Artificial Intelligence & Humanoid Robotics

or getting robots closer to people making them (robots:) intelligent

Maria VIRCIKOVA (maria.vircik@gmail.com)
Peter SINCAK (peter.sincak@tuke.sk)

Dept. of Cybernetics and Artificial Intelligence,
Kosice, Slovak Republic

Outline

I. Who we are

II. What we do

III. Why AI in Robotics

IV. What I did

V. What I want to do

I. WHO WE ARE

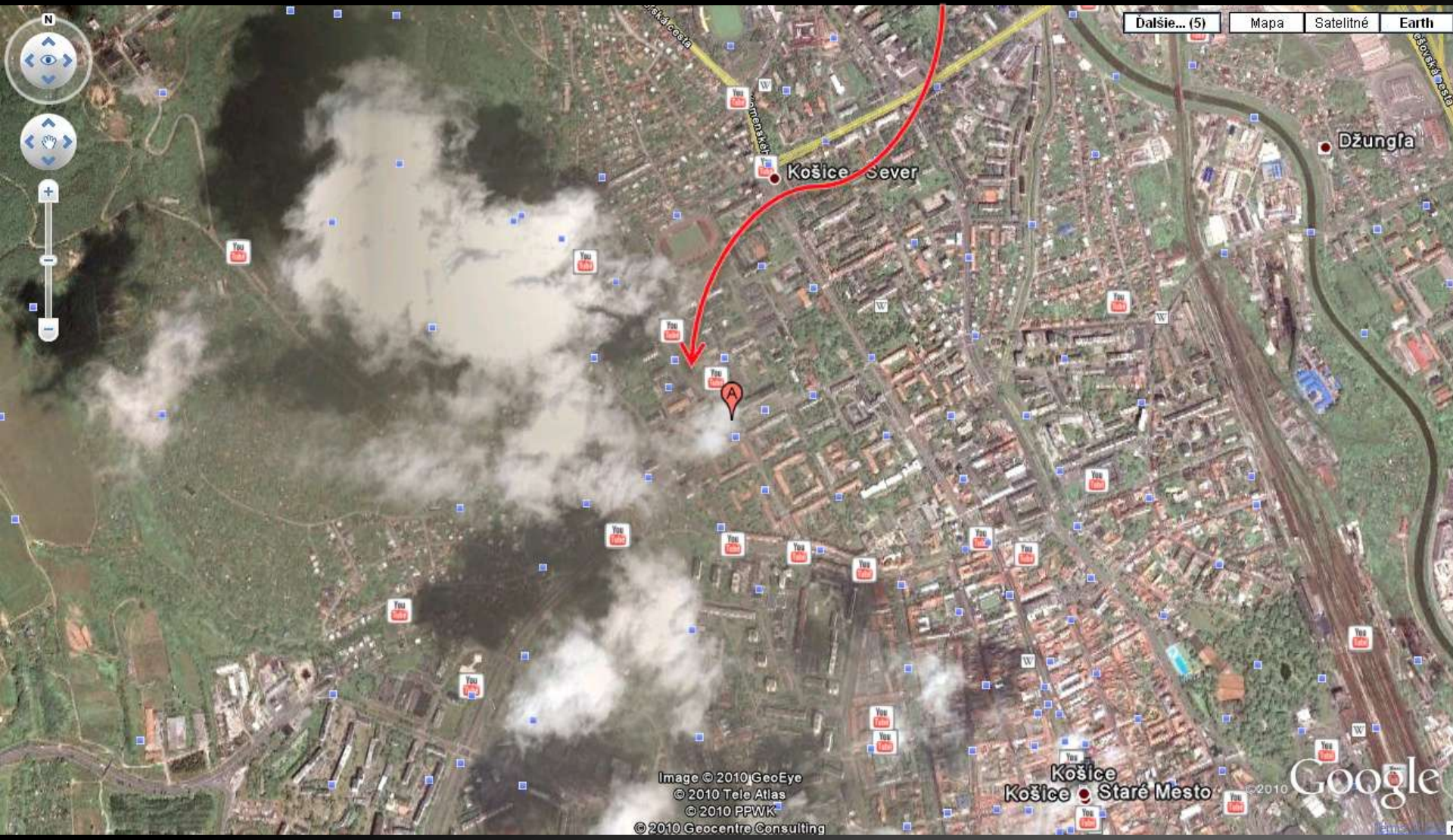
Center for Intelligent Technologies

www.ai-cit.sk

Founded :

September **1995**

Here we are ☺


Ďalšie... (5)
Mapa
Satelitné
Earth
Košice - Sever
Džungľa
Košice
Košice - Staré Mesto
Image © 2010 GeoEye
© 2010 Tele Atlas
© 2010 PPWK
© 2010 Geocentre Consulting
Google

Human Staff – Our head ☺

Prof. Peter Sincak

- learning Systems

intelligent technologies,

Incremental learning systems,

Neural – fuzzy systems,

Distributed Intelligence ,

Clouds.....

Human Staff – „our doctors“ ☺

Dr. Rudolf Jakša - 2 years at Fukuoka, Japan, 2001-2003, prof. Takagi – interactive EC, fitness is Human... Dance evolution....

Dr. Ján Vaščák - 1 year at Tokyo Institute of Technology – 2001-2002, prof. Hirota – fuzzy systems, Adaptive FS, HCI ...

Dr. Marek Bundzel - 2 years at Waseda University, Tokyo , 2008-2010, prof. Hashimoto, - neural network, Confabulation theory , stereo vision ...

PhD. students

Ing. Zlatik Fedor - speech

Ing. Jaroslav Tuharsky - stability

Ing. Peter Smolar - vision

Ing. Maria Virčíková - ??? ☺

Robotic Staff ☺

5 pieces

2 pieces

1 piece

2 pieces

13+2 pieces

Let me introduce NAO ☺

human-like appearance and various sensors for interacting with humans

25 degrees of freedom for great mobility

the inertial sensor and closed loop control provide great stability while moving and enable positioning within space

VIDEO – Robot Nao

http://www.youtube.com/watch?v=rSKRgasUEko

II. WHAT WE DO

Technological Challenges

MASS or other distributed intelligence tool embedment into Cloud computing as a service

Knowledge handling in MASS(ROS, Rtmiddleware….)

Microsoft NATAL / Nao collaboration

discuss possibility to join http://www.ispacelabnet.org/members

Engage cloud computing in our problems

prefer Microsoft for research – Imagine cup

Research challenges

Create learnable interactive and incremental system with demo in image recognition, command recognition

Improve MF ARTMAP for dynamic feature space in sense of Wald sequential classification

Improve Adaptive FS model behavior creation

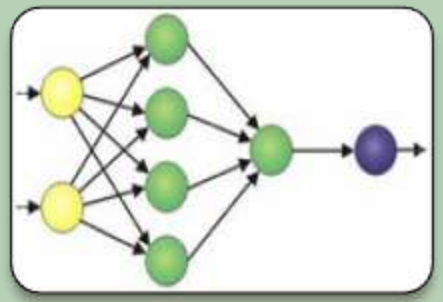
Get model of human behavior in interactive Evolutionary computation…

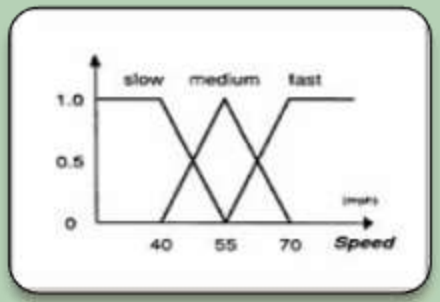
MASS – brain.fei.tuke.sk – rozpoznávanie povelov

