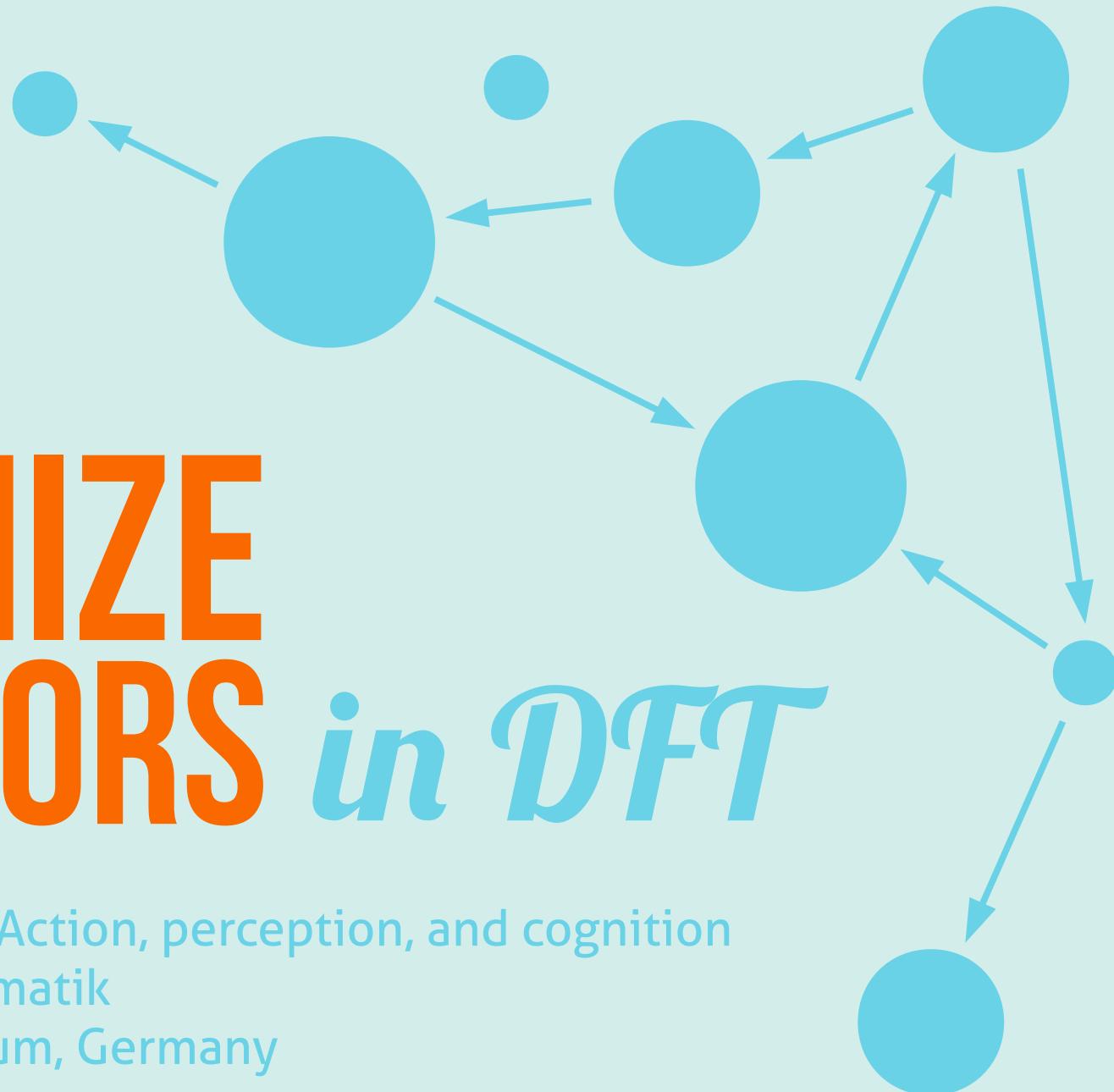


How to ORGANIZE BEHAVIORS in DFT

Autonomous robotics: Action, perception, and cognition
Institut für Neuroinformatik
Ruhr-Universität Bochum, Germany
June 01, 2017

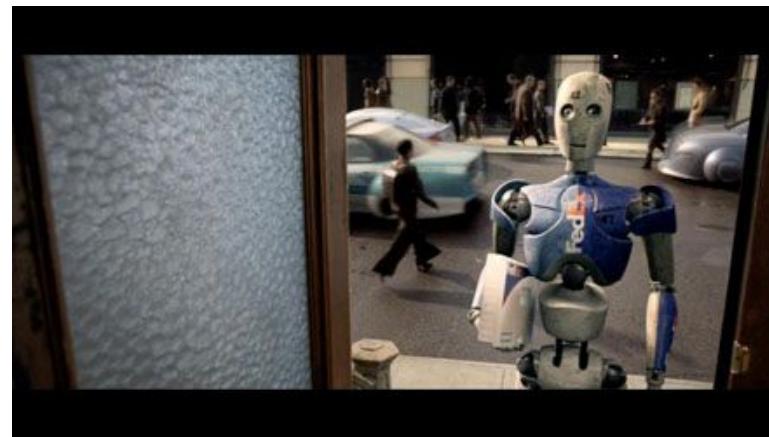
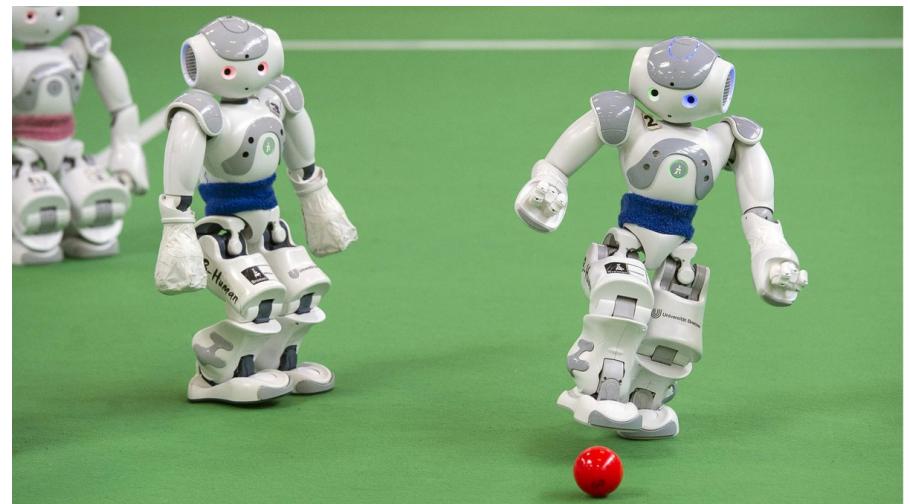


Mathis Richter

ORGANIZING *behaviors*



ORGANIZING *behaviors*



```
if (hungry)  
{  
    eat();  
}
```

```
if (hungry)
```

```
{  
    eat();  
}
```

BEHAVIOR

ORGANIZATION

```
if (hungry)  
{  
    eat();  
}
```

BEHAVIOR

ORGANIZATION



BEHAVIOR

CONDITION

NEURONS



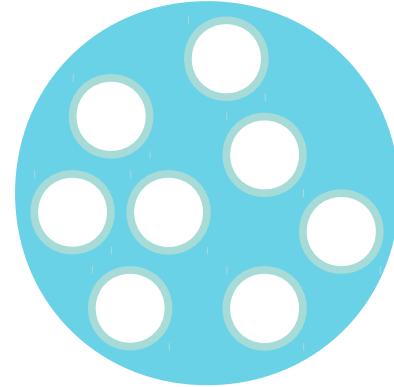
NEURONS



“hungry?”

NEURAL *dynamics*

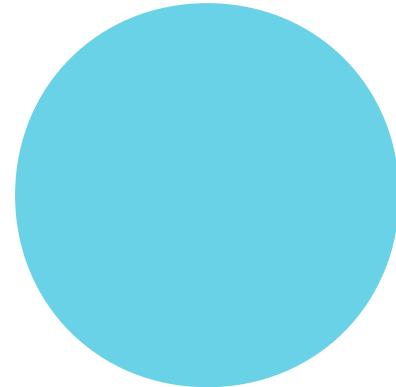
NEURAL NODE



“*hungry?*”

