# Using Apache Spark with Amazon SageMaker

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# Agenda

- Apache Spark on AWS
- Amazon SageMaker
- Combining Spark and SageMaker
- Demos with the SageMaker SDK for Spark
- Getting started

Services covered: Amazon EMR, Amazon SageMaker



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# Apache Spark on AWS

# Apache Spark

https://spark.apache.org/


- Open-source, distributed processing system.
- In-memory caching and optimized execution for fast performance (typically 100x faster than Hadoop).
- Batch processing, streaming analytics, machine learning, graph databases and ad hoc queries.
- API for Java, Scala, Python, R, and SQL.



# Apache Spark – *DataFrame*

- Distributed collection of data organized into named columns.
- Conceptually equivalent to a table in a relational database.
- Wide array of sources: structured files, databases.
- Wide array of formats: text, CSV, JSON, Avro, ORC, Parquet.

```
{"name":"Michael"}
{"name":"Andy", "age":30}
{"name":"Justin", "age":19}
```

```
df = spark.read.json("people.json")
df.show()
+----+-------+
| age| name  |
+----+-------+
|null|Michael|
| 30 | Andy  |
| 19 | Justin|
+----+-------+
```

# MLlib – Machine learning library

https://spark.apache.org/docs/latest/ml-guide.html


- ML algorithms: classification, regression, clustering, collaborative filtering.

- Featurization: feature extraction, transformation, dimensionality reduction.

- Tools for constructing, evaluating and tuning ML pipelines
- *Transformer* – a transform function that maps a *DataFrame* into a new one
    - Adding a column, changing the rows of a specific column, etc.
    - Predicting the label based on the feature vector.
- *Estimator* – an algorithm that trains on data
    - Consists of a *fit*() function that maps a *DataFrame* into a *Model*.



# Apache Spark on Amazon EMR

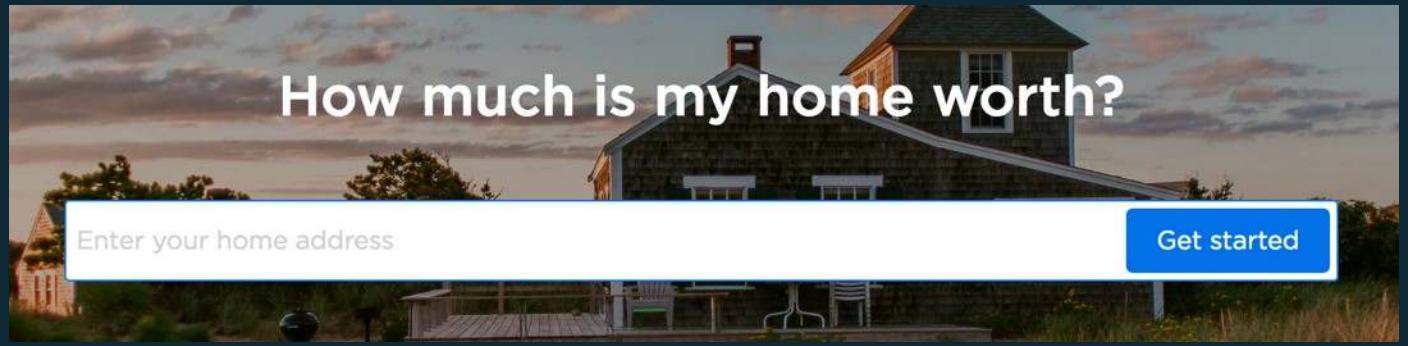
https://aws.amazon.com/emr/

- Spark is natively supported in Amazon EMR.
- Amazon S3 connectivity using the EMR File System (EMRFS).
- Amazon Kinesis, Redshift and DynamoDB as data sources.
- Integration with the AWS Glue Data Catalog.
- Auto Scaling to add or remove instances from your cluster.
- Integration with the Amazon EC2 Spot market.

