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Practical Data Science

Built-In Algorithms

Machine Learning Workflow

Ingest & Analyze	Prepare & Transform	Train & Tune	Deploy & Manage
Data exploration	Feature engineering	Automated ML	Model deployment
Bias detection	Feature store	Model train and tune	Automated pipelines
Amazon S3 & Amazon Athena	Amazon SageMaker Data Wrangler	Amazon SageMaker Autopilot	Amazon SageMaker Endpoints
AWS Glue	Amazon SageMaker Processing Jobs	Amazon SageMaker Training & Debugger	Amazon SageMaker Batch Transform
Amazon SageMaker Data Wrangler & Clarify	Amazon SageMaker Feature Store	Amazon SageMaker Hyperparameter Tuning	Amazon SageMaker Pipelines

Why use built-in algorithms?

- Implementations are highly-optimized and scalable
- Focus more on domain-specific tasks rather than managing low-level model code and infrastructure
- Trained model can be downloaded and re-used elsewhere

When to choose built-in algorithms vs. custom code

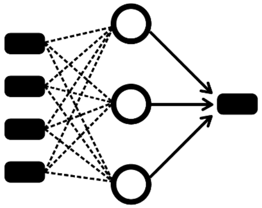
Amazon SageMaker	Amazon SageMaker	Amazon SageMaker
Built-in Algorithms	*Bring Your Own Script*	*Bring Your Own Container*

Less Code

More Customizable

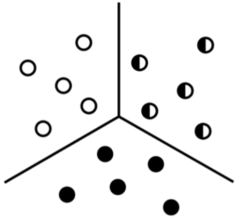
Use cases and algorithms

Popular ML tasks and learning paradigms



Classification
& Regression

Supervised



Clustering

Unsupervised

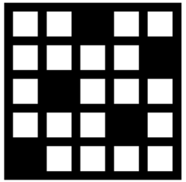
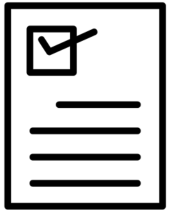


Image Processing

Computer Vision



Text Analysis

NLP / NLU

Classification & regression

Example problems and use cases	Problem types	Input format	Built-in algorithms
Predict if an item belongs to a category: an email spam filter	Binary/multi-class classification	Tabula r	XGBoost, K-Nearest Neighbors (k-NN)

Classification & regression

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Predict sales on a new product based on previous sales data	Time-series forecasting	Tabula r	DeepAR Forecasting

Clustering

Example problems and use cases	Problem types	Input format	Built-in algorithms
Drop weak features such as the color of a car when predicting its mileage.	Feature engineering: reduce dimensions	Tabular	Principal Component Analysis (PCA)

Clustering

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Clustering

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Clustering

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Group high/medium/low-spending customers from transaction histories	Clustering / grouping	Tabular	K-Means
Organize a set of documents into topics based on words and phrases	Topic modeling	Text	Latent Dirichlet Allocation (LDA), Neural Topic Model (NTM)

Image processing

Example problems and use cases	Problem types	Input format	Built-in algorithms
Content moderation	Image classification	Image	Image Classification

Image processing

Example problems and use cases	Problem types	Input format	Built-in algorithms
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Image processing

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Detect people and objects in an image	Object detection	Image	Object Detection
Self-driving cars identify objects in their path	Computer vision	Image	Semantic Segmentation

Text analysis

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Convert Spanish to English	Machine translation	Text	Sequence-to-Sequence

Text analysis

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Text analysis

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Transcribe call center conversations	Speech-to-text	Text	Sequence-to-Sequence

Text analysis

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Summarize a research paper	Text summarization	Text	Sequence-to-Sequence
Transcribe call center conversations	Speech-to-text	Text	Sequence-to-Sequence
Classify reviews into categories	Text classification	Text	BlazingText

