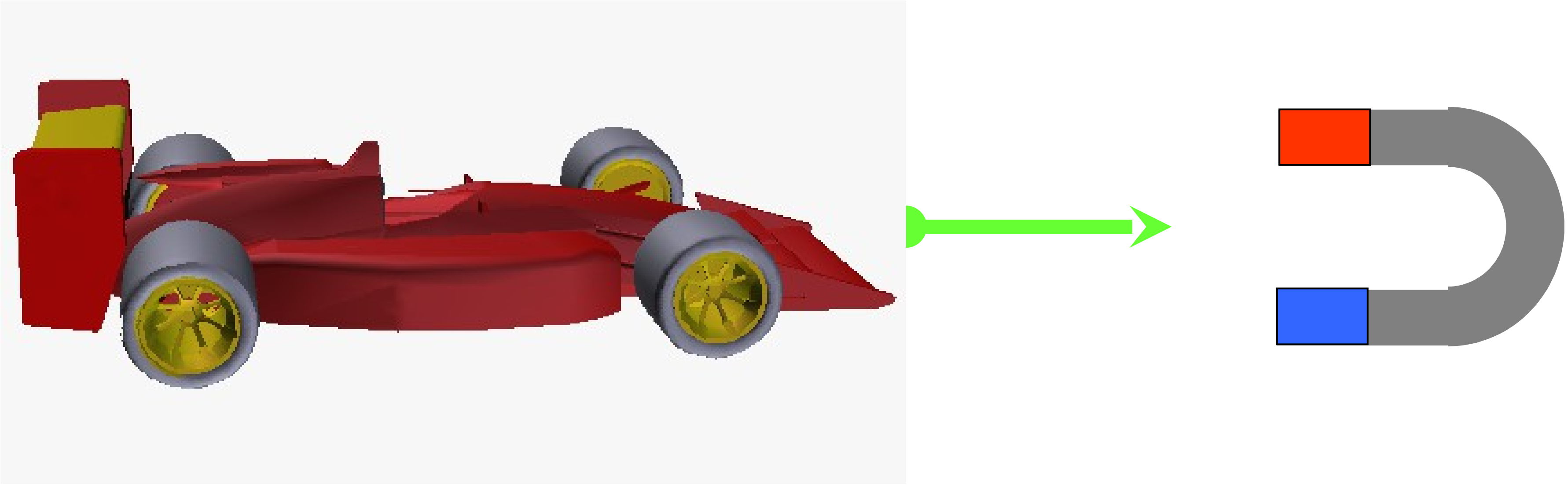
Drugi načini animacije

Kako še povzročimo gibanje

Zaradi zakonov fizike

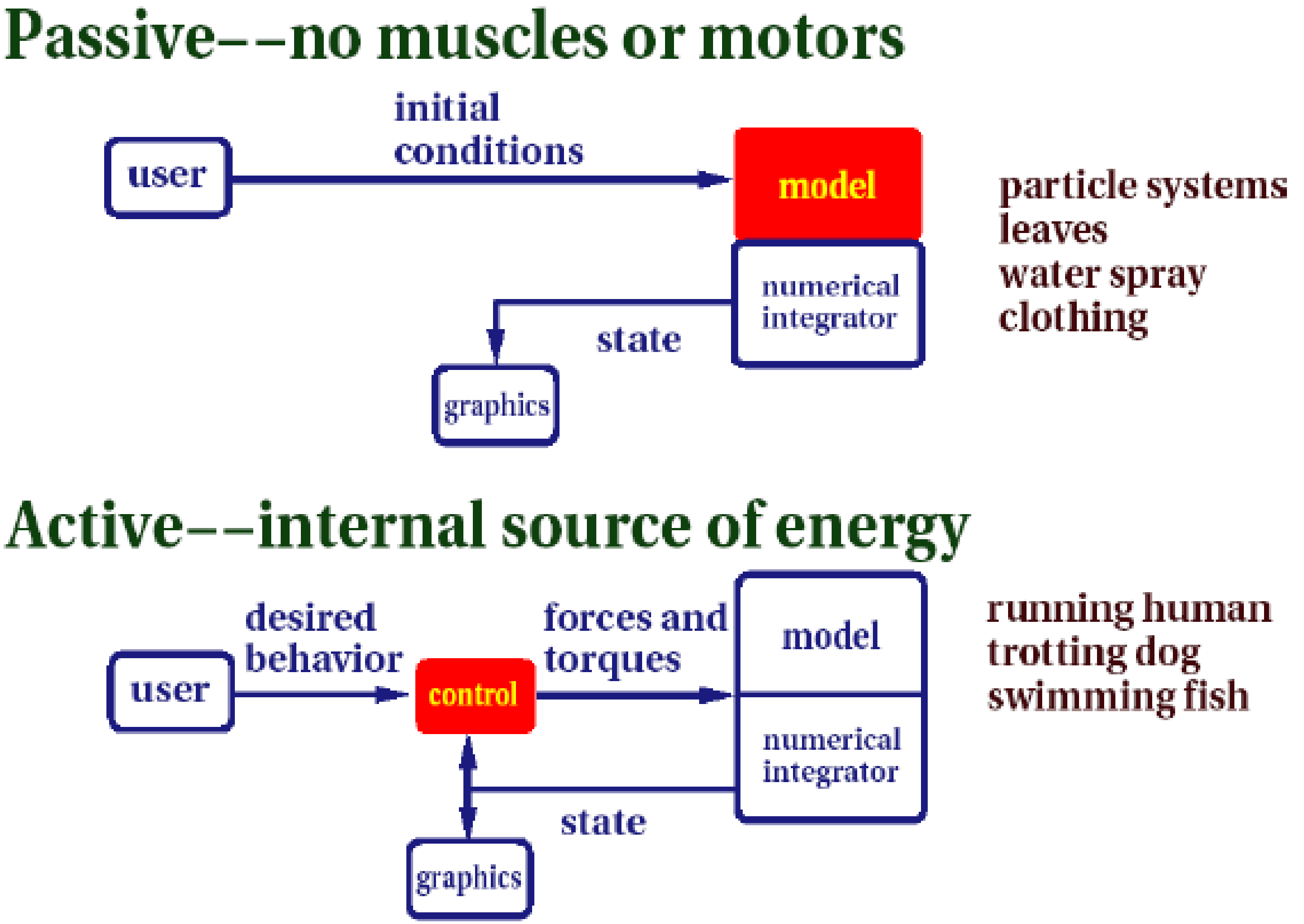


Posebni efekti: fizika, animacija delcev

Proceduralna animacija

- Gibanje definiramo s formulami
  - Napisanimi lastnoročno
  - Temelječimi na fiziki
- Animator mora biti programer
- Tehnika ključnih slik (keyframing) postane proceduralna, ko dodajamo izraze
- Pri določenem nivoju kompleksnosti postane proceduralna animacija bolj učinkovita

Pasivna in aktivna dinamika



Passive--no muscles or motors

particle systems
leaves
water spray
clothing

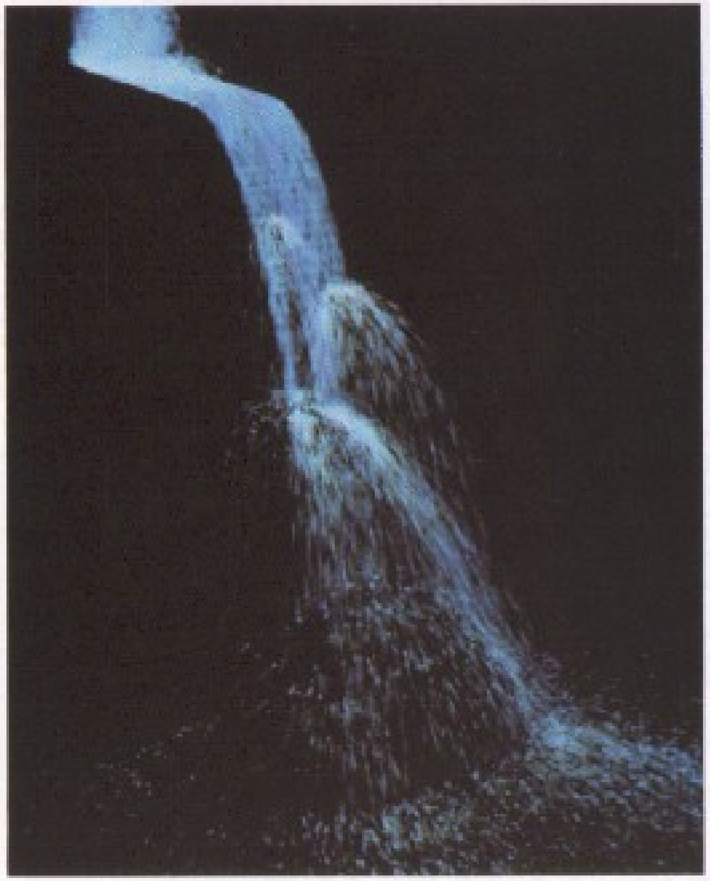
Active--internal source of energy

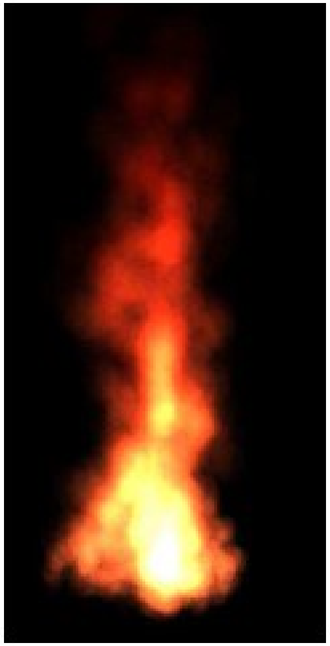
running human
trotting dog
swimming fish