# Customer use case: Zillow

https://aws.amazon.com/solutions/case-studies/zillow-zestimate/

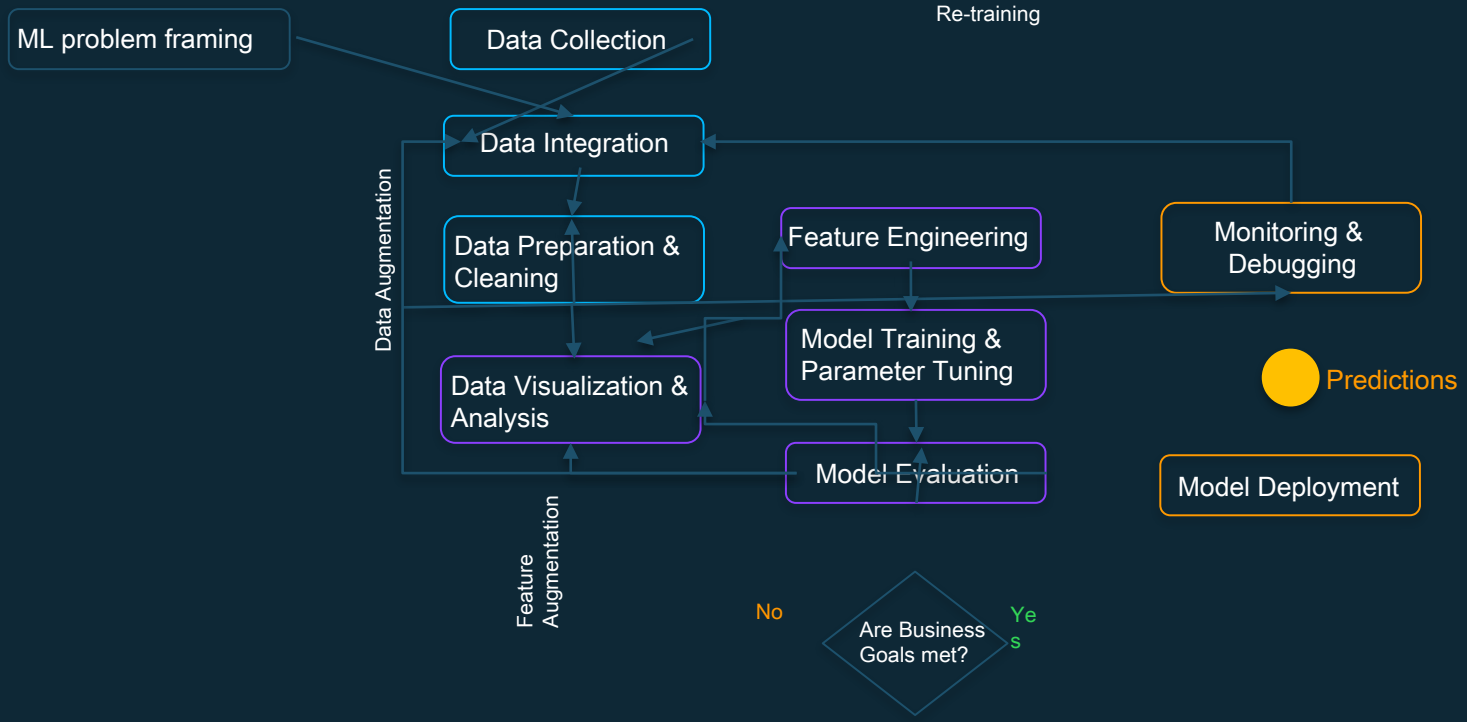
- Most popular online real-estate website in the US.
- Zestimate: a home valuation tool for over 100 million homes.
- Computed from data ingested into Kinesis and pushed into Spark on EMR.
- Machine learning models give users near real-time Zestimates.