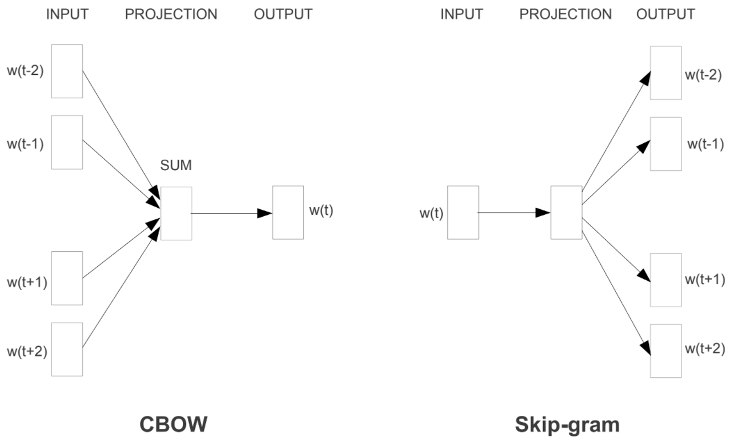
Text analysis

Evolution of text analysis algorithms

Text analysis algorithm - Word2Vec

Concepts

- Convert text into vectors called “embeddings”
- 300-dimensional vector space
- Perform machine learning on the vectors

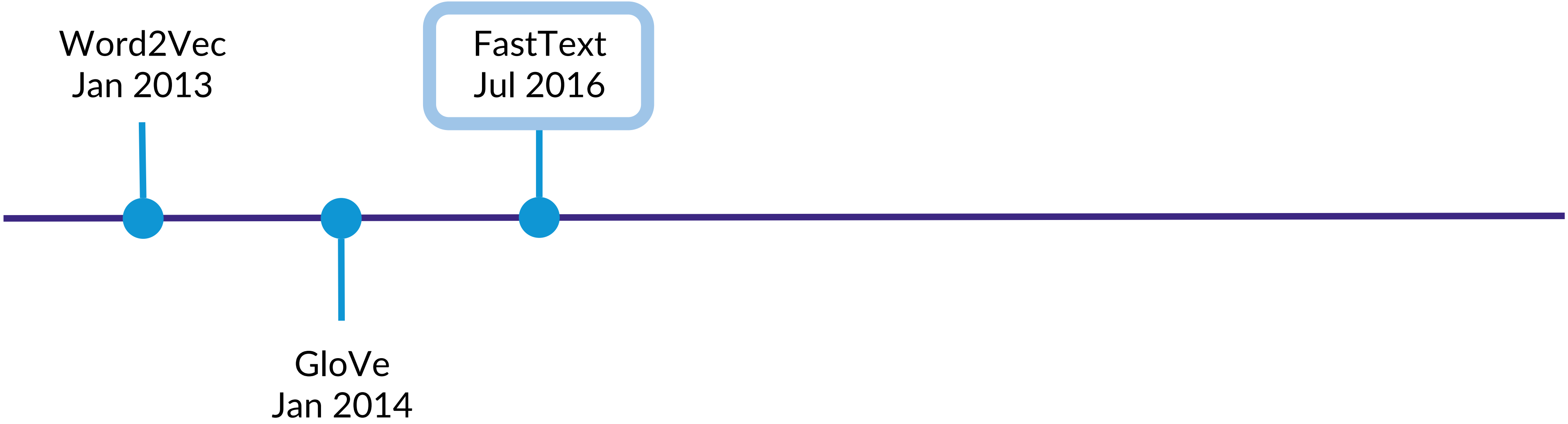


Model architectures to create the embeddings

- Continuous bag-of-words (CBOW)
- Continuous skip-gram

Source: "Efficient Estimation of Word Representations in Vector Space", Mikolov et al., 2013

Evolution of text analysis algorithms



Text analysis algorithm - FastText

Concepts

- Extension of word2vec
- Breaks the word into character sets of length n (n-grams):

```
"amazon" => "a", "am", "ama", "amaz", "amazo", "amazon"
```

