

Autonomous and Mobile Robotics

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Wheeled Mobile Robots

Mechanics of Mobile Robots

DIPARTIMENTO DI INGEGNERIA INFORMATICA
AUTOMATICA E GESTIONALE ANTONIO RUBERTI



SAPIENZA
UNIVERSITÀ DI ROMA

outline of this lecture

- ground locomotion
- balance
- wheels
- kinematic structures

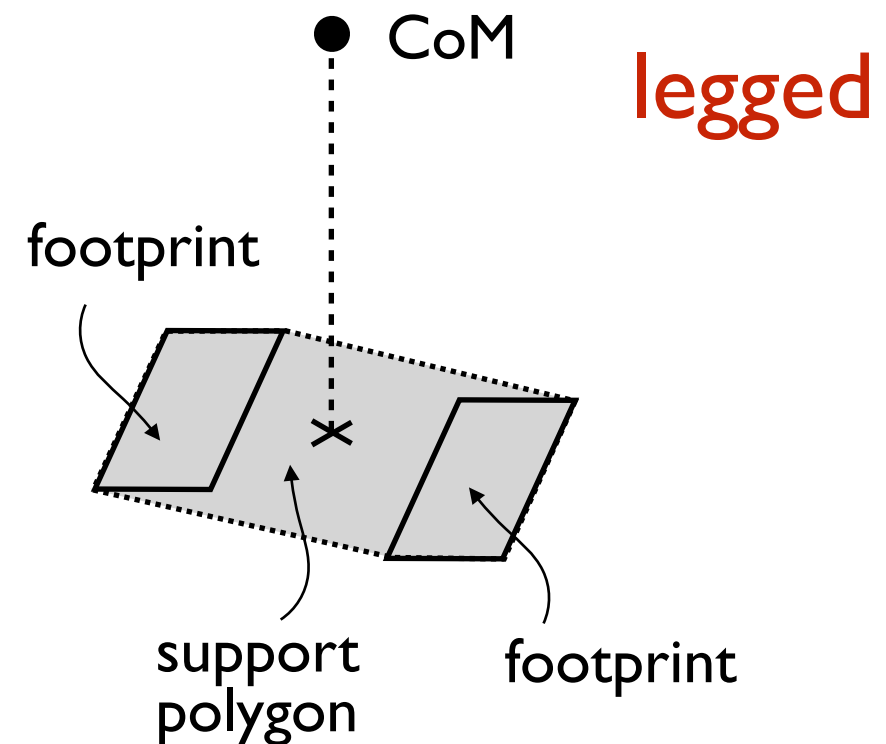
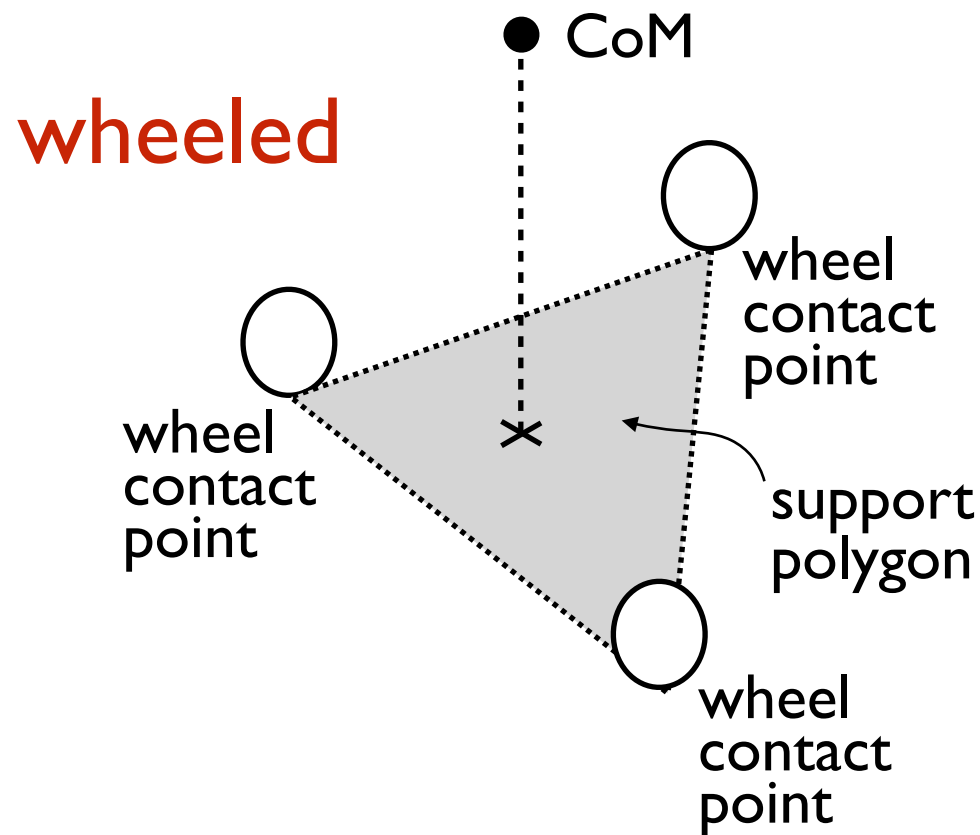
ground locomotion