http://www.youtube.com/watch?v=krbr25s1yt4

III. WHY AI in Robotics

Artificial Intelligence Techniques



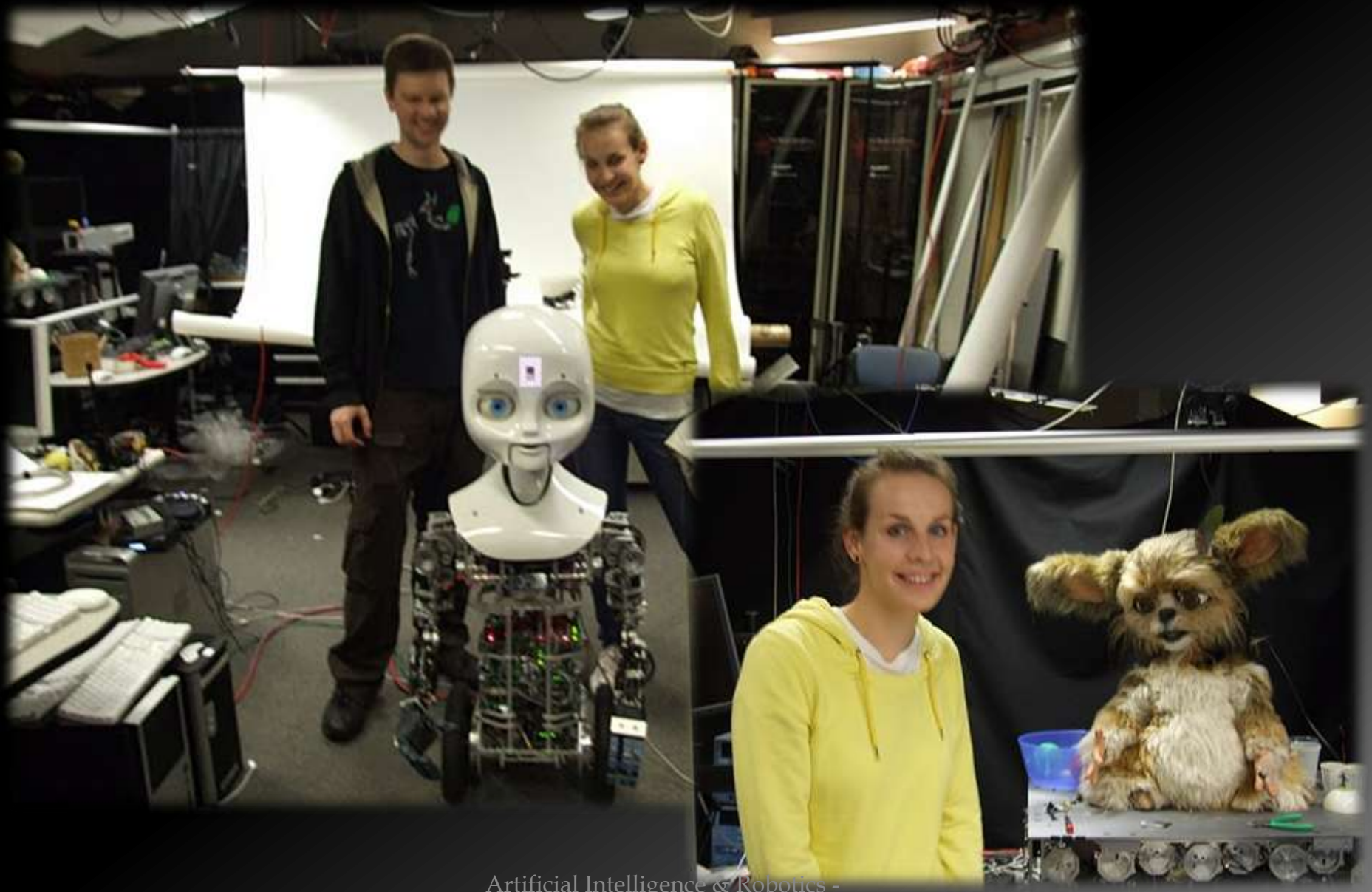


Neural networks

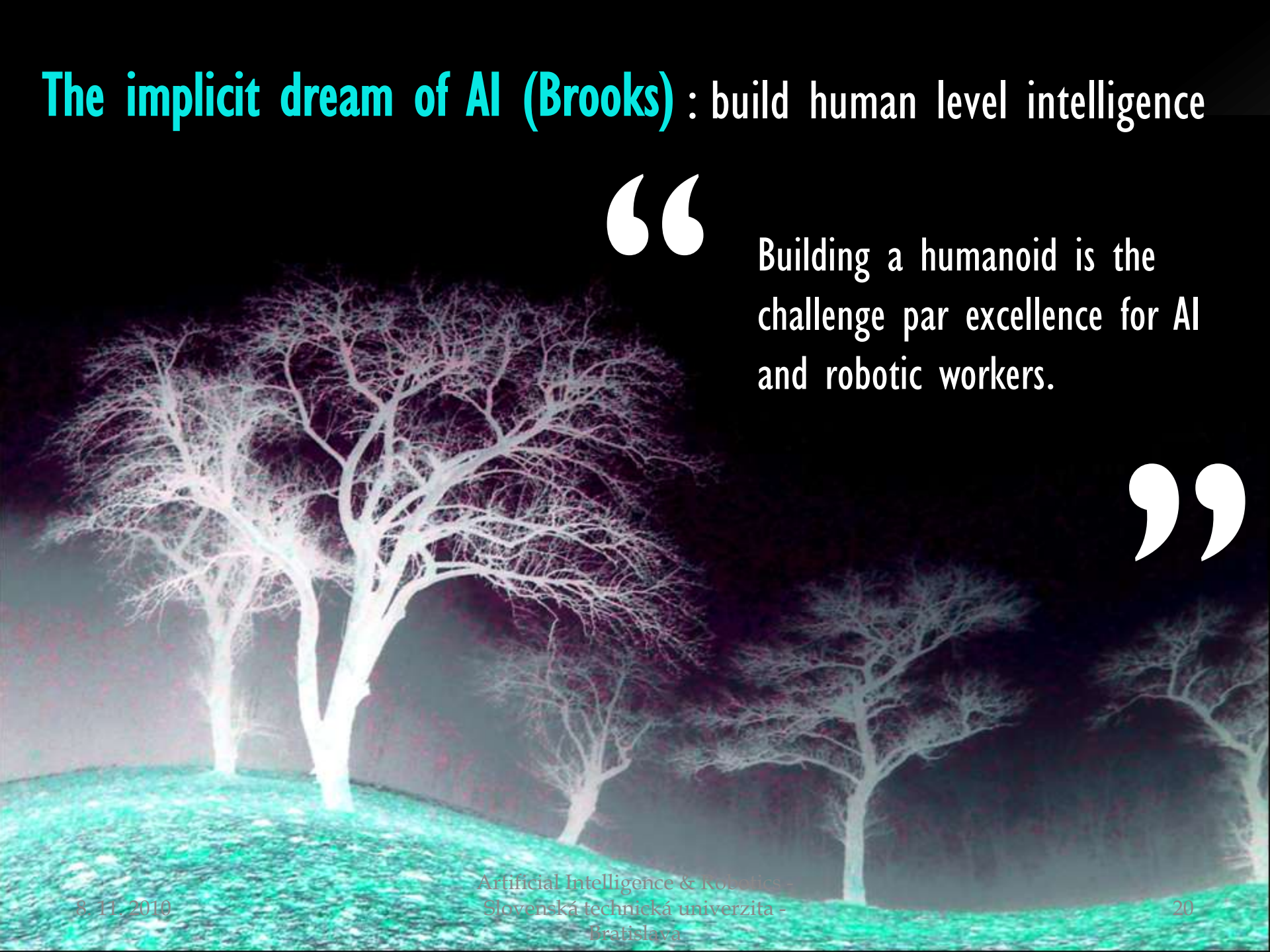
Fuzzy logic

Evolutionary computation

MIT Personel Robots Group (Cynthia Breazeal)



The implicit dream of AI (Brooks) : build human level intelligence

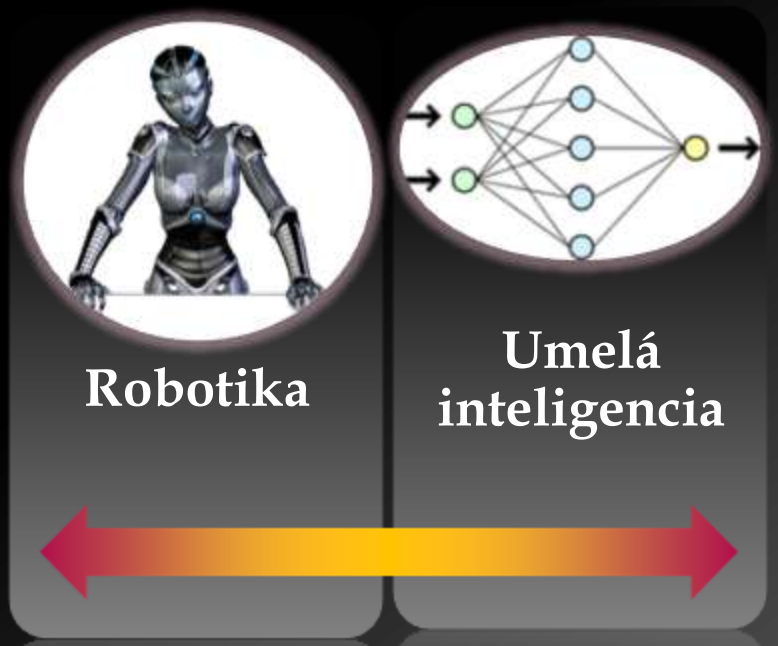


“Building a humanoid is the challenge par excellence for AI and robotic workers.”