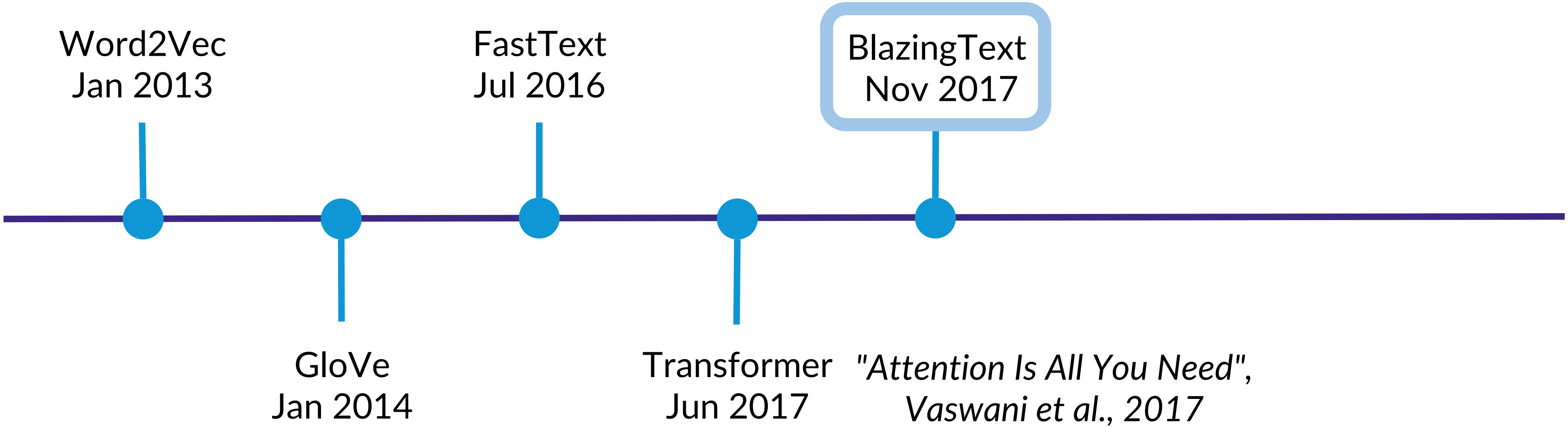
- Embedding for a word is the aggregate of the embedding of each n-gram within the word

Helps with the out-of-vocabulary (OOV) issue with word2vec

Implementation

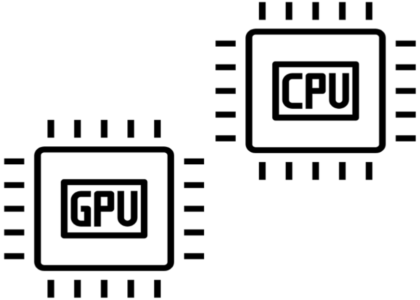
- CBOW and skip-gram models
- Adds text classification