Pasivna dinamika

No muscles or motors

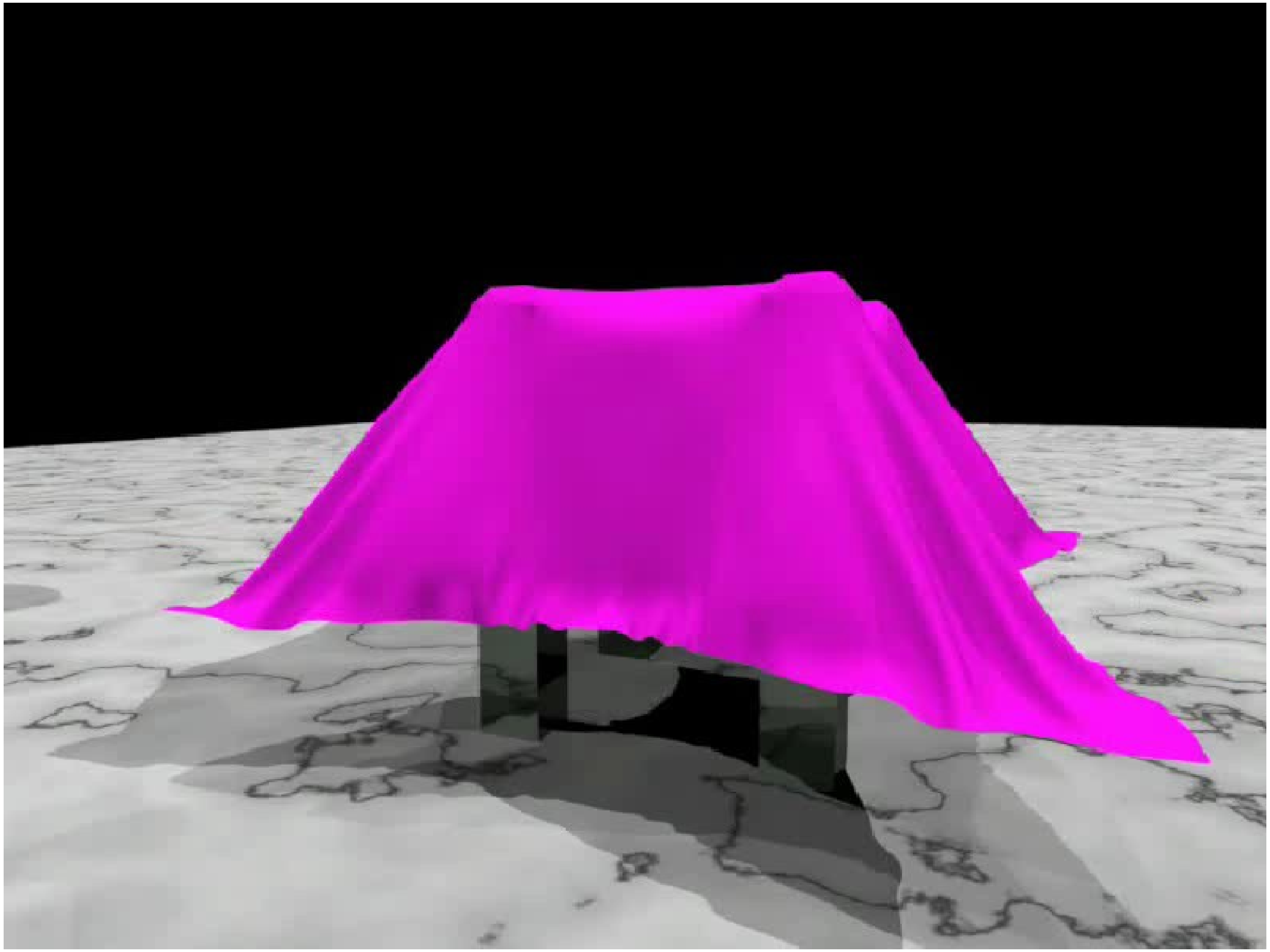
- Smoke
- Water
- Cloth
- Fire
- Fireworks





