

Deep Learning

An MIT Press book

Ian Goodfellow and Yoshua Bengio and Aaron Courville

[Exercises](#) [Lectures](#) [External Links](#)

The Deep Learning textbook is a resource intended to help students and practitioners enter the field of machine learning in general and deep learning in particular. The online version of the book is now complete and will remain available online for free.

The deep learning textbook can now be ordered on [Amazon](#).

For up to date announcements, join our [mailing list](#).

Citing the book

To cite this book, please use this bibtex entry:

```
@book{Goodfellow-et-al-2016,
  title={Deep Learning},
  author={Ian Goodfellow and Yoshua Bengio and Aaron Courville},
  publisher={MIT Press},
  note={\url{http://www.deeplearningbook.org}},
  year={2016}
}
```

To write your own document using our LaTeX style, math notation, or to copy our notation page, download our [template](#) files.

[Errata in published editions](#)

Deep Learning

- [Table of Contents](#)
- [Acknowledgements](#)
- [Notation](#)
- [1 Introduction](#)
- [Part I: Applied Math and Machine Learning Basics](#)
 - [2 Linear Algebra](#)
 - [3 Probability and Information Theory](#)
 - [4 Numerical Computation](#)
 - [5 Machine Learning Basics](#)
- [Part II: Modern Practical Deep Networks](#)
 - [6 Deep Feedforward Networks](#)
 - [7 Regularization for Deep Learning](#)
 - [8 Optimization for Training Deep Models](#)
 - [9 Convolutional Networks](#)
 - [10 Sequence Modeling: Recurrent and Recursive Nets](#)
 - [11 Practical Methodology](#)
 - [12 Applications](#)
- [Part III: Deep Learning Research](#)
 - [13 Linear Factor Models](#)
 - [14 Autoencoders](#)
 - [15 Representation Learning](#)
 - [16 Structured Probabilistic Models for Deep Learning](#)
 - [17 Monte Carlo Methods](#)
 - [18 Confronting the Partition Function](#)
 - [19 Approximate Inference](#)
 - [20 Deep Generative Models](#)
- [Bibliography](#)
- [Index](#)

FAQ

- Can I get a PDF of this book?

No, our contract with MIT Press forbids distribution of too easily copied electronic formats of the book.

- Why are you using HTML format for the web version of the book?

This format is a sort of weak DRM required by our contract with MIT Press. It's intended to discourage unauthorized copying/editing of the book.

- What is the best way to print the HTML format?

Printing seems to work best printing directly from the browser, using Chrome. Other browsers do not work as well.

- Can I translate the book into Chinese?

Posts and Telecom Press has purchased the rights.

If you notice any typos (besides the known issues listed below) or have suggestions for exercises to add to the website, do not hesitate to contact the authors directly by e-mail at: feedback@deeplearningbook.org

Since the book is complete and in print, we do not make large changes, only small corrections.

Known issues: In outdated versions of the Edge browser, the "does not equal" sign sometimes appears as the "equals" sign. This may be resolved by updating to the latest version.