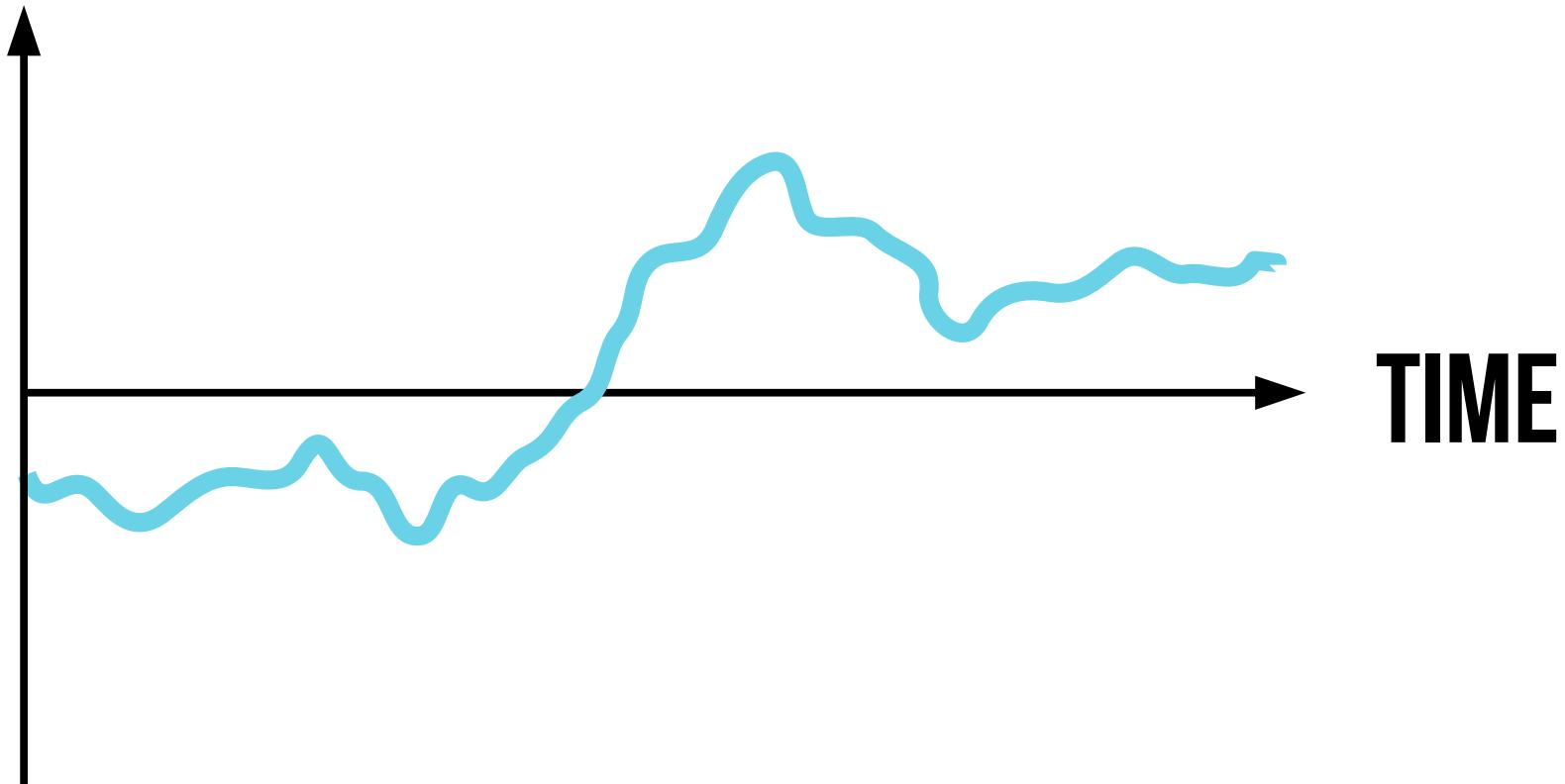
NEURAL *dynamics*

NEURAL NODE

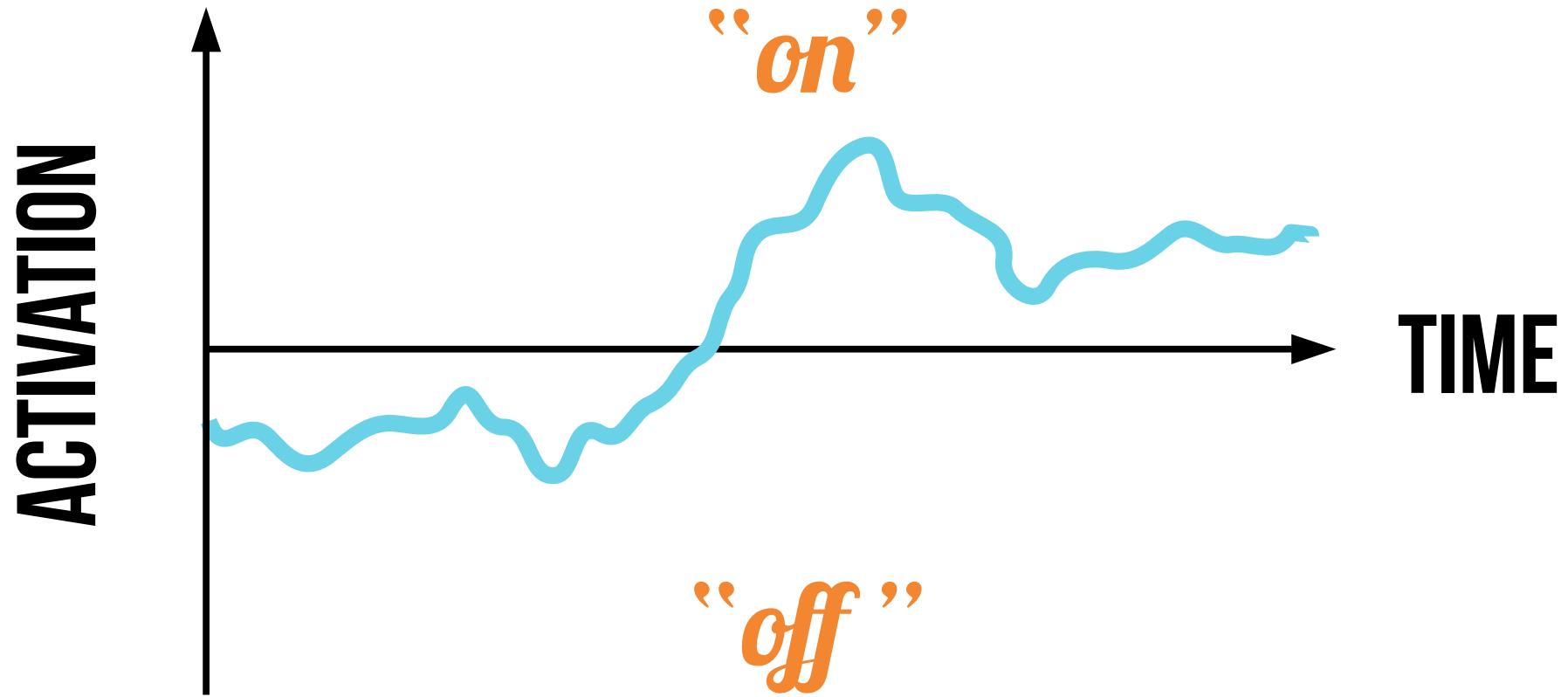


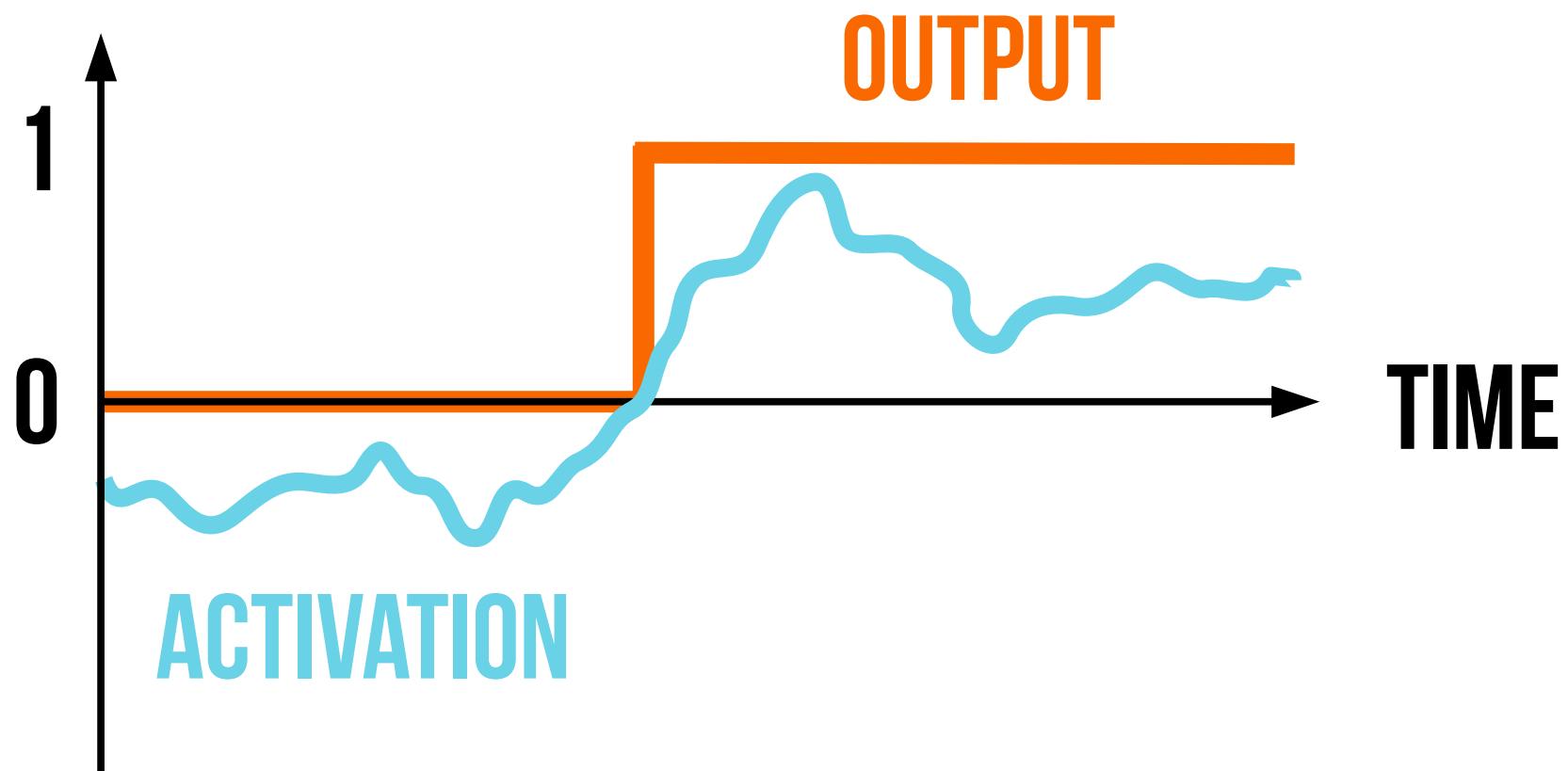
“*hungry?*”