Demo

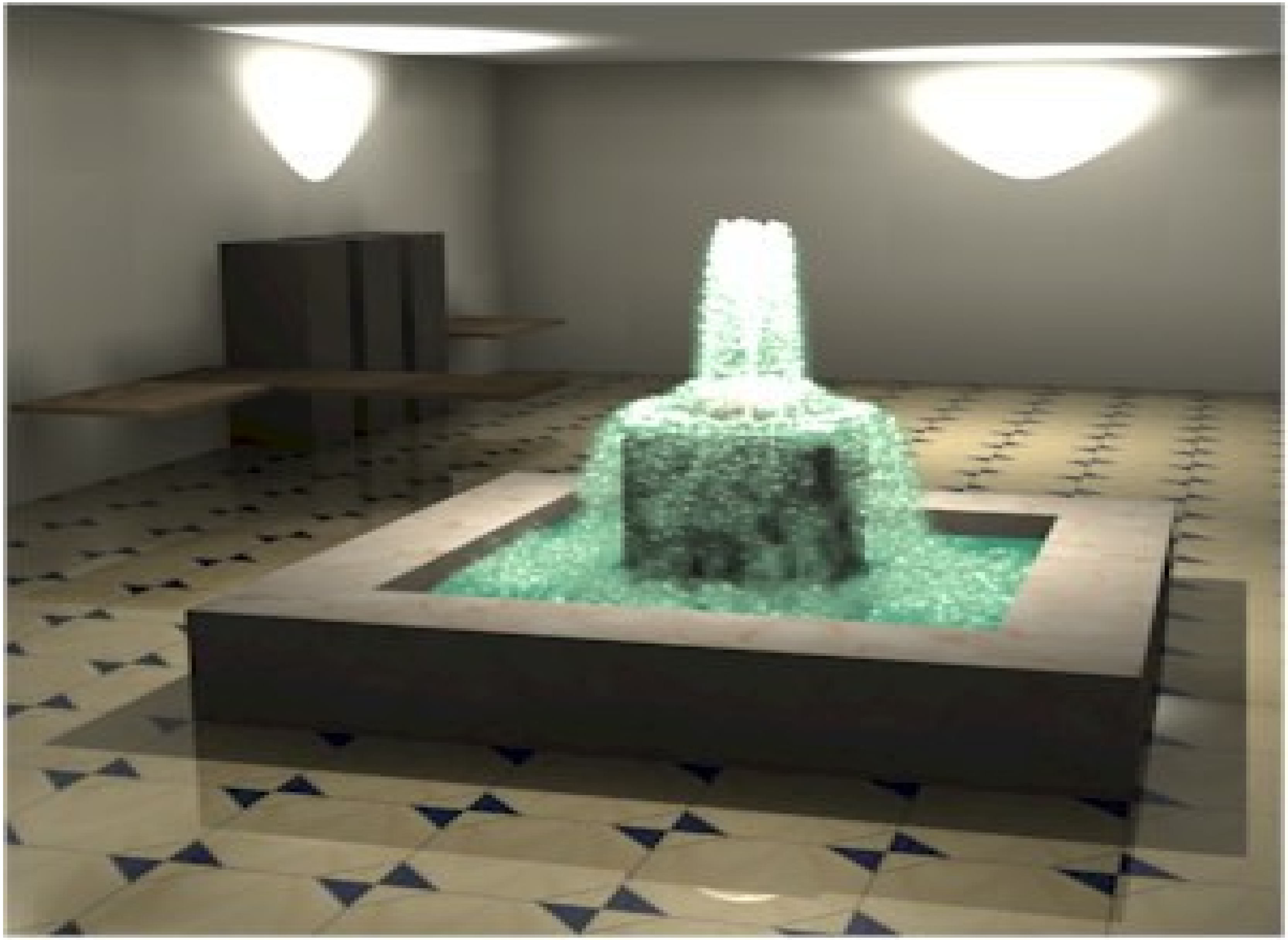
Prt na mizi



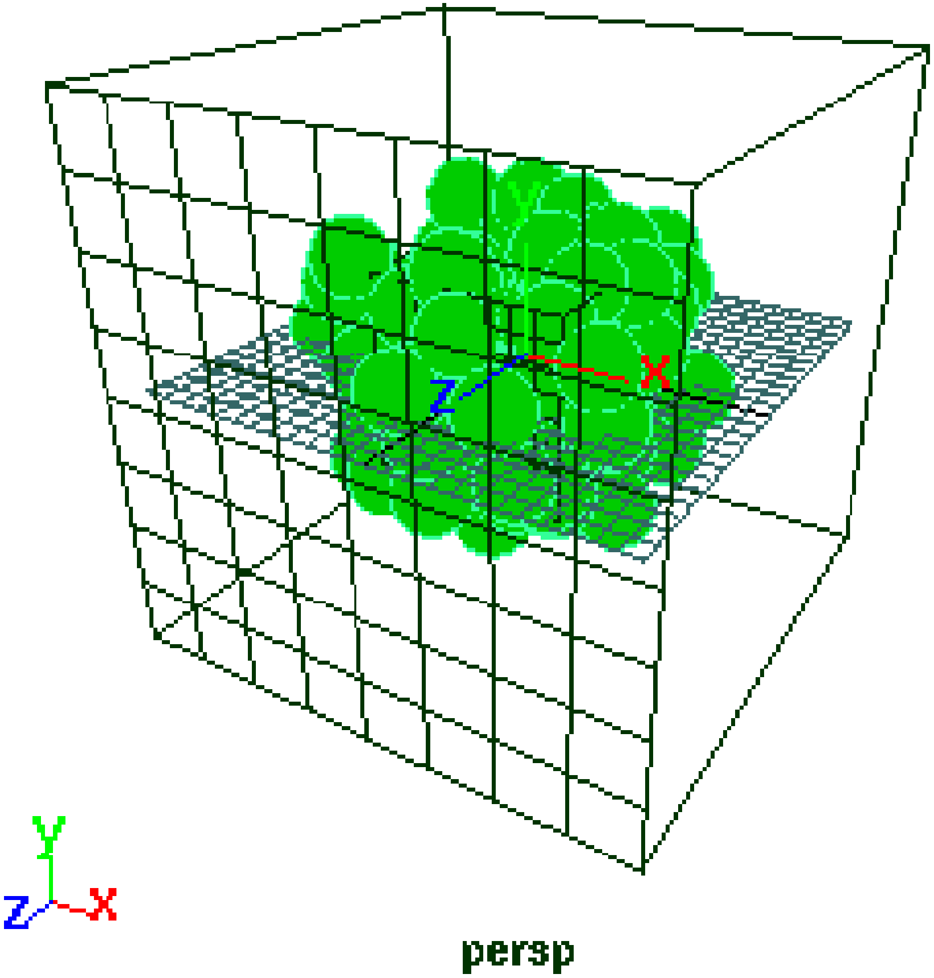
Demo

Oblačila – animacija oblačil

Delci (particles)

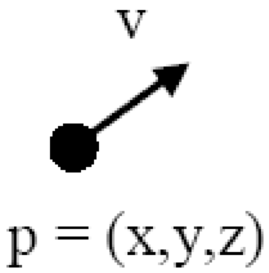


Animacija dima, ognja z animacijo delcev



O delcih

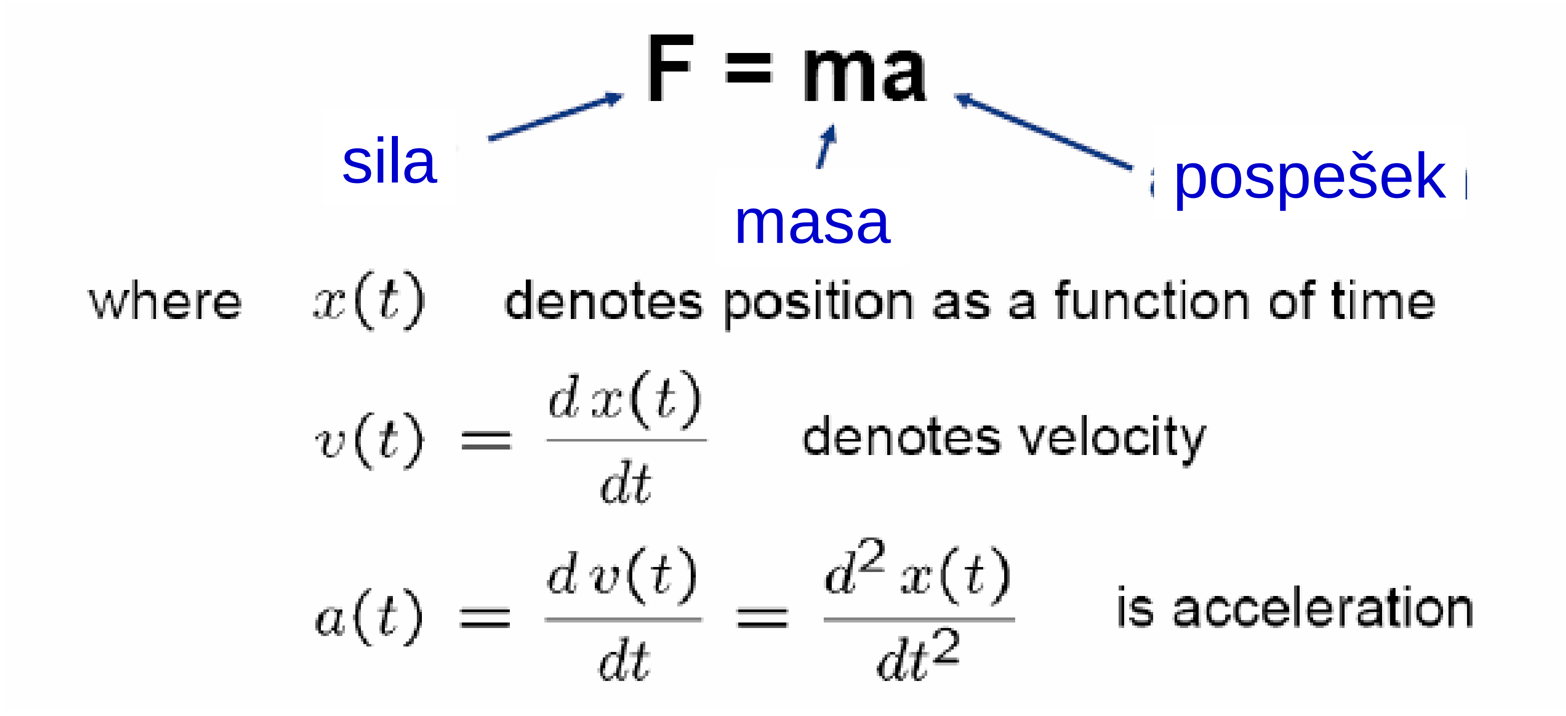
- A particle is a point mass
    - Mass
    - Position
    - Velocity
    - Acceleration
    - Color
    - Lifetime



- Use lots of particles to model complex phenomena
    - Keep array of particles

Fizikalna simulacija

Simuliramo dinamiko realnega sveta – drugi Newtonov zakon



F = ma

sila

masa

pospešek

where $x(t)$ denotes position as a function of time

$$v(t) = \frac{d\,x(t)}{dt}$$ denotes velocity

$$a(t) = \frac{d\,v(t)}{dt} = \frac{d^2\,x(t)}{dt^2}$$ is acceleration

X(t) računamo z numerično integracijo

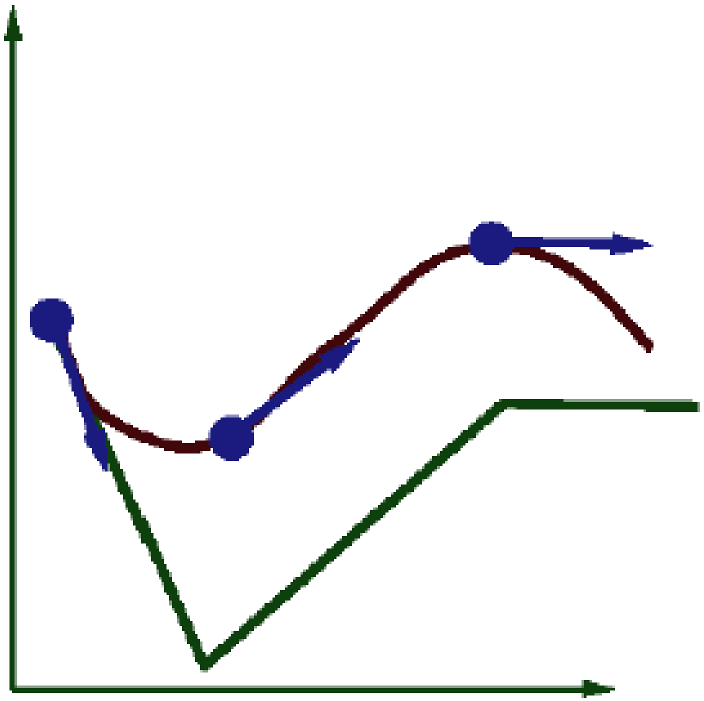
Enačba gibanja

- Newton’s Law for a point mass
  - $f = ma$

- Update every particle for each time step
  - $a(t+\Delta t) = g$
  - $v(t+\Delta t) = v(t) + a(t)^{*}\Delta t$
  - $p(t+\Delta t) = p(t) + v(t)^{*}\Delta t + a(t)^{2*}\Delta t/2$

