LEARN

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Preface

I believe the best way to learn is to solve problems. Solving a problem one time does not mean you understand it, so I would like to keep a catalog some of problems I solved for future reference.

Part I

COURSES

Practical Deep Learning (fast.ai)

Source: https://course.fast.ai/

Lesson 2

Daniel on forums.fast.ai has been kind enough to create summaries of each lesson in the form of a list of questions. These summaries can be used to preview a lesson or refresh your memory afterward.

New exciting content to come

- Can there be substantial new content given we have already 4 versions and a book?

Ways of reading the book

- How many channels are available to read the book? (physical, GitHub, Colab, and others)

Extra sweets from the book

- Are there interesting materials/stories covered by the book but not the lecture?
- Where can you find questionnaires and quizzes of the lectures?

aiquizzes.com

- Where can you get more quizzes of fastai and memorize them forever?

Introducing the forum

- How to make the most out of fastai forum?

Students' works after week 1

A Wow moment

- Will we learn to put a model in production today?

Find a problem and some data

- What is the first step before building a model?

Access to the magics of Jupyter notebook

- Do you want to navigate the notebook with a TOC?
- How about collapsible sections?
- How about moving between start and end of sections fast?
- How to install Jupyter extensions?

Download and clean your data

- Why use `ggd` rather than Bing for searching and downloading images?
- How to clean/remove broken images?

Get to docs quickly

- How to get basic info, source code, full docs on fastai code quickly?

Resize your data before training

- How can you specify the resize options to your data?
- Why should we always use `RandomResizedCrop` and `aug_transforms` together?
- How do `RandomResizedCrop` and `aug_transforms` differ?

Data images instantly transformed, not copied

- When resized, are we making many copies of the image?

More epochs for fancy resize

- How many epochs do we usually go when using `RandomResizedCrop` and `aug_transforms`?

Confusion matrix: where do models get it wrong the most?

- How to create a confusion matrix on your model performance?
- When to use a confusion matrix? *(category-level practice)*
- How to interpret a confusion matrix?
- What is the most obvious thing it tells us?
- How hard is it to tell grizzly and black bears apart?

Check out images with worse predictions

- Does `plot_top_losses` give us the images with the highest losses?
- Are those images ones the model made confidently wrong predictions? *(practice)*
- Do those images include ones that the model made correct predictions unconfidently?
- What does looking at those high loss images help with? *(expert examination or simple data cleaning)*

What if you want to clean the data a little

- How to display and make cleaning choices on each of those top loss images in each data folder? *(practice)*
- Without expert knowledge on telling apart grizzly and black bears, we can at least clean images which mess up teddy bears.

Myth breaker: train model and then clean data

- How can training the model help us see problems in the dataset? *(practice)*
- Won't we have more ideas to improve the dataset once we spot the problems?

Turn off GPU when not using

- How to use GPU RAM locally without much trouble?

Watch first, then watch and code along

- What is the preferred way of lecture watching and coding by the majority of students?

A Gradio + Hugging Face tutorial

Git and GitHub Desktop

- Is GitHub Desktop a less cool but easier and more robust way to version control than git?

Terminal for Windows

- How to set up a terminal for Windows?
- Why does Jeremy prefer Windows over Mac?

Get started with Hugging Face Spaces

- Go to huggingface.co/spaces and create a new space

Get the default app up and running

- How to use git to download your space folder?
- How to open VSCode to add an `app.py` file?
- How to use VSCode to push your space folder up to Hugging Face Spaces online?
- Then go back to your space on Hugging Face to see the app running

Train and download your model

- Where is the model we are going to train and download from Kaggle notebook?
- How to export your model after training it on Kaggle?
- Where do you download the model?
- How to open a folder in terminal? `open .`
- Make sure the model is downloaded into its own Hugging Face Space folder

Predict with loaded model

- How to load the downloaded model to make predictions?
- How to make predictions with the loaded model?
- How to export selected cells of a Jupyter notebook into a Python file?
- How to see how long a code runs in a Jupyter cell?

Turn your model into a Gradio app locally

- How to prepare your prediction result into a form Gradio prefers? *(code)*
- How to build a Gradio interface for your model?
- How to launch your app with the model locally?
- *(Not in video: run the code on Kaggle in cloud)*

Push this app onto Hugging Face Spaces

- Make sure to create a new space first (e.g., `testing`)
- How to turn the notebook into a Python script?
- How to push the folder up to GitHub and run app in cloud?
- *(Not in Video: if stuck, check out Tanishq's tutorial – shooting)*

Additional questions

- How many epochs are ideal for fine-tuning?
- How to save model from Colab?