Umelá inteligencia v humanoidnej robotike

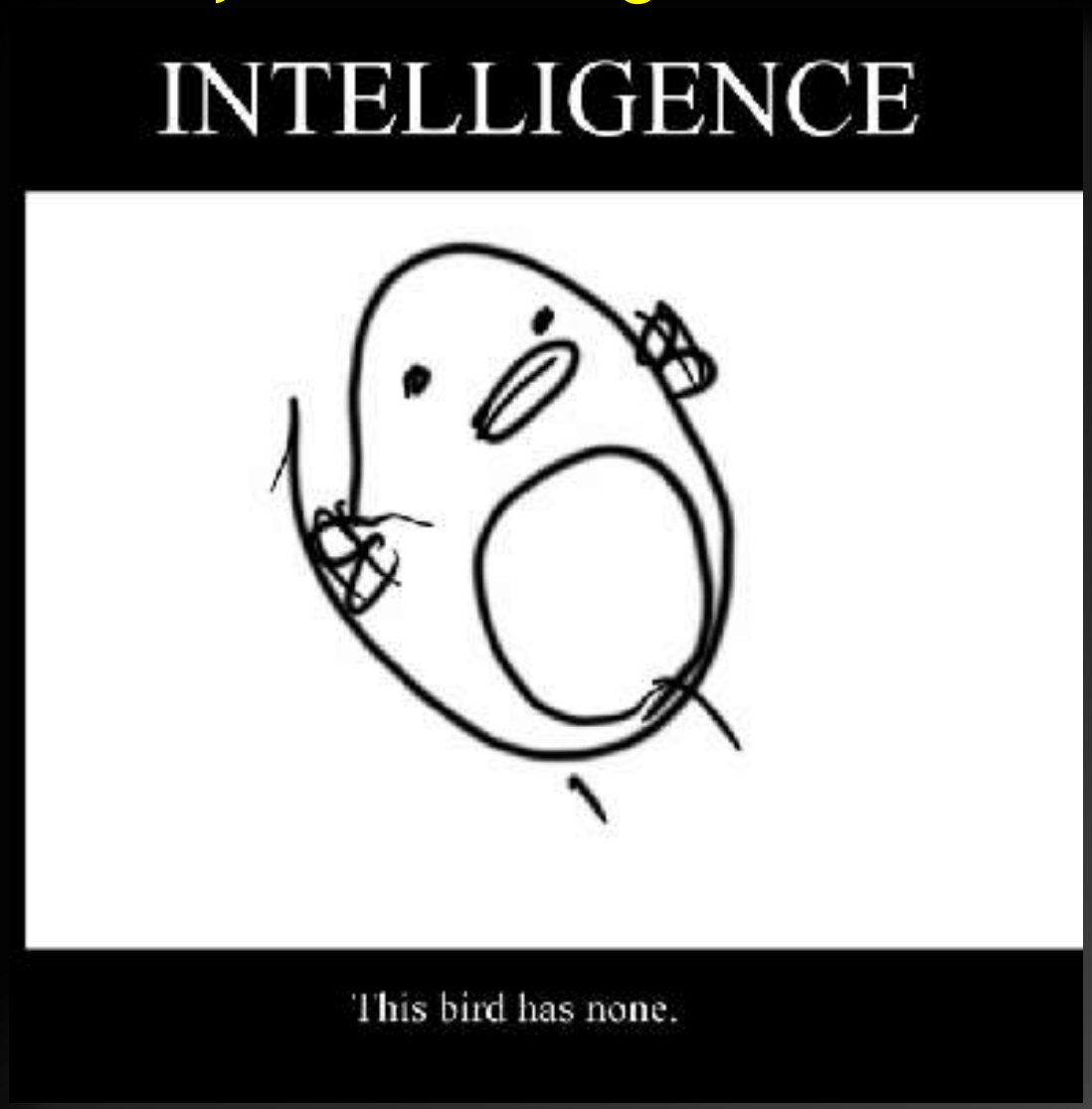
Cieľom UI [Brooks] je:

- konštrukcia užitočných inteligentných systémov a
- pochopenie ľudskej inteligencie



WHY???
NAČO???

Čo je to inteligencia????

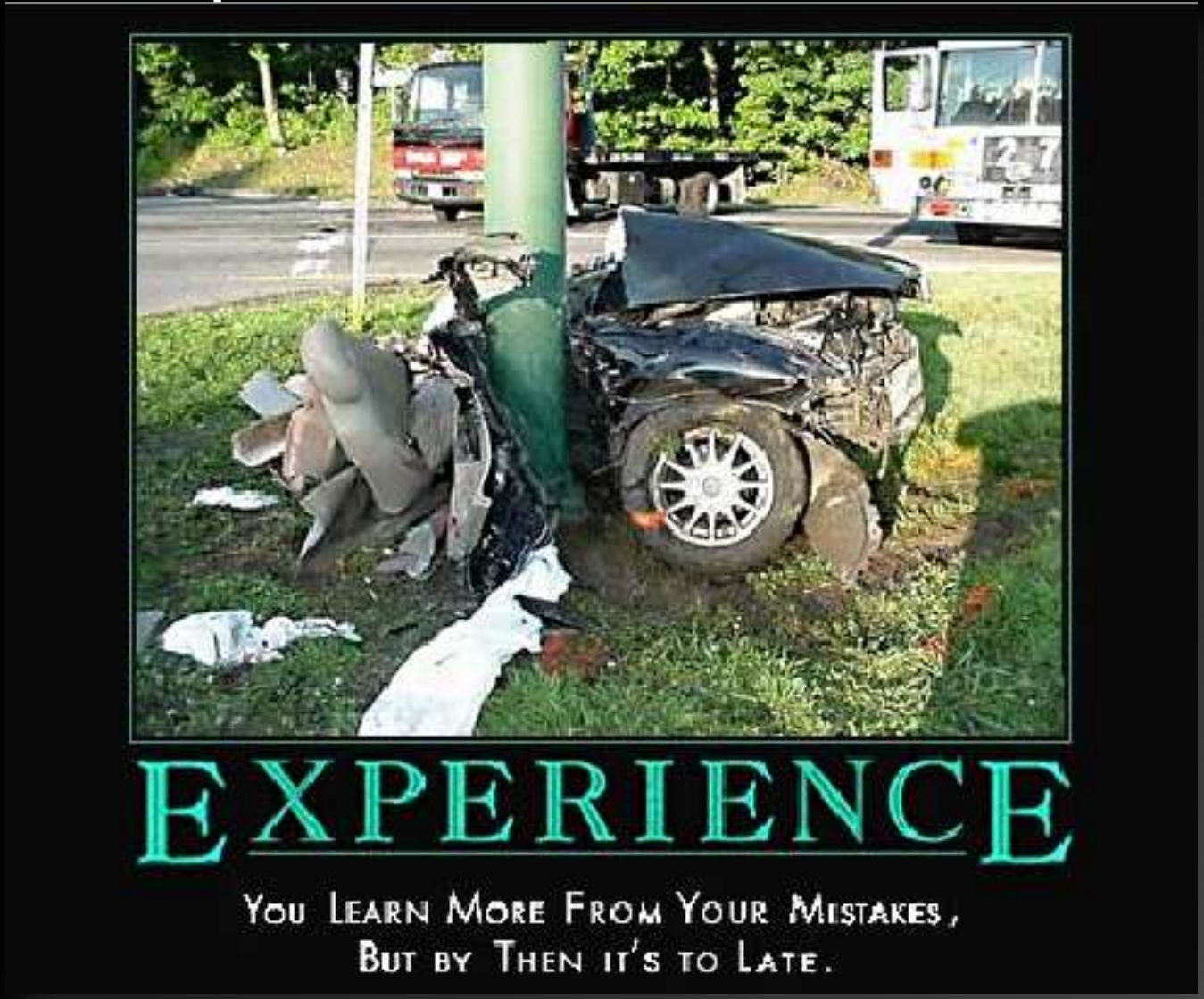


Inteligentné systémy???

VIDEO – Charlie Chaplin: Modern Times (1936) The eating machine

http://www.youtube.com/watch?v=pZlJ0vtUu4w

Schopnosť učenia sa zo skúseností



technológia sa v daných ako aj v nových postupne sa meniacich podmienkach ADAPTUJE a vie postupne zvládať situácie, ktoré sa v nejakej forme aspoň raz počas jej činnosti vyskytli

súčasne by už v budúcnosti mala VYUŽIŤ ZÍSKANÉ POZNATKY na riešenie podobných situácií.

V Európe sa často takéto technológie nazývajú aj tzv. Smart technológie - predstavujú vyšší stupeň technológií vo všeobecnosti.

User-FRIENDLY

I. učiť sa z dát a získavania poznatkov

II. ukladať poznatky

III. využívať získané poznatky pri riešení konkrétnych situácii – uvažovanie

MACHINE INTELLIGENT QUOCIENT (MIQ)

?????