Reševanje enačbe gibanja

- Euler integration
  - $p(t+\Delta t)=p(t) + \Delta t\ f(x,t)$

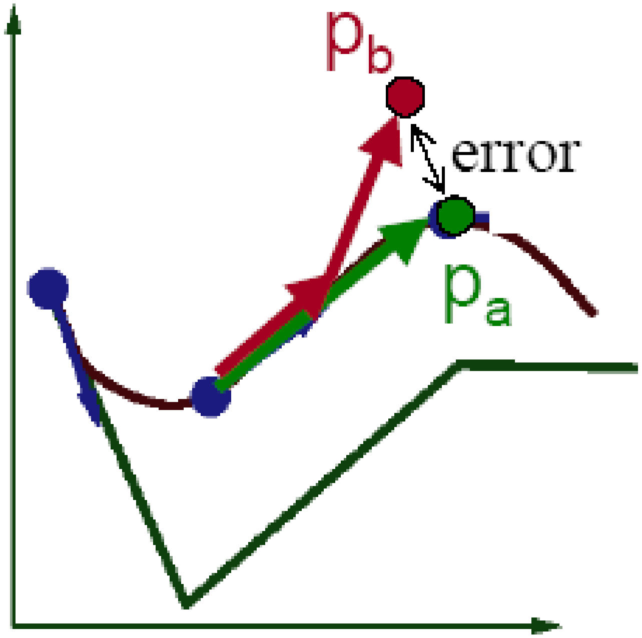


Problem:

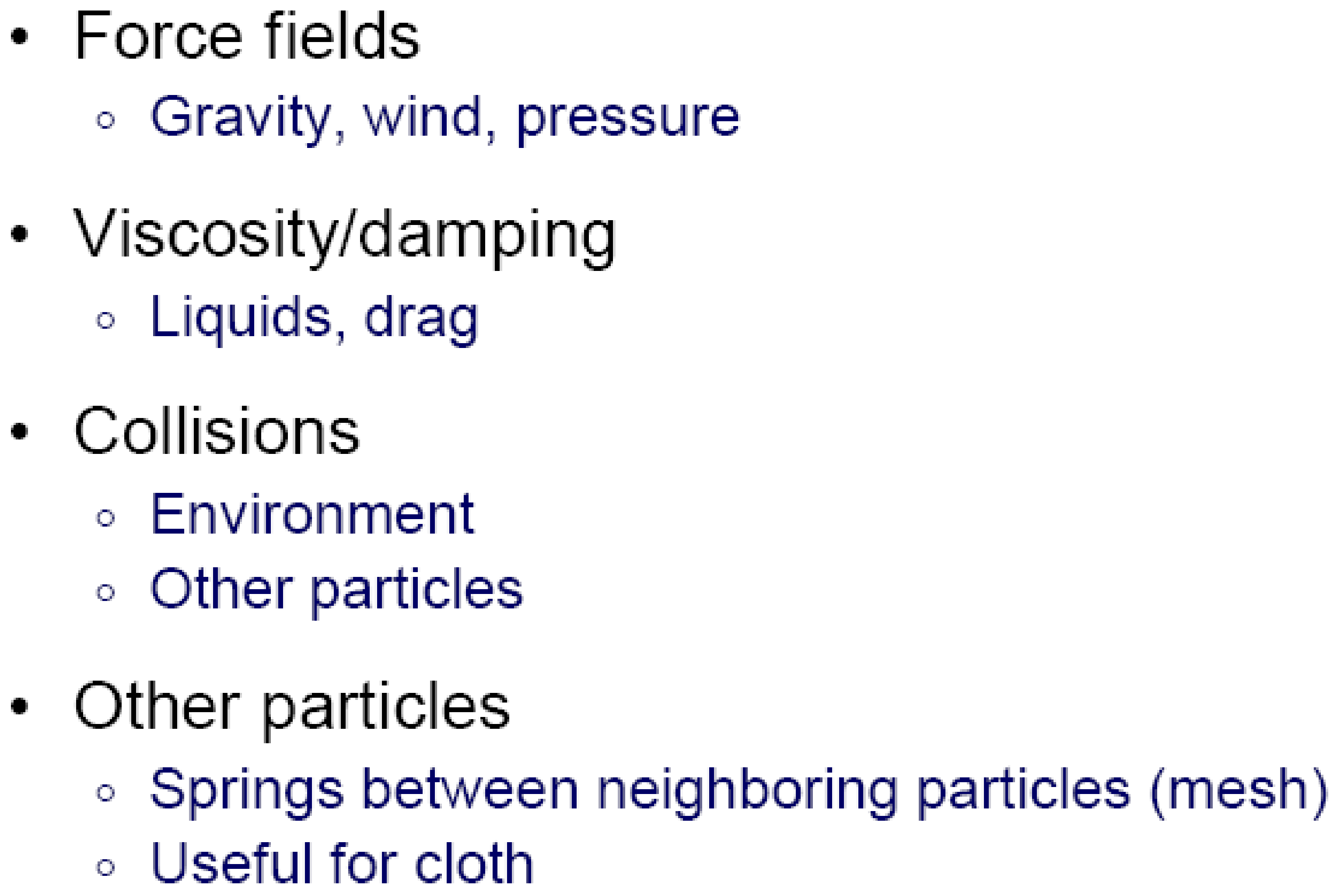
- Accuracy decreases as Δt gets bigger

Prilagajanje koraka

- Adapting step size
    - Compute p_a by taking one step of size h
    - Compute p_b by taking 2 steps of size h/2
    - Error = $| p_a - p_b |$
    - Adjust step size by factor $(\text{epsilon}/\text{error})^{1/f}$