Evolution of text analysis algorithms

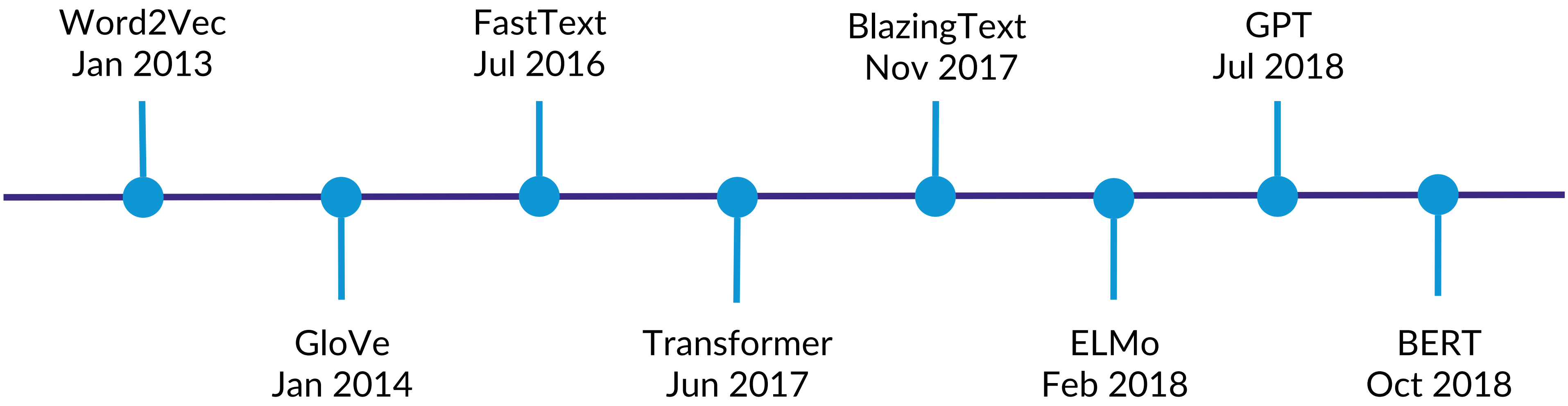


Text analysis algorithm - BlazingText

- Scales and accelerates Word2Vec using multiple CPUs or GPUs for training
- Extends FastText to use GPU acceleration with custom CUDA kernels
- Creates n-gram embeddings using CBOW and skip-gram
- Saves money by early-stopping a training job
  - when the validation accuracy stops increasing
- Optimized I/O for datasets stored in Amazon S3



