On Benchmarking Benchmarking

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The Power of Dreams

On Benchmarking Benchmarking

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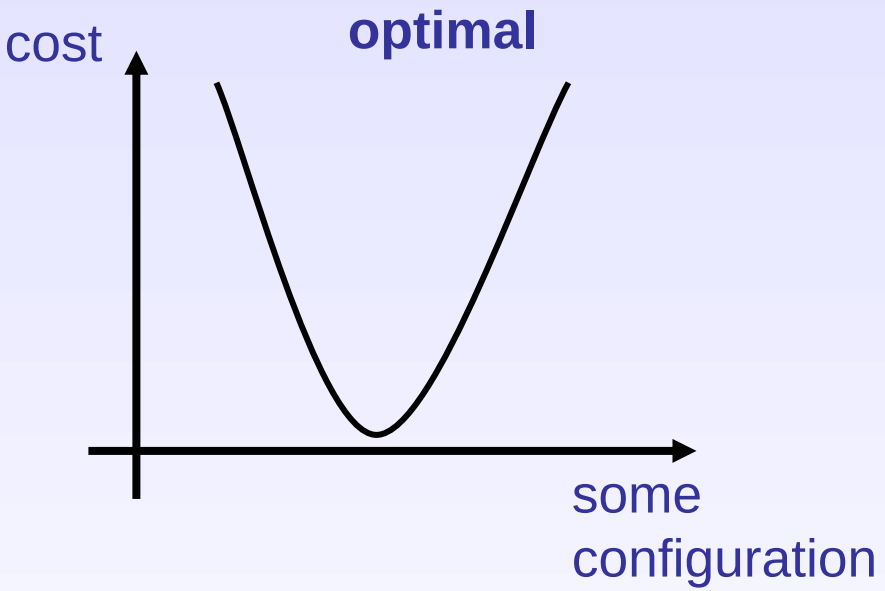
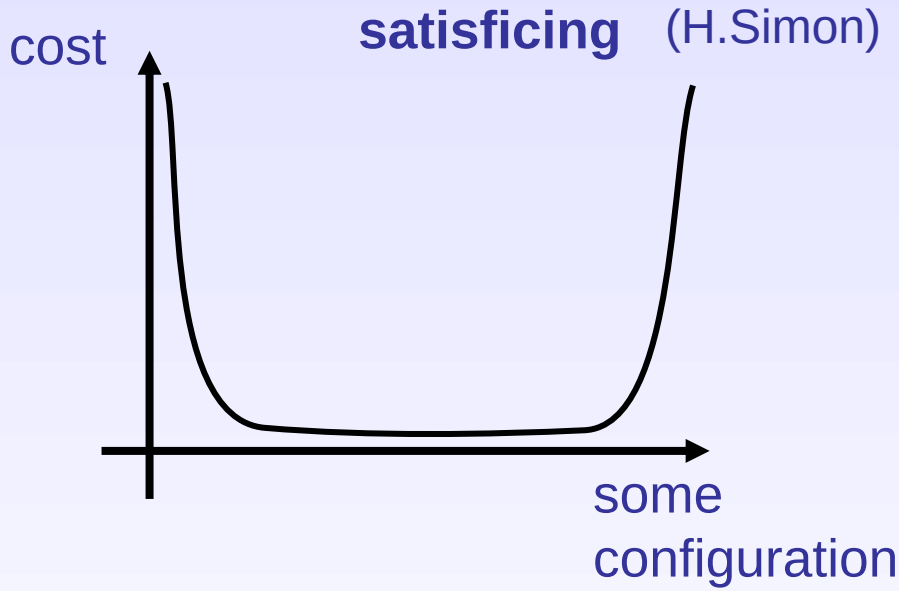
What are abstract requirements in cognitive robotics and how can they be transformed into benchmarks?

- robustness
- learning & autonomous development
- flexibility
- cognitive diversity
- openness of representations
- ... your favorite here ...

i.e. the issues we admire our own brains for ... maybe not so easy to formalize ...

Optimality vs. Satisficing





traditional engineering design:

- target for one optimal solution
- broader optimum for robust solution

natural cognitive systems:

- have viability range
  e.g. homeostasis
- allow for several solutions to one problem

Satisficing: “As long as it does it within acceptable bounds it is ok.”

Specificity vs. Generality

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- Specific solution always outperform general solutions on fixed tasks (e.g. on benchmarks)
- nevertheless, general solution that can be adapted to any task are preferred

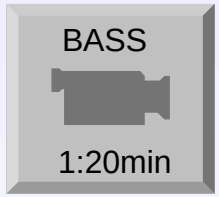
→ benchmarks should include the requirement for adapting one system to qualitative different tasks

robo soccer: changing requirements over a longer time scale with similar goal

Value of error recovery / treatment

- What kind of value do we attribute to errors the system can overcome?

