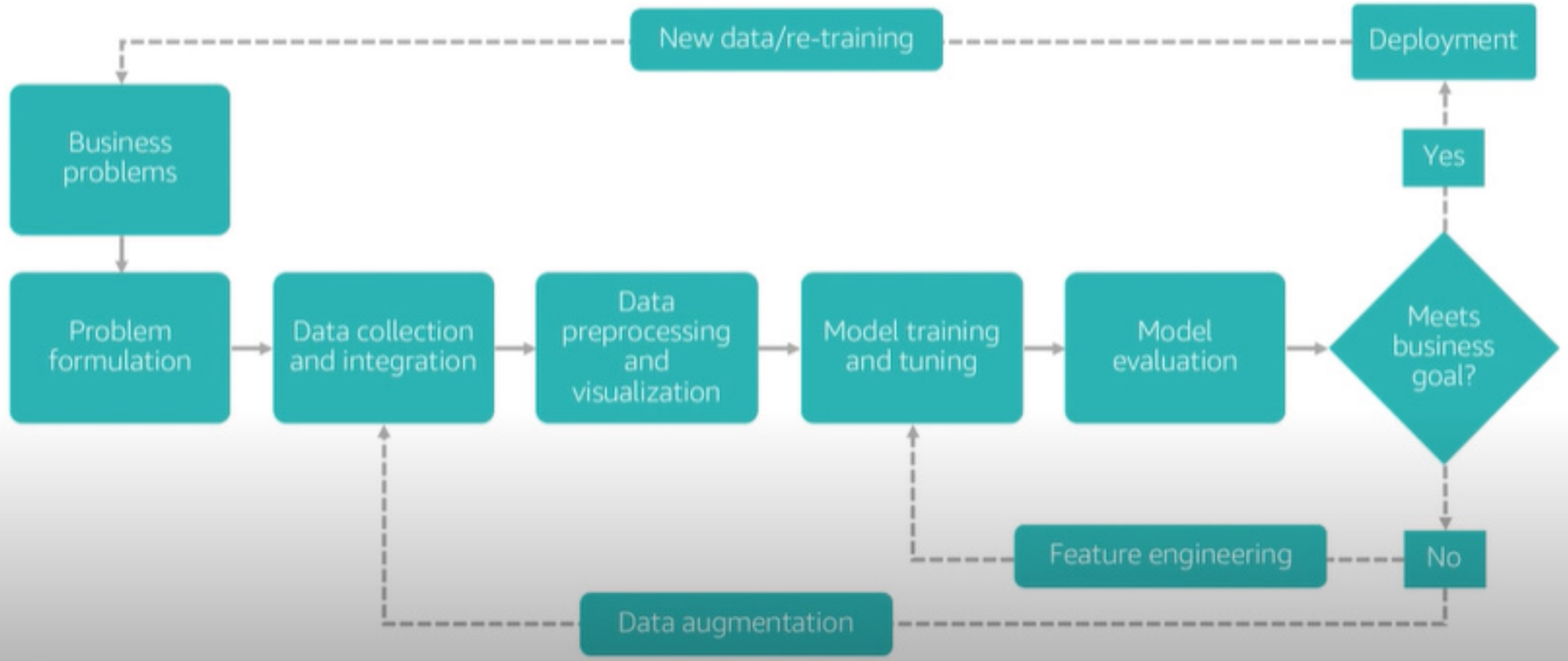
The Machine Learning Pipeline



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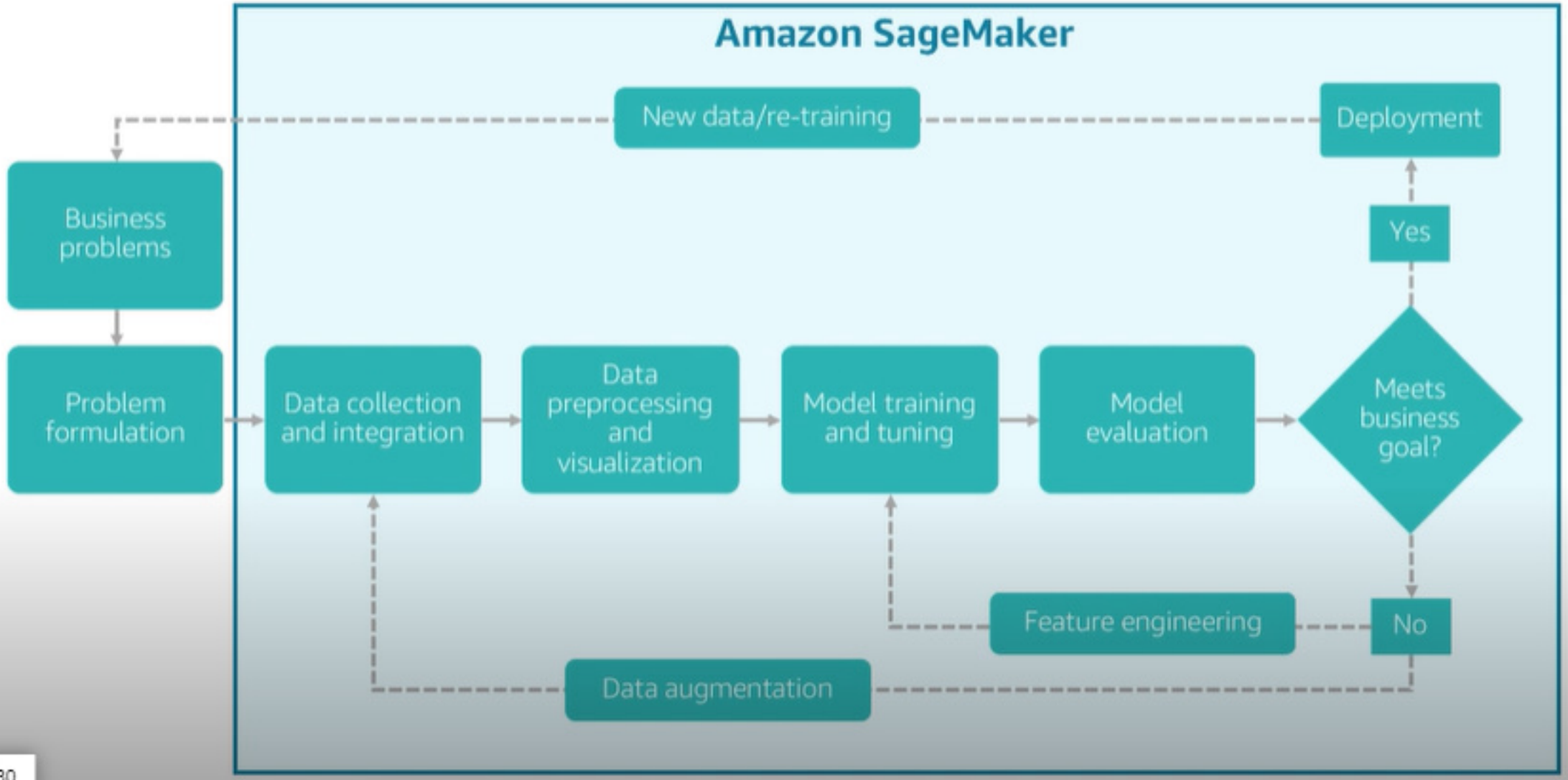
Where does Amazon SageMaker fit?

