



# **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 environmentalists d-

# 1 Introduction

o do n od d n d o o nc c  
o o n c n o o d c on o cy ood  
d o n y d n y o y o n on n con n  
nc o ndo no y n d od n d c d  
d o z on o d c d o o  
o nc o no n n o y c on o c  
c c c z d y n o co o nd co c n con  
o non d o c o n d c nd c y M  
on y o o n n o y c o o y o d od y  
o d y o n n on on n n n on c  
n on o c od y on nd n n o o c  
on d nd on ody o y nd dyn c o nd ncy  
o d no o on on nd n  
d nc o c n n M on y  
n c d o o d o  
o n o d d nd no c n o d n on d  
o o n c n no n c y o n ny o c n  
o o n d d n **preference** n o co n  
c o c o c n c d c n  
o o n od n nd o on n n o n  
c nc y c y nd o o n c y  
n y n n n y d o o y n o d  
no d n nc n o d o nd nd c d o  
dyn c y c o con n n o dy nd  
cond on nc y c n nc o  
c y c o con o n on  
o d **preference** ny co n conno on  
y no c d y n d n on n on nd co  
nz dyn c y c o y d n do no do  
c o c n o conc n nc n o  
co n c on n n d c con nd o  
con c n n o nd o o c y o o  
**minimal** dyn c o d y ny n nc  
o d o o o d c on o yn c n  
c nd nd d o o d c yn co d  
n co n c nc B y o o ood nn c  
nd d c o c c c c on o **preference**  
**disposition tendency commitment conation** c

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 pinoz's ppro ch

n con o nc on co on o c dyn c



n nn            y nd        n            o   n o o    od    o  
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 dn o  
o nd n n nc o n c on n o o c  
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 do o o  
on c do n o coo d n on c n  
n c on c nno n n n nd 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 no 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<sup>o</sup>od d d o c o c d<sub>o</sub> o on o<sub>o</sub>d  
nd n n o o o o c c d<sub>o</sub> d<sub>o</sub>

o n c d

**Agenda** An n od d d d o o  
 c c ody o d nd od c yo o d o o o o  
 c nd n c d nd o d n n d n A n  
 y o o o d c y d n  
 n n oc y on 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 dn d ne o o  
 o o o y d dn o n on d  
 o n nd o on d o d n c  
 n o o n o o od n o c **A** nd **B**  
 o n d n o = d n o o dd c on o do  
 no n c o nd od ne d do od c d  
 y n ody  
**P s c con ro er** 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

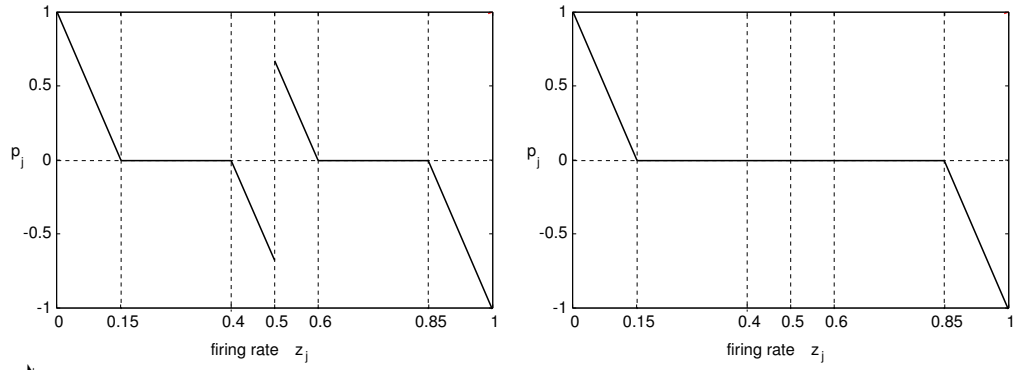
$$y_i - y_i \sum_{j=1}^N w_{ji} z_j = e^{-x - b_i};$$

$y_i$  n c o n o n on  $z_i$  n i  
 n : ; con n  $b_i$  n - ;

n d n o o c c o o d n o n o n d d  
 od o d on y co ond n o n  
 o : ; : nd : ; : o n n / nd o c n on c on  
 y nd o o o **A o B** o o on y  
 n o d c o o on o o n n n  
 on nd 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

**▲w<sub>ji</sub> j<sub>i</sub>Z<sub>i</sub>p Z<sub>j</sub>**

**Z<sub>i</sub> nd Z<sub>j</sub>** n o nd o yn c n on  
 c y **▲w<sub>ji</sub>** c n n o o **w<sub>ji</sub> p x** c  
 nc on / nd **j<sub>i</sub>** 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 o n on **j Z<sub>j</sub>** n ; : o  
 : ; : c



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

### 4.1 Evolutionary setup

A o on o n o d n n d n c o  
 A n o  $w_{ji}; i b_i; j_i$  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 co 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  
 o n o o n on o c d cco d n o n  
 n d nd d n on  $\omega$

d

n n c

## 5.1 Basic phototactic behaviours

o n d o c c o on y o o o c c  
o nd n n nc o n n dyn c n d o  
on cc on o on y d d n o on n  
c o n c n n **A** o o **A** con n  
**A** nd n n **B** n o on y o n  
o o o **A** nd n n nc o n n dyn c  
n o nd n c o n c n n **B** o o  
**B** n n **A** nd con n **B** y n n  
o c n o o o n n n on o y n  
o o c on o **A** n n o c n **B** n o  
no o o o o o c d nc n  
o o n on n o y o o o n  
o o n n y c y o o  
o y o o o **B** o o n n  
n o n cc c on no o o  
nc

