I Can't Believe It's Not Real Data!

An Introduction into Synthetic Data

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Imagine

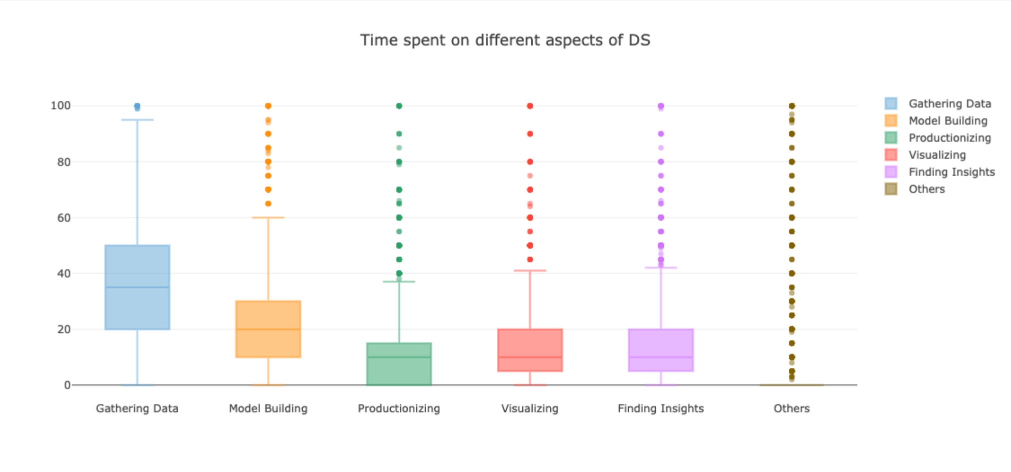
- You're a developer working on a web application (Django) at work that manages students in a classroom
  - Time to test!
  - Can't access production DB for security reasons
    - FERPA data is protected by law
  - Have to use a test DB with only a handful of records
  - **An edge case slips through that wasn't represented in the test DB**

Imagine

- You're a Data Scientist trying to build a model
  - Figured out what you want to do, you want to try to predict a rare disease
  - Start looking for relevant data sets, but find out you don't have enough of the data you need
  - Have to train the model with the limited data set
  - **The model is unsuccessful due to size**
  - But wait! Someone in another hospital has a similar data set you think will work!
  - **Can't get access to it due to PII (Personally Identifiable Information) in the dataset**

Data is a Scarce Resource

- Lack of access to usable testing data
  - 35% of DS time is spent in the “data gathering” stage
  - Data is inaccessible due to PII
- Limited Data Sets
  - Lack of quality data can affect model training results
  - Prohibitively expensive or even impossible to collect more
- Biased Data
  - Data can be skewed towards representation of subjects in a data set



Solution: Synthetic Data

- **Synthetic Data**: *Synthetic data is artificially annotated information that is generated by computer algorithms or simulations, commonly used as an alternative to real-world data.* – Alex Watson

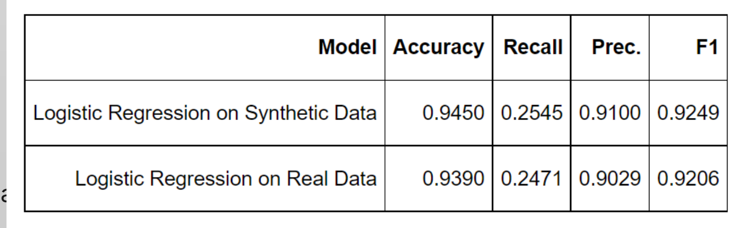
- Synthetic data is created by training a generative machine learning model on your data.

Isn’t That Just Fake Data?

- Synthetic data is different from “fake” or “mock” data
  - You may be thinking of Faker
- Fake/mock data may not be representative. It is purely random
  - Fake/mock data can be “too clean”
- Synthetic Data is generated from existing data
  - It will look and behave like the initial dataset
- Synthetic data can be nearly as representative as the initial dataset

How Accurate is Synthetic Data?