aws training and certification



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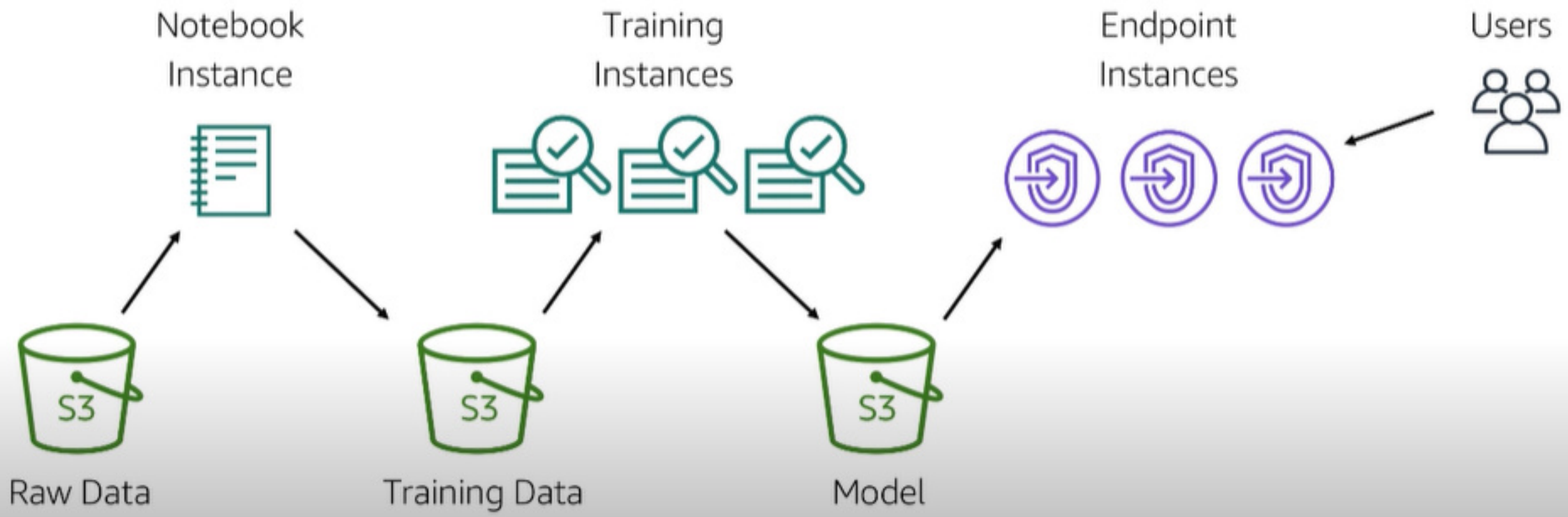
Amazon SageMaker Workflow

aws training and certification



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Amazon SageMaker - Instance types

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	Ideal for notebooks	Ideal for traditional machine learning training				Ideal for deep learning	Ideal for inference
Instance Family	t family	m family	r family	c family	p family	g family	Elastic Inference
Workload Type	Short jobs/ notebooks	Standard CPU to memory ratio	Memory optimized	Compute optimized	Accelerated computing-training and inference	Accelerated inference, smaller training jobs	Cost-effective Inference Accelerators

For lower demand workloads → For higher demand workloads

https://aws.amazon.com/sagemaker/pricing/instance-types/

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SageMaker > Data Exploration

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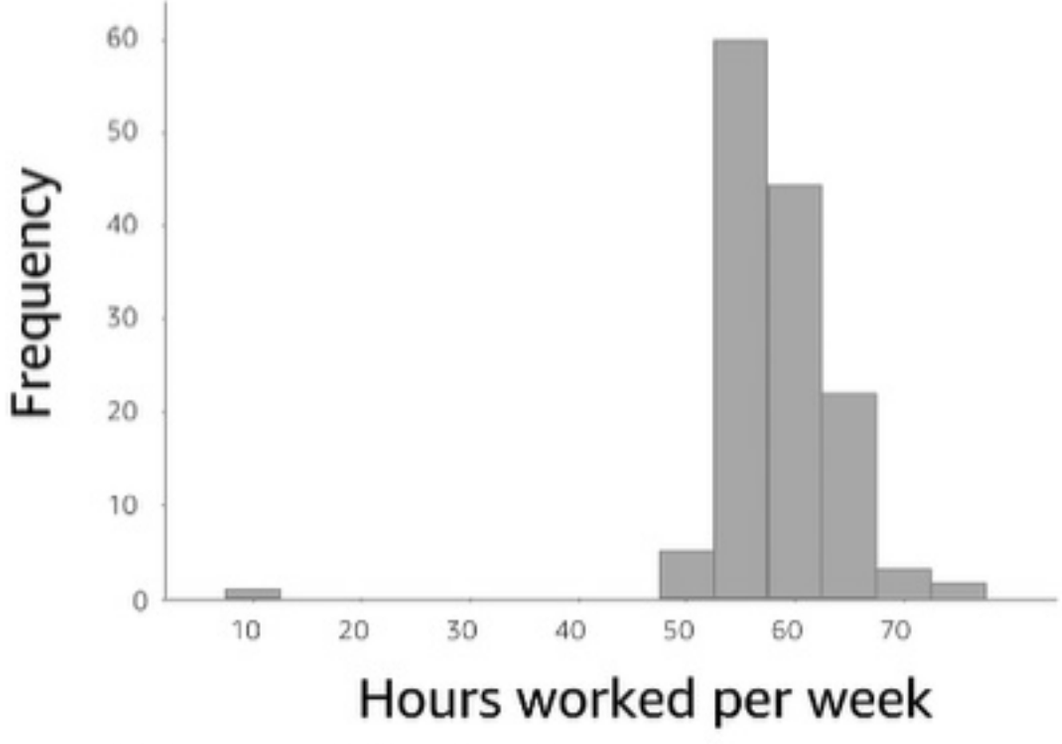
Large amounts of data are easier for the brain to process visually.