[video shows interactive error correction during online learning of visual object]



- Distinguish between
  - playful learning (where errors are necessary) and
  - hard evaluation (where errors are maybe not acceptable).
- benchmarks should account for this

Intermediate Process Benchmarking I

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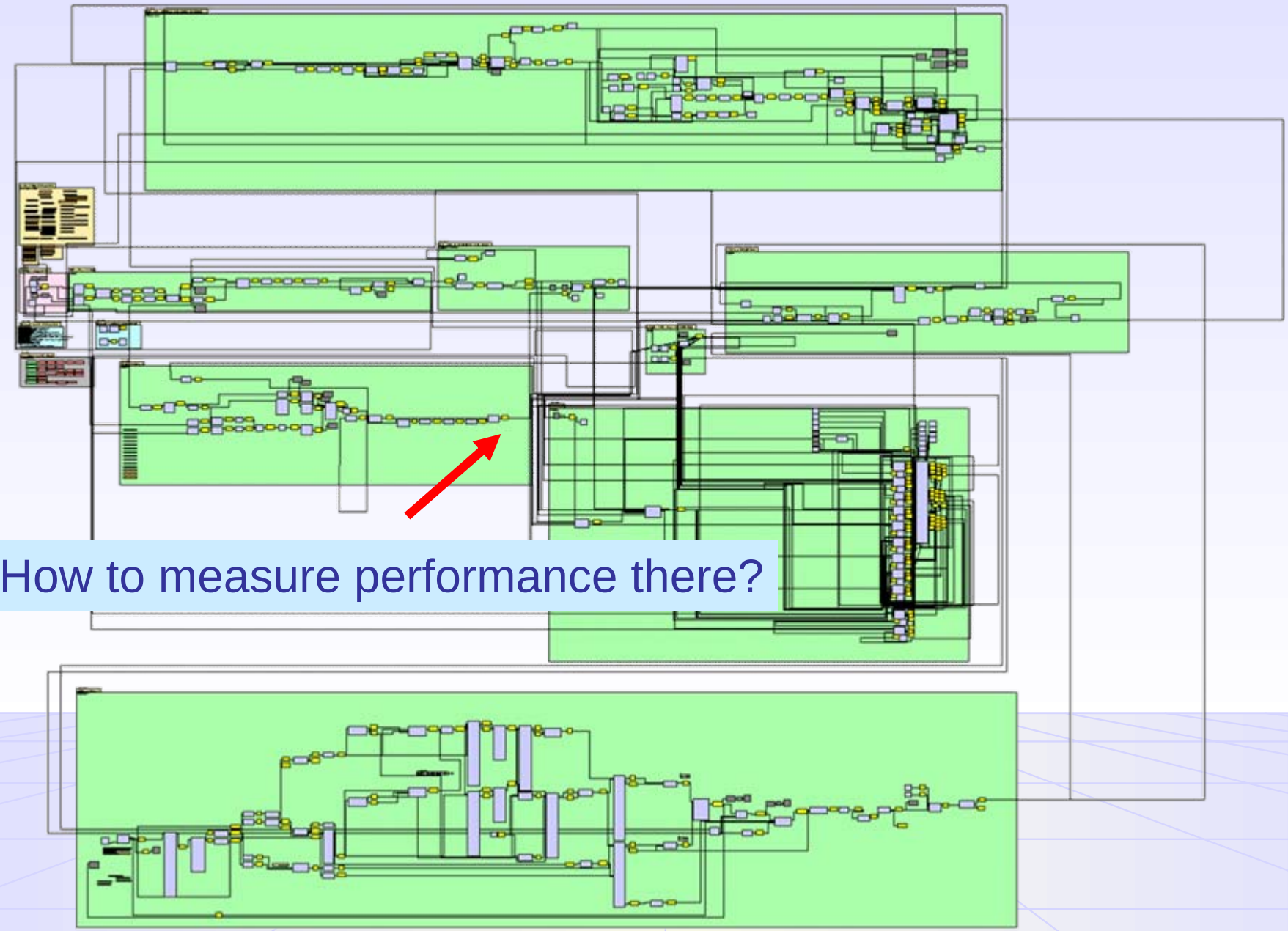

How to measure performance there?

Intermediate Process Benchmarking II

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- Independent optimization of intermediate results may not contribute to a good overall performance

  → classical credit assignment problem

  → build and evaluate complete systems

- intermediate benchmarking must be congruent with the overall processing

  example: statistical covering of input and optimizing reconstruction error maybe unsuited for solving any tasks

→ intermediate benchmarking is maybe necessary but never sufficient

Static vs. Dynamic Benchmarks

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- **static benchmarks** := system does not influence sensory data, e.g. image databases, good for papers or baseline comparison
- **dynamic benchmarks** := system influences the generation of the sensory data, e.g. active camera on humanoid robot, interactive scenarios, closed loop systems
- Dynamic benchmarks may include situations where the predictions of the system fail
  → interesting case, learning starts here
- good static performance does not guarantee a good dynamic performance

→ target dynamic interaction as early as possible

Temporal coherence of systems I

- -- or – do we always want to start from scratch?
- For one specific scenario / task infinitely many systems can be build (e.g. look at Alife wrt. locomotion, result from theory of nonlinear dynamical system)

→ sequence of scenarios itself does not lead to temporally congruent series of incremental systems

Temporal coherence of systems II

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→ three different views, related, each with a temporal sequence

- **Method oriented:** quality of the internal methods, e.g. vision recognition, motion control
- **Skill oriented:** capabilities of the overall system, observable, independent of context
  e.g. inspection and manipulation of proto-objects
- **Scenario oriented:** context to show a capability
  e.g. learn what my cup looks like and fetch it later from the cupboard

→ Benchmark is often just one view to a system (e.g. scenario),

neglecting the other views may lead to an inferior system

Natural benchmarks?