- Unlike “fake” data, Synthetic data can be nearly as accurate as the real data
  - In some cases, accuracy is improved
- Downstream data consumers can readily make use of Synthetic Data
  - Eg: A classifier trained on Synthetic Data can get the same accuracy as a classifier trained on the original dataset
    - Did the user buy pizza or not?



Model	Accuracy	Recall	Prec.	F1
Logistic Regression on Synthetic Data	0.9450	0.2545	0.9100	0.9249
Logistic Regression on Real Data	0.9390	0.2471	0.9029	0.9206

What Can I Use Synthetic Data For?

- Synthetic Data acts as an alternative to real-world data
- Any task where you need data, you can use Synthetic Data
  - Training models
  - Testing applications
  - Creating sample data for demos
  - Anonymizing data
  - and more!

How Do I Use Synthetic Data?

- Make private data accessible and safely shareable
- Generate more samples with limited data sets
- Reduce bias in machine learning datasets

Make Private Data Accessible & Shareable

- Data often contains PII (Personally Identifiable Information) making it *very risky* or even *illegal* for developers to work with
  - Developers and Data Scientists often don’t want access to PII, developers want access to data that is relevant to their problem
- Generating a Synthetic Dataset allows you to have statistically similar data while removing the PII
  - This allows you to share your data, not only within the company but externally as well
  - Eg: You can have your data in an S3 bucket and then automatically generate synthetic data on access

Augment Small Data Sets

- Not having enough of the right data is a serious bottleneck
  - Data is often your most valuable asset and collecting data is expensive and hard
- Synthetic Data allows you generate an unlimited amount of data based on a relatively small data set
  - Eg: You have a Machine Learning model and a small amount of data, you can use Synthetic Data to regularize your model training
  - Eg: From a testing standpoint, you can load/stress test your application

Reduce bias in Data Sets

- Biased data is a *big* problem
  - Leads to inaccurate models, unfair results, and may even cause harm
- If you can identify the bias in your data, you can use Synthetic Data to balance your data set
  - Reducing AI Bias with Synthetic Data in heart disease prediction models
  - 68% male data, 32% female, 2:1 ratio
  - Use Synthetic Data to generate more female patients to balance the data set
  - Increase in accuracy from 88.5% to 96.7%
  - 6.17% more females with heart disease can now be accurately diagnosed

Synthetic Data in Action

- **Automotive and Robotics** — leveraging synthetic data to create simulated environments for training robots, self-driving car software, and even testing safety and crash prevention technologies.
- **Financial Services** — creating synthetic time-series data to enable data sharing that doesn’t compromise their customers’ privacy
- **Cybersecurity and Infosec** — using synthetic data to train machine learning models to better detect rare events including fraud and cyber attacks
- **Healthcare and Life Sciences** — creating synthetic genomic data to fuel medical breakthroughs and encourage better medical care
- **Manufacturing** — using synthetic data to simulate complex supply chain operations and predict where failures may occur.
- And More!

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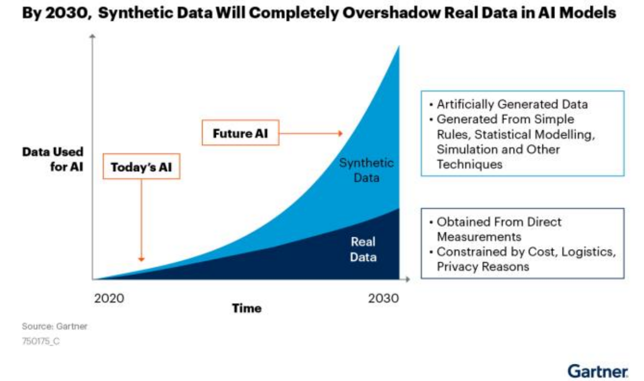
Current Challenges in Synthetic Data

- Highly dimensional datasets with hundreds or thousands of columns can be compute-intensive.
- Synthesizing relational datasets can require some manual configuration.
- Some privacy-preserving technologies such as differential privacy, require large amounts of data to provide strong privacy guarantees without degrading accuracy, and thus may not be appropriate for all datasets.
- Synthetic data generation requires time and effort.

What does the future hold for Synthetic Data?

