NEUROEVOLUTION

The hitchhiker’s guide to neuroevolution in Erlang.
The hitchhiker’s guide to NEUROEVOLUTION IN ERLANG

Jeroen Soeters
This is useful when you have a nice photo or color-block as a background. On this slide only, you can put your elements behind a master element.
This is useful when you have a nice photo or color-block as a background. On this slide only, you can put your elements behind a master element.
A content headline

Did you know demoting a line turns it into body copy like you see here. Then promoting it again makes it a ...

Headline.

And back down to body by demoting.

- Demote again for a bullet

- Enter begins the next bullet
  - Demote again for sub-bullets
  - And again for tiny bullets
A content headline

Did you know demoting a line turns it into body copy like you see here. Then promoting it again makes it a ...

Headline.

And back down to body by demoting.
Sometimes we use PowerPoint for page layout.

And in that case we need room for body copy. That’s what this slide is for.

You can still create bullets

■ By hitting tab

Inline headline

Nullam id dolor id nibh ultricies vehicula ut id elit. Cras mattis consectetur purus sit amet fermentum. Nulla vitae elit libero, a pharetra augue. Duis mollis, est non commodo luctus, nisi erat porttitor ligula, eget lacinia odio sem nec elit.

“Sometimes you need a quote and you’ll have to copy this block since there’s no way to predefine a quote style.”
Sometimes you need a blank template.
Sometimes you want to say something simply and boldly on a dedicated slide. This template is called the "quote".
COLOR-PALETTE

Safe on Projectors

- #0078bf 0,120,191
- #00bccd 0,188,205
- #7dced5 125,206,213
- #00aa5b 0,170,91
- #85b880 133,184,128
- #bdbd32 189,189,50
- #fff350 255,243,80
- #fbe0ce 251,224,206
- #f2ba97 242,186,151
- #a17861 161,120,97
- #808184 128,129,132
- #eeeeee 238,238,238

Risky on Projectors

- #ee5ba0 238,91,160
- #702269 112,34,105
- #b51b58 181,27,88
- #ed312f 237,49,47
- #f58a33 245,138,51
- #5f3c25 95,60,37
Buy default, a floating text box looks like this.

Shapes are tinted gray with lots of padding.

Works for any shape.

<table>
<thead>
<tr>
<th>PowerPoint doesn’t ...</th>
<th>offer much ...</th>
<th>in the way ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>of custom ...</td>
<td>table ...</td>
<td>styles.</td>
</tr>
<tr>
<td>It prefers to use predefined</td>
<td>colors from ...</td>
<td>The built in theme.</td>
</tr>
</tbody>
</table>
PARTING THOUGHTS (USING THE CHECKLIST TEMPLATE)

☐ First, get the proper font: http://opensans.com/

☐ Start with a clean template.

☐ When in doubt, copy and paste from something that already works.

☐ Be brave:

☐ Learn to use master pages properly.

☐ Edit! Brevity, not design, makes presentations great.
DON’T MISS THE OTHER THEME COLORS

Check the themes tab for alternate colors

- Black
- Blue
- Khaki
- Orange
- Green
- Magenta
- Pink
THANK YOU

For questions or suggestions
Contact us via the Brand Hub:

https://my.thoughtworks.com/groups/brand
AN INTRODUCTION TO NEUROEVOLUTION IN ERLANG

Jeroen Soeters
ARTIFICIAL NEURAL NETWORKS

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Brain glyph, zooming in on neuron

Did you know demoting a line turns it into body copy like you see here. Then promoting it again makes it a ...
MEET FRANK AND HIS PERCEPTRON

Frank Rosenblatt (1957)

Perceptron

Output = \( w_i \)
Perceptron learning rule

\[ w_i(p + 1) = w_i + a x_i(p) e(p) \]

\[ e(p) = Y_d(p) - Y(p) \]
The and gate

<p>| | | | |</p>
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</table>
TRAINING A PRECEPTRON

Wtaf did that actually just do?

Graph

The perceptron is a linear classifier.
LIMITATIONS OF THE PERCEPTRON

But what about an XOR gate?

Graph xor
MULTILAYER PERCEPTRON

We need more layers

Image of DNN
Back propagation algorithm

Based on a differentiable activation function, often sigmoid
PROBLEMS WITH BACK PROPAGATION

- You need a training set
- Topology must be known in advance
- Very computationally intensive
Something on supervised vs unsupervised learning
EVOLUTIONARY ALGORITHMS

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MEET JOHN AND HIS SCHEMA THEOREM

John Holland (1970s)

Schema theorem, looks more complicated than it is.
EVOLUTIONARY ALGORITHM

- Represent candidate solutions as chromosomes and determine fitness function
- Create seed population
- Calculate fitness for all members in population
- Select parents based on fitness
- Use mutation and crossover to create offspring
- Repeat until some stop criterion is satisfied
AN EXAMPLE: TRAVELLING SALESMAN

Cities.. Explain problem
THE FITNESS FUNCTION

$\text{1/ distance, want to maximize fitness}$
Easy...
Easy...
Easy...
NEUROEVOLUTION

What if we could evolve neural networks to an optimal topology with an optimal set of weights?
Gene Sher (2011)

Deux Ex Neural Network
Chromosome is represented as a graph
Fitness function is performance of the NN on a real problem
TWEANN: KEY CHARACTERISTICS

- No crossover but RIM

- It uses a memetic algorithm
  - Competition algorithm for the topology search
  - Stochastic hill climbing for weight tuning
TWEANN: THE ALGORITHM

Create initial seed population

Start all agents, tune weights and find best fitness

When all agents finished

if ending condition not reached

  calculate number of survivors

  gather survivors based on effective fitness

  run selection algorithm (competition)

  start all agents, tune weights and find best fitness
TWEANN: THE ALGORITHM

Calculate mutant allotment

Calculate normalizer

Calculate normalized mutant allotment

If Nallotment > 1 then

    agent survives and creates Nallotment -1 mutant copies

Else if Nallotment = 1

    agent survives but doesn’t create offspring

Else if Nallotment = 0

    agent dies
When agent finishes

if fitness > best fitness then

update best fitness
backup weights
attempts = 0

else

restore weights
attempts += 1
mutate weights
start agent

Until attempts > max attempts
MEET JOE AND HIS ERLANG

Joe Armstrong (1960)

Created Erlang
WHY ERLANG?

1 on 1 mapping (Joe’s quote?)
Basic code example
MESSAGE PASSING EXAMPLE

Basic code example
TWEANN: NEURONS

\[
dot([I|\text{Input}],[W|\text{Weights}],\text{Acc}) \rightarrow
\dot{\text{dot}}(\text{Input},\text{Weights},I^*\text{InputIdsPlusWeights}, \text{MInputIdsPlusWeights})
\]

\[
\text{dot}([],[],\text{Acc}) \rightarrow \text{Acc}.
\]

\[
\text{receive}
\]

\[
\{\text{Input_PId}, \text{forward}, \text{Input}\}
\]

\[
\text{Result} = \dot{\text{dot}}(\text{Input}, \text{Weights})
\]

CortexPid, AF, \{InputIdsPlusWeights, MInputIdsPlusWeights\}
Sensors, actuators and code
Scapes and code
Cortex and code
TWEANN: EXOSELF

Exoself and code
Population monitor and code
Feed forward vs. recurrent
HOW TO MAKE THIS WORK AT SCALE

Only tune the stuff that recently changed

Different types of sensor links

Neural plasticity

Substrate encoding
TWEANN: DEMO

XOR and pole balancing demo