Getting robots **closer** to people

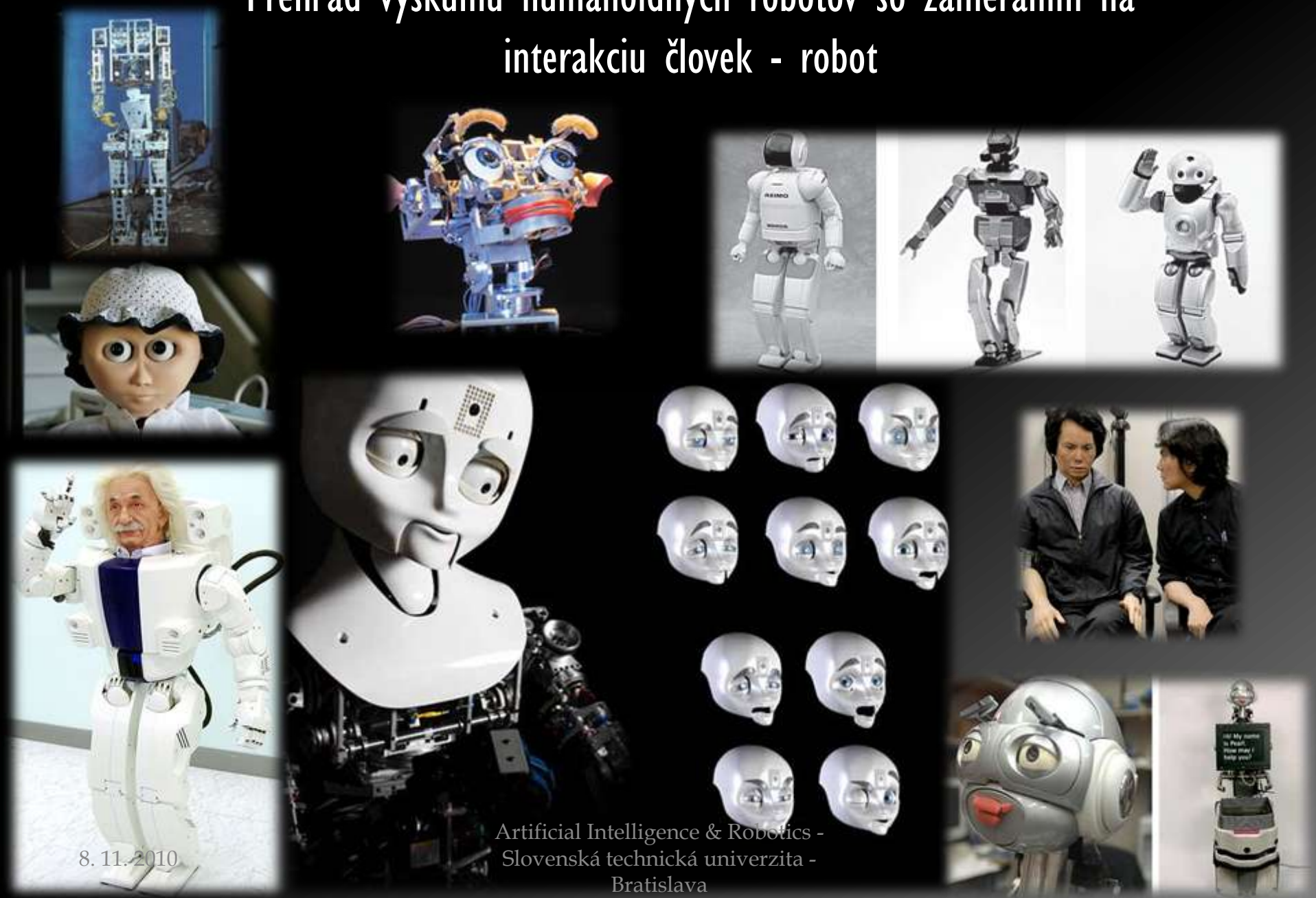
Friendly human-robot interfaces

Safe human-robot interaction

Emotion expression and perception

Social learning

Prehľad výskumu humanoidných robotov so zameraním na interakciu človek - robot



HRP-4

VIDEO:

http://www.youtube.com/watch?v=fJFfcBGdh-s

IV. WHAT I DID

WHAT

IEC for a system of Robotic Dance for humanoids

HOW

User interactively co-operates with the System designing his own robotic dance choreography

WHY

The HRI is the key factor of their success, because they must exist in a human environment

Our system is special because ...

PERSONALIZATION

The proposed system in this work interacts with human

Motion is evolving in accordance with his evaluation of the seen dance section

State of the Art: Robotic Dances

Tokyo: learning-from-observation training method

Kyoto: intermodality mapping to generate robot motion from various sounds (BP)

Tohoku: ballroom dances in coordination with a human

Tokyo: Chaos to trade synchronization and autonomy in a dancing robot

LFO (Tokyo)

Robot like dancing partner
(Tohoku University)

Mahru – dancing robot
(Korea Institute of Science and Technology)

Most of the systems: preprogrammed motions ☹

(VIDEO)

How can Nao move ...

Robot functionality is encapsulated in software modules. ***ALMotion :*** A set of methods to move the robot motors.

Methods:

set a joint angle,

let us to set robot chains (head, foots, and arms) to a desired cartesian position,

provides a high level functionality, such as walking movement.

General GA process

1 Initialize the population of chromosomes.

2 Calculate the fitness for each individual in the population using fitness function.

3 Reproduce individuals to form a new population according to each individual's fitness.

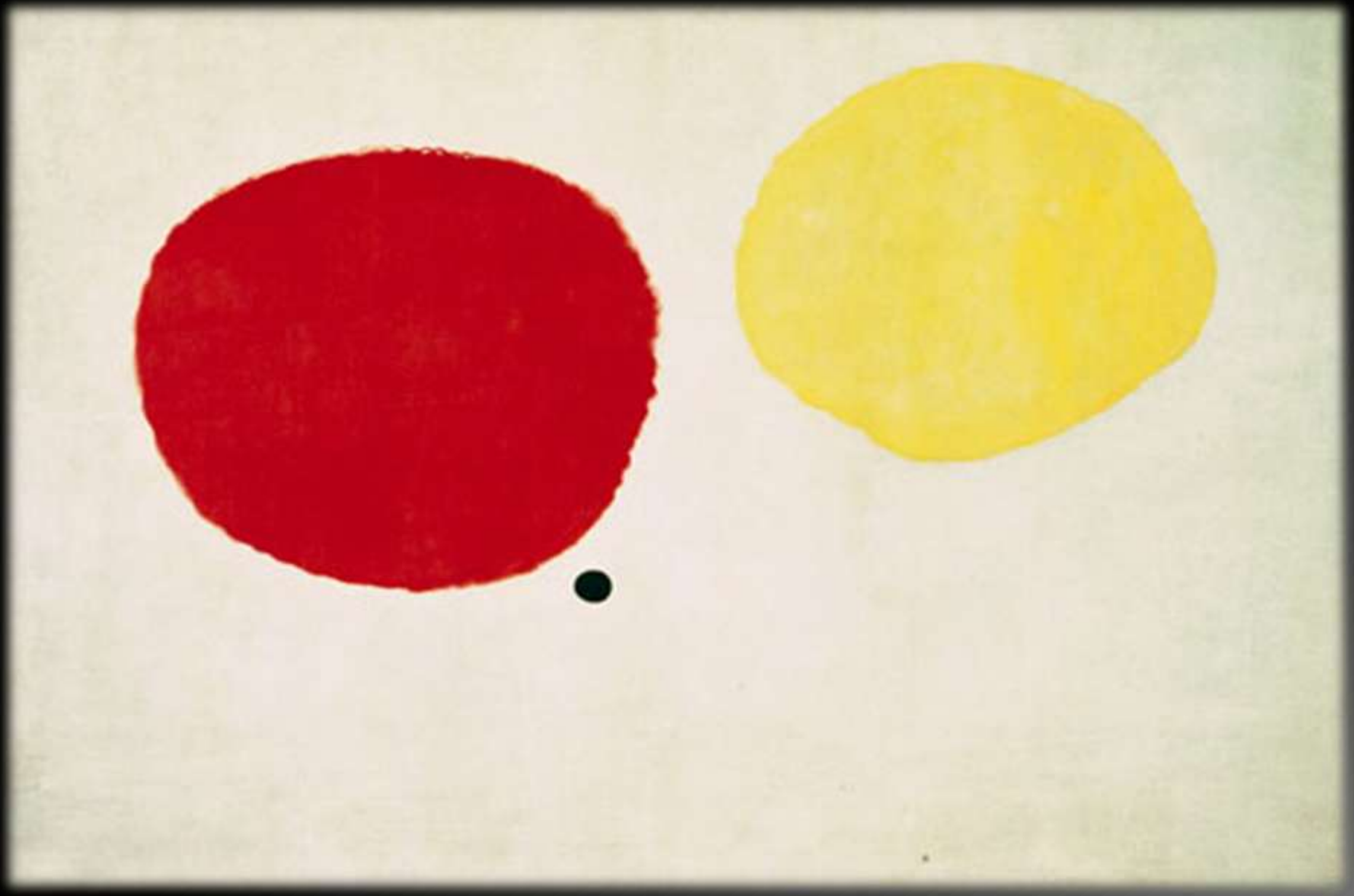
4 Perform crossover and mutation on the population.

5 Go to step 2 until some condition is satisfied.

What is... BEAUTY ???

How we establish fitness function if every person has different feelings, preferences, emotions

???



Solution for this:

Interactive evolution

technology

- embeds human preference, intuition, emotion, psychological aspects, or a more general term, KANSEI, in the target system