Positive correlation

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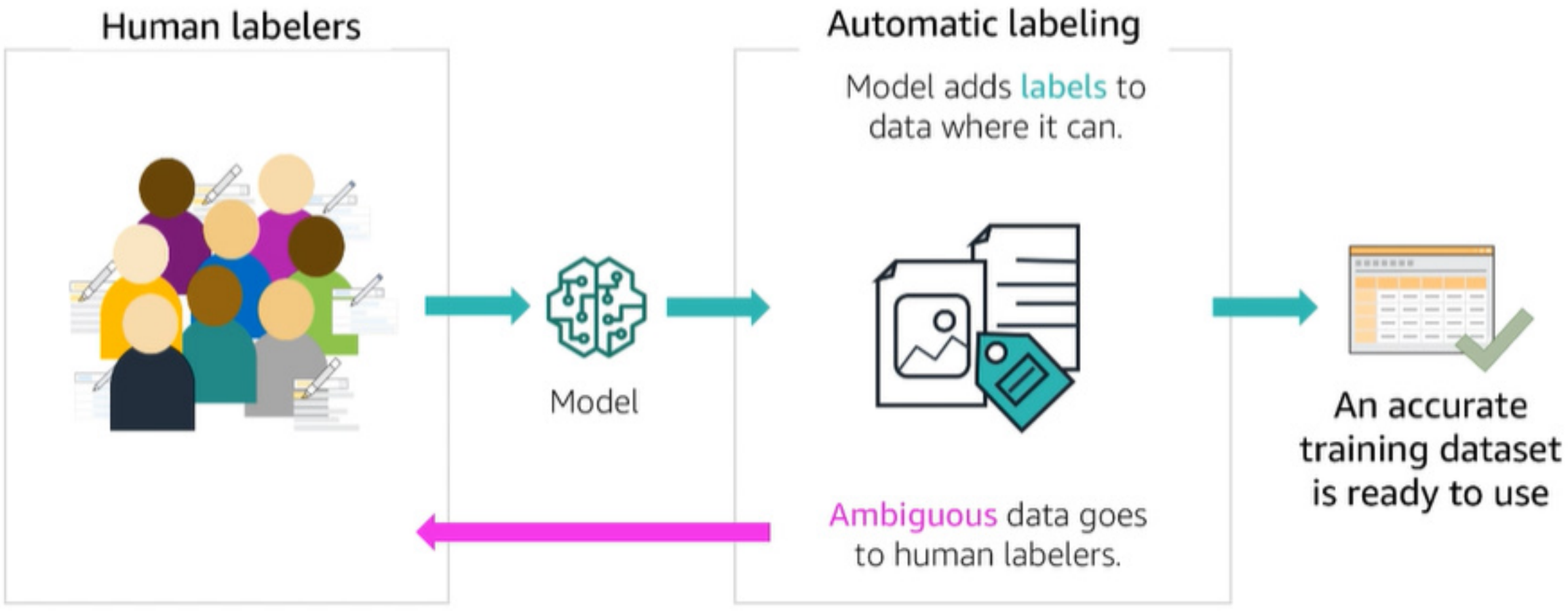
SageMaker Ground Truth > Dataset Labels

aws training and certification



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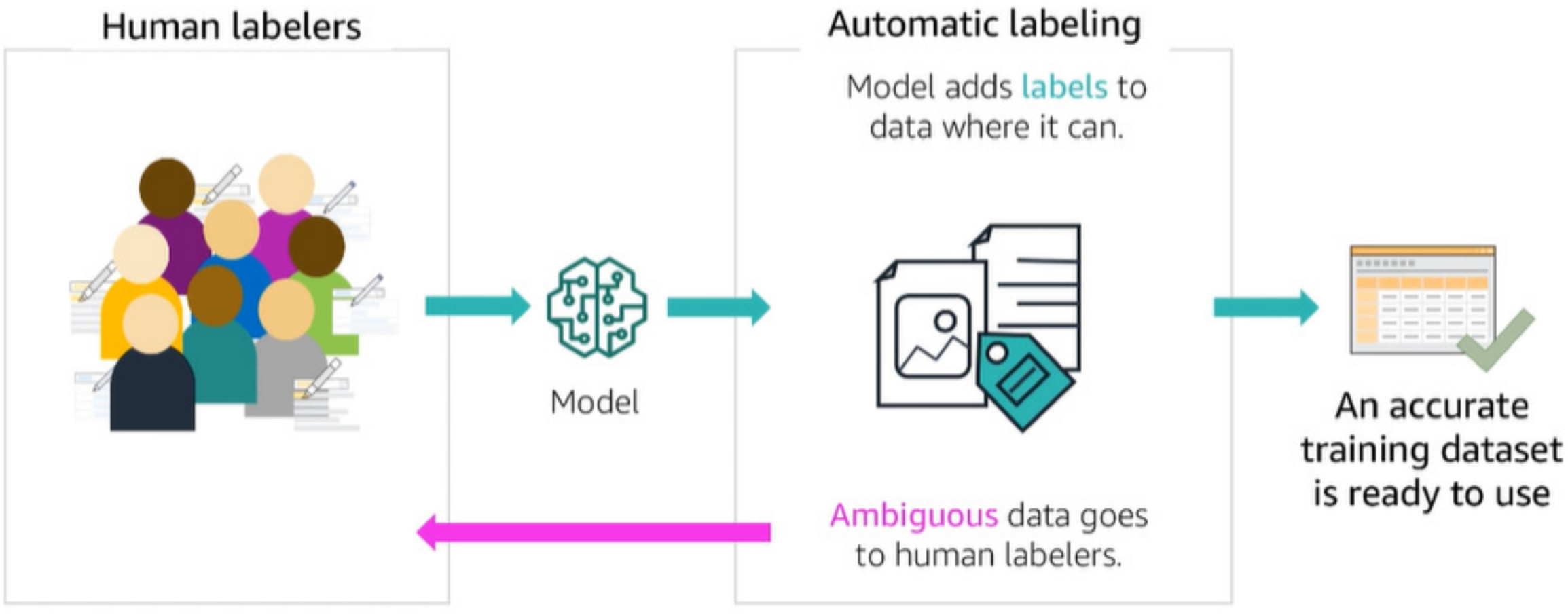
SageMaker Ground Truth > Dataset Labels

aws training and certification



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SageMaker > Model Selection

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Algorithm options

- Use a SageMaker built-in algorithm
- Write a script in your framework
- Get an algorithm from AWS Marketplace
- Bring your own algorithm