- requires **contact** via
 - **wheels: wheeled mobile robots (WMRs)**, typically consisting of a rigid body (base or chassis) + wheels
 - **feet: legged robots**, typically consisting of several rigid bodies, articulated through joints
- some mobile robots can achieve locomotion on the ground without wheels or feet: e.g., snake robots



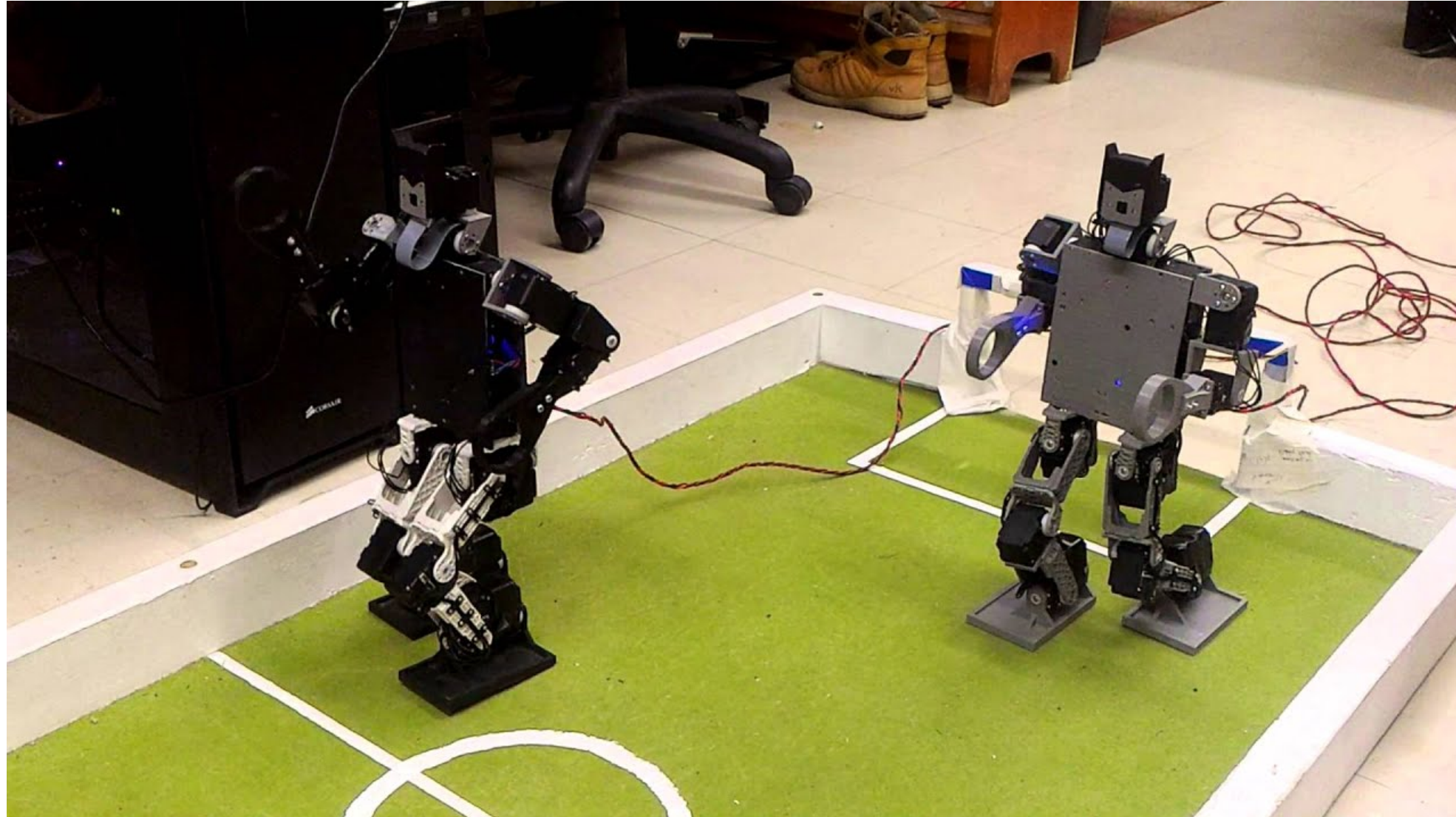
balance (not falling)

- **statical balance** is achieved when the projection of the robot Center of Mass (CoM) falls inside the **support polygon**; in the case of WMRs, one needs 3 wheels!



