Toward Spinozist Robotics: Exploring the Minimal Dynamics of Behavioural Preference

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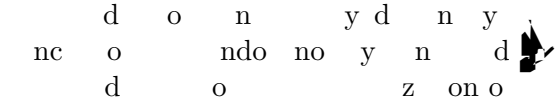
A r c

A preference is not located anywhere in the agent's cognitive architecture, but it is rather a constraining of behaviour which is in turn shaped by behaviour. Based on this idea, a minimal model of behavioural preference is proposed. A simulated mobile agent is modelled with a plastic neurocontroller, which holds two separate high dimensional homeostatic boxes in the space of neural dynamics. An evolutionary algorithm is used for creating a link between the boxes and the performance of two different phototactic behaviours. After evolution, the agent's performance exhibits some important aspects of behavioural preferences such as durability and transitions. This paper demonstrates 1) the logical consistency of the multi-causal view by producing a case study of its viability and providing insights into its dynamical basis and 2) how durability and transitions arise through the mutual constraining of internal and external dynamics in the flow of alternating high and low susceptibility to environmental variations. Implications for modelling autonomy are discussed.

keywords : o nc o o c d on
dyn c y o c o co n on o on y o o c

1 Introduction



preference **minimal** **preference** **disposition tendency commitment conation**

n n o dyn c y

yn c y o c o co n on y c y n d o

c o c c d c n on coo d n on nd

n n B  o nd y o y

n n n nd c n n nc

A p nozi pproach

n con o nc on co on o c dyn c

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o o o c c n on y on o y o c n
o n c o nc c d y nd n on n
o c n c d
o

o A y c c n n n d n n o
con o d d c o d n nc on d n o
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on o n n c y n co n on c
o o o on o no nd o co n n
n n nd n on n dyn c nc n ocon o
o o coo d n on n n n on n on
n n n y yn c c n no on n
on c n c n n n on o d o o o
on c do n o coo d n on c n
n c on c nno n n n n d n o o
c on A n oc d c n c d
n nd n c yn c c c n n
c on n o o c on nd y y o no n c
y o o coo d n on A n c n
d o on n nc d o
o c c n d n on o nd d o o
n c co ond o n o o o n n d o
o nc dyn c n o n c o
o o o o nd n o o n con on y d n
c n c y n y co c n n o o c o
n n o y con on no on c n
c y dyn c on o o coo d n on o occ
nd c c nc n nc on o o c c
o n c nd oc n o o o o
o c nno c od d d o c o c d o o on o o
nd n n o o o o c c d d

o nc d

Agent. An n od d d d o o c c ody o d nd o d c y o o d o o o c n d n c d nd o d n ‑ n d n A n y o o o o d c y d n n n oc y o n o ody o o oc d n on o n o o o c c d n oc y o c n o c y o o n n oc nd o on o n c c d y d d n d nc o o o o o y d d n o n on d o n nd o on d o d n c n o o n o o o d n o c **A** nd **B** o n d n o **=** d n o o d d c on o do no n c o nd od nc d do od c d y n ody

Plastic controller. A y conn c d con n o c n n n o ‑ NN B d n con o o on o o n on d y

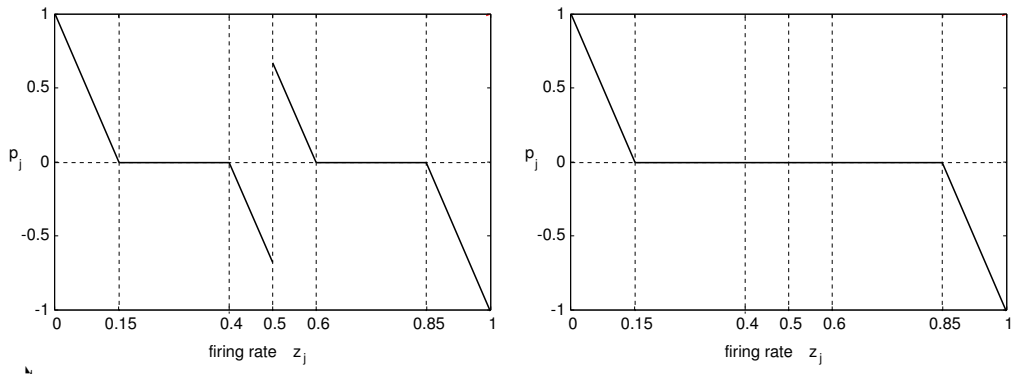
$$_{\mathbf{i}}\mathbf{y_i} \quad -\mathbf{y_i} \quad \sum_{\mathbf{j}=1}^{\mathbf{N}} \mathbf{w_{ji} z_j} \quad \mathbf{y_j} \quad \mathbf{l_i}; \quad \mathbf{z_i} \quad \mathbf{x} \quad = \quad \mathbf{e}^{-\mathbf{x}-\mathbf{b}_i} \; ;$$