Sile pri sistemih z delci

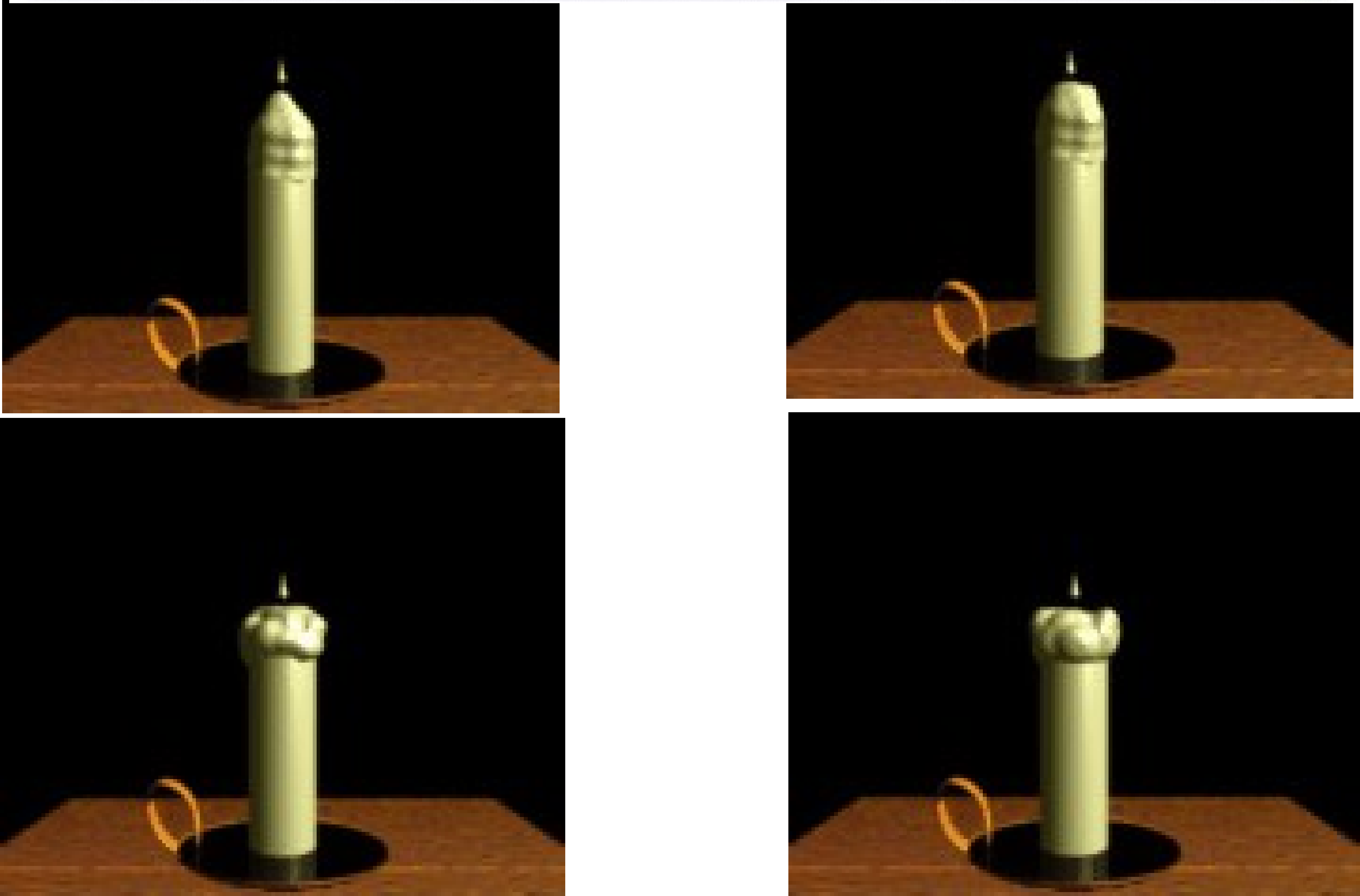


- Force fields
  - Gravity, wind, pressure
- Viscosity/damping
  - Liquids, drag
- Collisions
  - Environment
  - Other particles
- Other particles
  - Springs between neighboring particles (mesh)
  - Useful for cloth

Oblačila, ogenj, fizika

Kako to napravimo

Animacija delcev: sveča



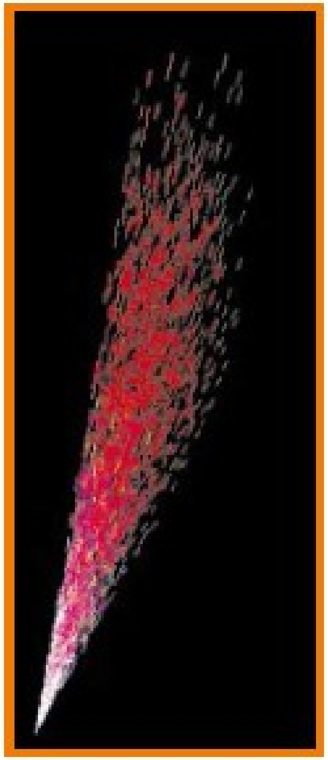
For each frame:

- Create new particles and assign attributes
- Delete any expired particles
- Update particles based on attributes and physics
- Render particles

Tvorba/brisanje delcev

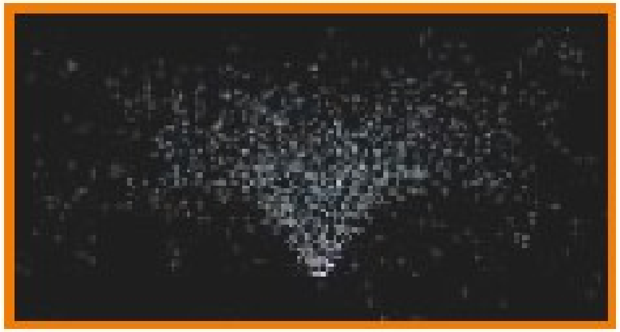
- Where to create particles?
  - Around some center
  - Along some path
  - Surface of shape
  - Where particle density is low
- When to delete particles?
  - Where particle density is high
  - Life span
  - Random

This is where user controls animation



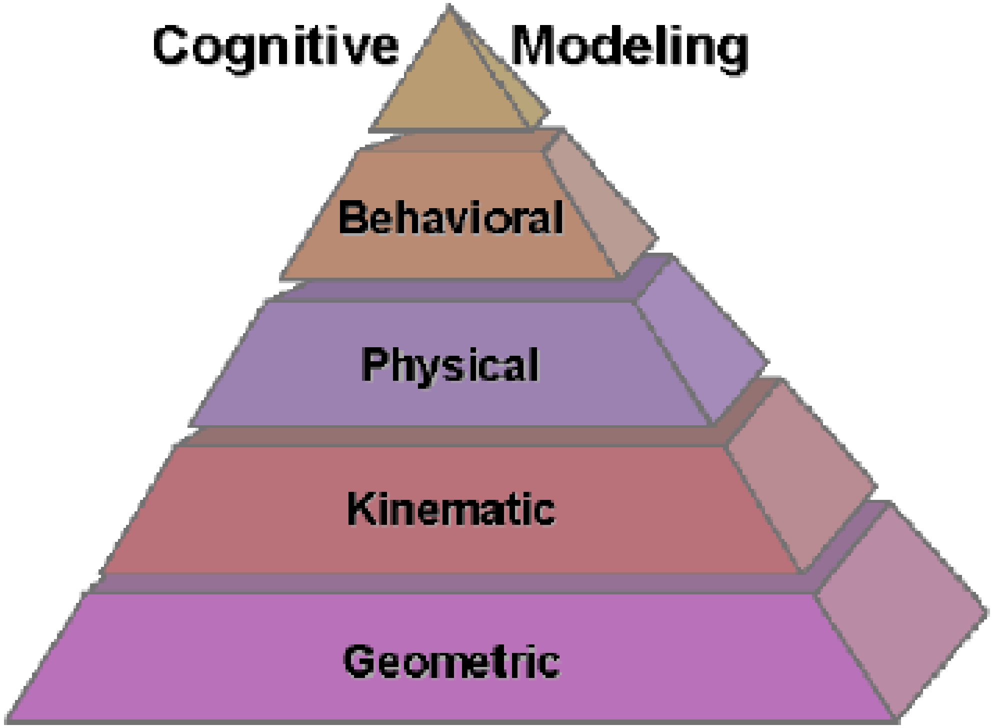
Upodabljanje delcev

- Volumes
  - Ray casting, etc.
- Points
  - Render as individual points
- Line segments
  - Motion blur over time