How to install fastai properly

- How to download `github/fastai/fastsetup` using git?
  `git clone https://github.com/fastai/fastsetup.git`
- How to download and install mamba?
  `./setup_conda.sh`
- *(Not in Video: problem of running `./setup_conda.sh`)*
- How to download and install fastai?
  `mamba install -c fastchan fastai`
- How to install nbdev?
  `mamba install -c fastchan nbdev`
- How to start using Jupyter Notebook?
  `jupyter notebook --no-browser`
- *(Not in Video: other problem related to Xcode)*

The workflow summary

HuggingFace API + Gradio + JavaScript = real app

How easy does HuggingFace API work?

How easy to get started with JS + HF API + Gradio?

App example of having multiple inputs and outputs

App example of combining two models

How to turn your model into your own web app with fastpages

How to fork a public fastpages for your own use

Part II

PAPERS

1 Optical Computing

Wetzstein, G., Ozcan, A., Gigan, S. et al. Inference in artificial intelligence with deep optics and photonics. Nature 588, 39–47 (2020). https://doi.org/10.1038/s41586-020-2973-6

General Optical computing is not practical yet, but using optics for inference for visual computing applications is practical. This paper is a review on recent work on optical computing for AI.

Motivation 1: Edge devices (cameras, cars, robots, headsets, IoT) need leaner (low latency, light, small, low power) computational imaging systems.

Optical computing systems promise small form factor, massive parallelism, little to no power consumption. Optical interconnects are already widely used in data centers today.

Linear optical elements can calculate convolution, fourier transforms, random projections, as a byproduct of light-matter interaction. These operations are what's needed for DNNs.

"Incorporating all-optical nonlinearities into photonic circuits is one of the key requirements for truly deep photonic networks. Yet, the challenge of efficiently implementing photonic nonlinear activation functions at low optical signal intensities was one of the primary reasons that interest in ONNs waned in the 1990s. Creative approaches from the last decade, such as nonlinear thresholders based on all-optical micro-ring resonators35, saturable absorbers29,36, electro-absorption modulators37, or hybrid electro-optical approaches38, represent possible solutions for overcoming this challenge in the near future."

Although programmability has traditionally been more difficult with photonic systems, first steps towards simplifying the process have recently been demonstrated

"One direction that seems particularly well suited for optical and photonic processing is **optical inference with incoherent light to rapidly process scene information under ambient lighting conditions**. Such an approach presents many exciting opportunities for autonomous vehicles, robotics and computer vision, which we discuss next."

Part III

TEXTBOOKS

Maxwell's Equations - Dan Fleisch

Sources: Official Website

Gauss's law for electric fields

1. Find the electric flux through the surface of a sphere containing 15 protons and 10 electrons. Does the size of the sphere matter?

Answer

2. A cube of side L contains a flat plate with variable surface charge density of $\sigma = -3xy$. If the plate extends from $x = 0$to $x = L$ and from $y = 0$ to $y = L$, what is the total electric flux through the walls of the cube?

Answer

3. Find the total electric flux through a closed cylinder containing a line charge along its axis with linear charge density $\lambda = \lambda_0(1 - x/h)$ C/m if the cylinder and the line charge extend from $x = 0$ to $x = h$.

Answer

4. What is the flux through any closed surface surrounding a charged sphere of radius a_0 with volume charge density of $\rho = \rho_0(r/a_0)$, where r is the distance from the center of the sphere?

Answer

5. A circular disk with surface charge density 2×10^{-10} C/m² is surrounded by a sphere with radius of one meter. If the flux through the sphere is 5.2×10^{-2} V · m, what is the diameter of the disk?

Answer

Advanced Engineering Electromagnetics

Chapter 1 – Time-Varying and Time-Harmonic Electromagnetic Fields

- What is Electomagnetic field theory?

Answer

the Study of charges.

- What is Circuit Theory?

Answer

A special case of electromagnetic theory, when the physical dimensions of the circuit is small compared to the wavelength.

- What does Chapter 1 Cover?

Answer

- Maxwell's equations (differential and integral forms)
- Relations between electromagnetic field and circuit theories
- Boundary conditions
- Power and Energy
- Time-harmonic Fields

1 Maxwell's equations (differential and integral forms)

- Who is James Clerk Maxwell?