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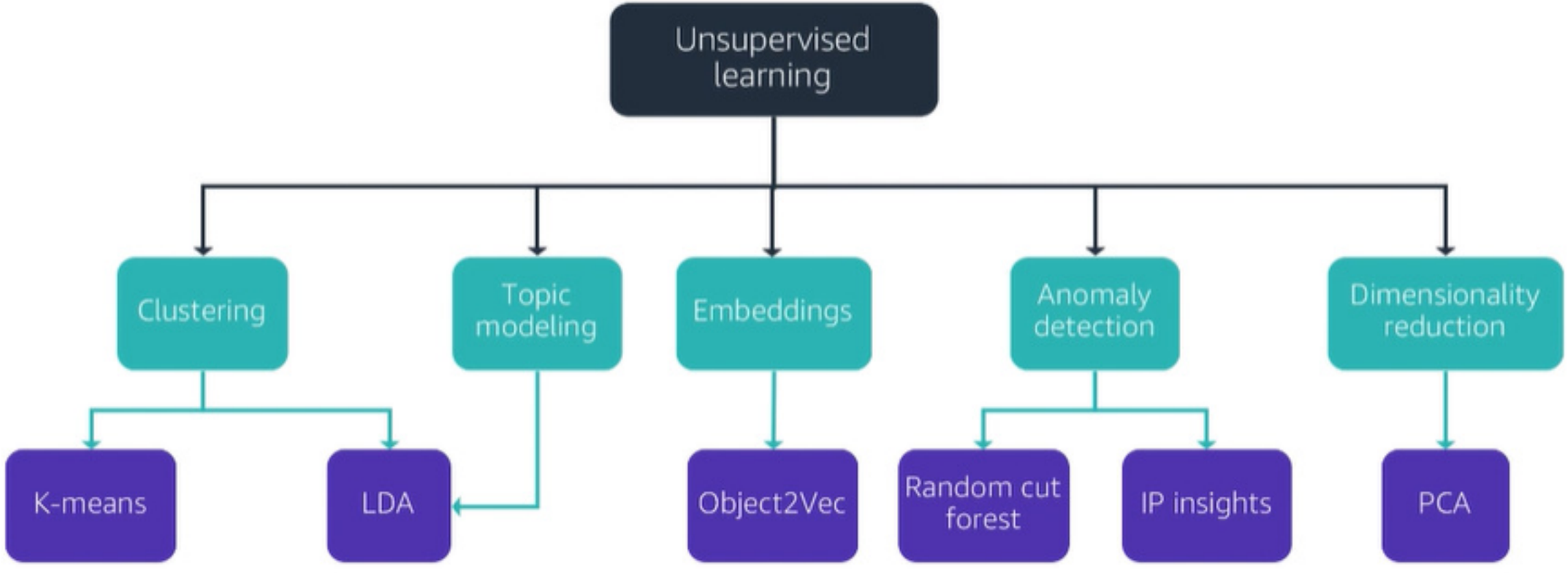
Choosing a SageMaker built-in algorithm

aws training and certification

What problem do you need to solve?



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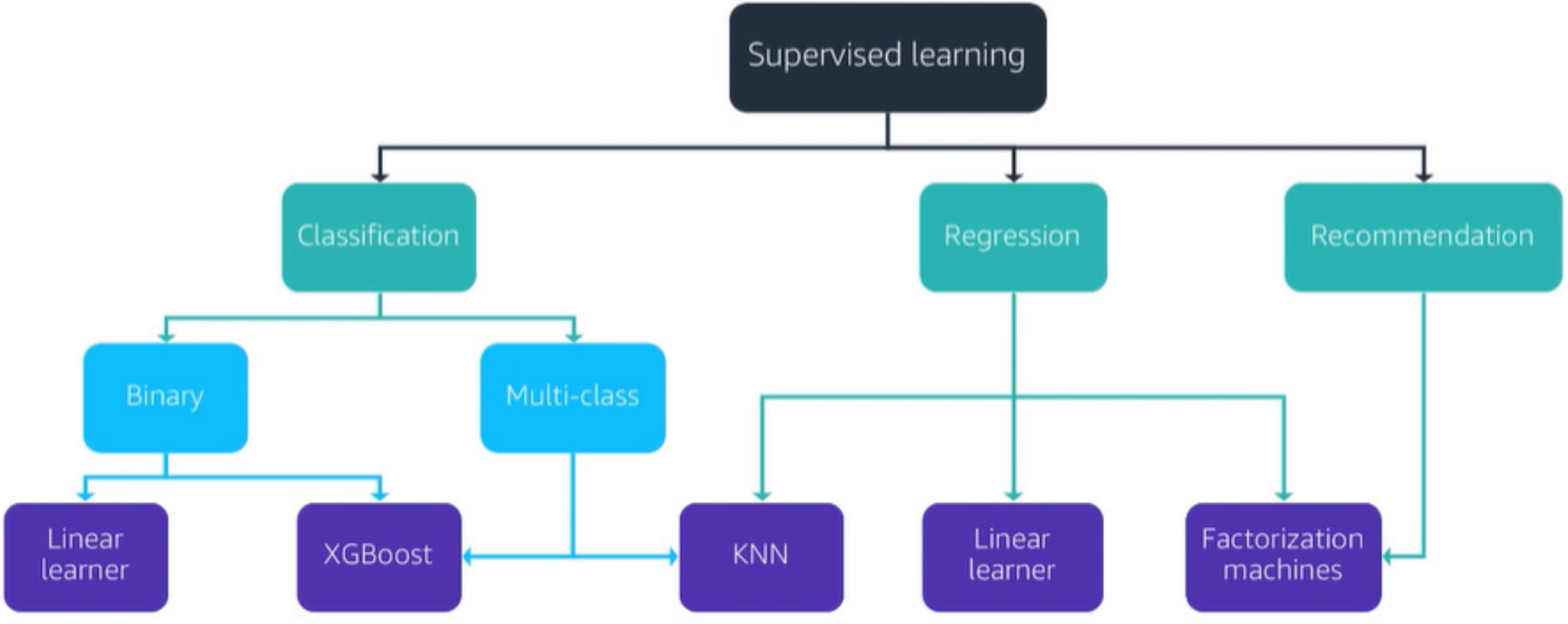
Choosing a SageMaker built-in algorithm

aws training and certification

What problem do you need to solve?