ACTIVATION



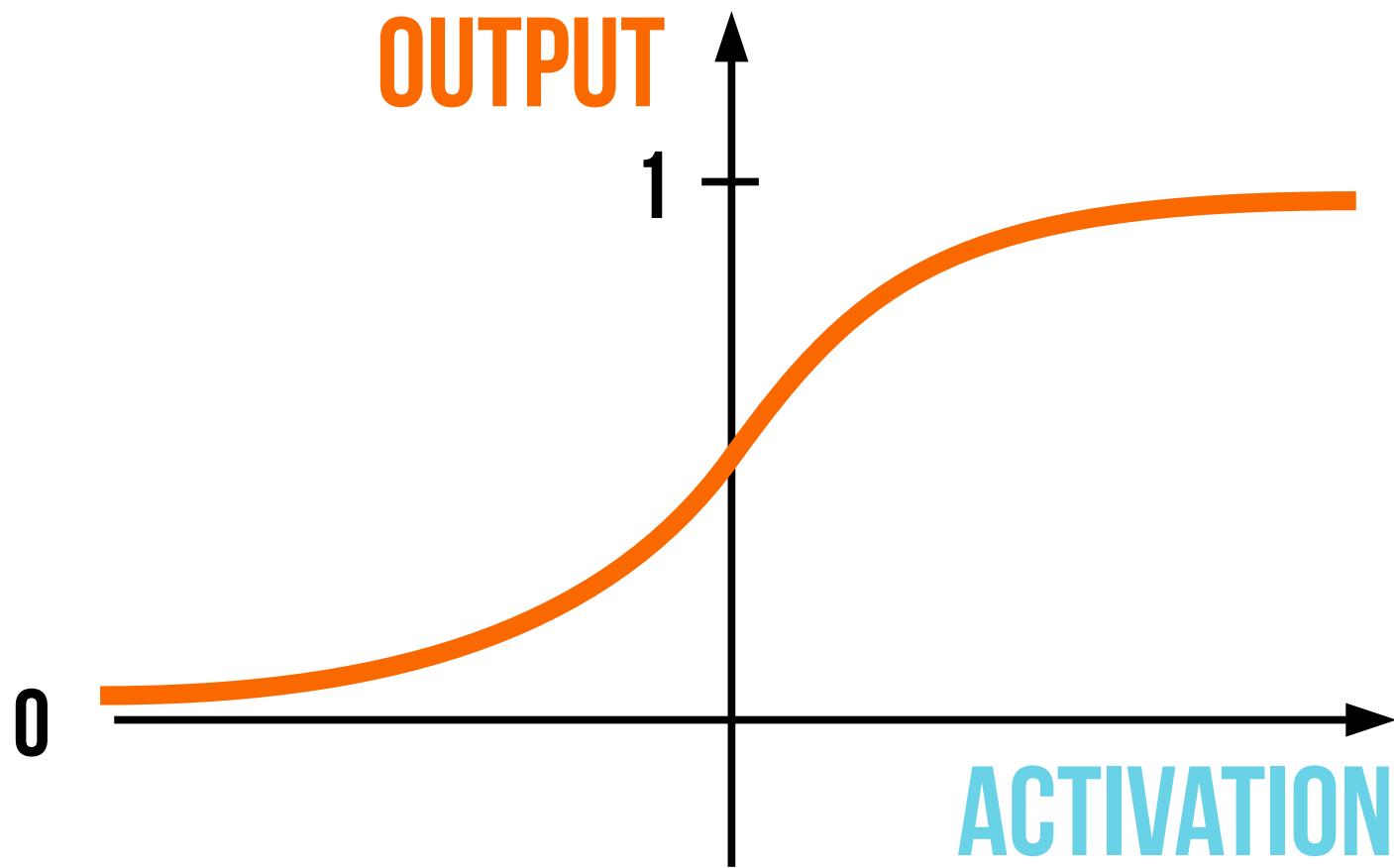
TIME



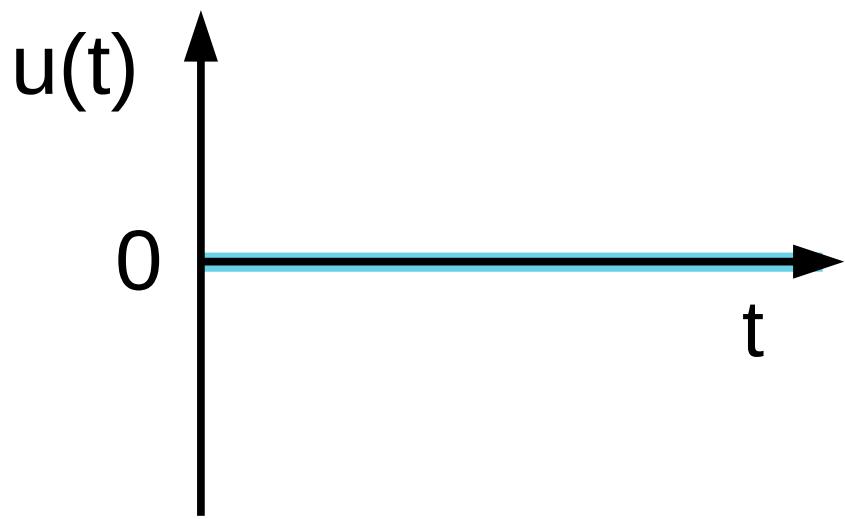


SIGMOID

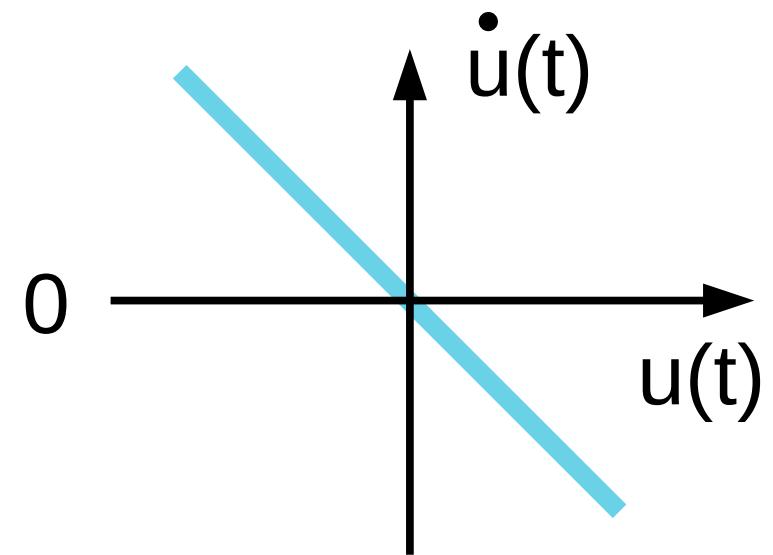
function



$$\tau \dot{u}(t) = -u(t)$$

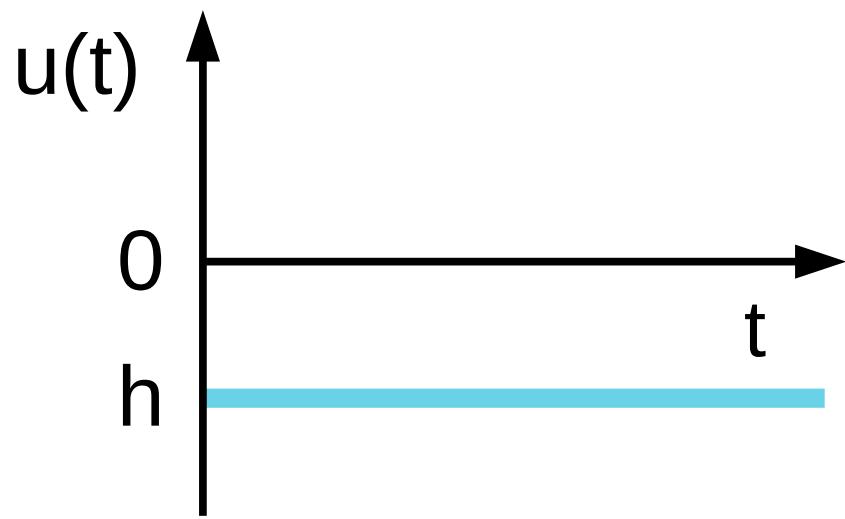


TIME COURSE PLOT

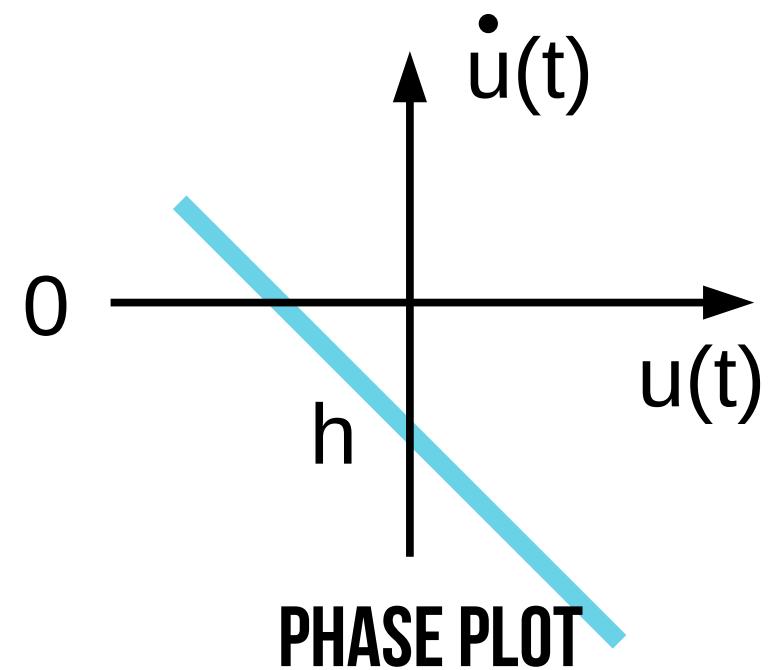


PHASE PLOT

$$\tau \dot{u}(t) = -u(t) + h$$

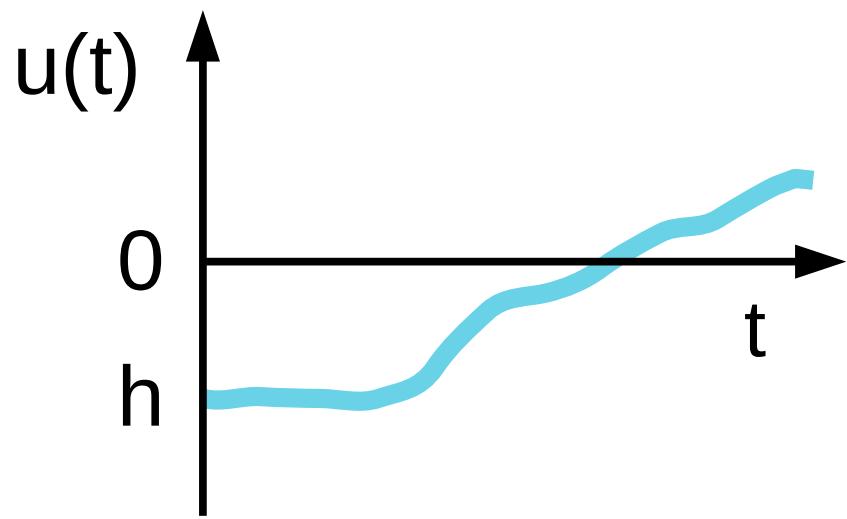


TIME COURSE PLOT

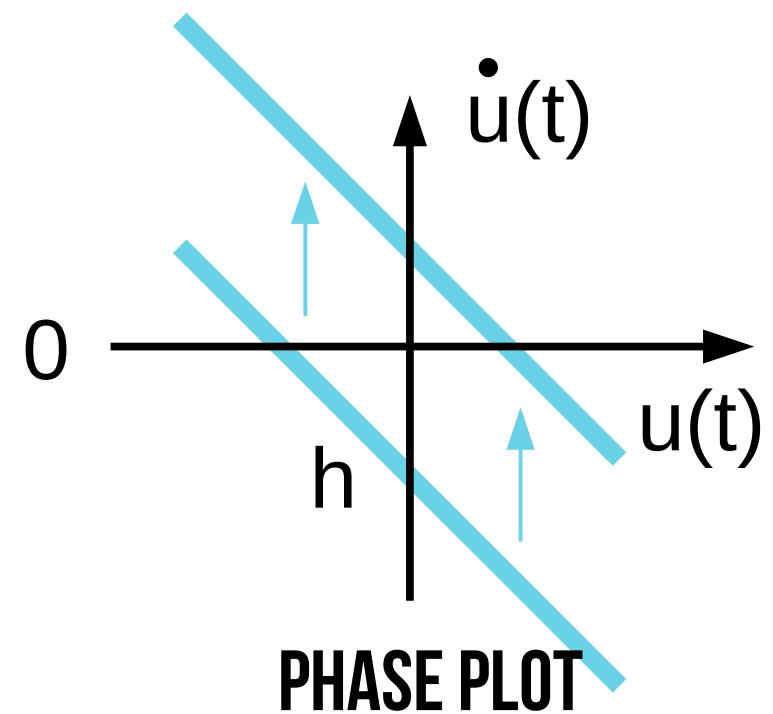


PHASE PLOT

$$\tau \dot{u}(t) = -u(t) + h + s(t)$$



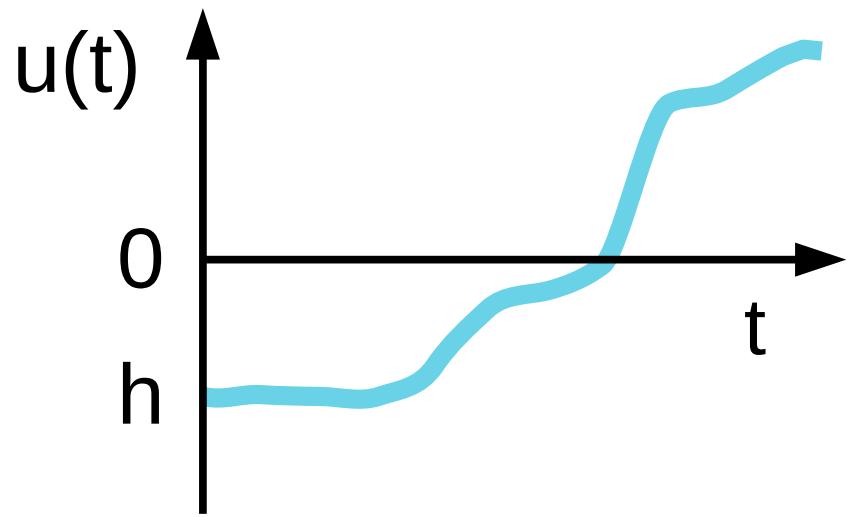