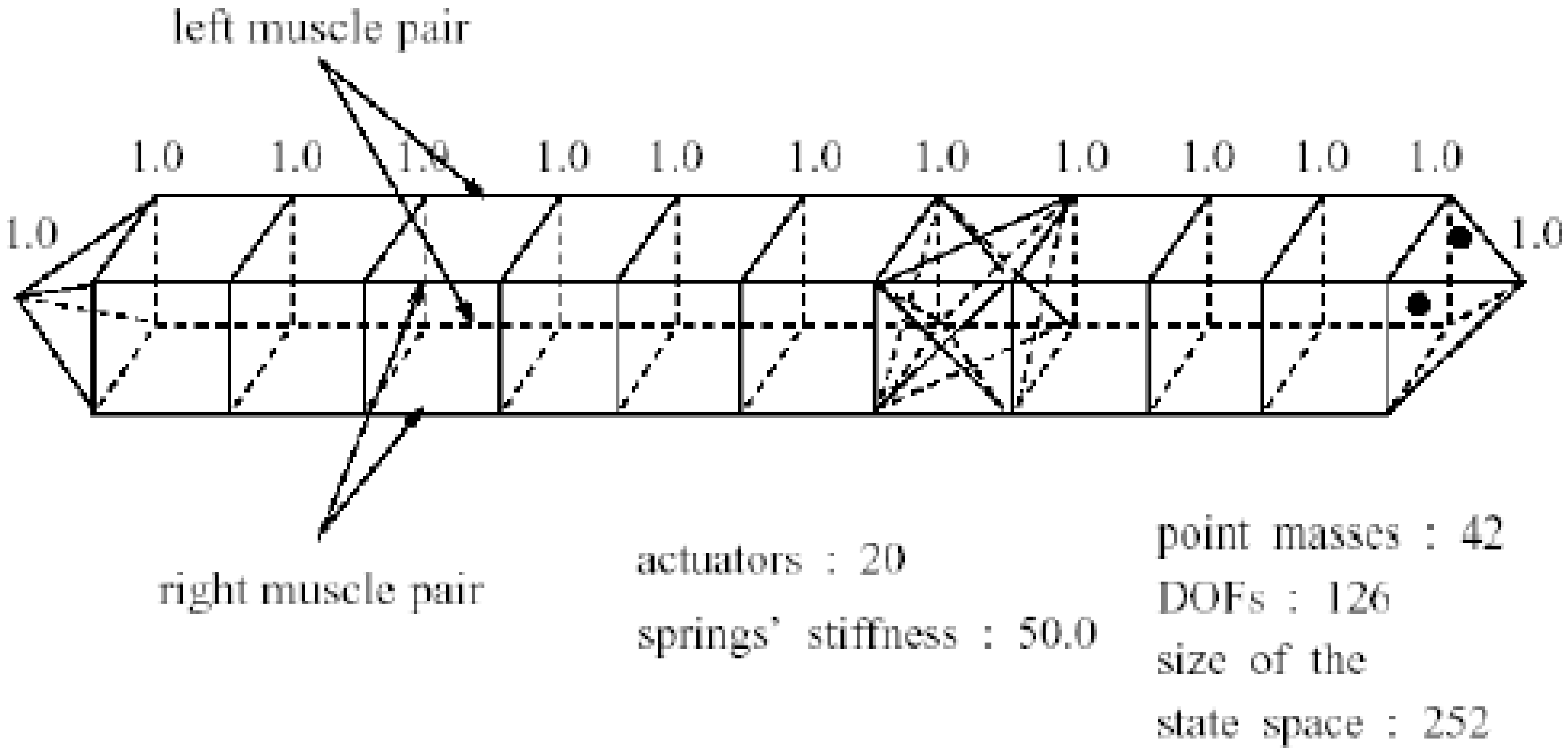
Aktivna dinamika

- Motions
  - Physics
  - Controllers
- Behaviors
  - Learning
- Cognition
  - Planning



Kako se premikajo črvi in kače?

Biomehanični model črva



actuators : 20

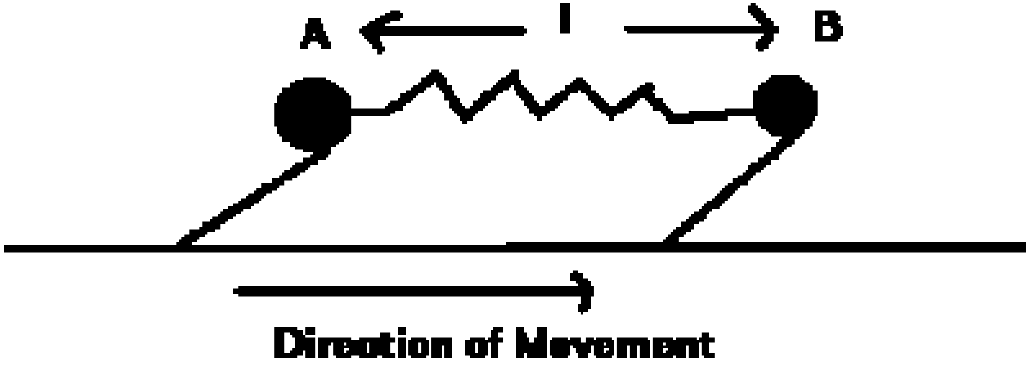
springs' stiffness : 50.0

point masses : 42

DOFs : 126

size of the
state space : 252

Fizika črva



$$f = k(L - I) - D\frac{dl}{dt}$$

$$a = f / m$$

$$X = \frac{1}{m}\int\int f dt dt$$

f = force along spring direction
k = spring force constant
D = damping force
I = current spring length
L = minimum energy spring length

... plus forces due to friction with ground.