$\mathbf{y_i}$ n c o n o n on $\mathbf{i}$ $\mathbf{z_i}$ n $_{\mathbf{i}}$ n : ; con n $\mathbf{b_i}$ n − ;

n d n o o c c o o d n o n o nd d
od o d on y co ond n o n
o : ; : nd : ; : o n n nd o c n on c on
y n d o o o **A** o **B** o o on y
n o d c o o on o o n n n
on n d o o o **A B** nd o on o o o
B A n n n o on d n
o on y n o c o on no
d o n nd o n on c o d n od c n
n n y c c y o o n o
n nd n on nc on c n o o c on
d
c n o o n c o d nd n y on
n o yn c n on nd n n
o n on **i** o **j** d d cco d n o

$$\blacktriangle w_{ji} \quad {}_{ji} z_i p\, z_j$$

z$_i$ nd **z**$_j$ n o nd o yn c n on
c y $\blacktriangle$**w**$_{ji}$ c n n o o **w**$_{ji}$ **p x** c
nc on nd **ji** o c n n **; :** c
n c y o c conn c on o c y c
o o n o od c o nd c nc
on y o n d c on o n n o n o o o c
on o n on **j z**$_j$ n **; :** o
: ; : c



c c on nc on o n o n n n on
nd o n o n on

4.1 Evolutionary setup

A o on o n o d n n d n c o
A n o w_{ji}; $_i$ b_i; $_{ji}$ nd n
n d y d c o c d cod d n y o
n co ond n o c on o n
c on n y c d o o nd c o on o o
c dd ndo c o o d no y B
d n o o on o c n
o n n o d n y ndo y n n o
o n on cco d n o n nd o y d cod d
o n o o n on o c d cco d n o n
n d nd d n on ∞

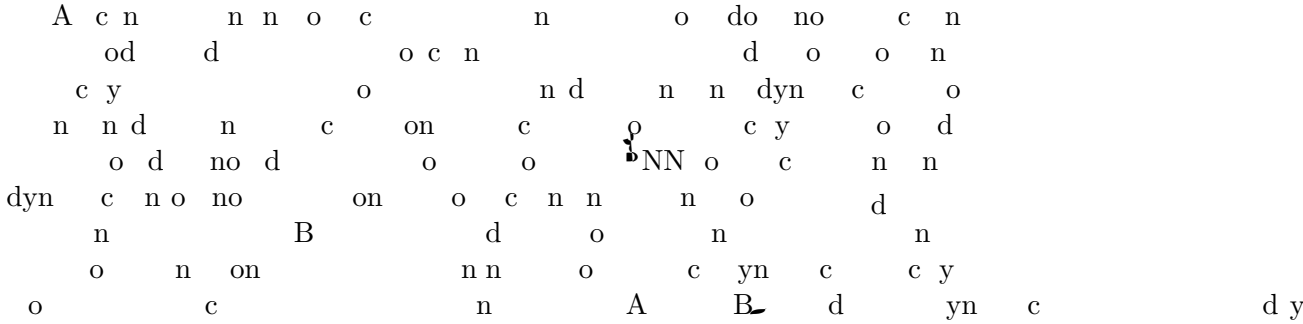
n n c

5.1 Basic phototactic behaviours

5.2 Transitions

con n less8c,8(less)1816 0 Td (w)Tj 7.54912 0 Td (e204554 0 Td (neurons)Tj 40.0036 0 Td (b)Tj 6.k 7.1890eak)Tj

n d no n o no nd co
ond o n n od c n n y
ndo nd n on y c
o o c n n o **A** o **B** no n o
n o o o d n on d n o on
n nd n n