TIME COURSE PLOT



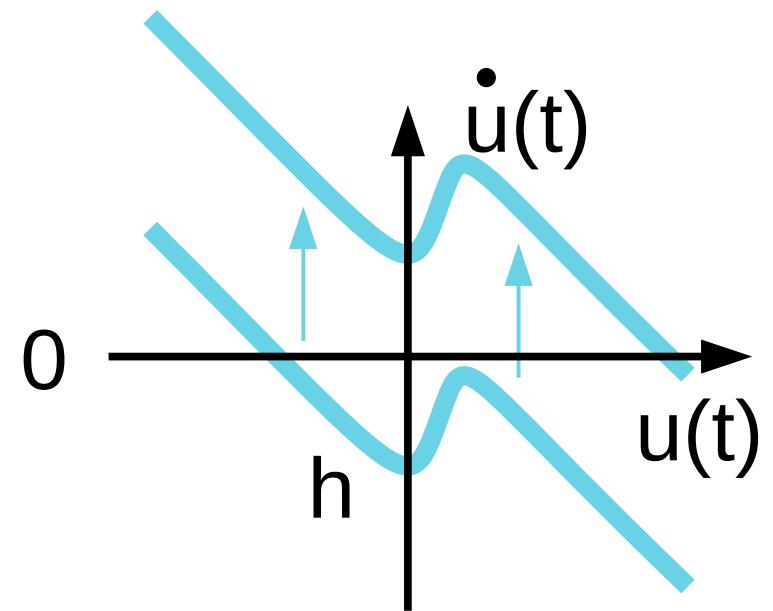
PHASE PLOT

$$\tau \dot{u}(t) = -u(t) + h + s(t)$$

$$+ w_{\text{se}} \cdot g(u(t))$$



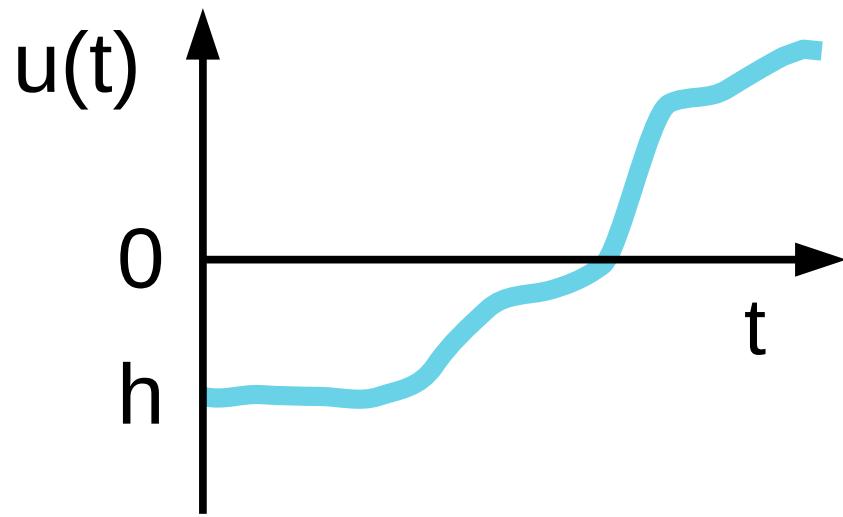
TIME COURSE PLOT



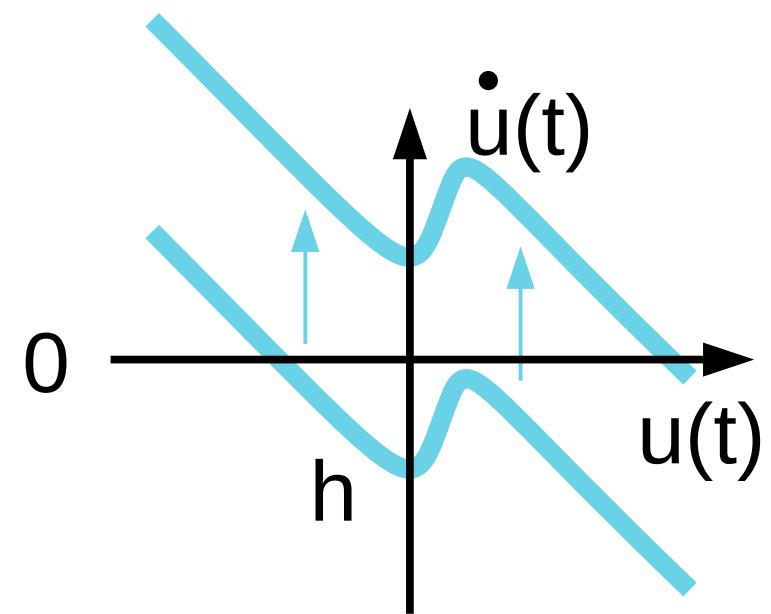
PHASE PLOT

$$\tau \dot{u}(t) = -u(t) + h + s(t)$$

$$+ w_{\text{se}} \cdot g(u(t)) + w_{\xi} \cdot \xi(t)$$



TIME COURSE PLOT



PHASE PLOT

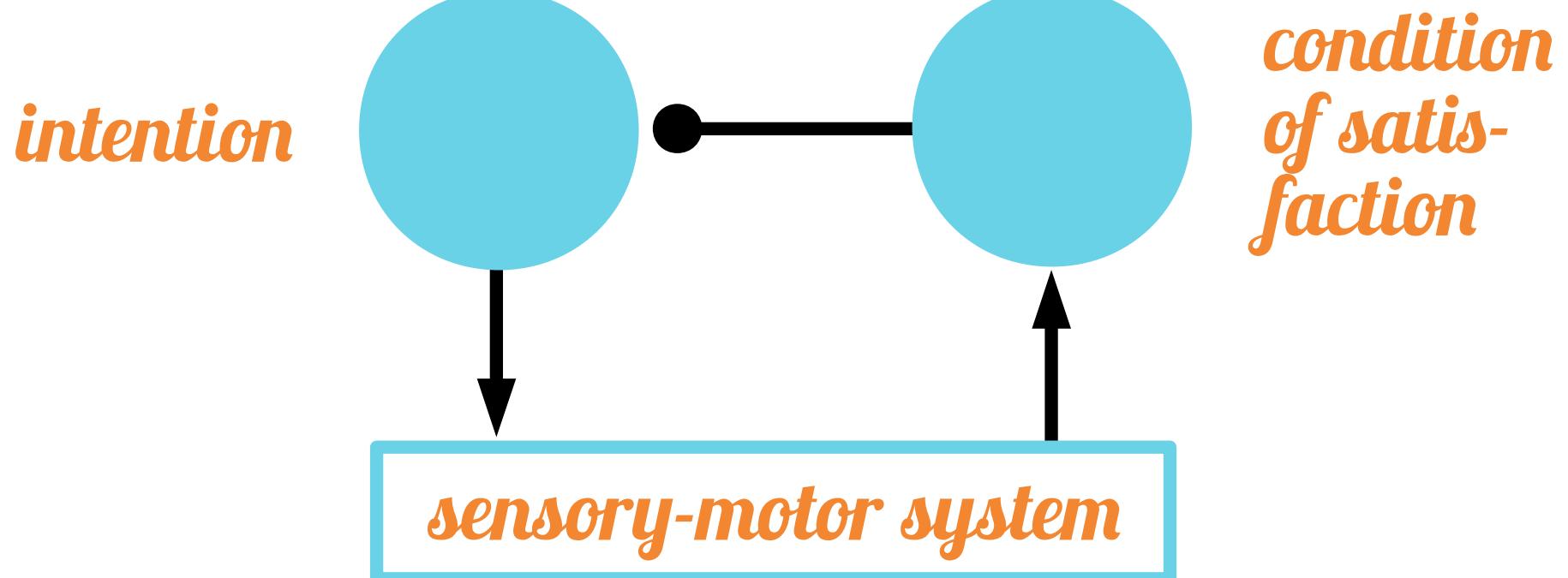
SIMULATIONS OF *discrete nodes*

```
if (hungry)
```

```
{  
    eat();  
}
```