# Amazon SageMaker

Business Problem –

# The Machine Learning Process

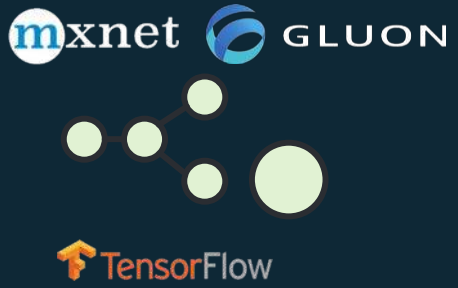


# Amazon SageMaker

## Build, train, and deploy models at scale

End-to-End Machine Learning Platform

Zero setup




Flexible Model Training


Pay by the second



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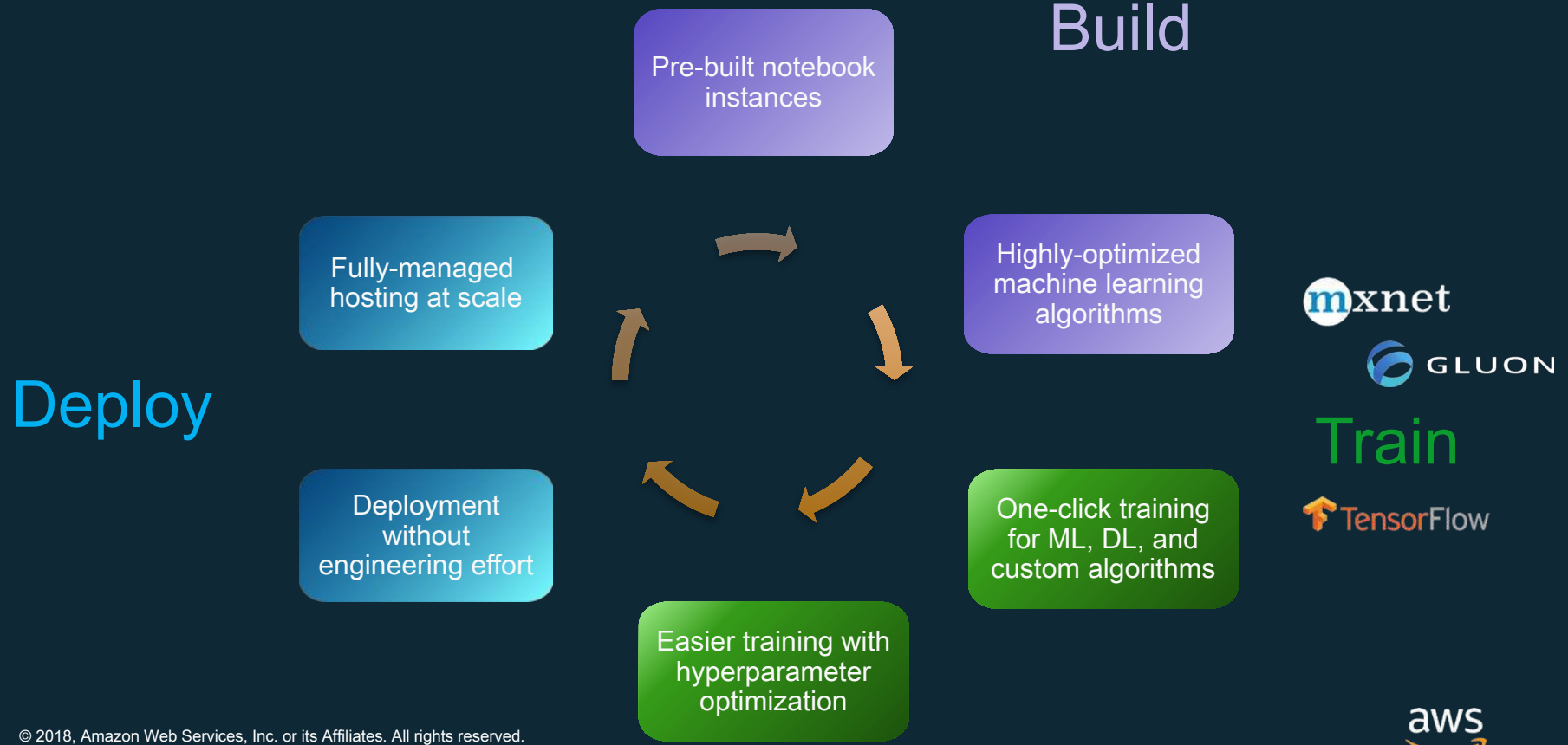
# Amazon SageMaker