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- Since we are targeting for cognitive systems, aren't there "benchmarks" for natural cognitive systems?
- Screening tests for development of children?
  - focus primary on sensing and development of the body, cognitive skills are focused on later
  - time line is not clear, variance of occurrence of a specific skill is in the order time of the occurrence itself
  - e.g. speaking starts between 12 month and 24 month, walking starts between 10 month and 24 month
- Psychology
  - I.Q. tests etc.
  - currently far beyond abilities of technical systems

What do we do at HRI-EU?

- pursue analysis by synthesis approach for understanding real cognitive systems
- follow the biological paradigm in various levels
- check system performance in skill level
  - Method oriented: quality of the internal methods
  - Skill oriented: capabilities of the system, observable, independent of context
  - Scenario oriented: context to show a capability

EBI - Embodied Brain-Like Intelligence

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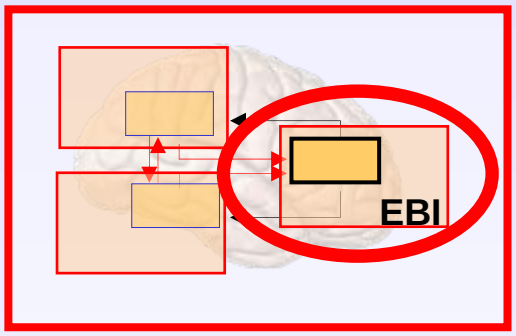
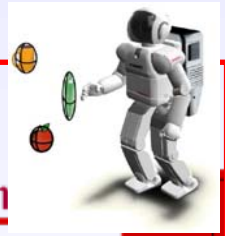


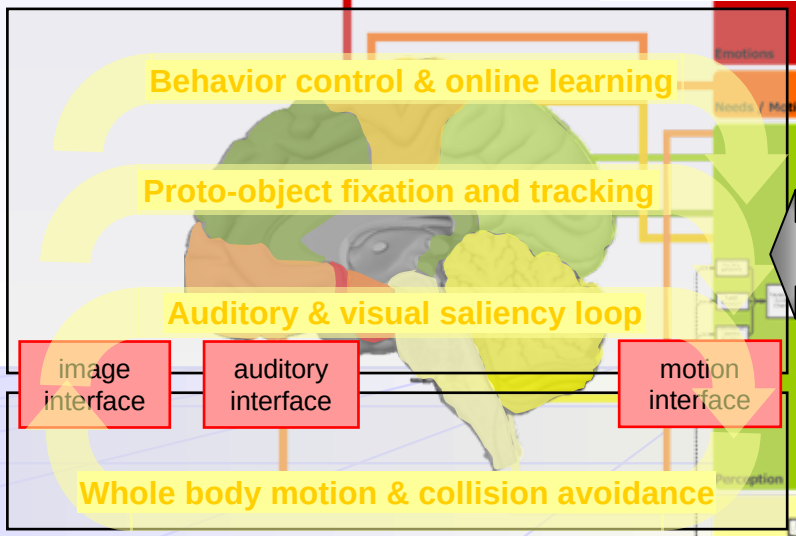
Objectives

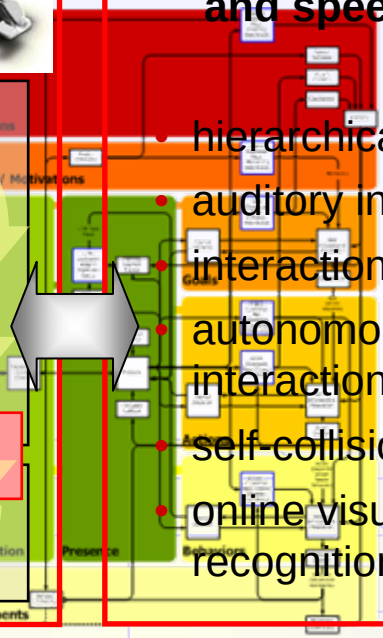
- develop individual cognitive abilities based on practical experience
- evolve system from initially few innate abilities towards an autonomous compliant partner

- **Autonomous Learning & Interaction System (ALIS) on ASIMO**



Building a coherent system





- **Integrated system for vision, behavior and speech I/O comprising**
  - hierarchical processing architecture
  - auditory interaction initiation
  - interaction related object representation
  - autonomous behavior generation and interaction
  - self-collision free online whole body motion
  - online visual object learning and recognition

Episodes 2:00 | NoCut 2:42 | Internal 5:58 | External 4:45

Thank you for sharing our thoughts