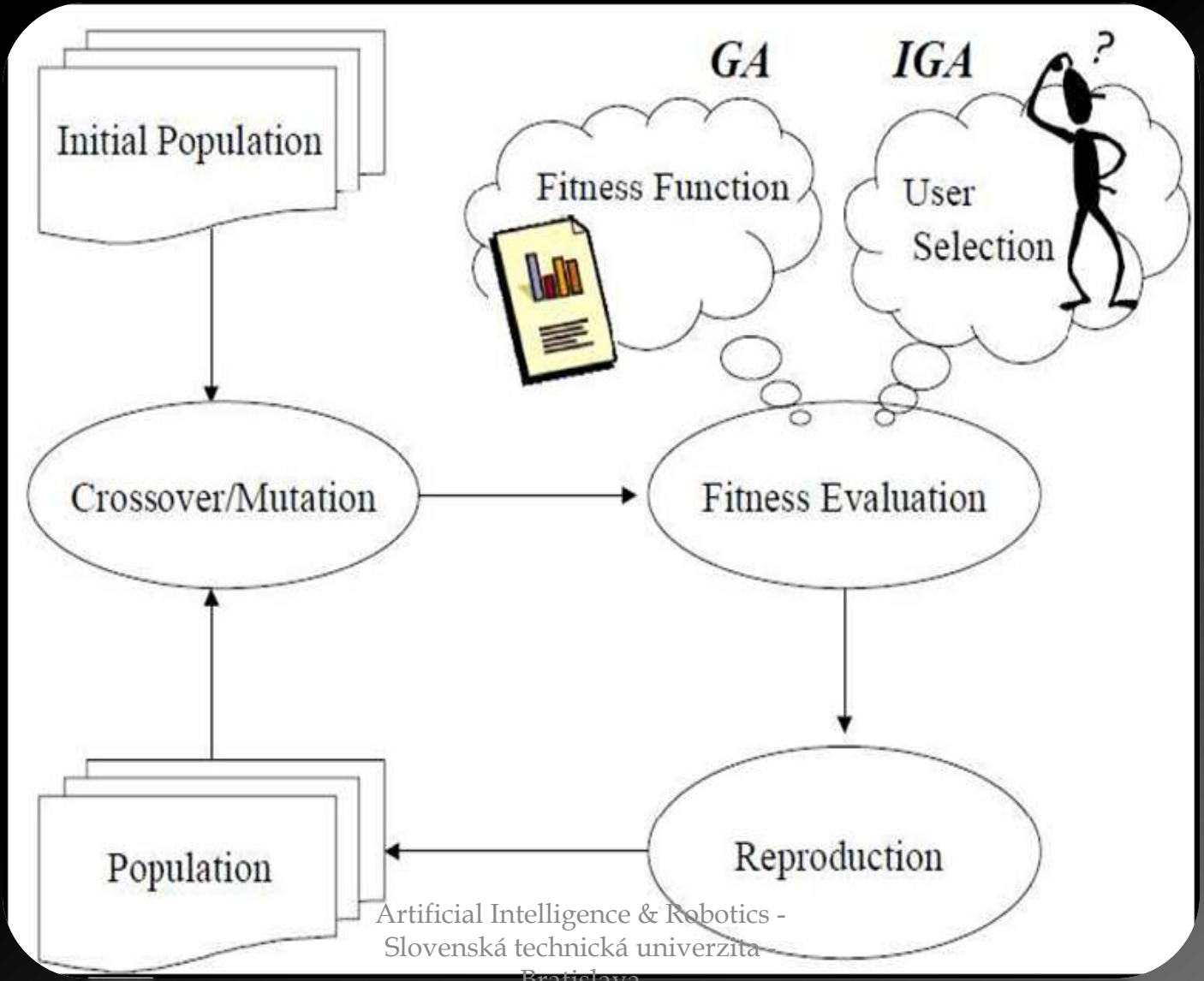
applications

- when the fitness function cannot be explicitly defined
- many applications

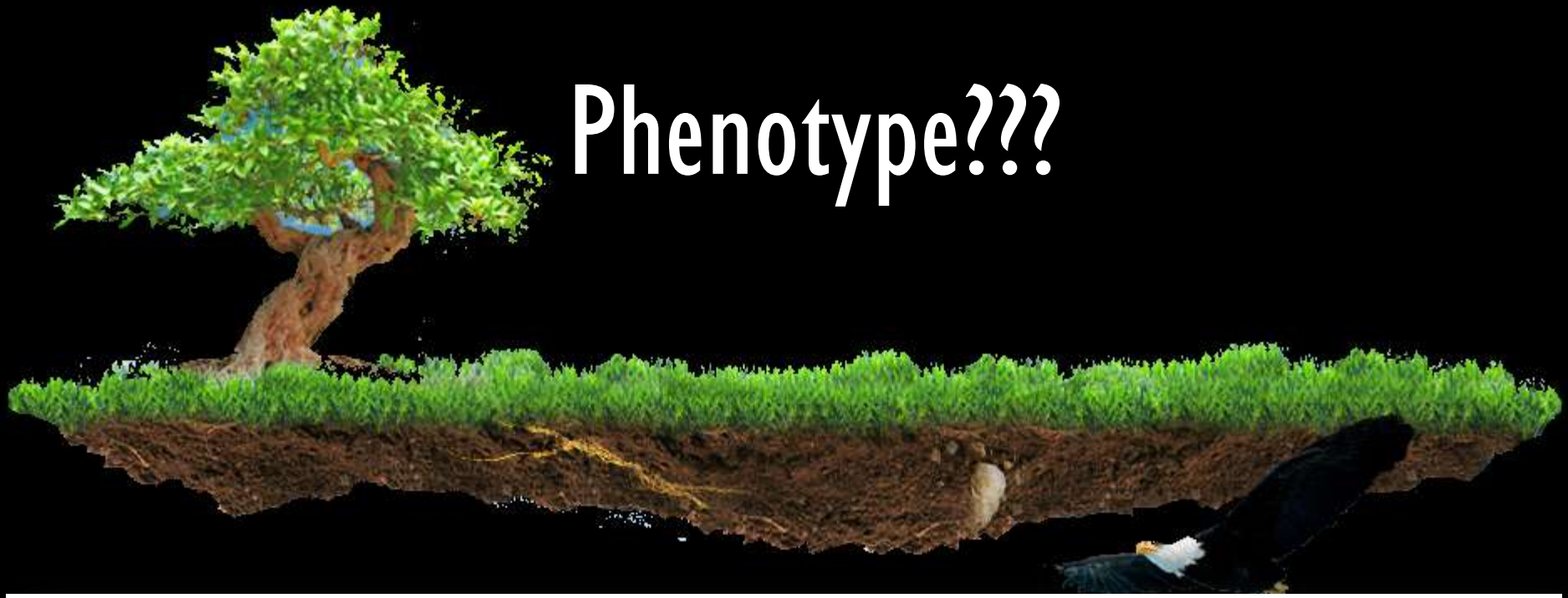
human's response as fitness value

- this enables algorithm to be applied to artistic domains, and we propose a dance choreography design aid system for humanoid robots using it

IEC : ak riešenie musí byť adaptované na individuálneho človeka alebo okolnosť



Phenotype???



rightElbowRoll	
leftElbowRoll	
rightElbowYaw	
leftElbowYaw	
rightShoulderRoll	
rightShoulderRoll	
leftShoulderRoll	
leftShoulderPitch	
HeadPitch	
HeadYaw	
rightElbowRoll	
leftElbowRoll	
rightElbowYaw	
leftElbowYaw	
rightShoulderRoll	
rightShoulderRoll	
leftShoulderRoll	
leftShoulderPitch	
HeadPitch	
HeadYaw	

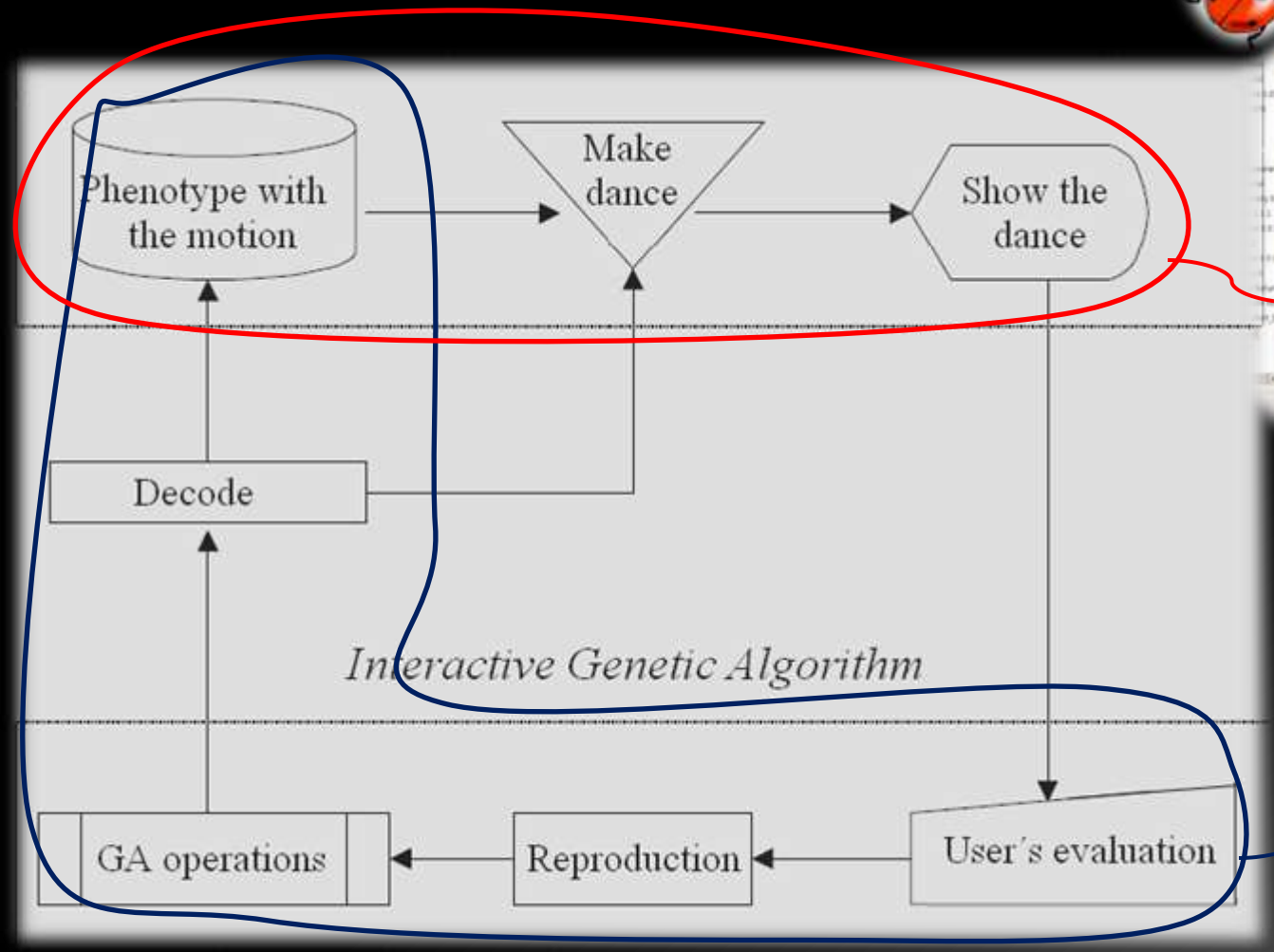
Každý parameter má nejaké prípustné hodnoty. Priestor definovaný tymito parametrami je karteziánsky súčin všetkých hodnôt všetkých parametrov. Pre N parametrov, každá N-násobnosť hodnôt je iný bod v prehľadávacom priestore:

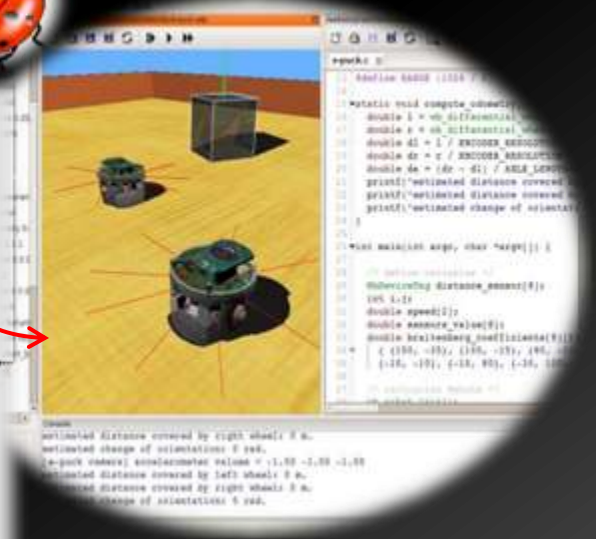
$$v_1, v_2, \ldots, v_N > \in P_1 \times P_2 \times \ldots \times P_N$$

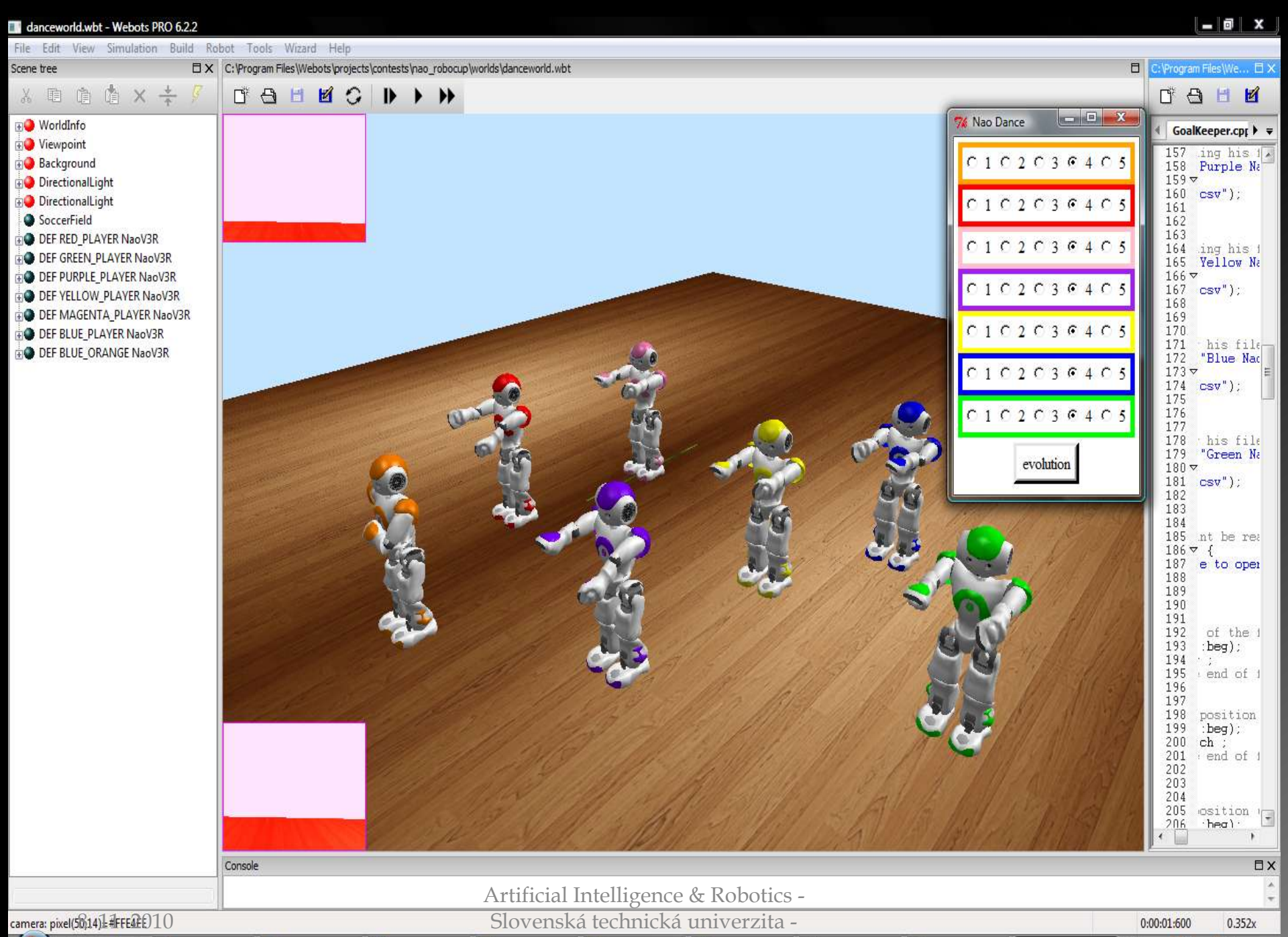
KOMBINATORICKÁ EXPLÓZIA

Bertin (1983): *„je potrebná viac trpezlivosť ako predstavivosť na generovanie 100 rôznych výtvorov z rovnakých dát“*

Our system


Phenotype with the motion
Make dance
Show the dance
Decode
Interactive Genetic Algorithm
GA operations
Reproduction
User´s evaluation




danceworld.wbt - Webots PRO 6.2.2
File Edit View Simulation Build Robot Tools Wizard Help
Scene tree
C:\Program Files\Webots\projects\contests\nao_robocup\worlds\danceworld.wbt
WorldInfo
Viewpoint
Background
DirectionalLight
DirectionalLight
SoccerField
DEF RED_PLAYER NaoV3R
DEF GREEN_PLAYER NaoV3R
DEF PURPLE_PLAYER NaoV3R
DEF YELLOW_PLAYER NaoV3R
DEF MAGENTA_PLAYER NaoV3R
DEF BLUE_PLAYER NaoV3R
DEF BLUE_ORANGE NaoV3R
Nao Dance
evolution
GoalKeeper.cpp
Console
camera: pixel(50,14)=#FFE4E1
0:00:01:600
0.352x

EXPERIMENTS

Subjects

20 students

Task

to design their choreography in simulation & on real humanoids

Process

They were shown examples & freely observed the robots in simulator and created their own dance.

Evaluation

evaluating the dances until they were satisfied with the generated dance or the algorithm convergated to one dance