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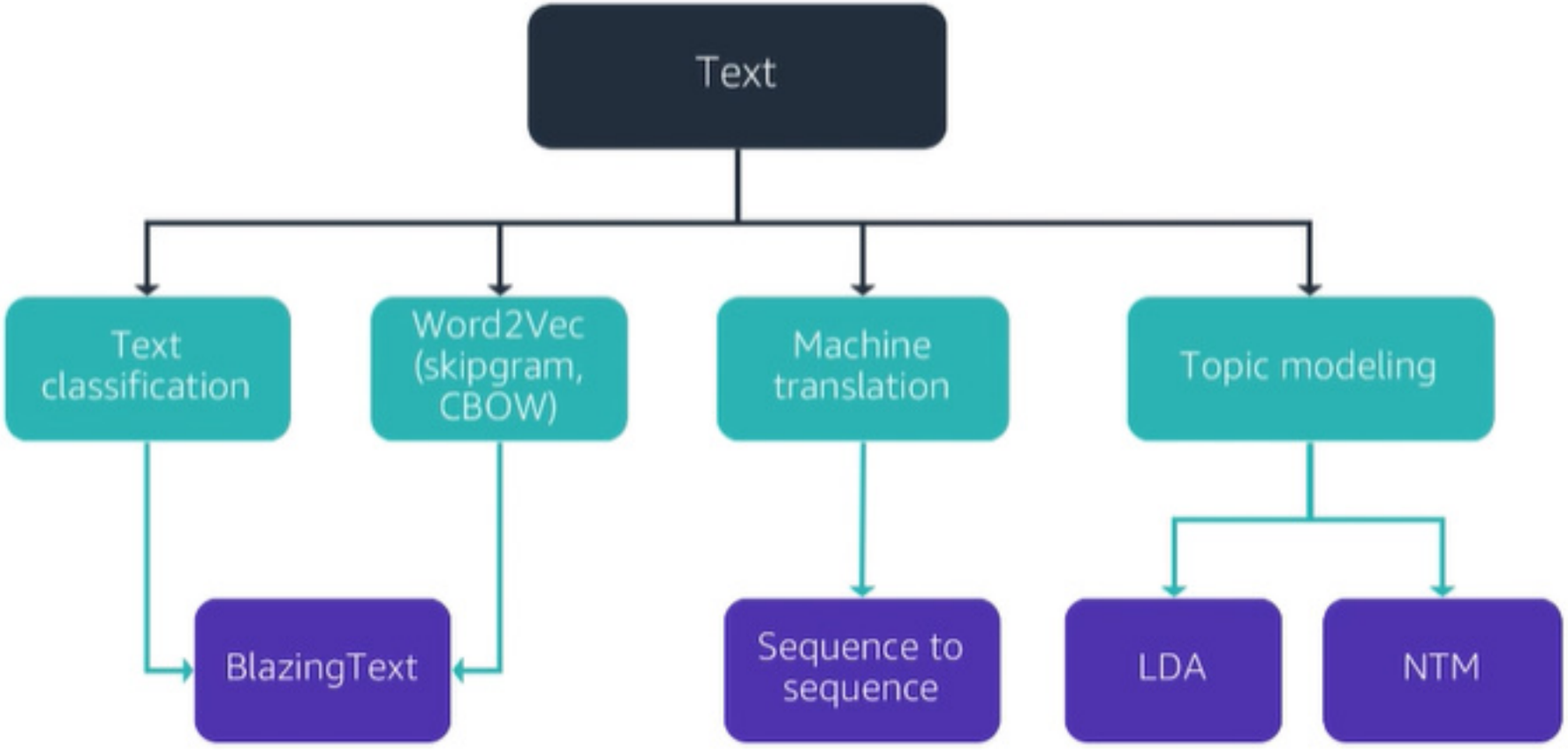
Choosing a SageMaker built-in algorithm

aws training and certification

What kind of data are you training with?



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Choosing a SageMaker built-in algorithm

aws training and certification

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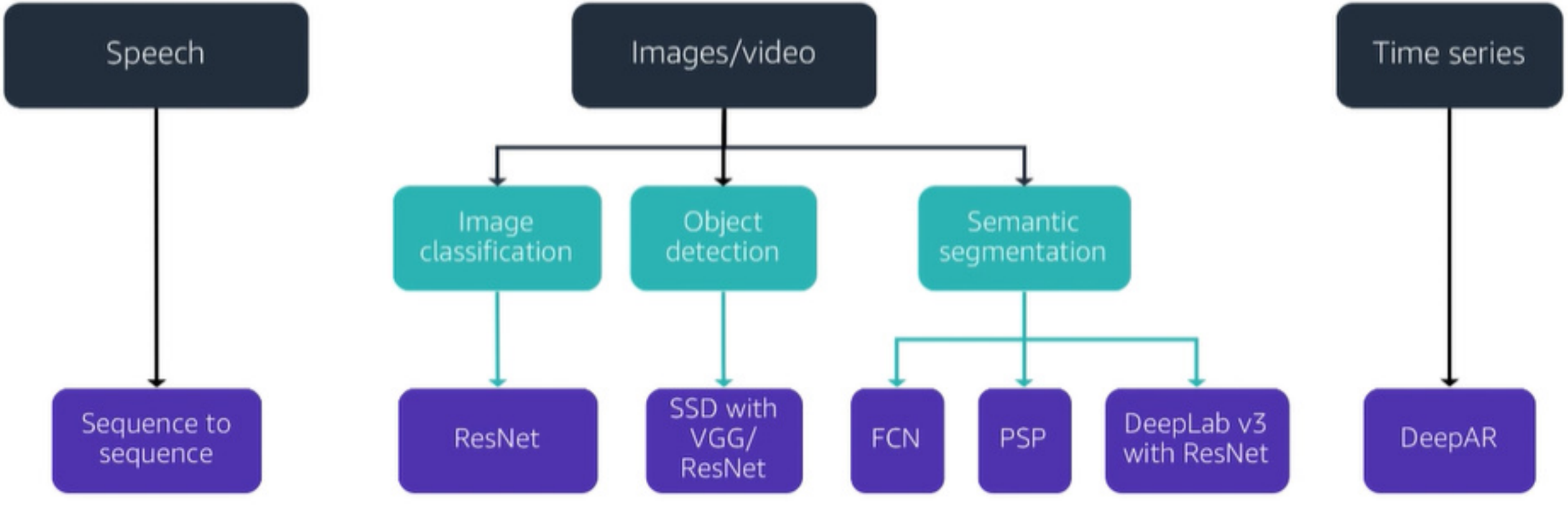