BEHAVIOR

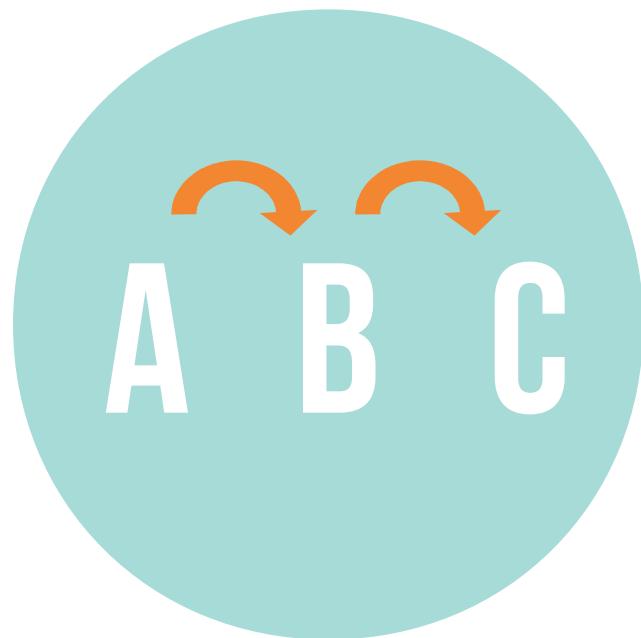
Elementary BEHAVIOR



ORGANIZATION

```
if (hungry)
{
    eat();
}
```

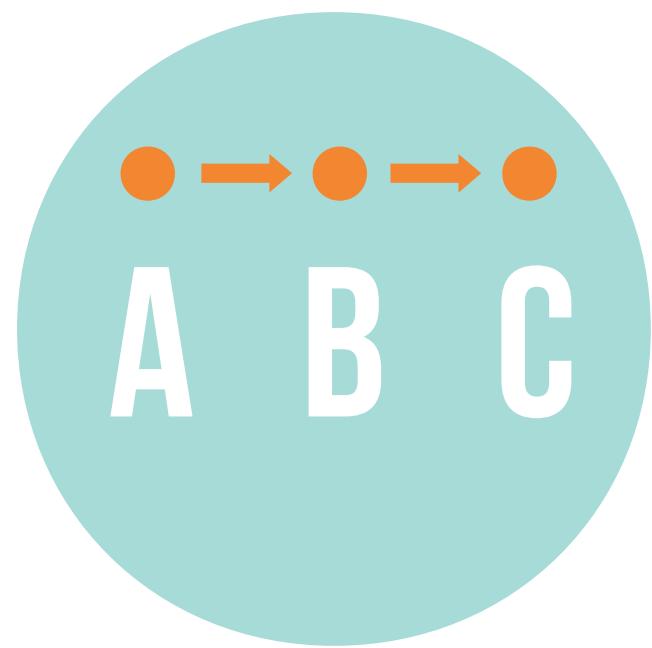
3 COGNITIVE MODELS *of sequences*



chaining



ordinal



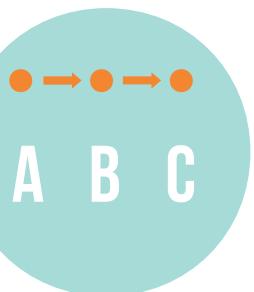
positional

(Henson, 1998)

2 TYPES *of organization*

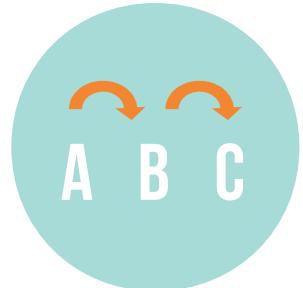
1

Serial order



2

Behavioral organization

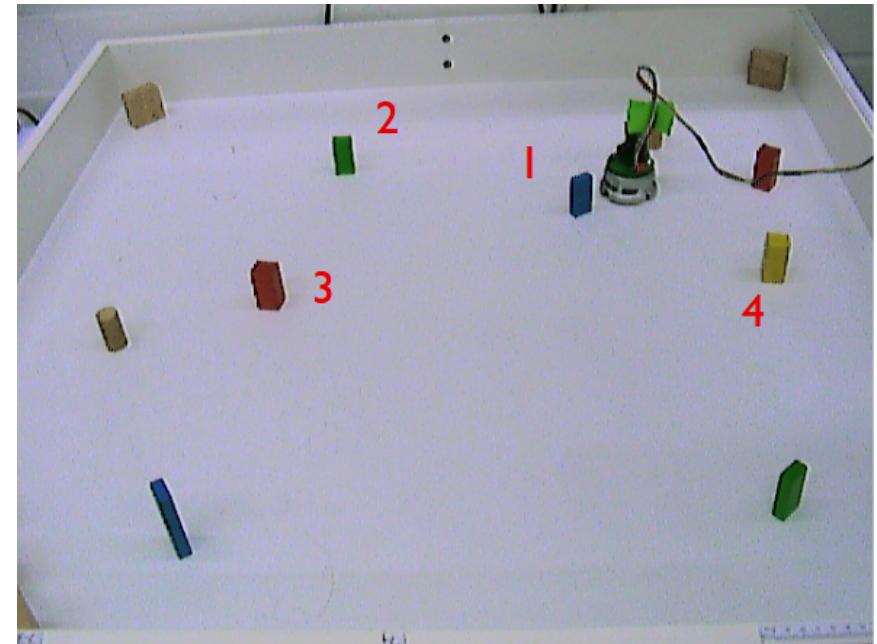
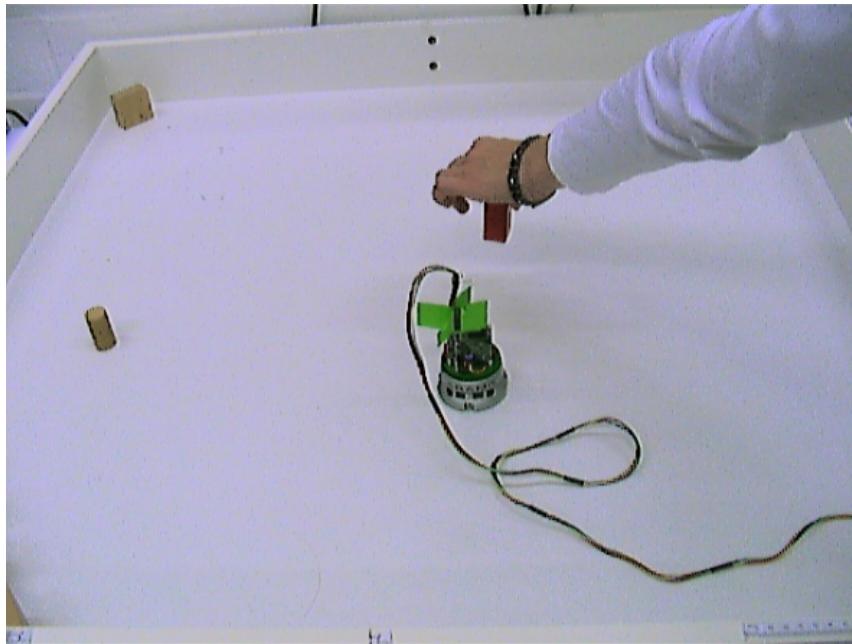


1 SERIAL ORDER

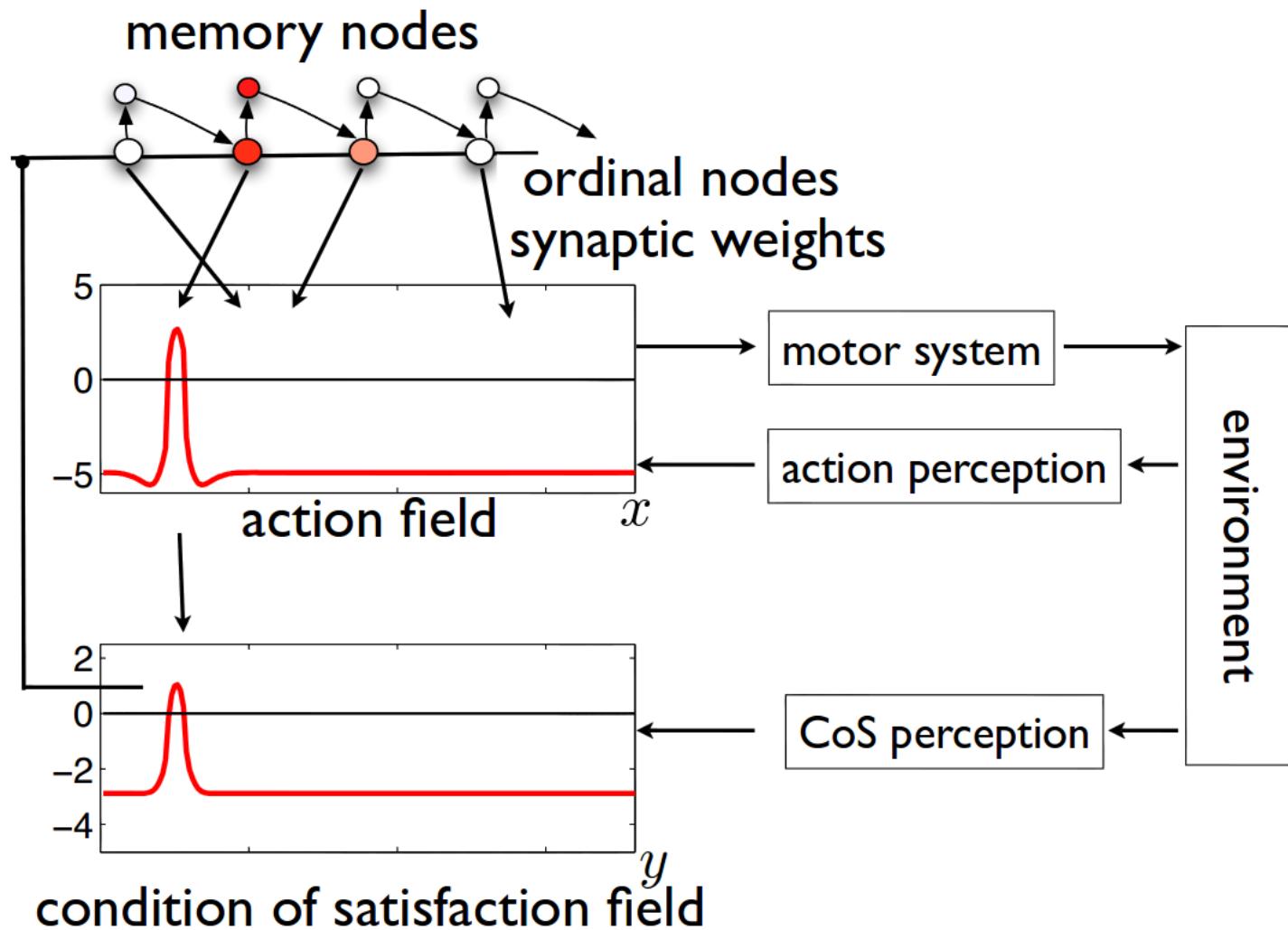
arbitrary sequences



a ROBOTIC example



SERIAL ORDER *architecture*



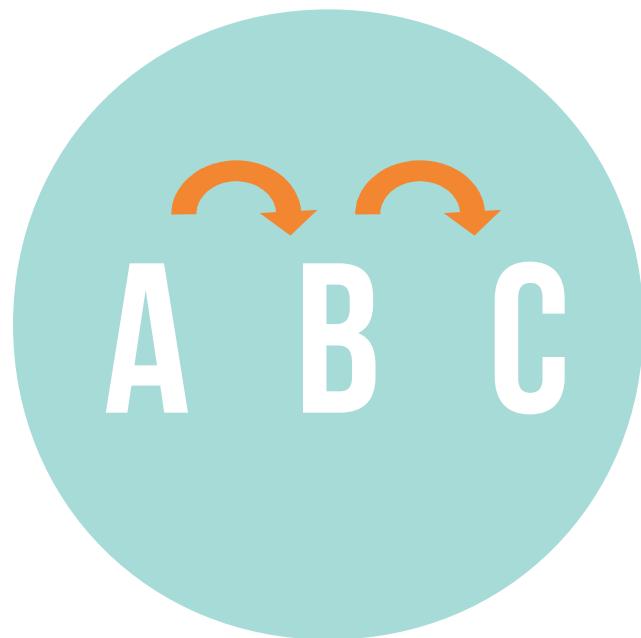
(Sandamirskaya, Schöner, 2010)