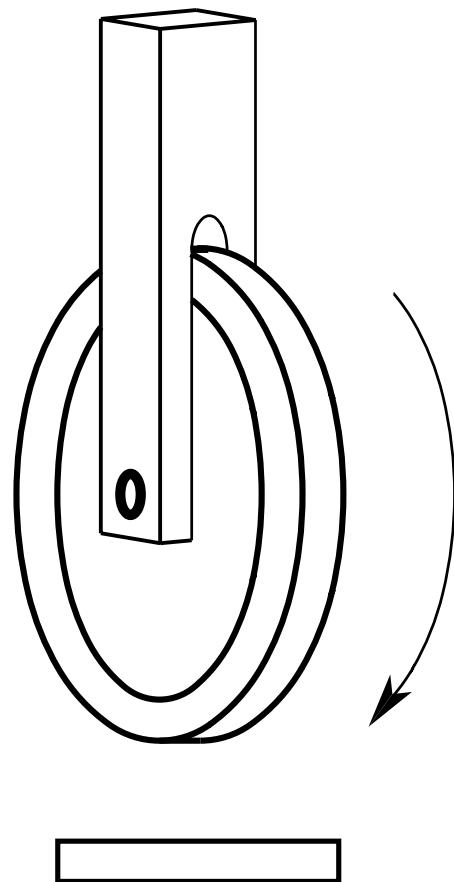
- **dynamical balance** is a different type of balance in which the CoM is replaced by the Zero Moment Point (ZMP)

balance (not falling)



dynamic walking vs static walking

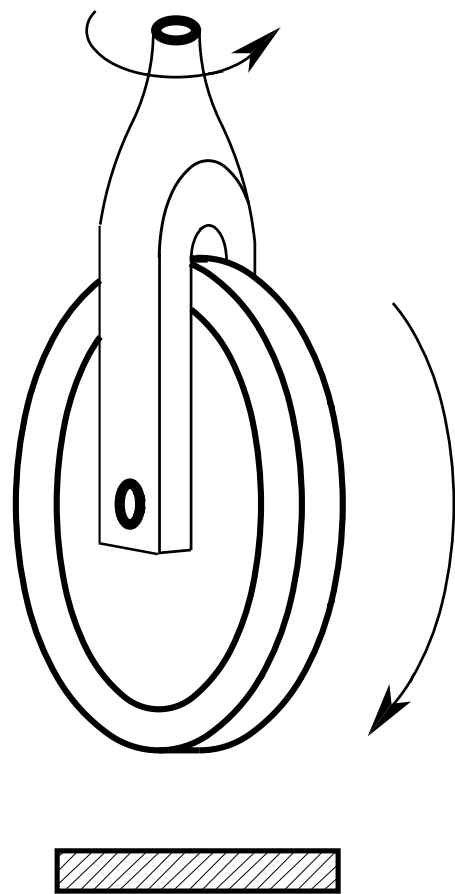
wheels: 3 basic types



fixed wheel

- **fixed orientation** w.r.t. the chassis
- may be **active** (used for driving) or **passive** (used for balance)

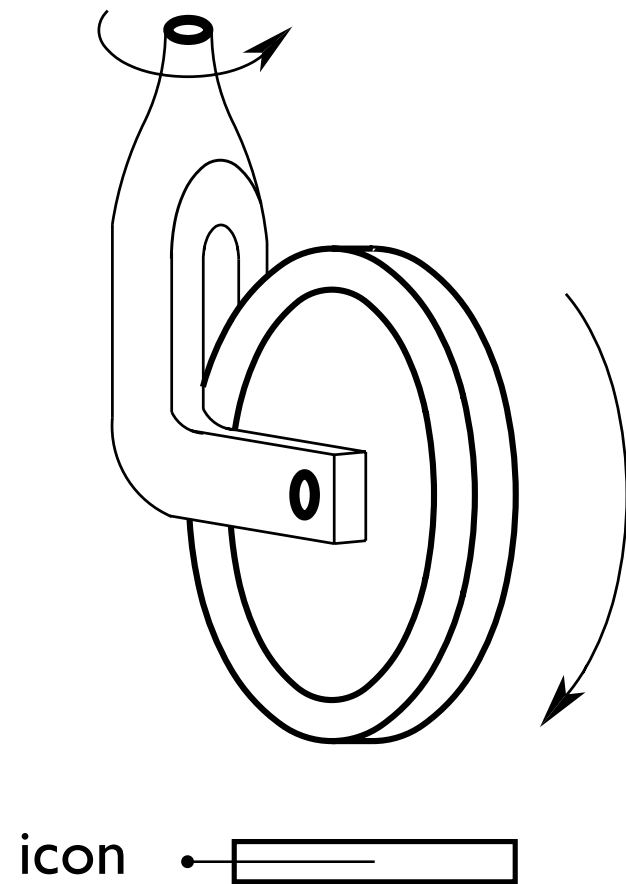
wheels: 3 basic types



orientable (steerable) wheel

- variable orientation w.r.t. the chassis
- typically active (used for steering)