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Formatting the data for an algorithm

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Amazon SageMaker data formats

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Most commonly supported for built-in algorithms

Comma separated values

Record-IO protobuf

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CSV formatting: Label on the left

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Participant ID	Age	Income	Education	State	Flu shot	Outbreak zone?
123456	39	45,000/ year	4-yr degree	New York	Yes	No
123457	23	1,500/ month	Baccalauréat	Minnesota	No	Yes
123458	78		Masters/PhD		Yes	Yes
123459	20	3,000,000 /year	HS diploma	California	No	No
123460	154	53,000 /year		Masters/PhD		
...	...	...	...	...	...	...

No	123456	39	45,000/ year	4-yr degree	New York	Yes
Yes	123457	23	1,500/ month	Baccalauréat	Minnesota	No
Yes	123458	78		Masters/PhD		Yes
No	123459	20	3,000,00 0/year	HS diploma	California	No
	123460	154	53,000 /year		Masters/PhD	
...	...	...	...	...	...	...

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RecordIO-protobuf formatting

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Amazon SageMaker automatically performs some transformations on your recordIO-protobuf formatted data.

- Python: We recommend using those transformations
- Other languages: We recommend using the protobuf definition file provided in the AWS documentation:
  - https://docs.aws.amazon.com/sagemaker/latest/dg/cdf-training.html

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Running training jobs in Amazon SageMaker

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Training with Amazon SageMaker

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Start with an SDK:

Amazon SageMaker Python SDK

or

AWS SDK for Python (Boto 3)

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Options for scripts, algorithms, and models

- Use a built-in algorithm *(previously discussed)*
- Use pre-built container images
- Extend a pre-built container image
- Build your own custom container image

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Use a built-in algorithm

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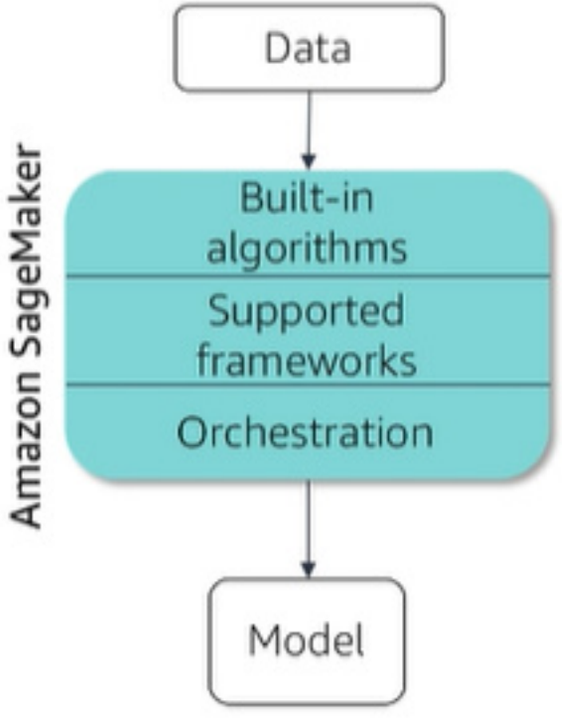
Amazon SageMaker built-in algorithms



17 built-in high-performance algorithms

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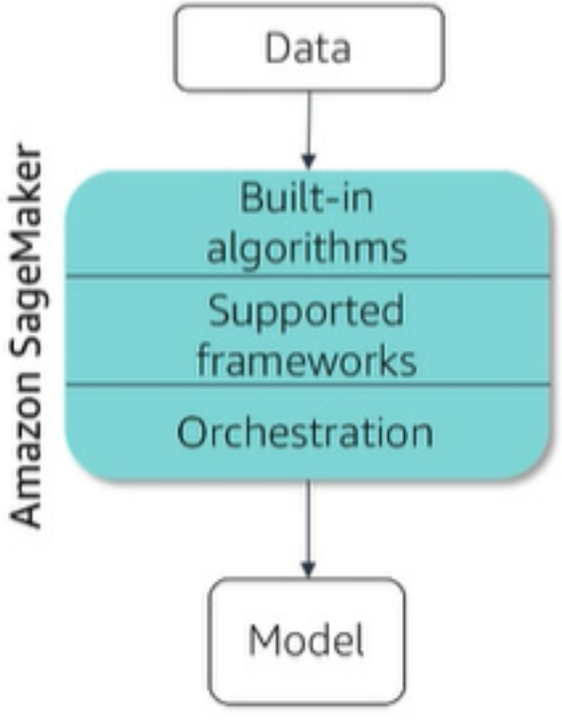
Build your own custom container image

