Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forwar Neural Networks

How They Work Universal Approximation (Briefly)

Training
Nonconve

Error-

Backpropagatio

Neural Networks Workshop: Training and Stochastic Gradient Descent

William Guss wguss@berkeley.edu Phillip Kuznetsov philkuz@berkeley.edu

University of California, Berkeley Robotics @ Berkeley

December 1, 2015

Overview



W. Guss & P. Kuznetsov

Feed-Forward Neural Networks

How They Work Universal Approximation (Briefly)

Fraining
Nonconvex
Optimization
ErrorBackpropagation

Deep Lea

Today we use and train Feed-Forward Artificial Neural Networks

- 1 Feed-Forward Neural Networks
 - How They Work
 - Universal Approximation (Briefly)
- 2 Training
 - Nonconvex Optimization
 - Error-Backpropagation
- 3 Deep Learning



Perceptron Review

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forward Neural Networks

How They Wor Universal Approximation (Briefly)

Training

Optimization Error-

Backpropagation

x_1 x_2 x_3 output

 Perceptrons are neural computation units which make weighted decisions:

$$p(\mathbf{x}) = \begin{cases} 1 \text{ if } \sum w_i x_i + b \ge 0 \\ 0 \text{ otherwise} \end{cases}$$
$$= \frac{\text{sign}(\sum w_i x_i + b) + 1}{2}$$

- Perceptrons are not powerful enough, as seen last time with XOR.
- What if we want real valued output for tasks like predicting the temparature or stock prices?

Feedforward Neural Networks

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forward Neural Networks

How They Worl Universal Approximation (Briefly)

Nonconvex Optimization Error-Backpropagation

Deep Learnin

[TODO: IMAGE OF FEED FORWARD NETWORK]

- Feedforward Artifical Neural Networks (ANNs) are the *continuous* extensions of perceptrons.
- ANNs can have many layers and different nodes which are fully connected.
- Generally, the more layers and nodes, the greater the computational power of the network!
- The intuition behind this model is that each neuron in the network makes a weighted decision like the perceptron.
 Many stacked decisions allows for extremely complex logic.

Blocks of Highlighted Text

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forward Neural Networks

How They Wor Universal Approximation (Briefly)

I raining
Nonconvex
Optimization
ErrorBackpropagation

Deep Learning

Block 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Integer lectus nisl, ultricies in feugiat rutrum, porttitor sit amet augue. Aliquam ut tortor mauris. Sed volutpat ante purus, quis accumsan dolor.

Block 2

Pellentesque sed tellus purus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Vestibulum quis magna at risus dictum tempor eu vitae velit.

Block 3

Suspendisse tincidunt sagittis gravida. Curabitur condimentum, enim sed venenatis rutrum, ipsum neque consectetur orci, sed blandit justo nisi ac lacus.

4 D > 4 P > 4 E > 4 E >

Multiple Columns

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forwar Neural Networks

How They Work Universal Approximation (Briefly)

Training

Optimization
ErrorBackpropagation

Deep Learning

Heading

- Statement
- Explanation
- 3 Example

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Integer lectus nisl, ultricies in feugiat rutrum, porttitor sit amet augue. Aliquam ut tortor mauris. Sed volutpat ante purus, quis accumsan dolor.

Table

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forwar Neural Networks

How They Work Universal Approximation (Briefly)

Training Nonconve

Error-

Deep Learning

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table: Table caption

Theorem

Neural Networks Pt. 2

Feed-Forward

Neural Networks

How They Worl Universal Approximation (Briefly)

Training

Nonconve

Error-

Deep Learning

Theorem (Mass-energy equivalence)

$$E = mc^2$$

Verbatim

```
Neural
Networks Pt.
2
```

P. Kuznetsov

Feed-Forward Neural Networks

How They Work Universal Approximation (Briefly)

Training

Optimization Error-

Deep Learning

Example (Theorem Slide Code)

```
\begin{frame}
\frametitle{Theorem}
\begin{theorem}[Mass--energy equivalence]
$E = mc^2$
\end{theorem}
\end{frame}
```

Figure

Neural Networks Pt. 2

P. Kuznetso

Feed-Forwa Neural Networks

How They Wor Universal Approximation (Briefly)

Nonconvex Optimization Error-

Deep Learning

Uncomment the code on this slide to include your own image from the same directory as the template .TeX file.

Citation

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Neural Networks

How They Wor Universal Approximation (Briefly)

Training

Optimization
ErrorRackpropagation

Deep Learning

An example of the \cite command to cite within the presentation:

This statement requires citation [Smith, 2012].

References

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forwa Neural Networks

How They Work Universal Approximation (Briefly)

Training

Optimization Error-

Backpropagatio

Deep Learning

John Smith (2012)
Title of the publication

Journal Name 12(3), 45 – 678.

Neural Networks Pt. 2

W. Guss & P. Kuznetsov

Feed-Forward Neural

Networks

Universal Approximation

(Briefly)

Training

Nonconvex Optimization

Backpropagatio

Deep Learning

The End