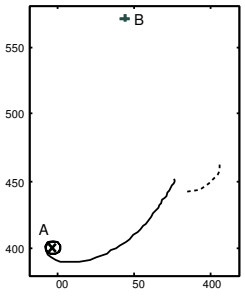
5.3 What makes a preference change?

o n c y d c y c o y o o
n on do no n n on c d o y y
c o n n o n n y d c o d c c on
n con o co od d dyn c y o n
c on y o d nc on n ndo no dyn c nd
n y d n n c on n o c y o n on
n n o d o dy c o d n c o c n c o
nc

5.3.1 Persistence of preference

n nc o nc o y n
n o on o o d o o n d
n o c n o n

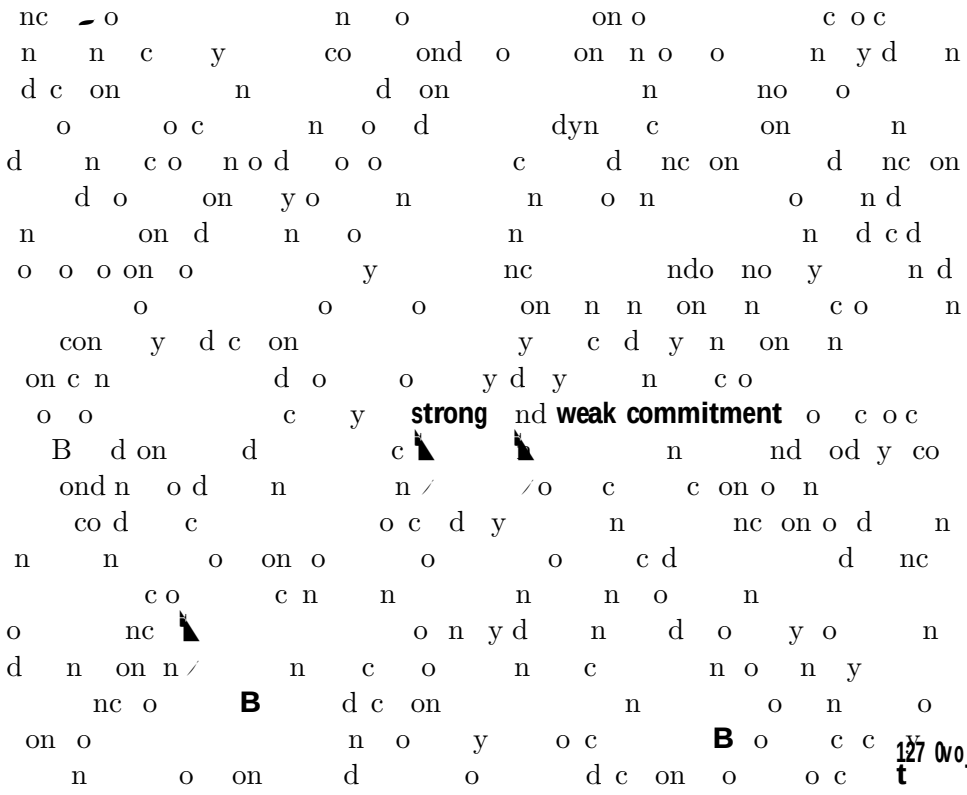
B n c o od c n on nd o n
o no o y o nd **B** n n nc no o
o on no on n n on n c o o n
on n o c n od c c n o nc n n
o n n y n nd n od o nd **t**
o o **A** nd **B** d no n d od
d y y co d c d o n on n c o
nd o n n dyn c od c con c



no on B→A A→ nd c **t** o on o **B** c n d o o **A** nd o n **A** d o n dd n y **B** on y o **A** nd no o A n n n c o no o on o **B** n c n nc o **B** nd n c o o c c n n n co ond n o o o n **t** n **does not approach** **B** n n on y o o on **A**