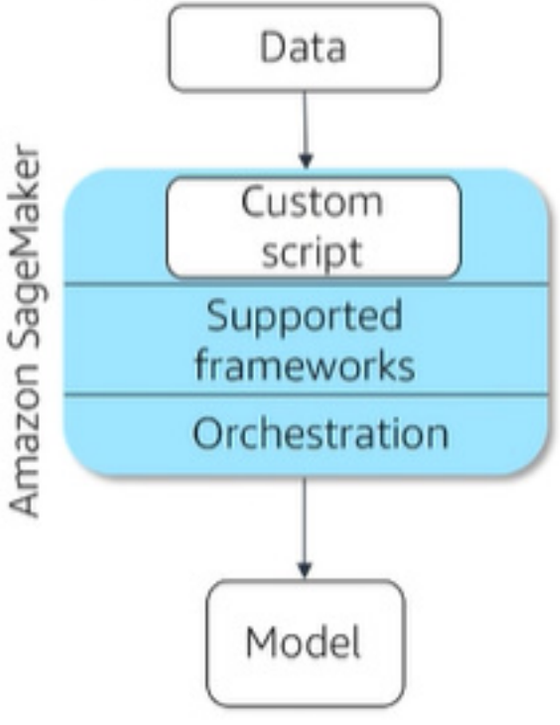
aws training and certification

Amazon SageMaker built-in algorithms



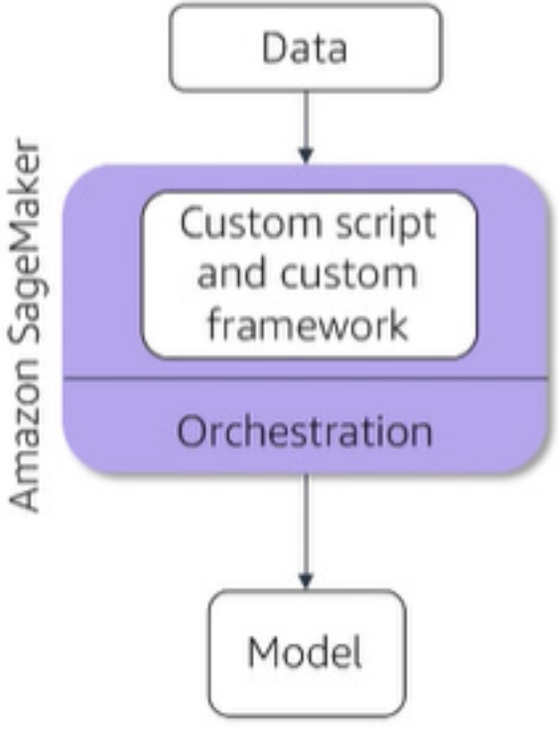
17 built-in high-performance algorithms

Custom script on supported framework



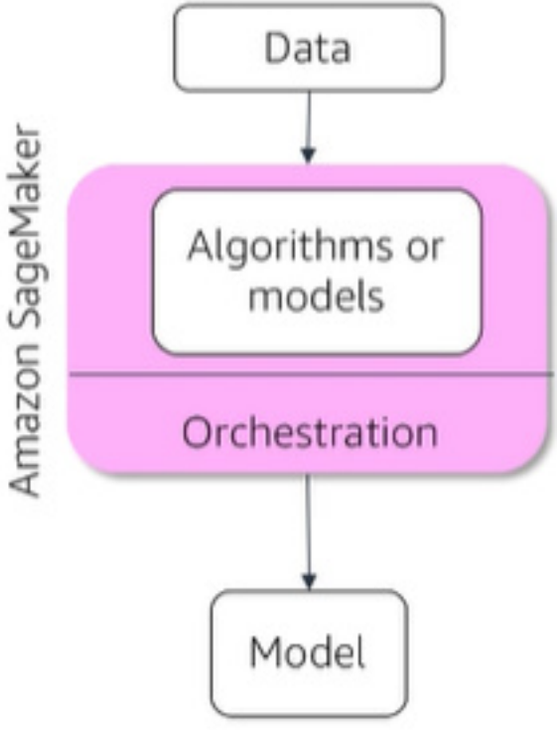
Supported frameworks: Apache MXNet, TensorFlow, Scikit-learn, PyTorch, Chainer

BYO algorithm and framework



Docker containers with your own algorithms and frameworks

AWS Marketplace algorithms



Third-party algorithms and models

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AWS Marketplace for machine learning

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Curated catalog of **250+ ML model packages** and **algorithms**

- **14+** industry segments (computer vision, natural language processing, speech recognition, fraud detection, etc.)
- Found through Amazon SageMaker console or AWS Marketplace
- Deploy through SageMaker console, SageMaker SDK, or AWS CLI
- Accessed through RESTful endpoints
- Consolidated into your AWS billing
- Pricing: Free, Free Trial, and Paid Subscriptions

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Creating a training job in Amazon SageMaker

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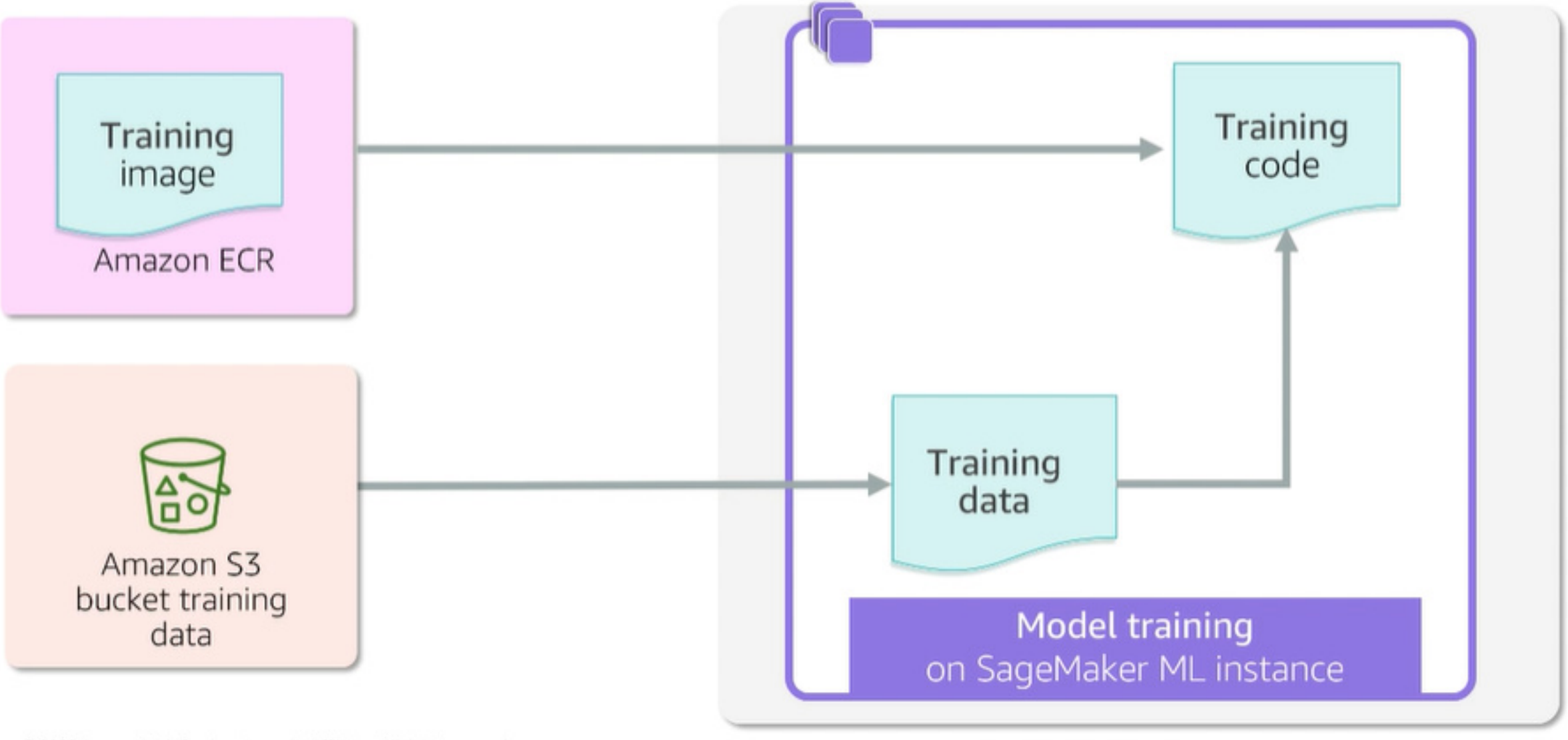