Video

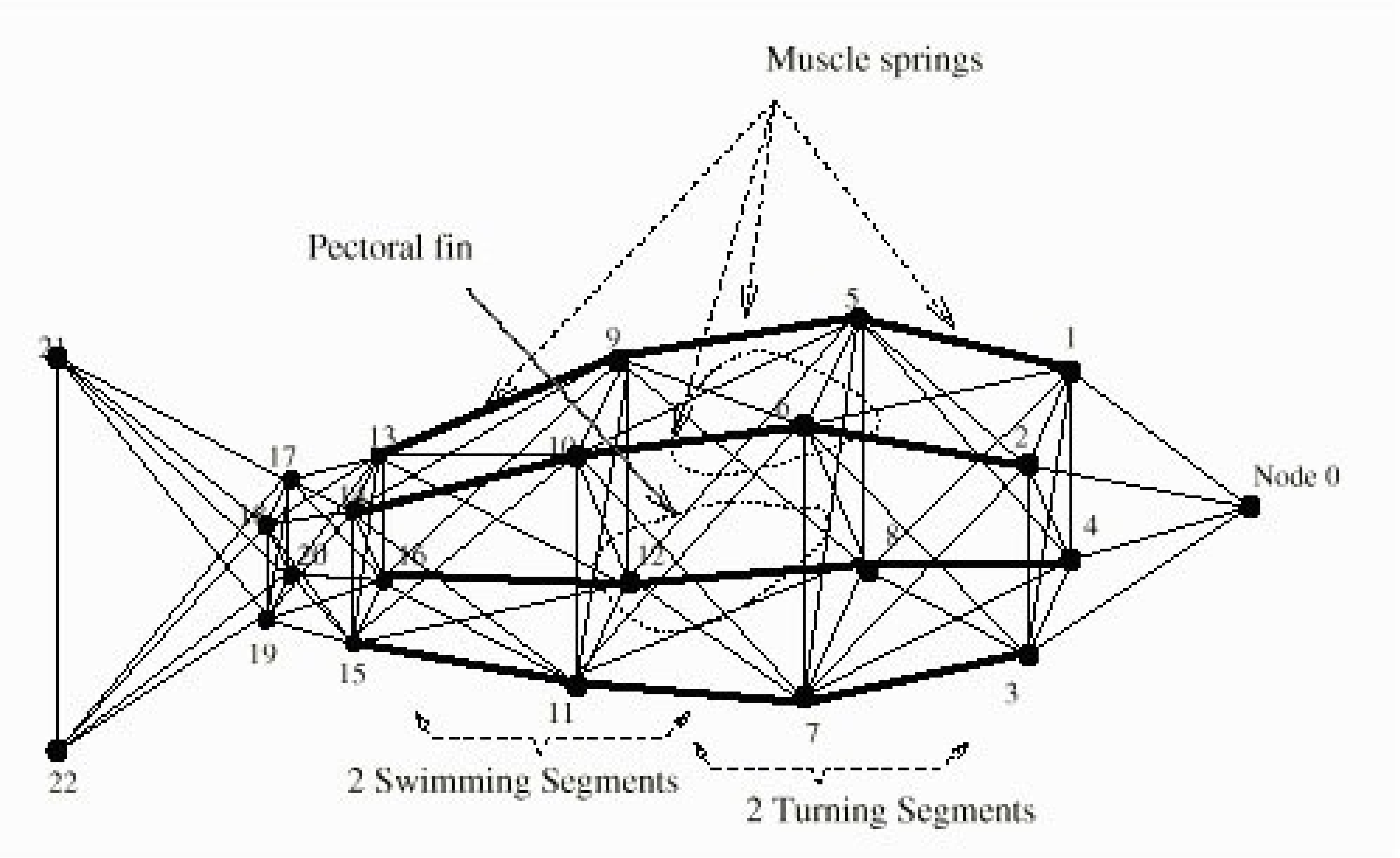
Premikanje kače

Demo

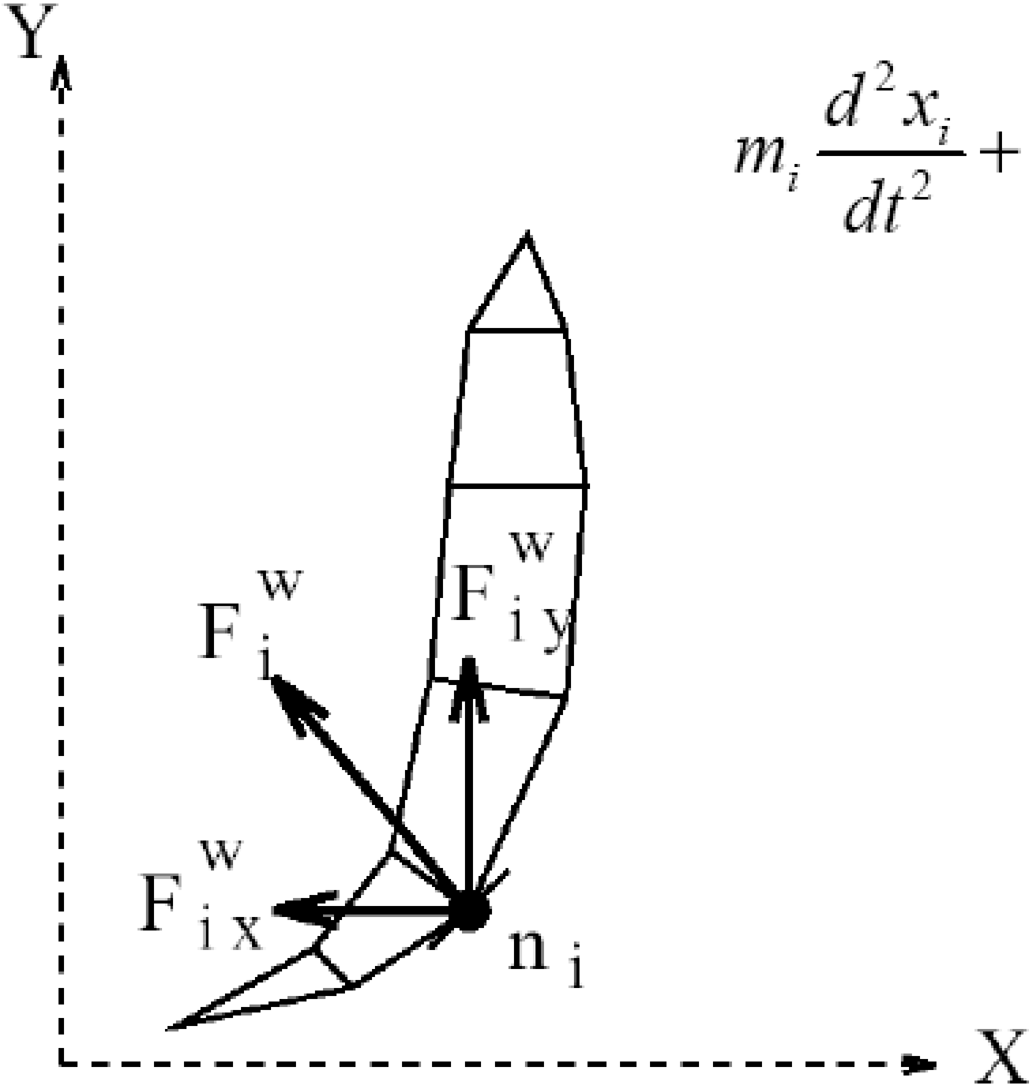
Premikanje črva

Demo

Riba – model z vzmetmi



Hidrodinamično premikanje



$$m_i \frac{d^2 x_i}{dt^2} + \varsigma_i \frac{dx_i}{dt} - w_i = f_i^w$$

Plavajoče ribe

The animation system for character animation in Shrek is based on muscle movements. Fiona shown here has 90 muscles

Demo

Pros and cons of simulation

Pros:

- Very realistic motion

Cons:

- Very slow
- Very hard to control
- Not expressive

Uses:

- complex physical phenomena

Data-driven animation

Video textures

Pros and cons of data-driven animation

Pros:

- potentially best of all worlds:
  - captures specific style of real actors
  - very flexible
  - can generate new motion in real-time

Cons:

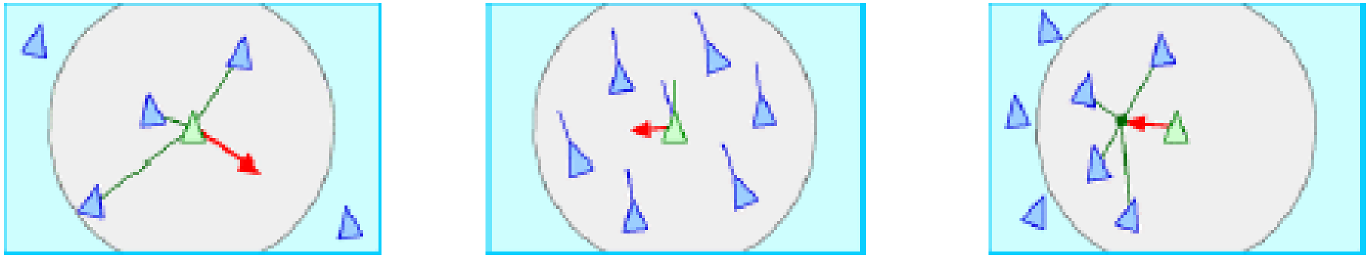
- requires good data (possibly lots of it)

Uses:

- character animation

Crowd behaviors

Particles with behavior



Visokonivojsko obnašanje

Avtonomna navidezna bitja morajo biti sposobna obnašanja:

Kar pomeni, da znajo upravljati sama s seboj.

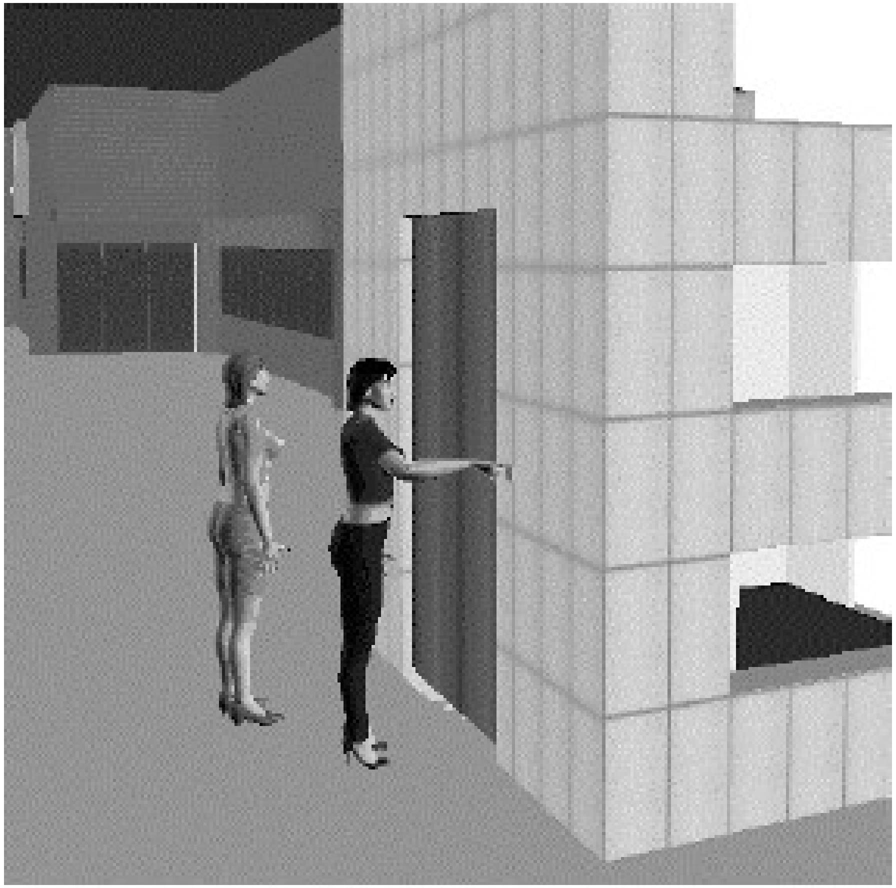
Tipično mora navidezno bitje zaznavati objekte in druga navidezna bitja v okolju s pomočjo virtualnih čutil (vid, tip, sluh)

Glede na sprejeto informacijo mora akterjev mehanizem obnašanja določiti izvedbeno akcijo.

Avtonomno sprehajanje

Avtonomno gibanje

Interakcija navideznih bitij s predmeti



Vzajemna komunikacija

Obnašanje mora biti odvisno od od čustvenega stanja akterja

Ne verbalna komunikacija upošteva izraze oziroma namige, kaj čutijo ljudje

Izrazna komunikacija je določena s specifičnimi položaji rok, nog in kotov telesa.

Tak način neverbalne komunikacije je bistven pri brezkontaktni komunikaciji med ljudmi.

Velike skupine (množice)

Velika skupina posameznikov v istem fizičnem okolju, ki si deli skupni cilj (na primer odhod na neko predstavo ali tekmo)