2 BEHAVIORAL ORGANIZATION

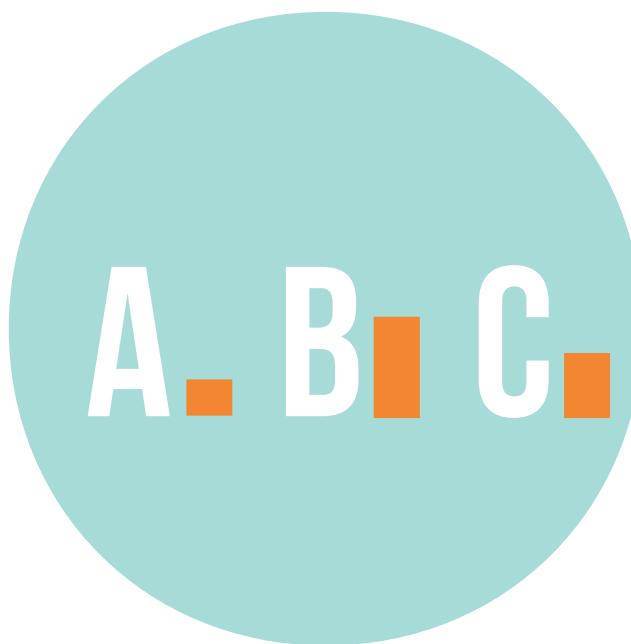
flexibility



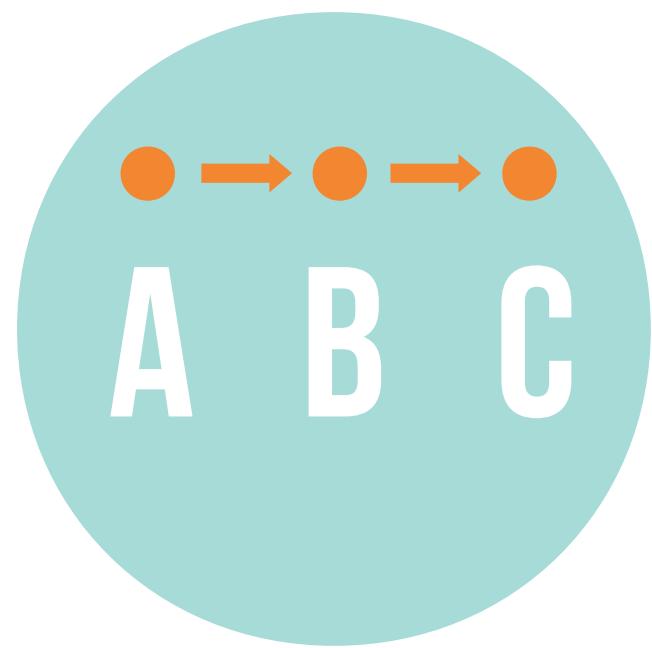
3 COGNITIVE MODELS *of sequences*



chaining



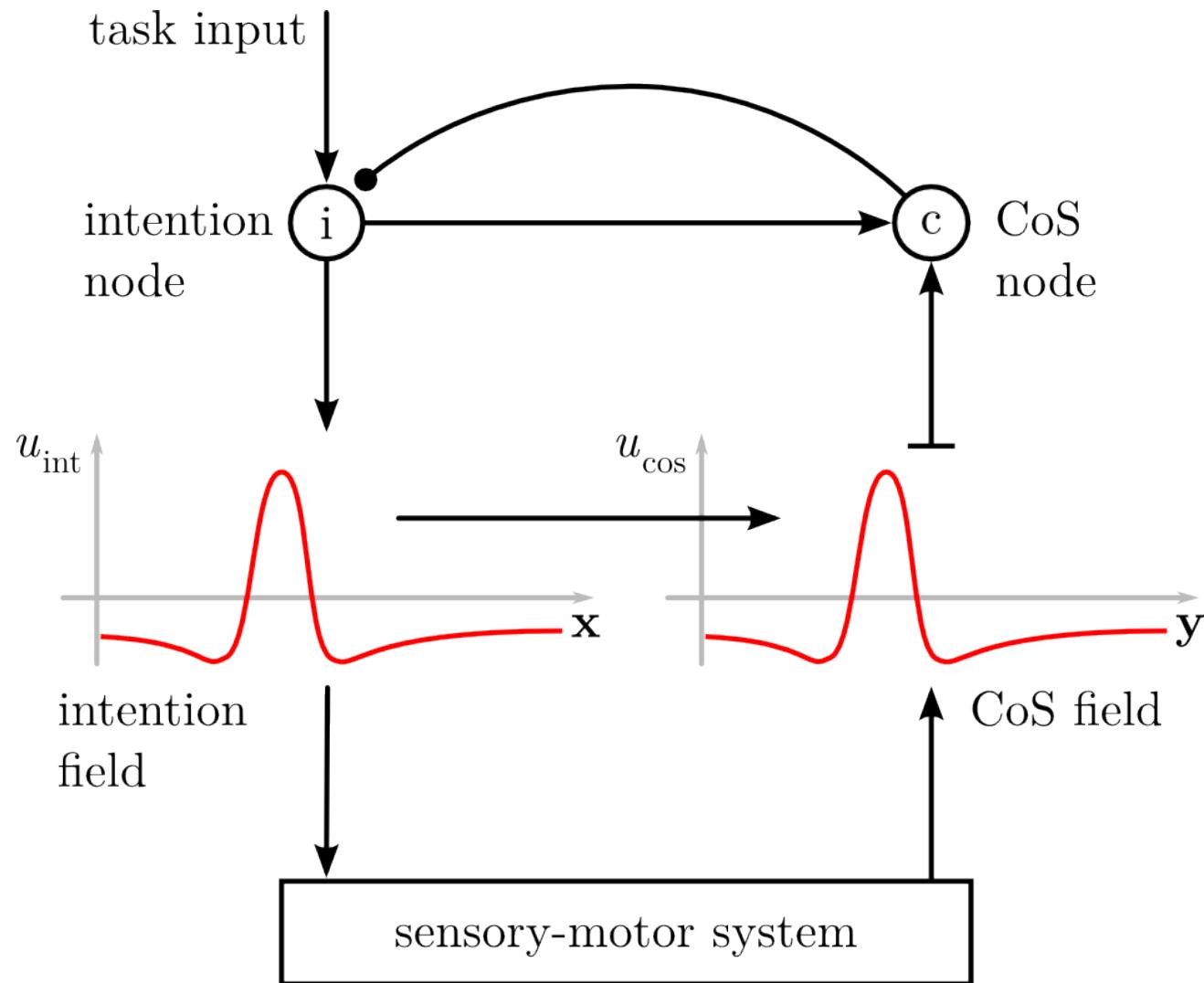
ordinal



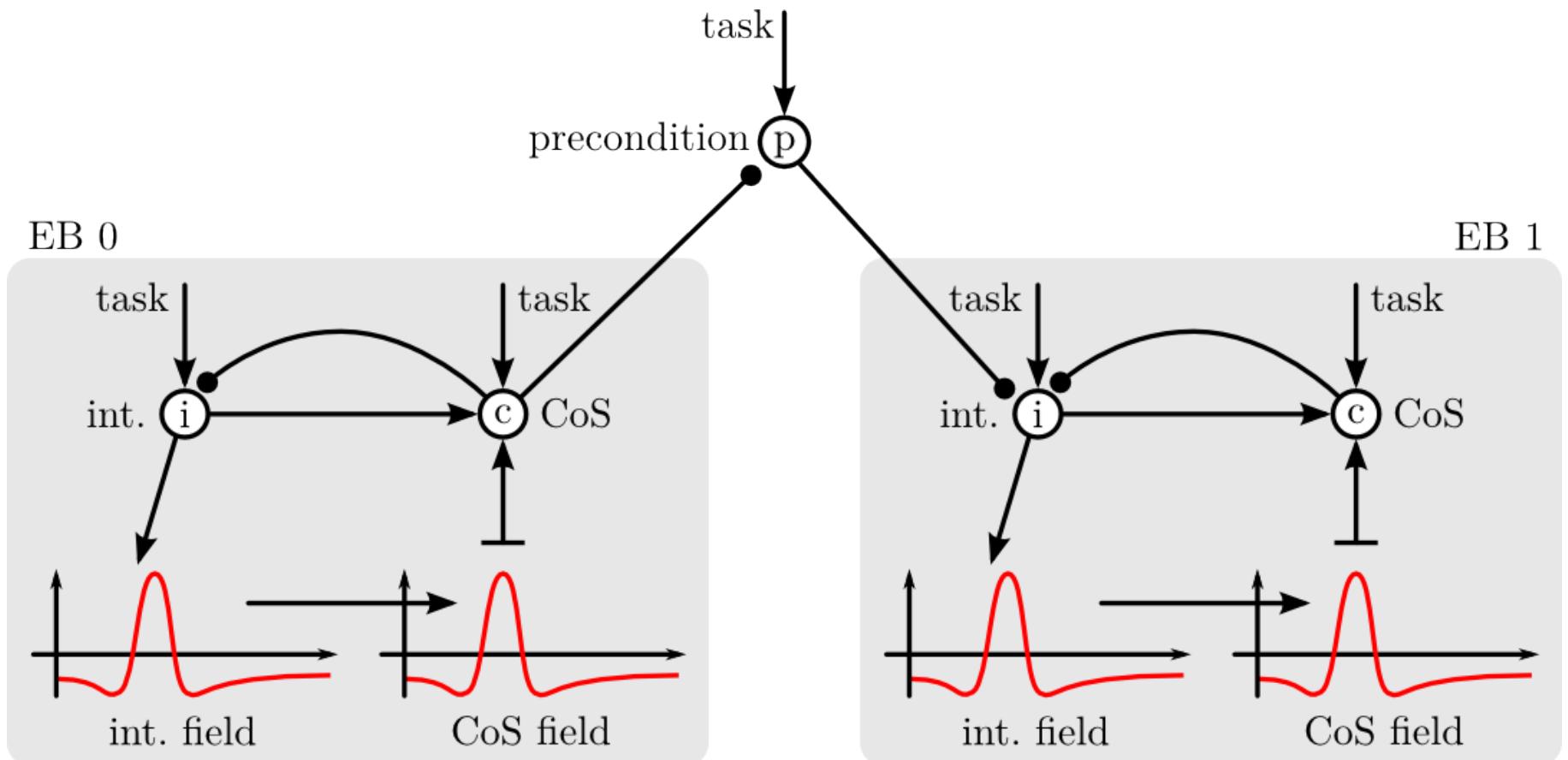
positional

(Henson, 1998)