## 5.2 Transitions

n n d n o y d n o on c n  
n c o n y d nc n  
con n ~~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~~





A c n      n n o c      n      o do no      c n  
od    d            o c n                    d o o n  
c y                    o            n d      n n dyn c o  
n n d      n      c      on      c      o      c y      o d  
o d no d            o      o      NN o c      n n  
dyn c n o no      on      o c n n      n o      d  
n                    B            d      o      n      n  
o      n on                    n n      o      c yn c c y  
o                    c                    n      A      B      d      yn c

d y

### 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 e 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

#### ĩ Pers s ence of preference

n nc o nc o y n  
n o on o o d o on 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  $B \rightarrow A$   $A \rightarrow$  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  
 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**

E ffects of red uction in r eadability

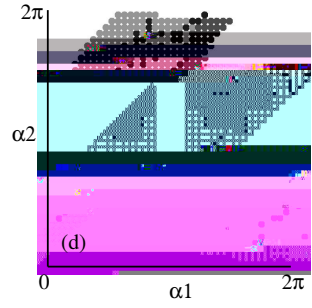
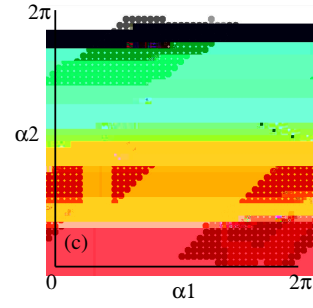
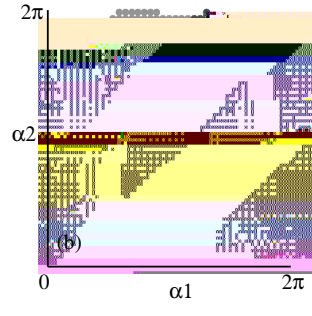
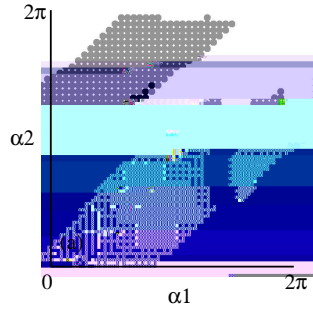
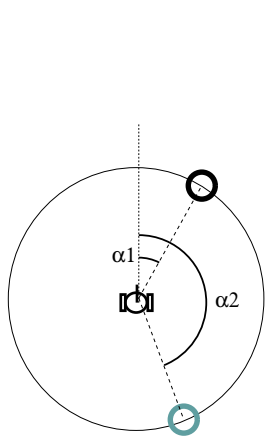
A o n o n c o n d o n o c o n o n d  
n c o n c n d n n dyn c no  
nd nd n o o y o n o n co n n c  
nc **through interactions** b ndo n c o on  
o c o o n on o n c n n  
c on o y o c n o n

nc - o n o on o c o c  
n n c y co ond o on n o o n y d n  
d c on n d on n no o  
o o c n o d dyn c on n  
d n c o n o d o o c d nc on d nc on  
d o on y o n n o n o n d  
n on d n o n n d c d  
o o o on o y nc ndo no y n d  
o o o on n n on n c o n  
con y d c on y c d y n on n  
on c n d o o y d y n c o  
o o c y **strong** nd **weak commitment** o c o c  
B d on d c n nd od y co  
ond n o d n n / / o c c on o n  
cod c o c d y n nc on o d n  
n n o on o o o c d d nc  
co c n n n o n  
o nc n on y d n d o y o n  
d n on n / n c o n c n o n y  
nc o **B** d c on n o n o  
on o n o y o c **B** o c c y  
n o on d o d c on o o c 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 co o  
 n o n c o c o **A** c n o d o  
 o co d dyn c  
 no yn 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 on ono yo n o c n  
 n o o n n nd o c y c n  
 n o yo 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 co od o  
 on n o on n c co c n d c d co  
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 y c n n n od y n con n n y  
 n n o n d on o c

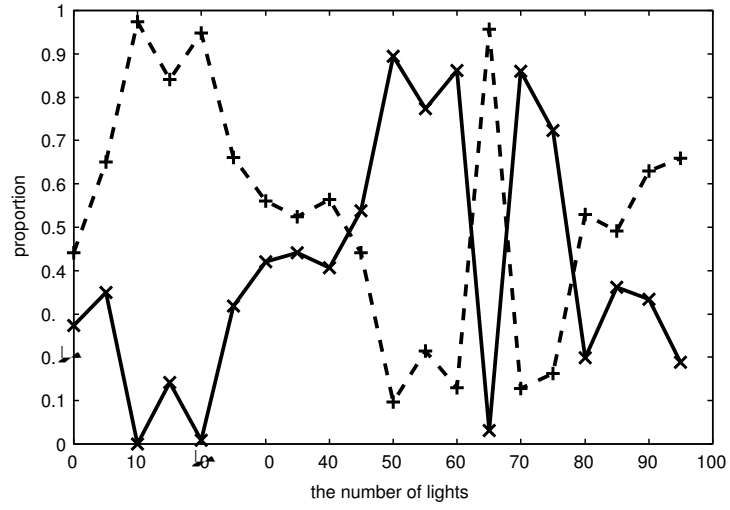
## Disc ssion





L

nc o



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

o n n no on d c nd od oc n  
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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 no 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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d o  
y c o c o noz n on o d n o  
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n o co d o o n od o n o o o o don o  
o y o n c on y n o c n  
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**Ac no edg en s** y o o nony o  
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## References

Ayoub, M. (2010). Design for a brain: The origin of adaptive b

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A / o no b o on d **From Animals  
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(PhD thesis)** y o d

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