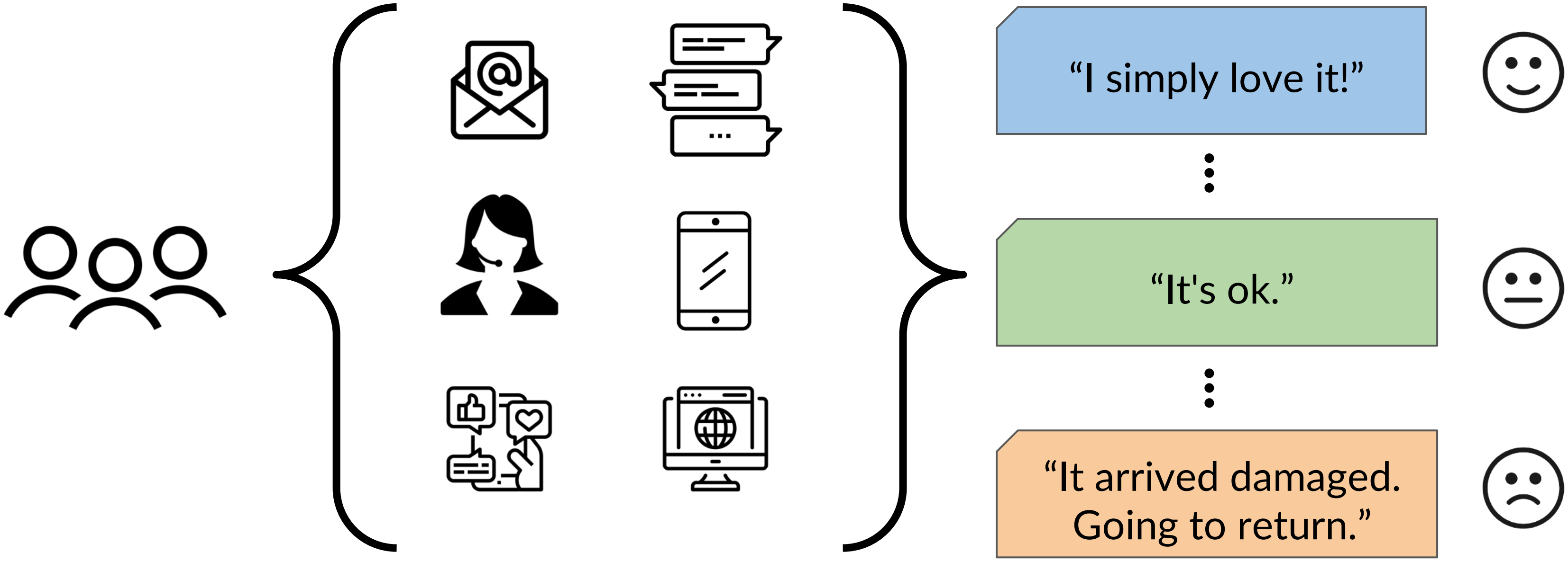
Evolution of text analysis algorithms



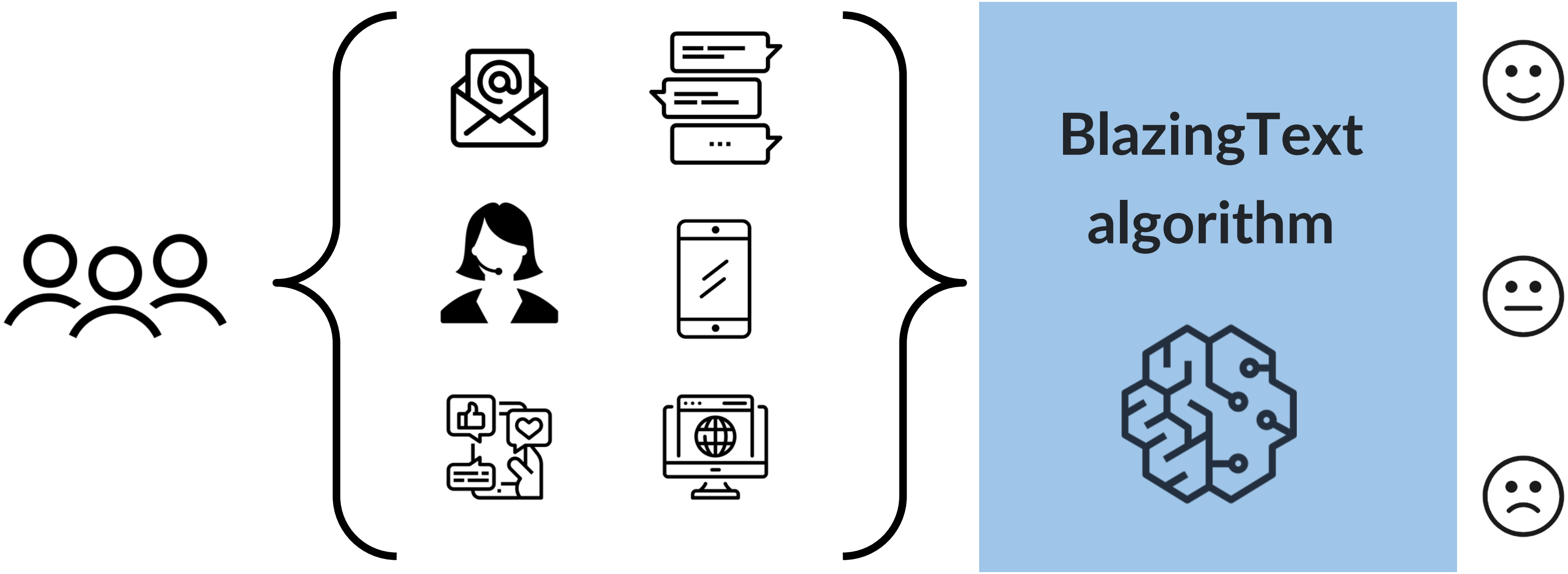
Train a text classifier

with Amazon SageMaker BlazingText

Multi-class classification for sentiment analysis of product reviews



Multi-class classification for sentiment analysis of product reviews



Transform raw review data into features

Ingest & Analyze → **Prepare & Transform** → Train & Tune → Deploy & Manage

```
sentiment,review_body
1,"i simply love it"

0,"it's ok"

-1,"it arrived damaged. going to return"
```

```
__label__1 "i simply love it ."

__label__0 "it's ok ."

__label__-1 "it arrived damaged ."
```

Transform raw review data into features

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NLTK

```python
def tokenize(review):
    return nltk.word_tokenize(review)
```

```
__label__1 "i simply love it ."
__label__0 "it's ok ."
__label__-1 "it arrived damaged, going to return ."
```