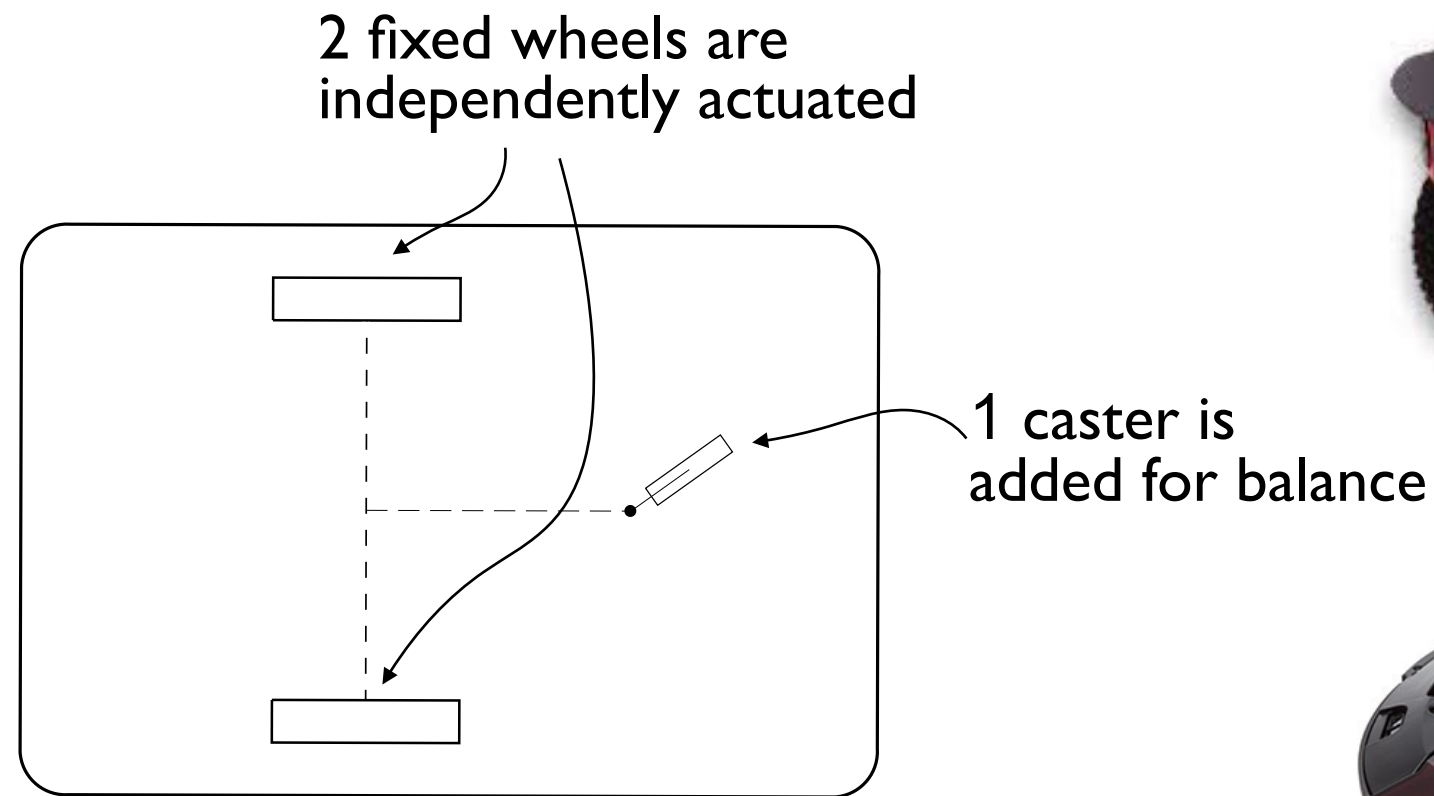
wheels: 3 basic types



caster wheel

- **variable orientation** w.r.t. the chassis
- **automatically aligns** with the direction of motion
- typically **passive** (used for balance)

