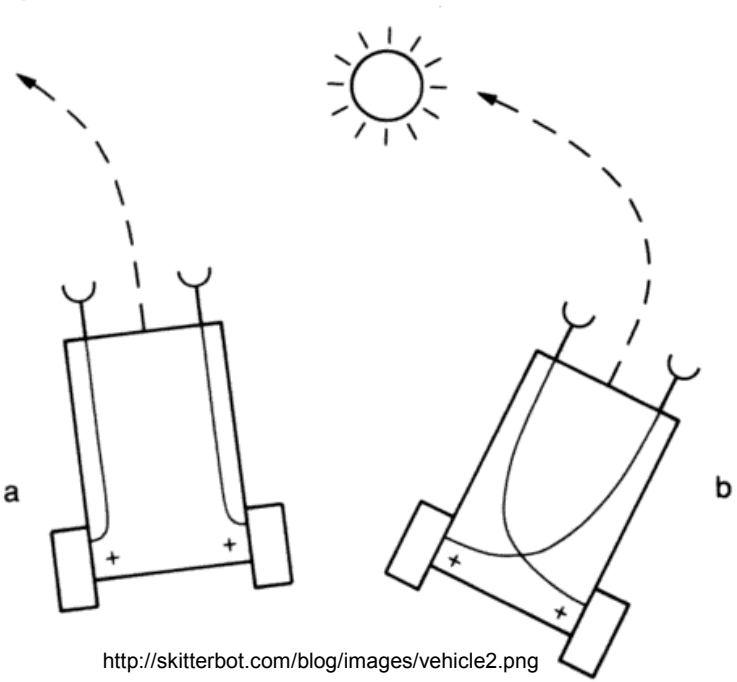




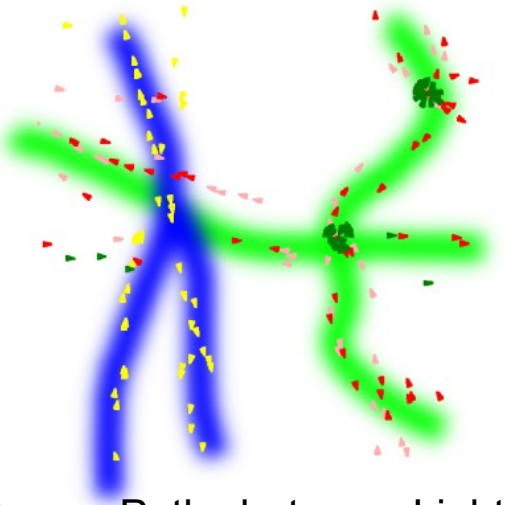
Framsticks Manual

Braitenberg vehicles

- Very simple rules create“intelligent” behavior
- Behavior without needing a model
  - No creature uses a model for defining actions
  - Creates actions directly from observed environment
- BraitenbergSim.jar from the material section



http://skitterbot.com/blog/images/vehicle2.png



Swarm Paths between Light2