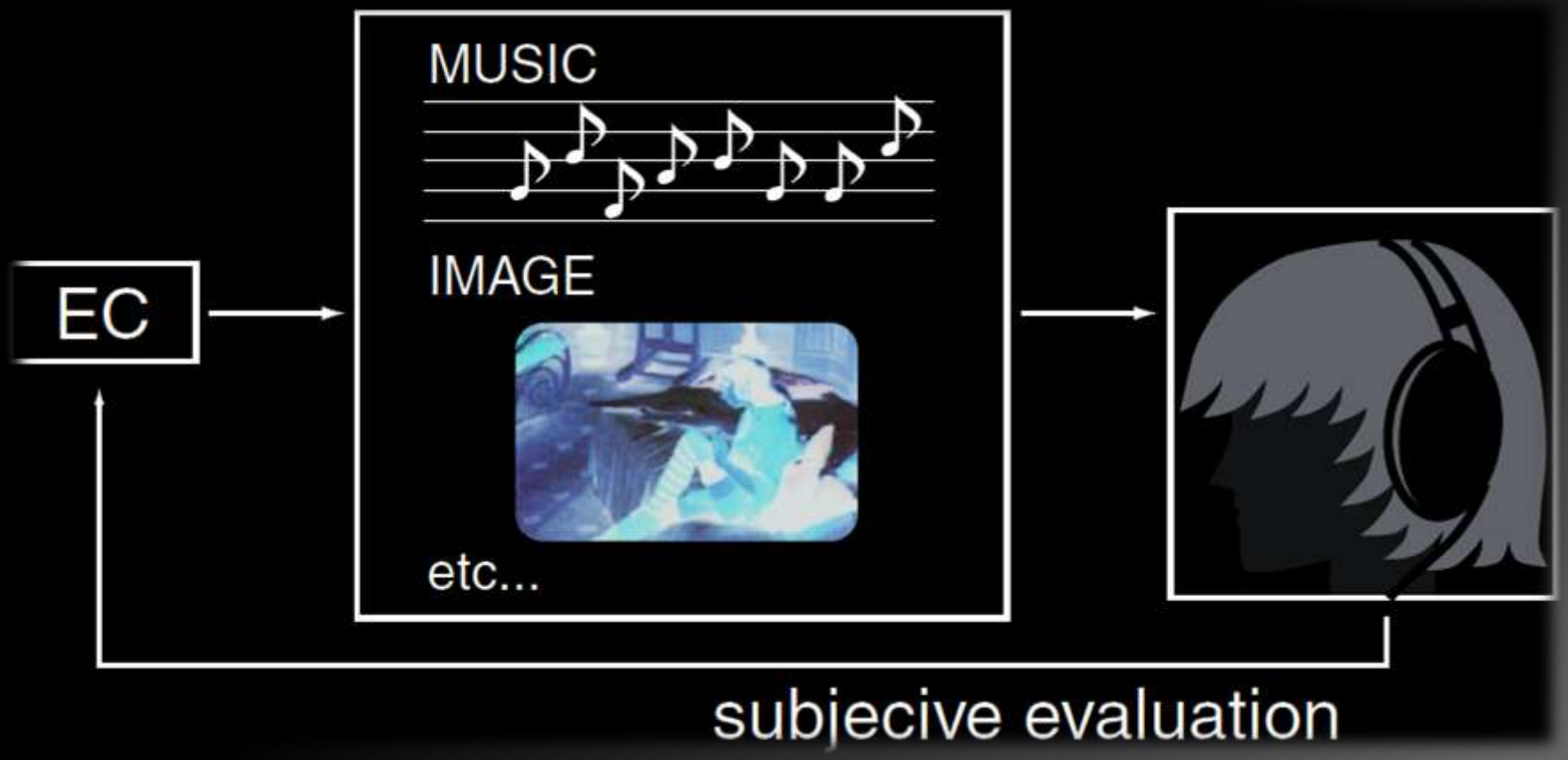
Results

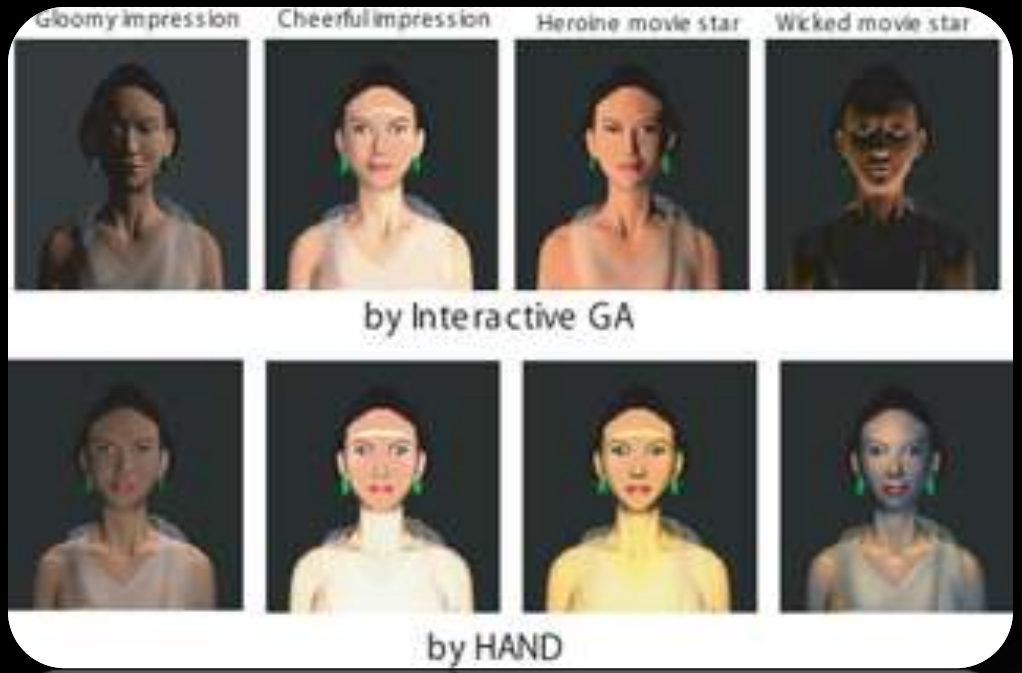
the GUI user-friendly

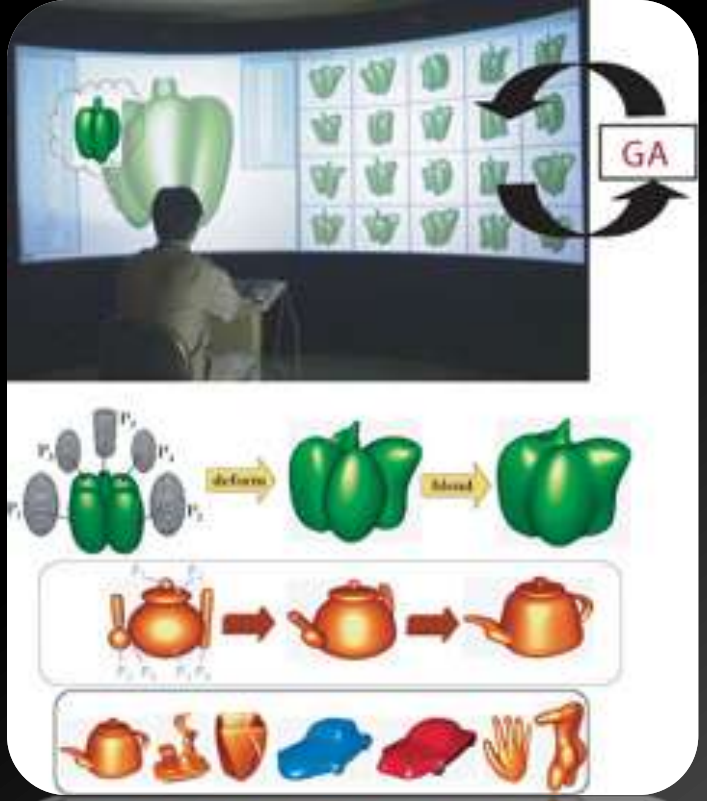
system is a helpful tool to create new robotic dance choreographies

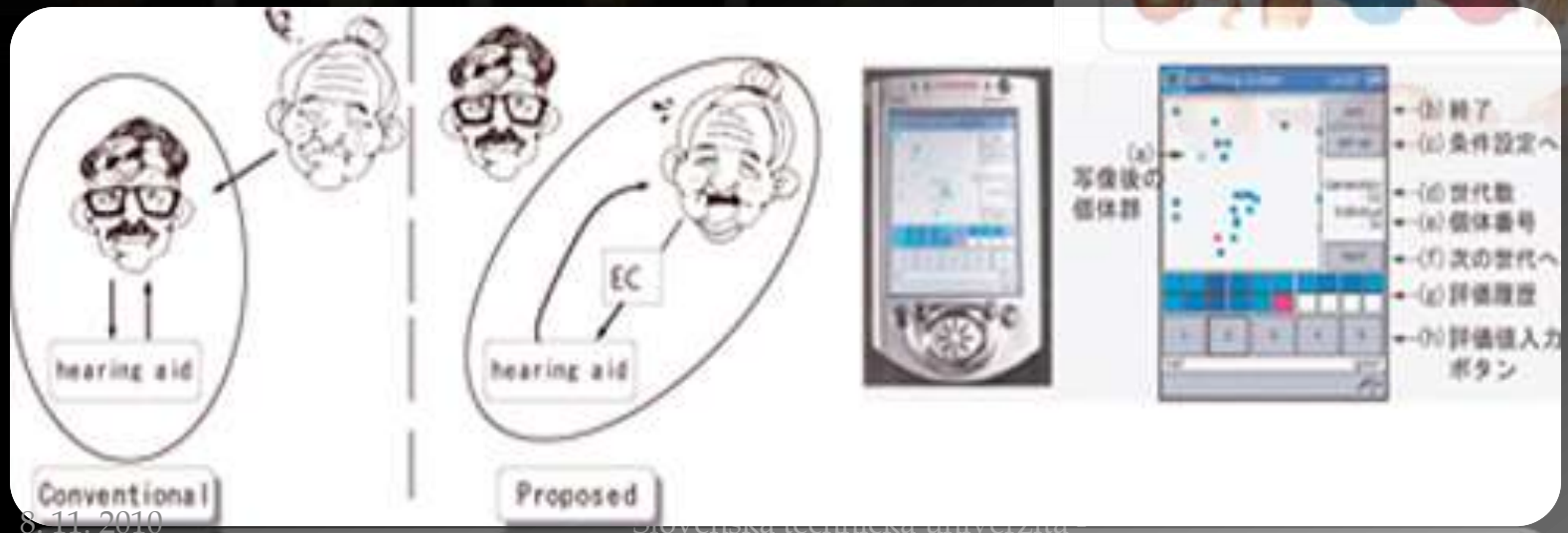
satisfactory solution with fewer searching generations: tasks do not require a large number of generations to achieve satisfactory results