5.3.2 Effects of reducing external variability

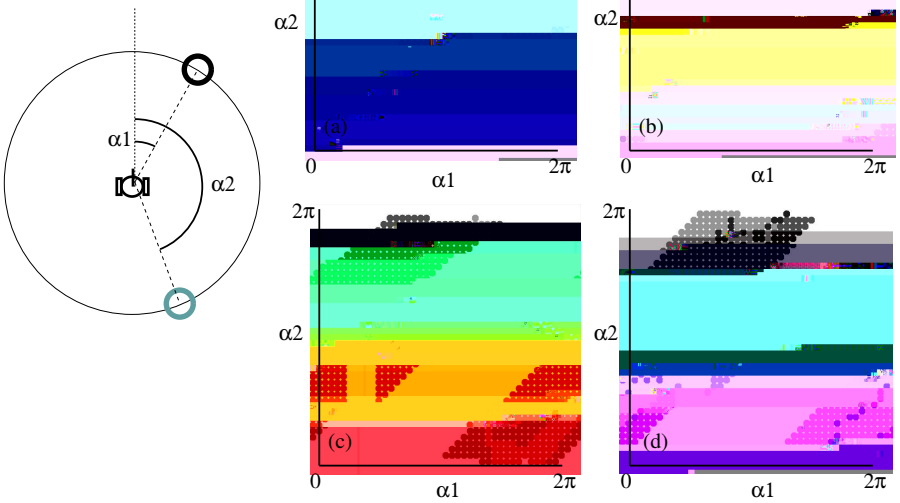
A o o nc o ndo no c o n o on nd
nc o nc n d n n dyn c no
nd nd n o o y o n on n co n n c
nc **through interactions** ndo n c o on
o c o o n on o n c n n
c on o y o c n o n


strong
weak commitment
B
B
127 0voj 17.2472 0d
(Eligh) T3 17.9672 0e
t

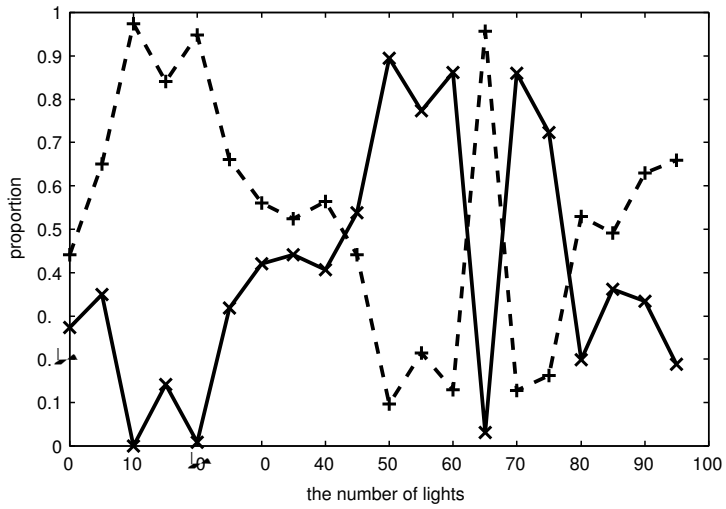
c o n on d o n nc c n o **B** o **A** nd o o on y o nd c n n do no on co n o c o d c d co o n on n c o o n c o c o **A** c n o d o o co d dyn c no y n d n od o n on n d nd nc ndo no dyn c o y on o n o nc n **all** c o o co o y co d n o o o oo c od o n on n d n d nc o on c n o nd o y o n o n n n dyn c o y o n c on n od o c y o n on n y on o n on n y n n co n o d n By con d n od o c y con n c on o con nc o o on n o n on n y

o n o n ono y o n o c n n o o n n nd o c y c n n o y o o o c c n n c o o c n n n no n o o o n nd n o o o dyn c nd o od o co n o nc o o No n n nc on od no n n c on N nc o d n od c n d n d nd d o d d c c n con d ono y y y d o c o o d n d n n y o c n y d n on ono y n con c y o d n n on o n o o o on o nc y o o cond on d y o n n nd n c o od o on n o on n c c o c n d c d co d o o n nd o d o y o on ono o y y c n n n od y n con n n y n n o n d on o c

Discussion



L nc o



o o on o o c d d o d on n d

o n n no on d c nd o d o c n
n n o o d
n nc o nc nd no non o o c
n nc o d n n n n y Acco d n o
conc o n o c o n n on o n nc
nd nd n o o no d y n c o c con
c n on o o A no B o n c on
o d n n c o oy no n oc on y n n
dd n n oc on y c d

n o o c n no c o nd n
o n y n nd o on co ond n o
n o c co d od n o c n
c o o c o y o d n
y o n on n y y o n o
n co d od c y n o c c nc n
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