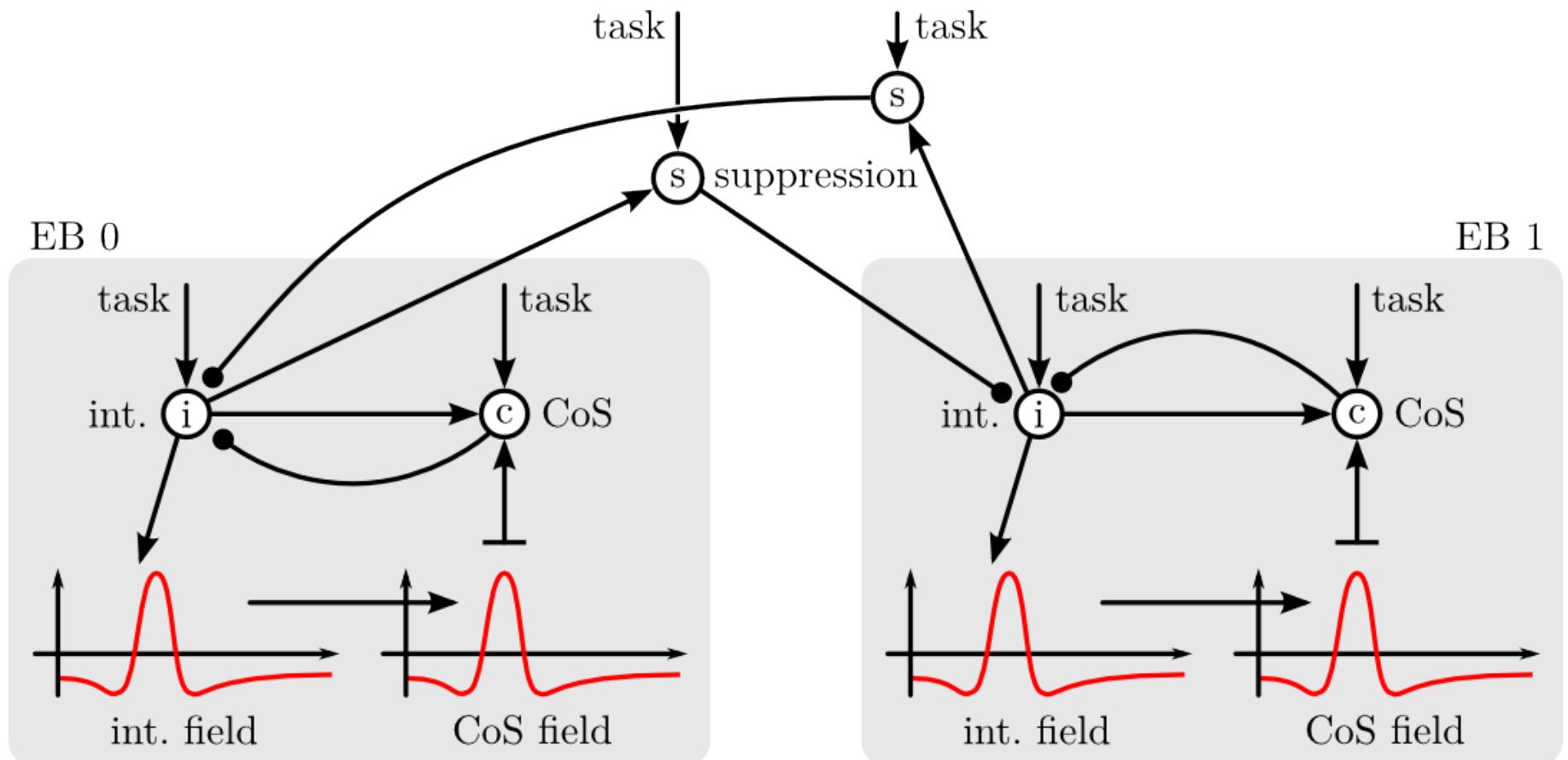
Elementary **BEHAVIOR**



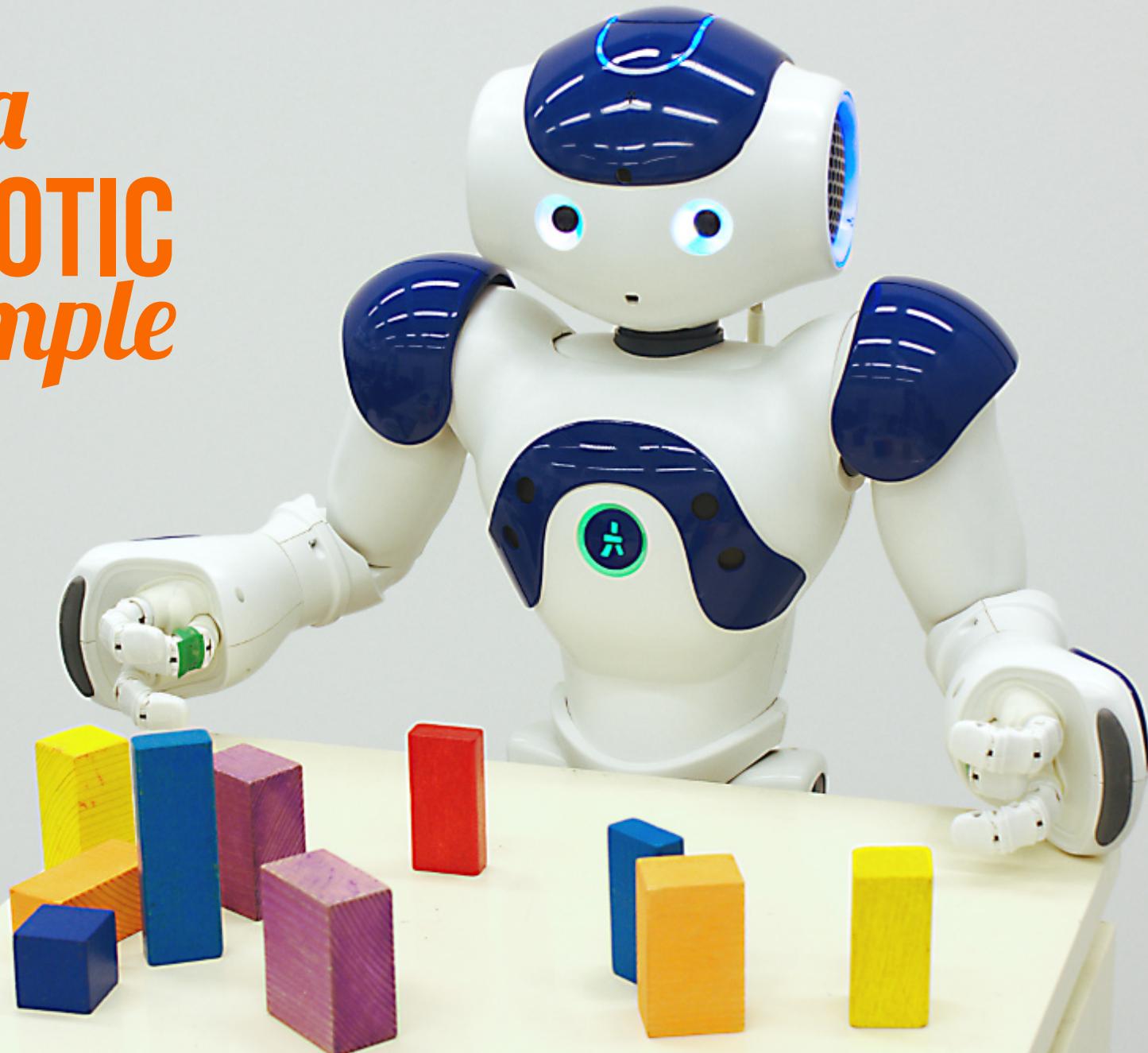
PRECONDITION *constraint*



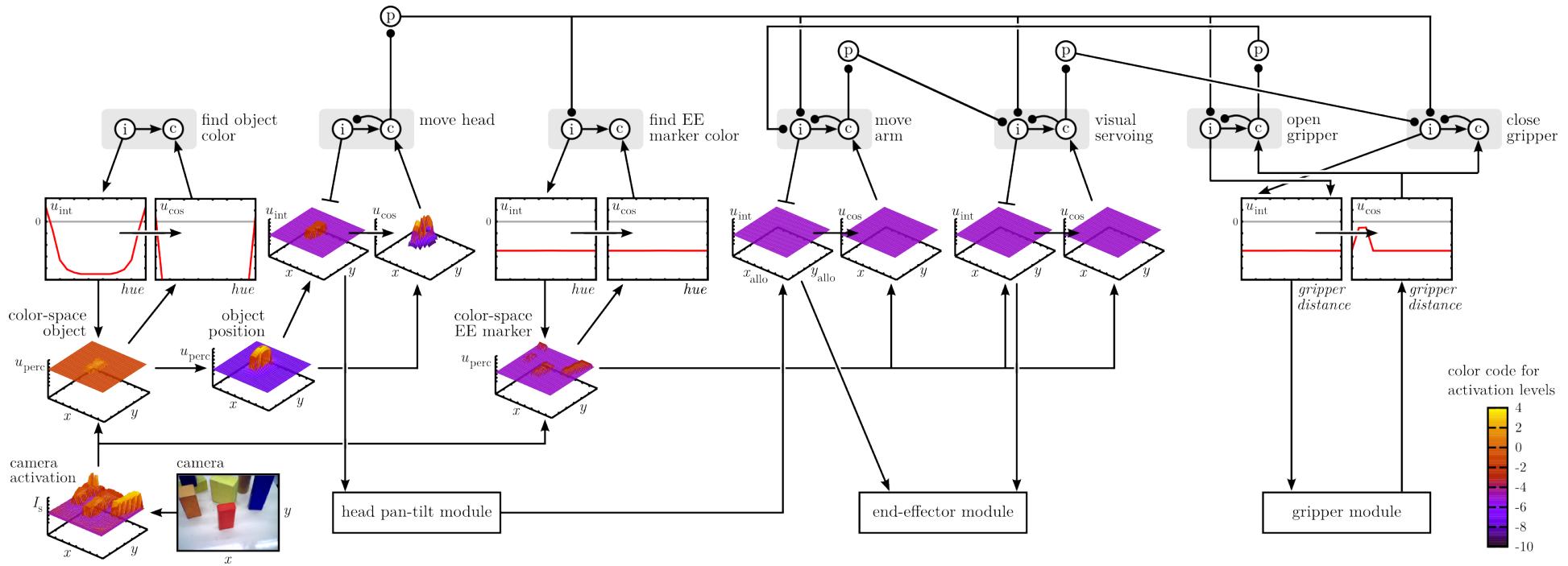
COMPETITION *constraint*



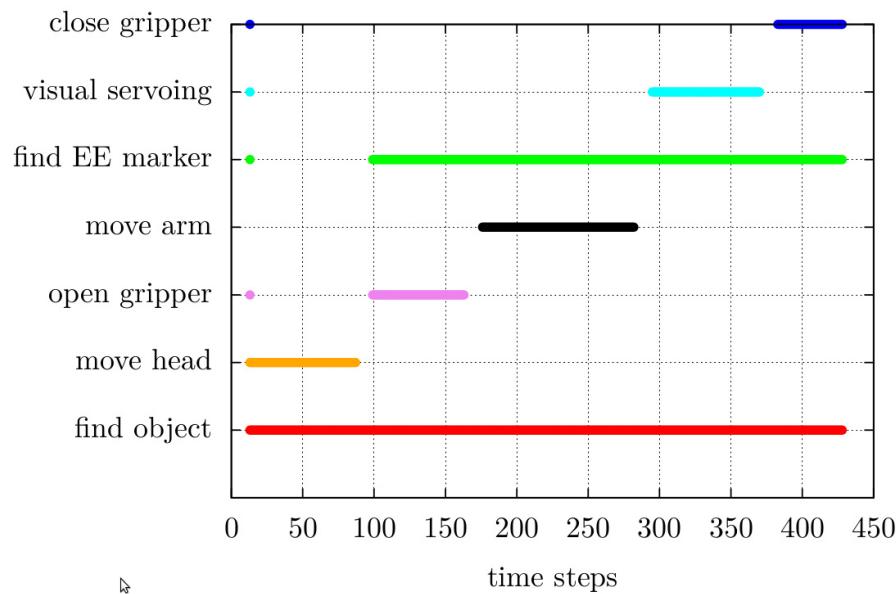
a
ROBOTIC
example



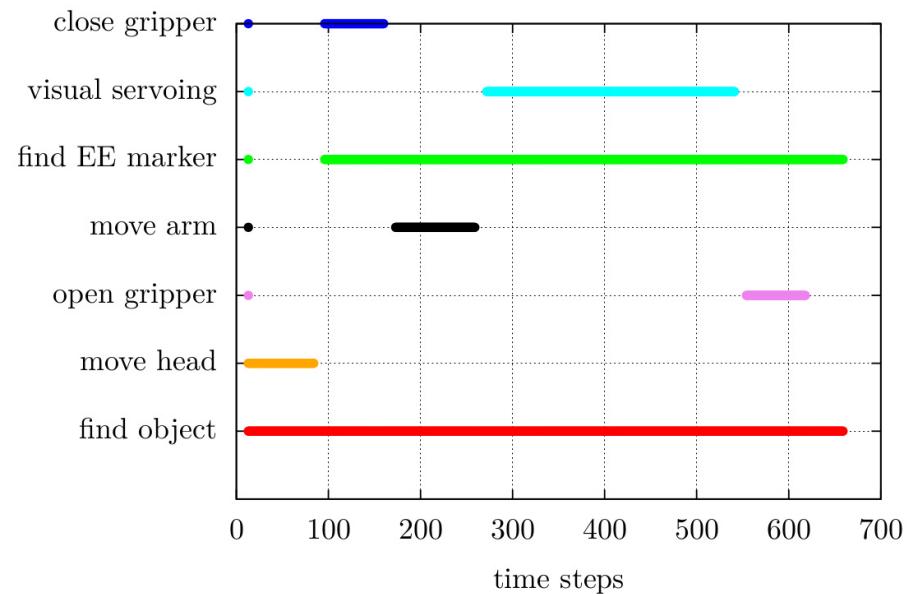
(almost) the whole ARCHITECTURE



EBs



EBs

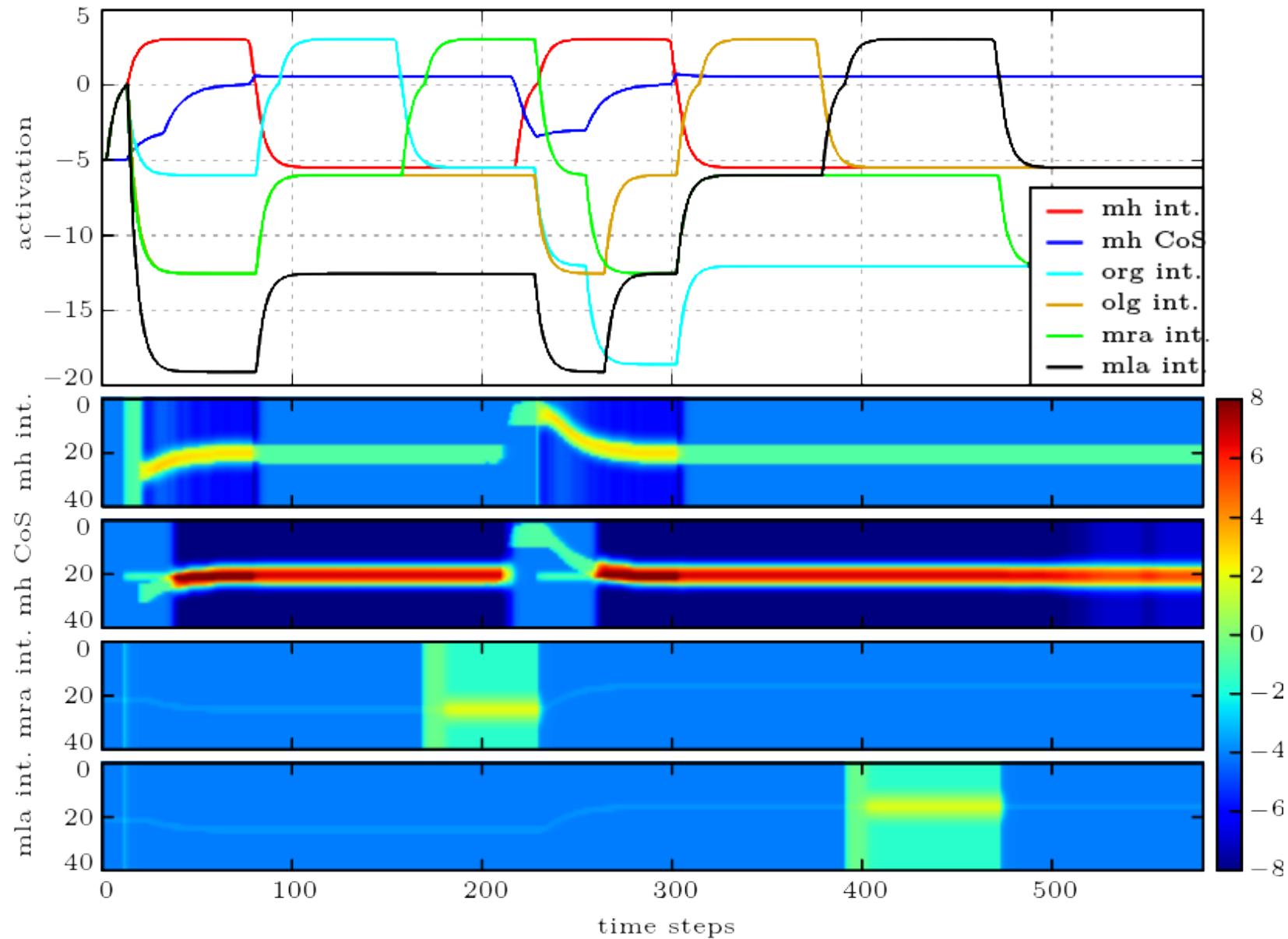


GRASPING

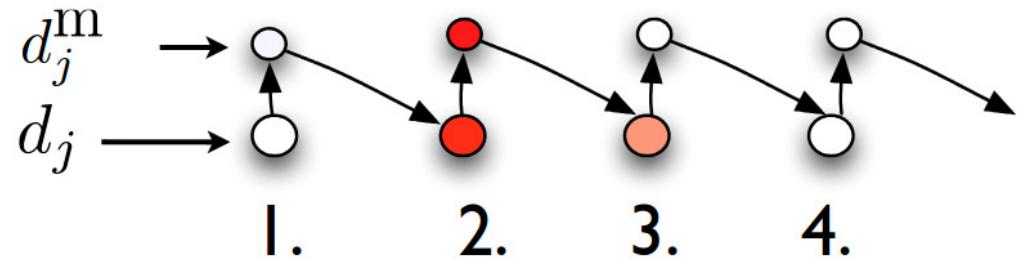
and

POINTING

ACTIVATION *over time*



Serial order EQUATIONS



$$\begin{aligned}\tau \dot{d}_i(t) = & -d_i(t) + h_d + c_0 f(d_i(t)) \\ & - c_1 \sum_{i' \neq i} f(d_{i'}(t)) + c_2 f(d_{i-1}^m(t)) \\ & - c_3 f(d_i^m(t)) - I_C(t)\end{aligned}$$

$$\begin{aligned}\tau \dot{d}_i^m(t) = & -d_i^m(t) + h_m + c_4 f(d_i^m(t)) \\ & - c_5 \sum_{i' \neq i} f(d_{i'}(t)) + c_6 f(d_i(t))\end{aligned}$$

CREDITS



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<http://www.flickr.com/photos/eflon/5079163335>