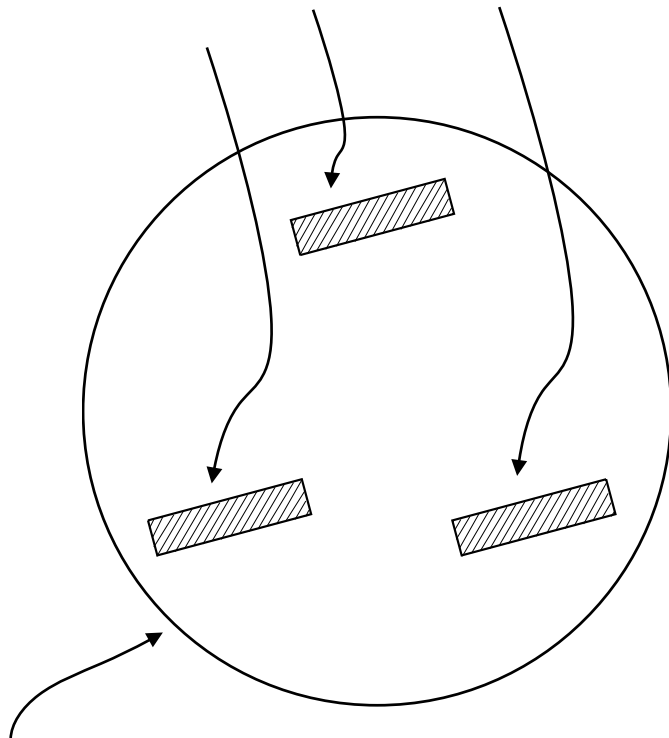
kinematic structures



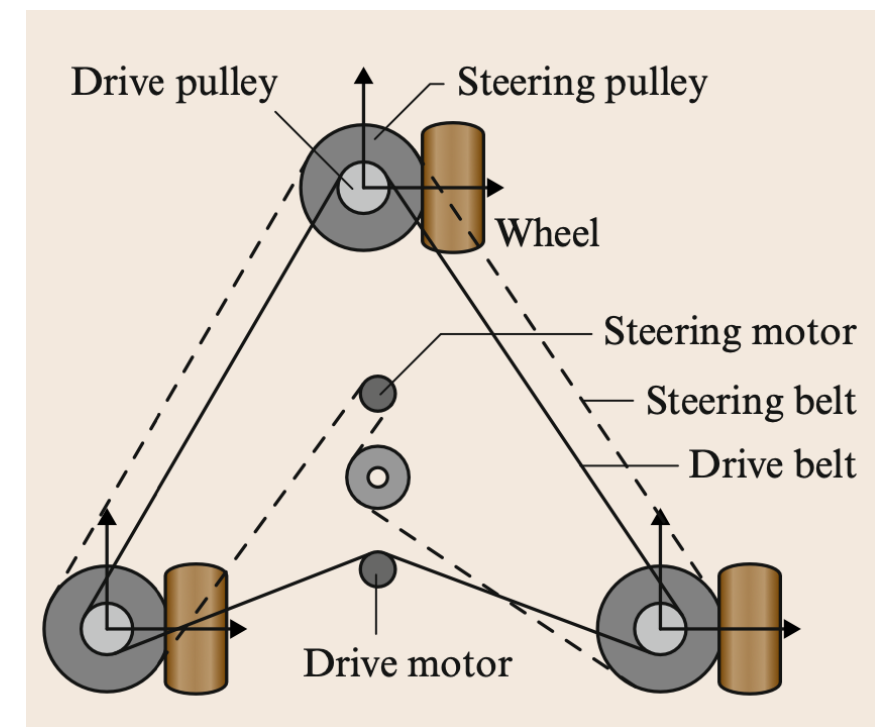
differential-drive mobile robot

kinematic structures

3 orientable wheels are simultaneously actuated



the orientation of the chassis remains constant!