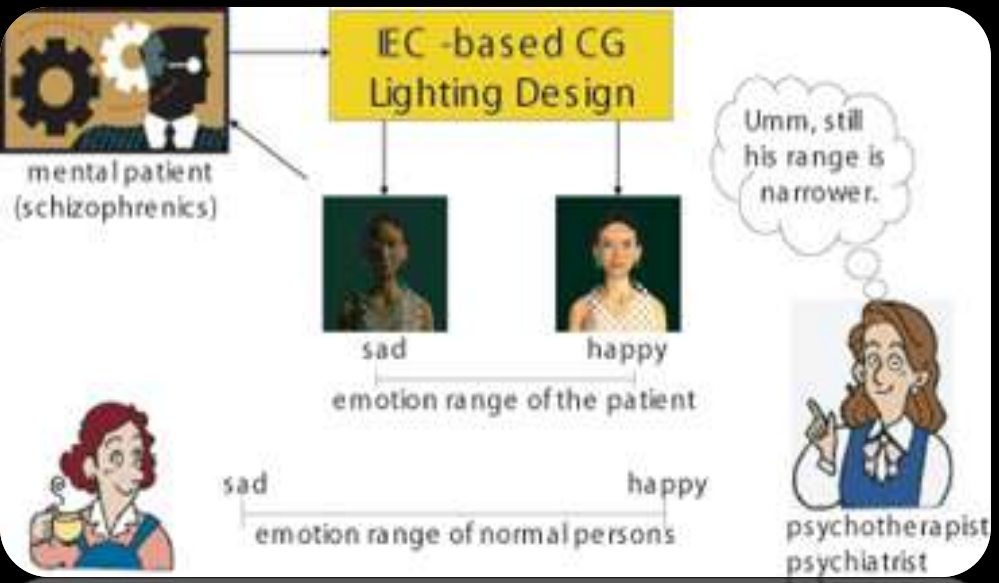
Applications IEC

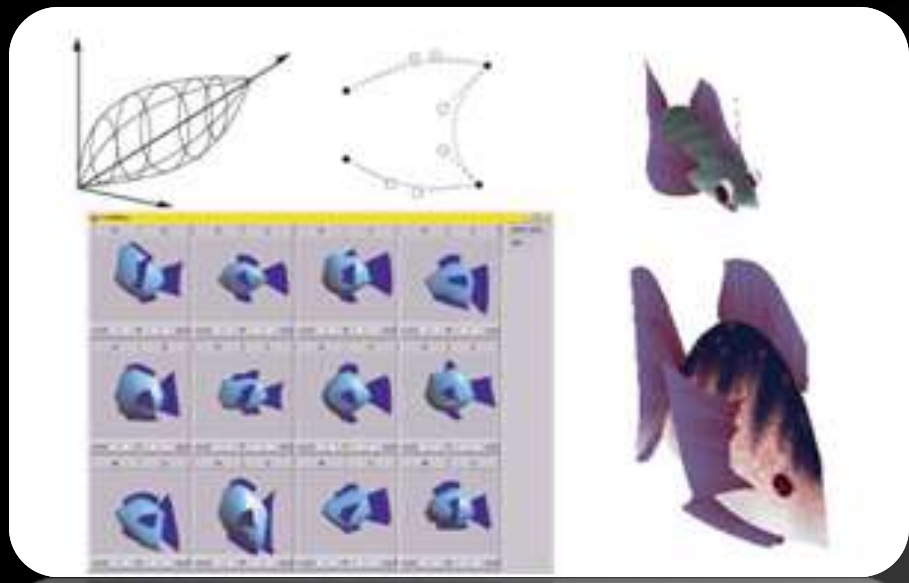


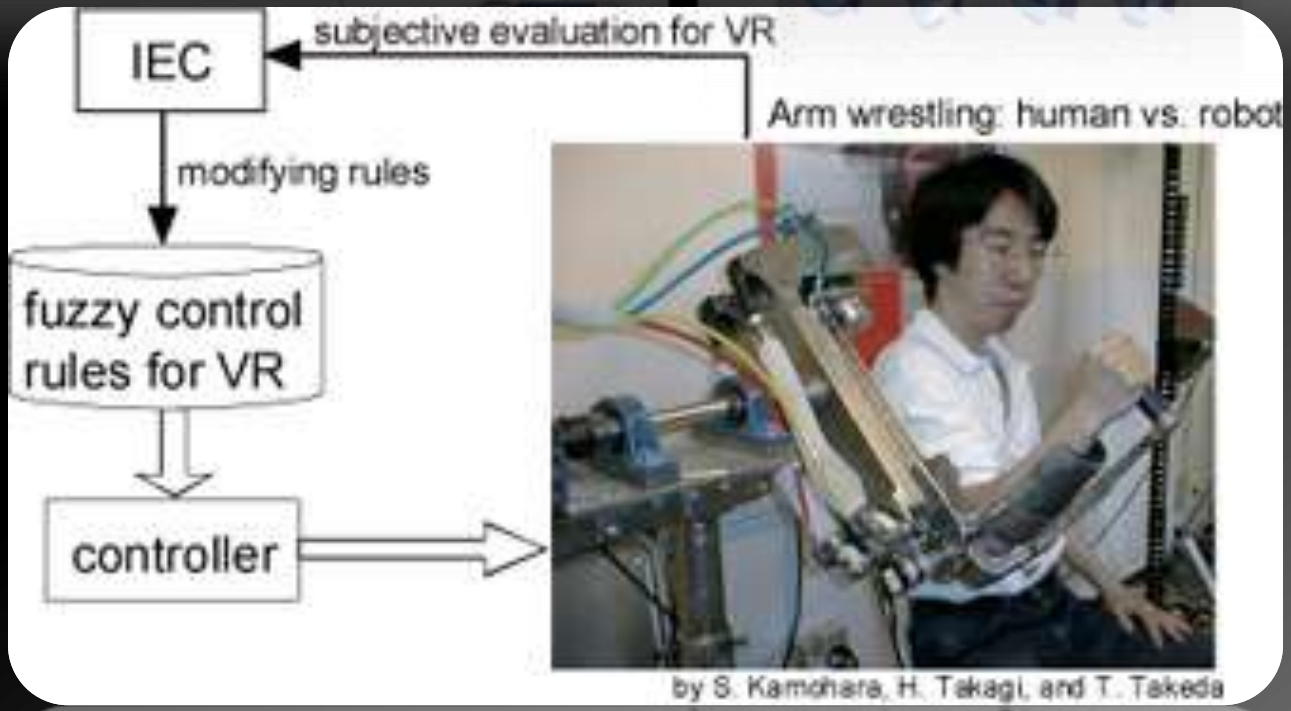

Gloomy impression
Cheerful impression
Heroine movie star
Wicked movie star
by Interactive GA
by HAND


GA


hearing aid
Conventional
EC
hearing aid
Proposed


IEC -based CG
Lighting Design
mental patient
(schizophrenics)
sad
happy
emotion range of the patient
Umm, still
his range is
narrower.
sad
happy
emotion range of normal persons
psychotherapist
psychiatrist




IEC
subjective evaluation for VR
modifying rules
fuzzy control
rules for VR
controller
Arm wrestling: human vs. robot
by S. Kamohara, H. Takagi, and T. Takeda

IEC robotic dance

http://www.youtube.com/watch?v=bLdPVxeXwuU

V. WHAT I WANT TO DO

Our dream or ... our future?

is for Nao to acquire its own mental model of people.

(Currently, he does not reason about the emotional state of others. We want to extract the information about the own preferences of human during his evaluation of the behavior of the robot in the IEC and make this process autonomous.)

Collaboration with Microsoft:
Kinect for Learning from Observation (Imitation) for Nao

http://www.youtube.com/watch?v=Mf44bWQr3jc

„Alter Ego“ of Nao

The robot learns by examples given to his avatar. He is able to extract the information of his avatar and model the user´s behavior.

1. connection between Nao and - create an avatar of the robot, his virtual body - his identity in cyberspace.

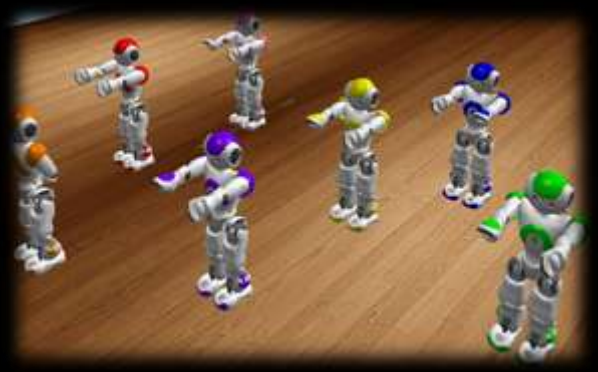
   environment for interaction between user and the avatar of the humanoid robot,

2. project this information into a robot

   Kinect would be like augmented space of the robot´s personality.

TO SUM UP...

(or if you remember just 1 thing from my presentation)



make robots more personal in interacting with humans - every person can **adapt** the robot´s behaviour in accordance to his own expectations and preferences using interactive evolution

More about Interactive Evolution...

www.design.kyushu-u.ac.jp/～takagi/TAKAGI/IECpaper/IIZUKA98.pdf

Artificial Intelligence & Humanoid Robotics

or

getting robots closer to people
making them (robots:) intelligent

Thank you