Teaching Intro ML to Engineers: Tips and Methods

Objectives

- Know your Audience
- Know your Content
- Engage your Audience
- Direct your Audience
- Inspire your Audience

Know your Audience

Who are your students?

- Engineers or Mathematicians?

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    - **HUMANS!!!**

Teach ML in terms of concepts and code

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- Expect your engineers to **maybe** remember a little bit of calculus.

Teach ML in terms of concepts and code

- The math is important to understand **intuitively** but not rigorously.
- Expect your engineers to **maybe** remember a little bit of calculus.
- The APIs are the **interface** between the students and the math.

Pay attention to prerequisites

- What are the **minimum skills** required to be proficient?

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- What are the **minimum skills** required to be proficient?
- Python? C? JS? R? GCP? Colab? Pandas? Matlab?
- Ensure that you share -- and your students know and study -- the prerequisites.

Don't assume junior Data Scientists are junior Engineers

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- Sometimes, your students will know more about Data Science than you!

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- Sometimes, your students will know more about engineering than you.
- Sometimes, your students will know more about Data Science than you!
- Try to encourage the more experienced students (in Eng or DS) to **engage** with the rest of the class and **share** their experiences.

Students are people too!

- They want to drink **coffee**.

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- **PLAN TIME FOR THEM!**

Know your Content

Teach the right concepts at the right levels

- Let's consider the question:

What is sigmoid?

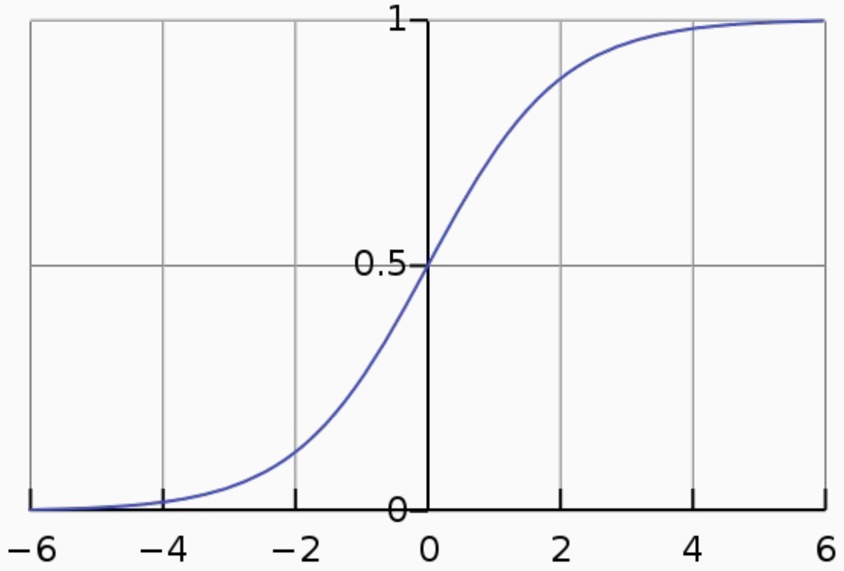
What is sigmoid?

- Is sigmoid an **equation**?

$$p = \frac{1}{1 + e^{-y}}$$

What is sigmoid?

- Is sigmoid a **graph**?



What is sigmoid?

- Is sigmoid an **API call**?

```
estimator = DNNClassifier(
    feature_columns=[sparse_feature_a_emb, sparse_feature_b_emb],
    hidden_units=[1024, 512, 256],
    optimizer=tf.compat.v1.train.ProximalAdagradOptimizer(
      learning_rate=0.1,
      l1_regularization_strength=0.001
    ))
```

What is sigmoid?