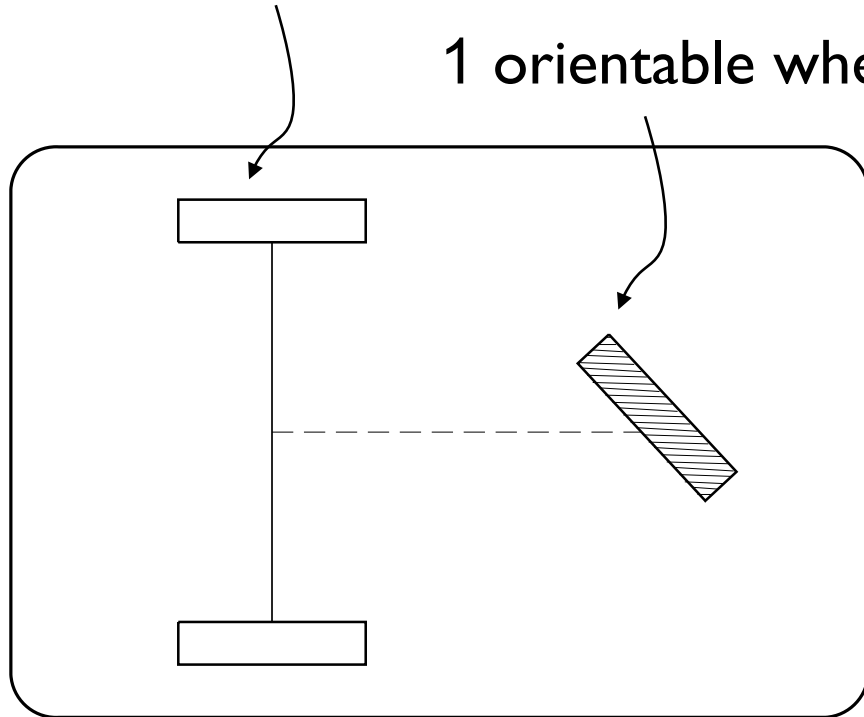


synchro-drive mobile robot

kinematic structures

2 fixed wheels
on a common axle

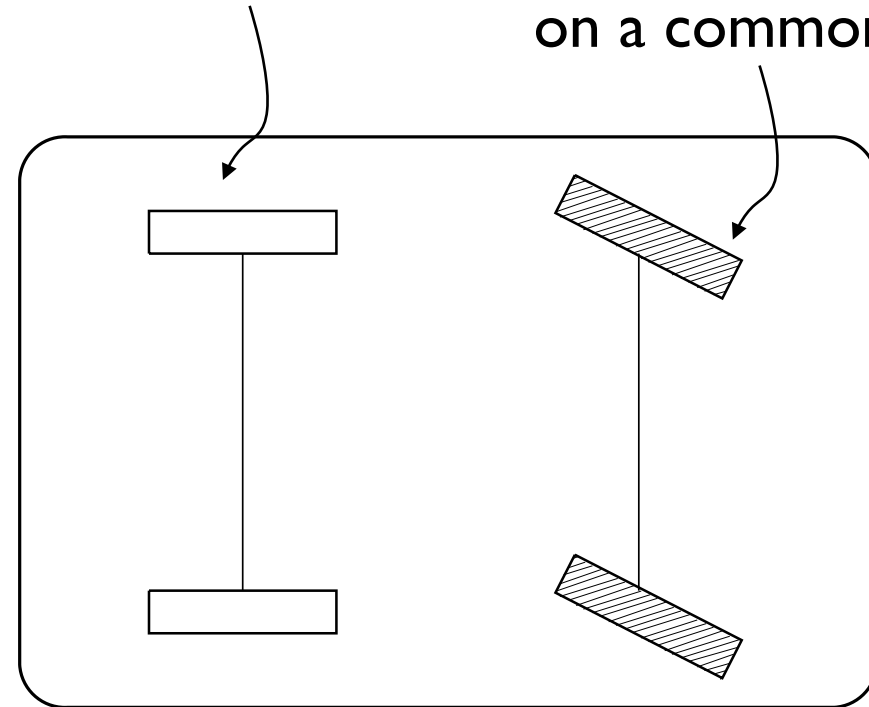
1 orientable wheel



tricycle

2 fixed wheels
on a common axle

2 orientable wheels
on a common axle

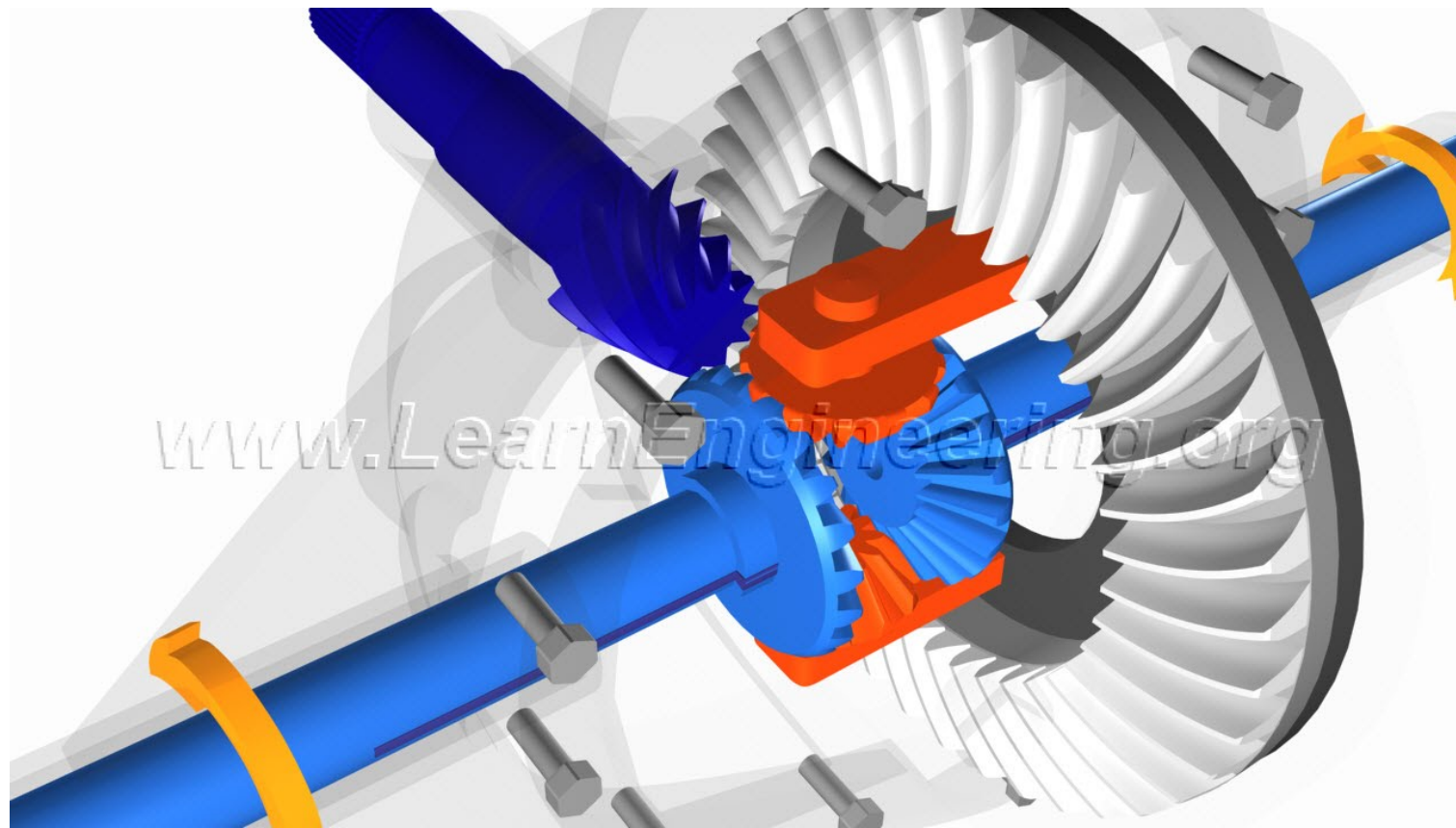