Amazon SageMaker BlazingText hyper-parameters for text classification

Parameter Name	Recommended Ranges or Values	Description
epochs	[5-15]	Number of complete passes through the dataset
learning_rate	[0.005-0.01]	Step size for the numerical optimizer
min_count	[0-100]	Discard words that appear less than this number
vector_dim	[32-300]	Number of dimensions in vector space
word_ngrams	[1-3]	Number of words n-gram features to use
early_stopping	True or False	Stop training if validation accuracy stops improving
patience	[5-15]	Number of epochs before early stopping

Train a text classifier using Amazon SageMaker BlazingText

Ingest & Analyze → Prepare & Transform → **Train & Tune** → Deploy & Manage

```
train_data = sagemaker.inputs.TrainingInput(...)
validation_data = sagemaker.inputs.TrainingInput(...)

data_channels = {
    'train': train_data,
    'validation': validation_data
}

image_uri = sagemaker.image_uris.retrieve(framework='blazingtext', ...)
```

Retrieves Amazon ECR image URIs for pre-built SageMaker Docker images.

Train a text classifier using Amazon SageMaker BlazingText

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}

image_uri = sagemaker.image_uris.retrieve(framework='blazingtext', ...)

estimator = sagemaker.estimator.Estimator(image_uri=image_uri, ...)
estimator.set_hyperparameters(...)
estimator.fit(...)
```

Retrieves Amazon ECR image URIs for pre-built SageMaker Docker images.

Evaluate the classifier

Ingest & Analyze → Prepare & Transform → **Train & Tune** → Deploy & Manage

time	metric_name	value
00.0	train:accuracy	0.4865
10.0	train:accuracy	0.5220
20.0	validation:accuracy	0.5364

Deploy the text classifier

and make predictions

Deploy the text classifier

Ingest & Analyze → Prepare & Transform → Train & Tune → **Deploy & Manage**

```
text_classifier = estimator.deploy(
    initial_instance_count=1,
    instance_type='ml.m4.xlarge', ...)
```

Increase instance_count > 1 to easily scale out

Deploy the text classifier

Ingest & Analyze → Prepare & Transform → Train & Tune → **Deploy & Manage**

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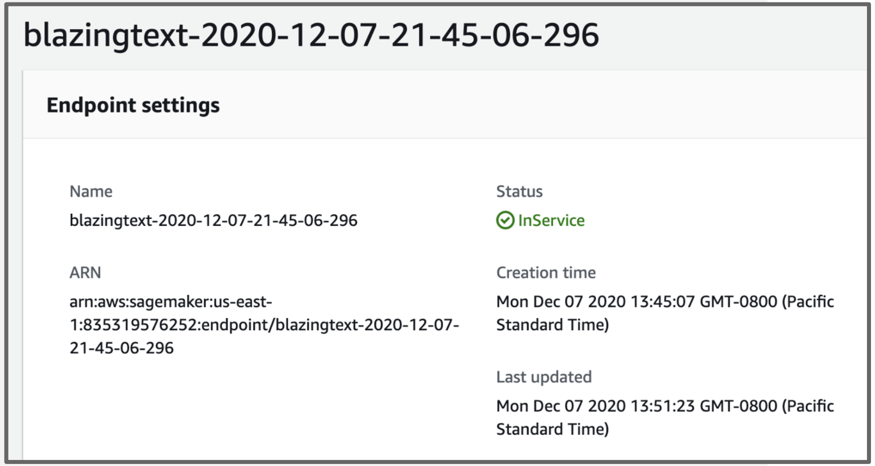

Deploy the text classifier

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```
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payload = {'instances': ['This product is great']}
response = text_classifier.predict(...)
```

Sample prediction request

Deploy the text classifier

Ingest & Analyze → Prepare & Transform → Train & Tune → **Deploy & Manage**

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text_classifier = estimator.deploy(
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payload = {'instances': ['This product is great']}
response = text_classifier.predict(...)

## Sample response:
[{
    "label": ["__label__1"],
    "prob": [0.9506041407585144]
}]
```

Sample prediction request

Prediction response and probability score