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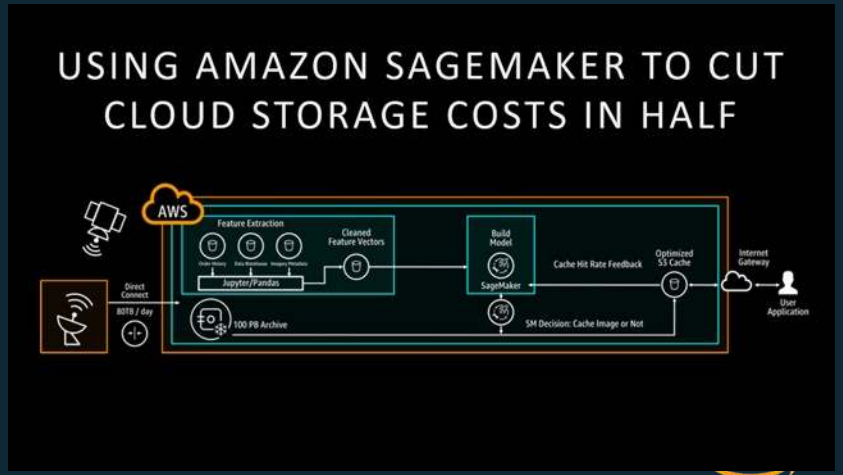
# Customer use case: Digital Globe

https://aws.amazon.com/solutions/case-studies/digitalglobe-machine-learning/

- Operating Earth imaging satellites and providing image analysis services.
- Over 100 PB of imagery.
- Extensive use of Machine Learning on SageMaker to extract information from images.
- Working with the AWS ML Lab, built a predictive model reducing cloud storage costs by 50%.



# Combining Spark and SageMaker

# Decouple ETL and Machine Learning

- Different workloads require different instance types.
  - Say, M4 for ETL, P3 for ML training and C5 for ML prediction?
  - If you need GPUs for training, running your EMR cluster on GPU instances wouldn't be cost-efficient.
- Scale them independently.
  - Avoid oversizing your Spark cluster because one part of the process requires more capacity.
  - Avoid time-consuming resizing operations on EMR.
  - Run ETL once, train many models in parallel.
- SageMaker terminates training instances automatically.

# Run any ML algorithm in any language

- Spark MLlib is great, but you may need something else.

- SageMaker algorithms, able to train on huge data sets without the need for huge clusters.
- Deep Learning libraries, like TensorFlow or Apache MXNet.
- Your own custom code in any language.



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# Deploy ML models in production

- Perform ML predictions without using Spark.
  - Save the overhead of the Spark framework.
  - Save loading your data in a *DataFrame*.
- Improve latency for small-batch predictions.
  - It can be difficult to achieve low-latency predictions with Spark ML models.
  - You can get real-time predictions with models hosted in SageMaker.
  - You can use very powerful instances for prediction endpoints.

# Sample use cases

- Data preparation and feature engineering before training.
- Data transformation before batch prediction (model reuse).
- Data enrichment with predictions.
  - Predict missing values instead of using median.
  - Add new predicted features.
- Train on extremely large datasets with built-in algos.

# SageMaker SDK for Spark

https://github.com/aws/sagemaker-spark

- Python and Scala SDK, for Apache Spark 2.1.1 and 2.2.
- Pre-installed on EMR 5.11 and later.

- Train, import, deploy and predict with SageMaker models directly from your Spark application.
  - Standalone,
  - Integration in Spark MLlib pipelines.

- *DataFrames* in, *DataFrames* out:
  automatic conversion to and from protobuf



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# SageMaker SDK for Spark – built-in algorithms

https://docs.aws.amazon.com/sagemaker/latest/dg/algos.html

- High-level API for:
  - Linear Learner
  - Factorization Machines
  - K-Means
  - PCA
  - LDA
  - XGBoost

Infinitely scalable algorithms:
no limit to the amount of data that they can process

- The *SageMakerEstimator* object lets you use any containerized code stored in Amazon ECR (just like the regular SageMaker SDK).



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# Demos

https://github.com/juliensimon/dlnotebooks

1 – Classifying MNIST in Python with XGBoost (SageMaker)
2 – Clustering MNIST in Scala with K-Means (SageMaker)
3 – Clustering MNIST in Scala with a Pipeline: PCA (MLlib) + K-Means (SageMaker)



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# Getting started

https://aws.amazon.com/machine-learning

https://aws.amazon.com/sagemaker

https://aws.amazon.com/emr

An overview of Amazon SageMaker

AWS re:Invent 2016: Best Practices for Apache Spark on Amazon EMR

https://github.com/aws/sagemaker-python-sdk

https://github.com/aws/sagemaker-spark

https://medium.com/@julsimon



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# Thank you!

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