car-like

- both may be front-wheel drive or rear-wheel drive!

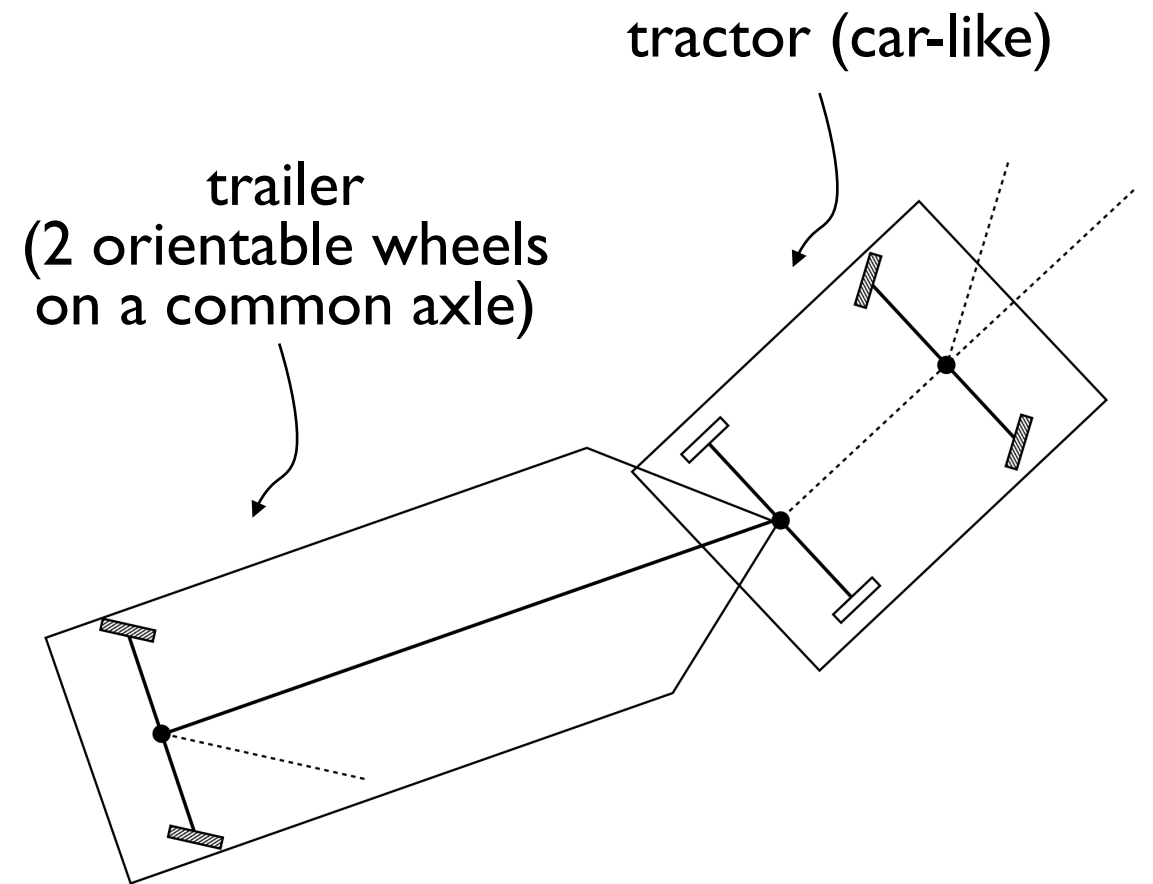
differential

- needed whenever two **driving** wheels are mounted on a **common axle**
- a mechanical device that allows the two wheels to move at **different speeds**