Posamezniki v množici se obnašajo drugače, kot če so sami ali v majhni

Obnašanje množic

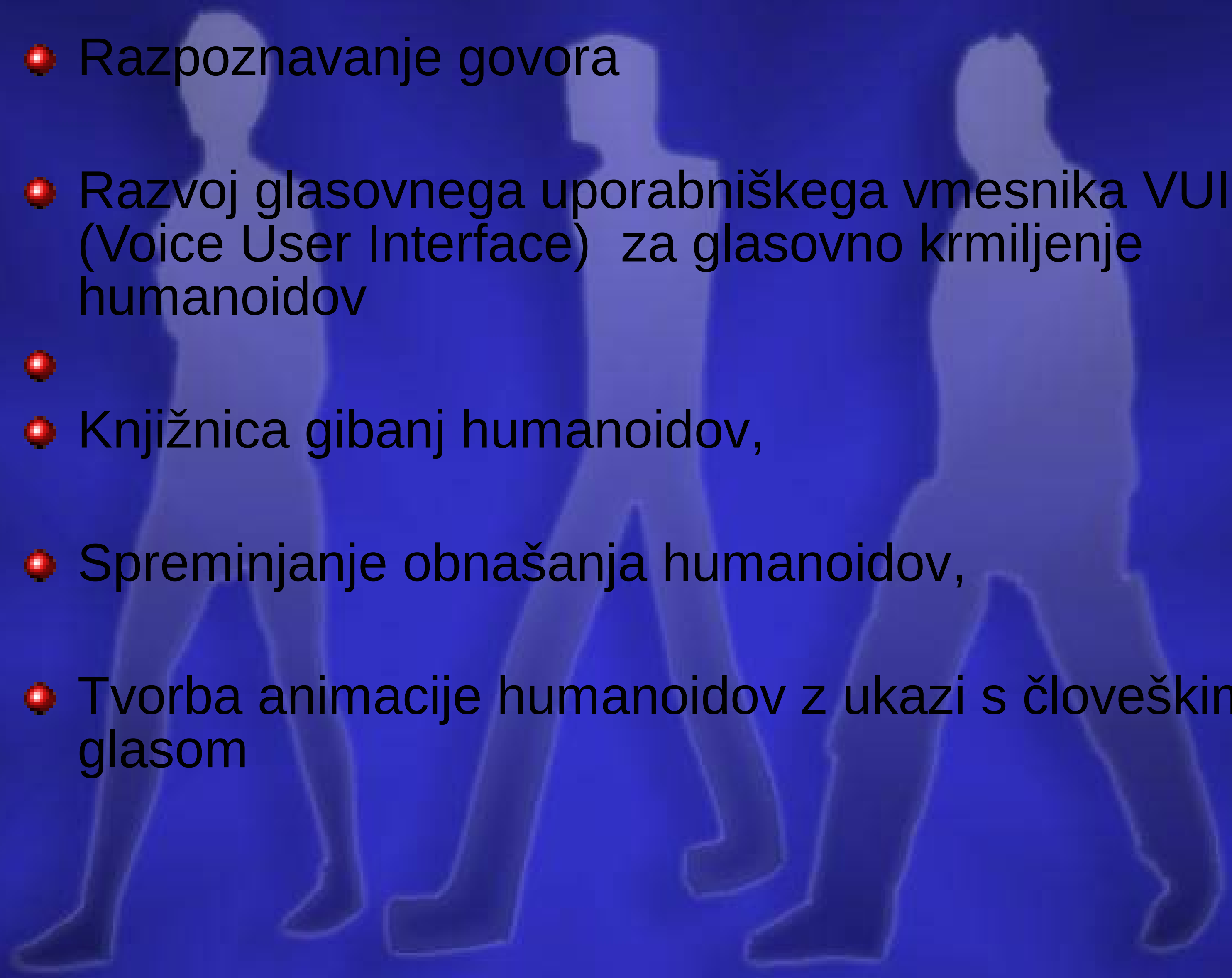
Obnašanje množic

Možnosti uporabe

- Učenje in urjenje s pomočjo simulacij (promet, gradbeništvo itd.)
- Simulacija ergonomskih delovnih okolij
- Virtualni pacienti v kirurgiji
- Rehabilitacija invalidov, protetika
- Virtualna psihoterapija
- Arhitekturne simulacije z zgradb in pokrajin z ljudmi
- Računalniške igre z ljudmi v navideznih svetovih
- Simulacije iger in športa
- Interaktivne drame z gledalci, ki lahko interaktirajo s simuliranimi osebami in so tako aktivno vključeni v sceno.

- Predstavitev obraza in telesa
- Funkcije avatarjev
- Krmiljenje gibanja
- Visokonivojsko obnašanje
- Interakcija s predmeti
- Interkomunikacija
- Interakcija z uporabnikom
- Sodelavna navidezna okolja
- Množice
- Upodabljanje
- Standardi
- Uporaba

Animacija humanoidov s pomočjo človeškega glasu



- Razpoznavanje govora
- Razvoj glasovnega uporabniškega vmesnika VUI (Voice User Interface) za glasovno krmiljenje humanoidov
-
- Knjižnica gibanj humanoidov,
- Spreminjanje obnašanja humanoidov,
- Tvorba animacije humanoidov z ukazi s človeškim glasom

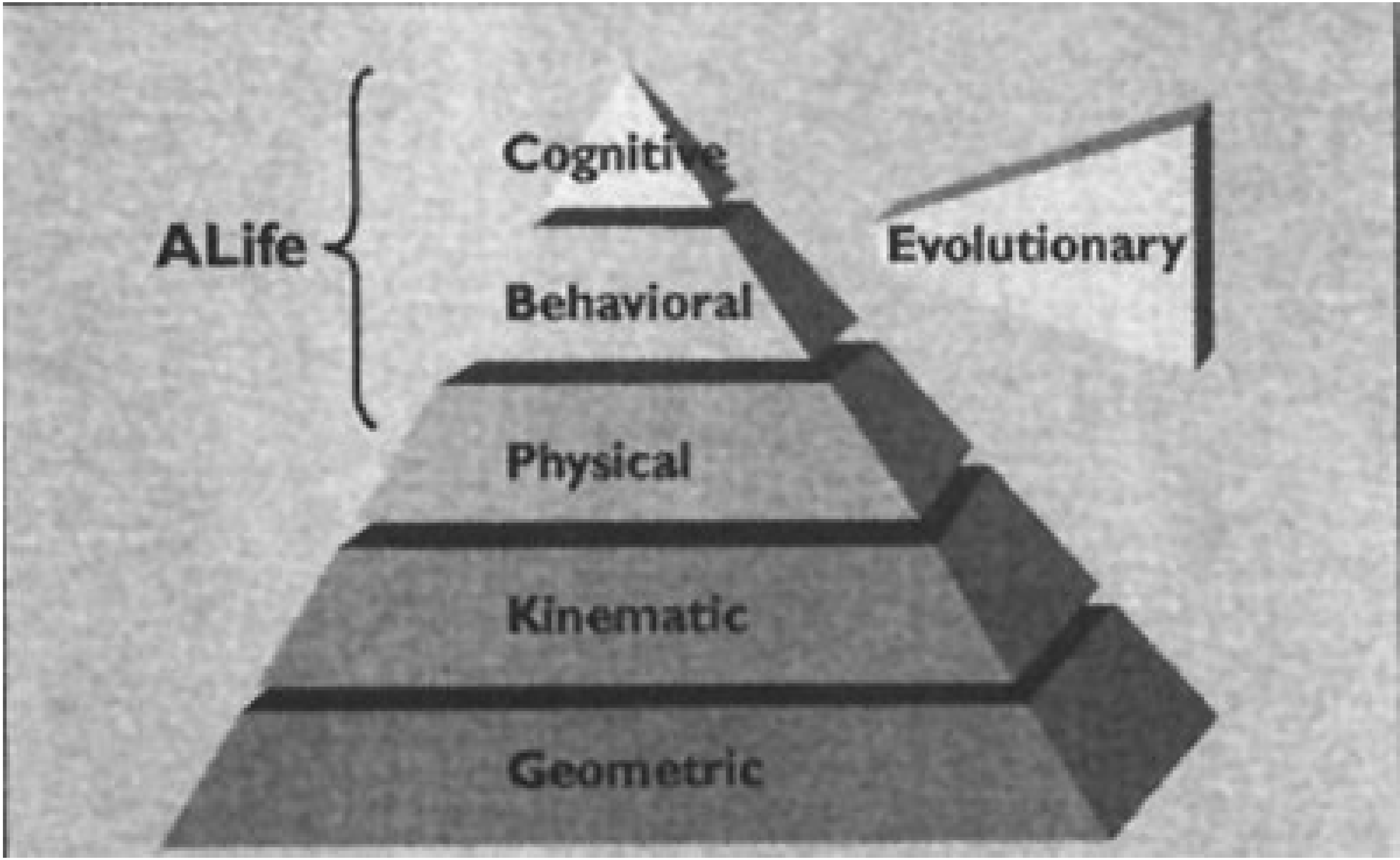
Večuporabniško omreženo navidezno okolje

Dodatne funkcije v primeri z enouporabniškim

Zaznavanje (ali je kdo v bližini)
Lokalizacija (kje je druga oseba)
Identifikacija (razpoznavanje osebe)
Vizualizacija fokusa interesa druge osebe (kaj jo zanima)
Vizualizacija akcij druge osebe (kaj dela)
Socialna samopredstavitev s pomočjo avatarja (kakšna je naloga in status druge osebe)

Parametrično krmiljenje osebkov

Umetno življenje



Umetno življenje

- Biomechanical Modeling
  - biological tissue
  - internal muscles actuators

- Behavioral Modeling
  - self-animating characters / objects that react to environment stimuli

- Cognitive Modeling
  - artificial intelligence
  - knowledge representation
  - complex perceptual mechanisms
  - reasoning
  - planning

Umetne rastline

environmentally
sensitive L-systems

interaction between
plant and environment
- light
- nutrients
- obstacles
- etc

Umetna evolucija

simulate evolution from genotypes to phenotypes

occasional mutations