- Is sigmoid an **API parameter**?

```
estimator = DNNClassifier(
    feature_columns=[sparse_feature_a_emb, sparse_feature_b_emb],
    hidden_units=[1024, 512, 256],
    activation_fn=tf.nn.sigmoid,
    optimizer=tf.compat.v1.train.ProximalAdagradOptimizer(
      learning_rate=0.1,
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- But the more important uses of sigmoid **depend** on what you're doing.
- For engineers just learning ML, the **API** and the **Graph** are most important.
- Be open to student curiosity, but don't act like equations must be memorized.

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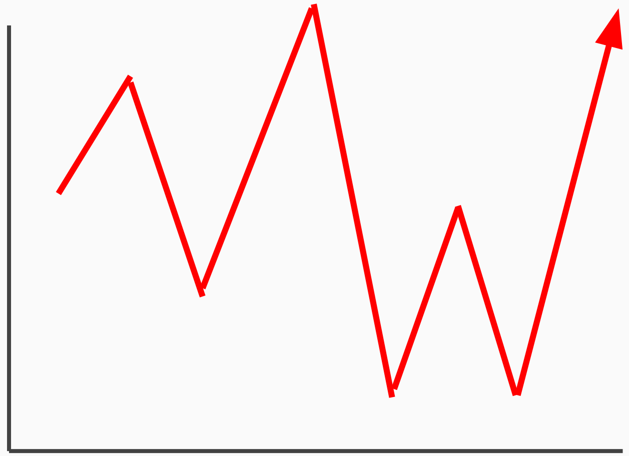
    - **X^2** - pushes big numbers, ignores small numbers.
    - **sigmoid** - asymptotes, from 0 to 1.
    - **ReLU** - simple hinge, super speedy calc and derivative.

Graphs matter!

- Loss over time graphs are super important!
- Teach the 4 basic types you will encounter:



"**Bouncy**"

- Lower LR

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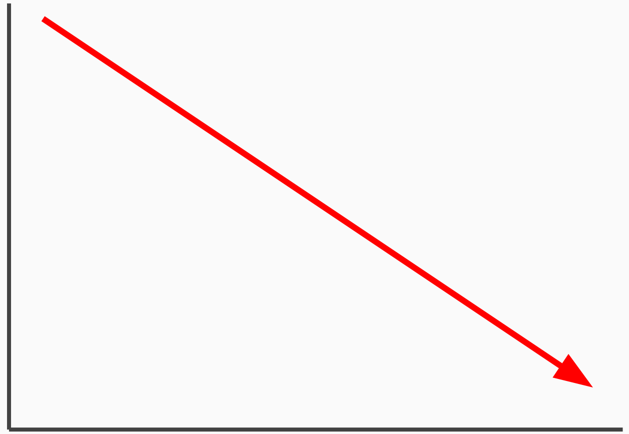

"**Falling**"

- More Steps
- Higher LR

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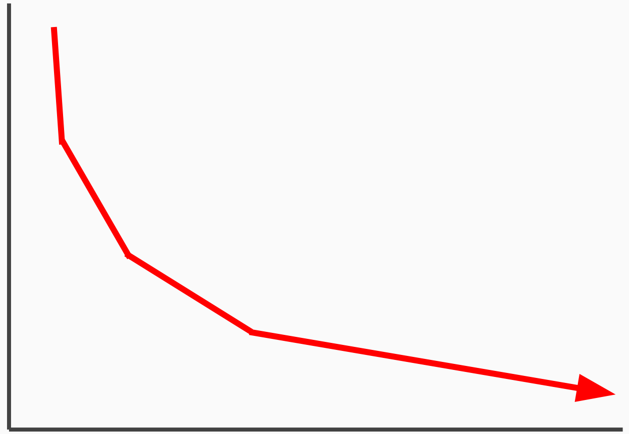

"**<u>Descending</u>**"

- More Steps

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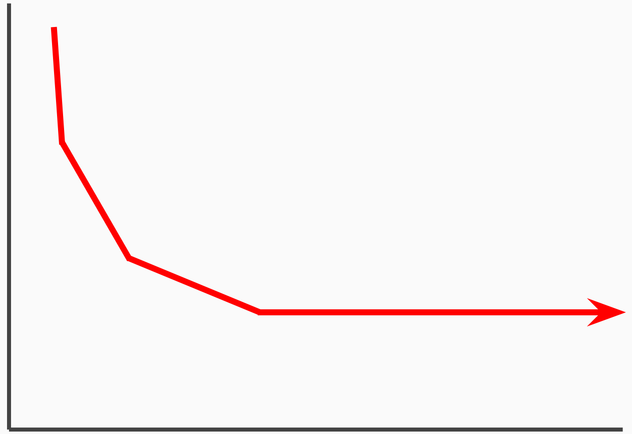

"**<u>Converged!</u>**"

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    - "**Learning Rate**" or "**Alpha**" ??
    - "**Features and Signals**" or "**Values and Features**" ??
    - "**Linear models**" or "**Wide models**" ??
    - "**Examples**" or "**Records**" ??

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    - "**Examples**" or "**Records**" ??
- Your students may have already learned a different vocabulary!
- Be aware. Point them out explicitly to avoid confusion.

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  - "**Bias**" - Societal bias? Line equation bias term? Prediction bias?
  - "**Embedding**" - Embedding vector? Embedding layer?
  - "**Performance**" - Speed? Quality?

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- And expect that many students will *still* be confused.

Engage your Audience

Lectures are only useful for concepts

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- Humans **only retain a little bit** when they sit through a lecture.
- Slides (and their presenters) are usually dry and boring.

You're already bored!

- I'm losing your attention.

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- I'm losing your attention.
- Right now.

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- As we speak.

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- I'm losing your attention.
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- As we speak.
- **What can we do about that?**

Go "hands-on"

- Learn by doing!

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  - **Colabs**
  - **Codelabs**
  - **Competitions**

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- Make sure the coding is **reinforcing** the lecture!

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- Best for **introductory concepts**, mixes code and text together in a web page.
- Can be weak, since the real world doesn't live in a notebook.

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Codelabs (& Qwiklabs)

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- Best for **intermediate students** using their concepts in the "real" world.
- Can be weak, since you need to have a working environment available.

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- **Humans like to compete!**

All of these are useful

- For example: start with introductory concepts in **Colab** notebooks.

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- Move on to **Codelabs** in GCP.

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- Move on to **Competitions** from Kaggle.

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- For example: start with introductory concepts in **Colab** notebooks.
- Move on to **Codelabs** in GCP.
- Move on to **Competitions** from Kaggle.
- **WIN!**

Direct your Audience

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Use it or lose it!

- If your students don't use what you've taught them after the class is over, they'll quickly **forget** it and everyone will have wasted their time.
- Encourage them to bring their own ML problems to class, or to think of a problem in their expertise while in or when finishing class.
- Having a project ready to go can help keep them **focused** on sticking with ML after the class is long in the past.

Next steps

ALWAYS try to provide
"Next Steps" content for your
students to continue their study!

More classes!

- Provide them links to **self-service** ML classes.

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    - `developers.google.com/machine-learning`
    - `codelabs.developers.google.com?cat=TensorFlow`
    - `ai.google/education`
    - Other Qwiklabs.
    - Coursera ML courses.