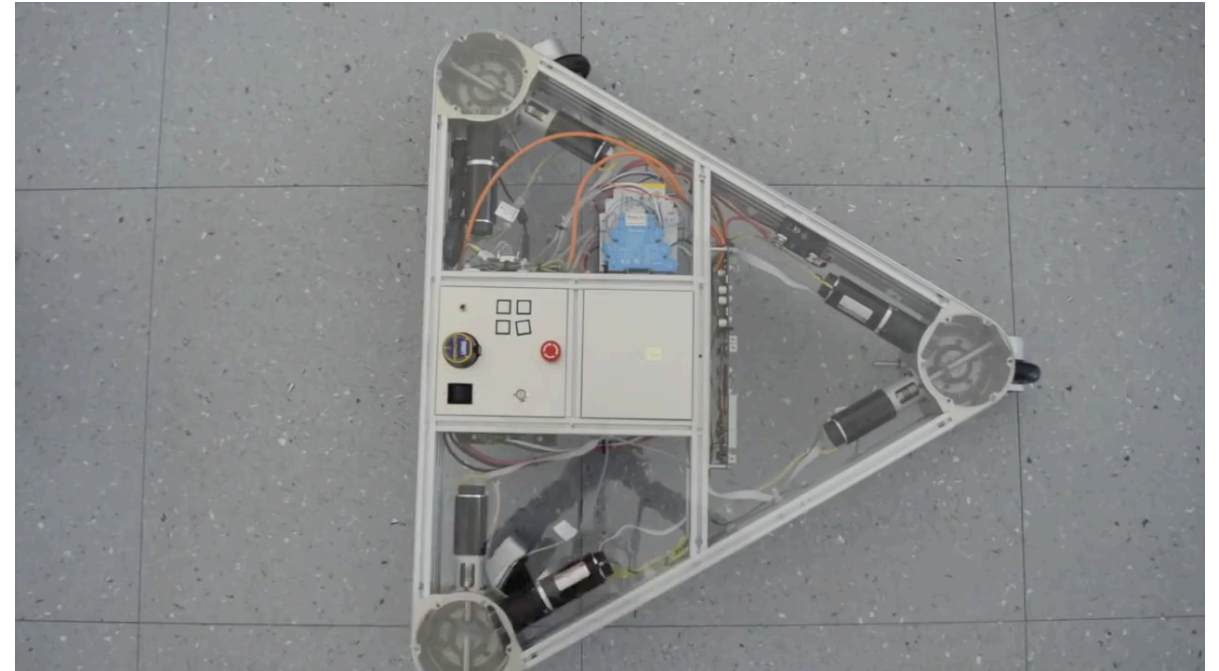
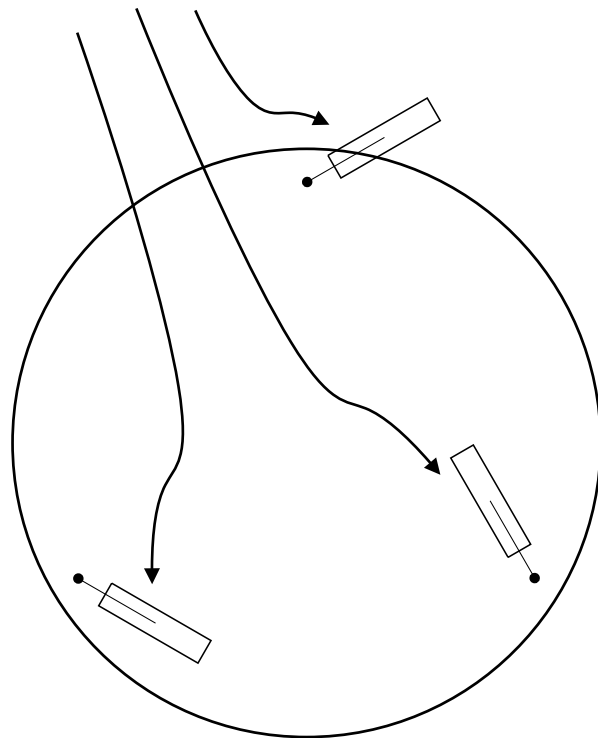
kinematic structures

firetruck



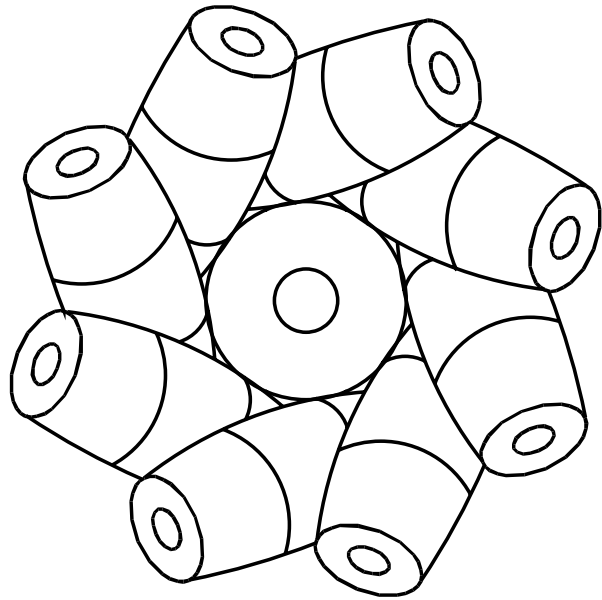
kinematic structures

active castor wheels



omnidirectional mobile robots with
actuated castor wheels

kinematic structures



Mecanum (Swedish)
wheels can be also used
to build omnidirectional
mobile robots