- By 2030 Gartner predicts that synthetic data will overshadow real data in AI models
  - Already happening today
  - Allows for easier compliance under data protections laws such as GDPR & CCPA
  - Reduces attack vector on data
- Eventually will solve the “cold start” problem
  - You have no data to start with


By 2030, Synthetic Data Will Completely Overshadow Real Data in AI Models

Source: Gartner
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Getting Started Using Synthetic Data

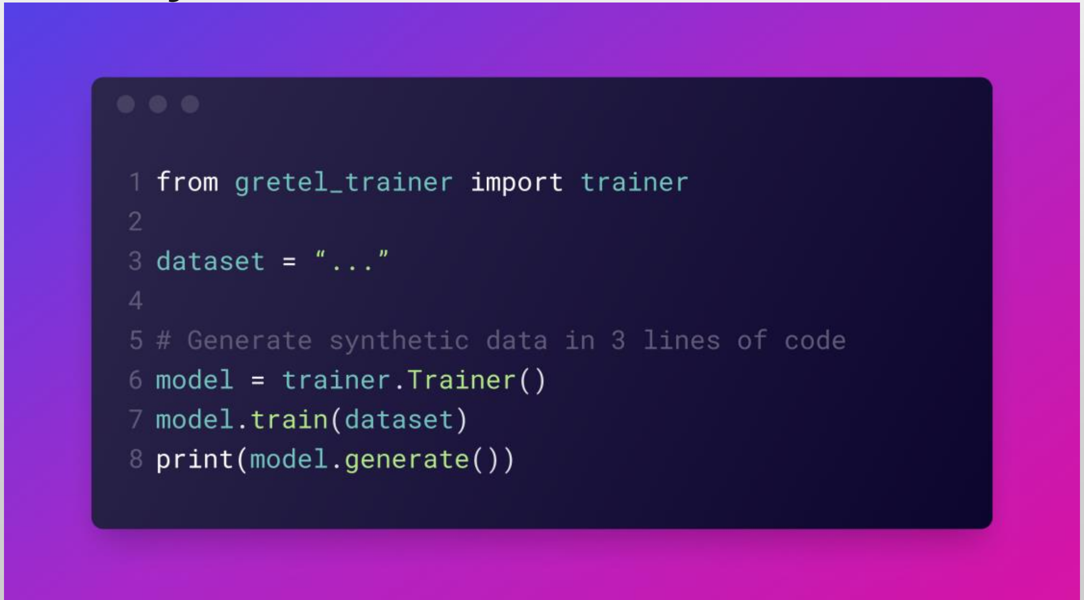
- Many resources available
  - https://www.opensourceagenda.com/tags/synthetic-data
  - https://github.com/gretelai/awesome-synthetic-data
- Open Source options available
  - gretel-synthetics
  - Synthetic Data Vault
  - Stable Diffusion - Images

gretel-synthetics

- Open Source
- Multiple models
  - LSTM
  - GPT
  - CTGAN
  - More to come
- Train the synthetic data models yourself
  - You'll need a GPU
- https://github.com/gretelai/gretel-synthetics
- https://synthetics.docs.gretel.ai/en/stable/

Gretel Cloud

- Don’t have a GPU? Want to just try it out?
  - Try the free tier at https://gretel.ai
- Train Synthetic Data in 3 lines of code



```
from gretel_trainer import trainer

dataset = “...”

# Generate synthetic data in 3 lines of code
model = trainer.Trainer()
model.train(dataset)
print(model.generate())
```

Additional Resources

- https://docs.gretel.ai/
- https://github.com/gretelai/gretel-blueprints
- https://github.com/gretelai/fun-with-synthetic-data

Free Swag!

- Fill out https://grtl.ai/dcus2022 and we'll mail you some stickers!
- Form closes a week after the premiere of this talk

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That’s all for this time!

- Follow me on Twitter @masonegger
- Follow Gretel on Twitter @gretel_ai to keep up with all things Synthetic Data
- Have questions? Ask in our Slack! https://grtl.ai/slack
- Get started with Gretel https://gretel.ai
- Slides on my website, https://mason.dev

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