    - Kaggle micro-courses.
    - Case studies: `cloud.google.com/customers`

More datasets!

- How can you get any **practice** if you don't have any data?

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- How can you get any **practice** if you don't have any data?
    - `ai.google.com` datasets.
    - Kaggle datasets and competitions.
    - UCI public datasets.
    - Skymind datasets.
    - Github open source datasets.
    - etc... Google for them!

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- ZOMG, there's lots and lots of ML conferences, everywhere!
- (Google/Kaggle/GCP have multiple!)

More AutoML!

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- AutoML models can be very useful to solve many different problems.
- AutoML systems aren't quite as **flexible** as manual model building.
- Still requires ML skills: esp. **Problem Framing** and **Data Preparation**.

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More AutoML!

- But even if you're really fired up to make your own models, AutoML can help!
- AutoML models can be a useful **sanity check** on your models and datasets.
- If AutoML can't make a model at all, you may not be able to either.
- If AutoML makes a great model, you now are challenged to beat it!

More of YOU!

- Try to schedule your ML classes to run periodically.

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    - "Every Thursday at 1500 in the lunchroom!"
    - Get everyone learning on a **schedule**.

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- Once you go through all of your course materials, start doing competitions.
- If you have lots of people, split into Beginner & Advanced cohorts.

NOW FOR THE HARD PART!

Inspire your Audience

Your #1 Responsibility

- Get your students to **understand** the content.

Your #2 Responsibility?

- Get your students to **understand** the content.

Your #2 Responsibility!

- Get your students to **understand** the content.

- Get your students to **love** the content.

Your Responsibility

- Get your students to **understand** the content.
- Get your students to **love** the content.
- **THESE ARE VERY DIFFERENT THINGS!**

Your attitude affects their attitude

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- If you're bored (or boring) your students might learn. Maybe.
- If you're **excited** and **exciting**, your students might love!
- They're far more likely to learn it if they learn to love it.

Your energy affects their energy

- Be well rested.

Your energy affects their energy

- Be well rested.

- If you can't be well rested, be well **caffeinated**!

Your authenticity is key

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- Show them the honest level of **excitement** you have for your work.

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- Show them the honest level of **excitement** you have for your work.
- If it doesn't excite you, why teach it?

Your experience is valuable

- Share **stories**! Share **anecdotes**! Share **experiences**!

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- **Personalize** your content for your students.

Your experience is valuable

- Share **stories**! Share **anecdotes**! Share **experiences**!
- **Personalize** your content for your students.
- People will **remember** stories and experiences better than slides.

Go above and beyond

- Show up early to help with prework and answer **questions**.

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- Stick around after to help with code and answer **questions**.

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- Make time outside of class for students who need extra **help**.
- Be available on **email**! Accept them on LinkedIn! Keep them **learning**!

Practice! Practice!! Practice!!!

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- Your first presentation of content will **always** be the worst!

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- You have to be okay with the fact that you're not going to do as well at first.
- Your first presentation of content will **always** be the worst!
    - Do it in front of a private audience, before teaching your students.
    - Record yourself with a camera, or teach to a spouse or friend.

Love what you do and you'll never work a day in your life.

Next steps

- ¯_(ツ)_/¯

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- There's actually not much online study material for *teaching* ML.
- **GO OUT THERE AND START TEACHING!**

Next steps

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- There's actually not much online study material for *teaching* ML.
- ~~GO OUT THERE AND START TEACHING!~~ **Not yet**!

Next steps

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- There's actually not much online study material for *teaching* ML.
- ~~GO OUT THERE AND START TEACHING!~~ **Not yet**!
- **(At least, participate in the role-play session that comes tomorrow!)**

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Q & A

THANK YOU!