Answer

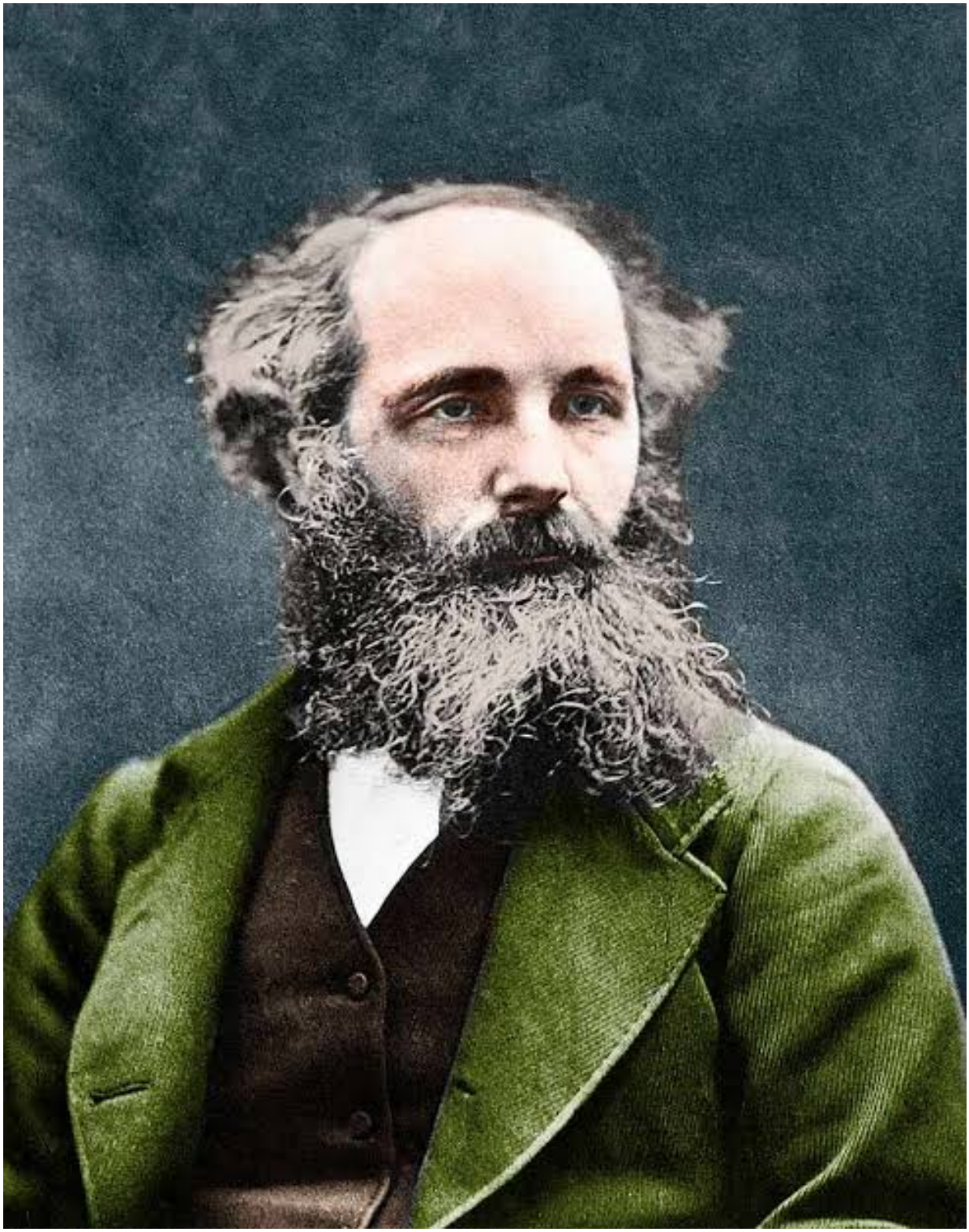

Figure 1.1: James Clerk Maxwell

A Scottish physicist and mathematician that lived from 1831 to 1879.

The Father of Modern physics

- What are maxwell's equations?

Relations and variations of electric and magnetic fields, charges, and currents

2 Relations between electromagnetic field and circuit theories

3 Boundary conditions

4 Power and Energy

5 Time-harmonic Fields