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Example training deployment code

aws training and certification

Import →

Hardware →

Parameters →

Start Training →

```
import boto3
import sagemaker

sess = sagemaker.Session()

pca = sagemaker.estimator.Estimator(containers[boto3.Session().region_name],
                                    role,
                                    train_instance_count=1,
                                    train_instance_type='ml.c4.xlarge',
                                    output_path=output_location,
                                    sagemaker_session=sess)
pca.set_hyperparameters(feature_dim=50000,
                        num_components=10,
                        subtract_mean=True,
                        algorithm_mode='randomized',
                        mini_batch_size=200)

pca.fit({'train': s3_train_data})
```

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Hyperparameter tuning

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The ML pipeline

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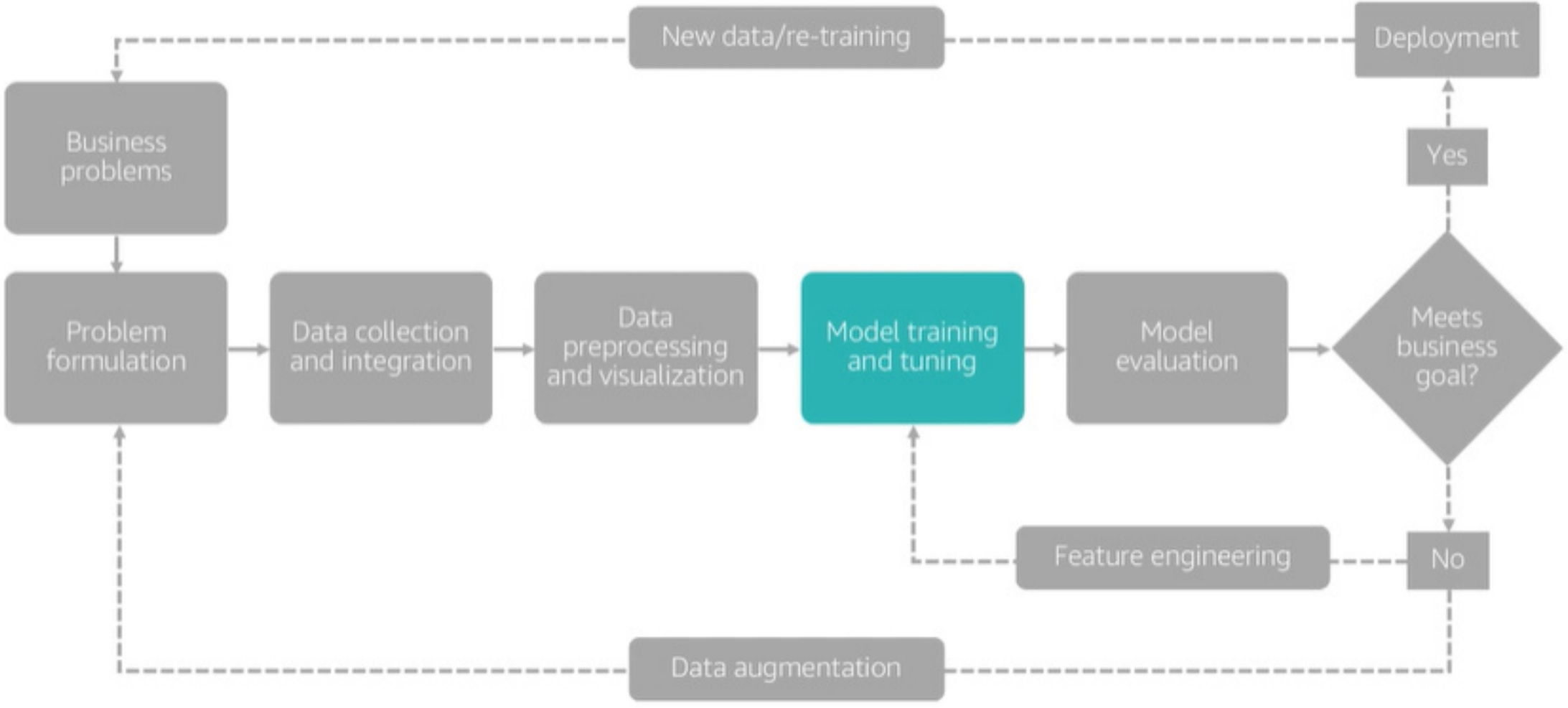

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Hyperparameter categories

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Model	Optimizer	Data
Help define the model	How the model learns patterns on data	Define attributes of the data itself
Filter size, pooling, stride, padding	Gradient descent, stochastic gradient descent	Useful for small/homogenous datasets

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Amazon SageMaker offers automated hyperparameter tuning

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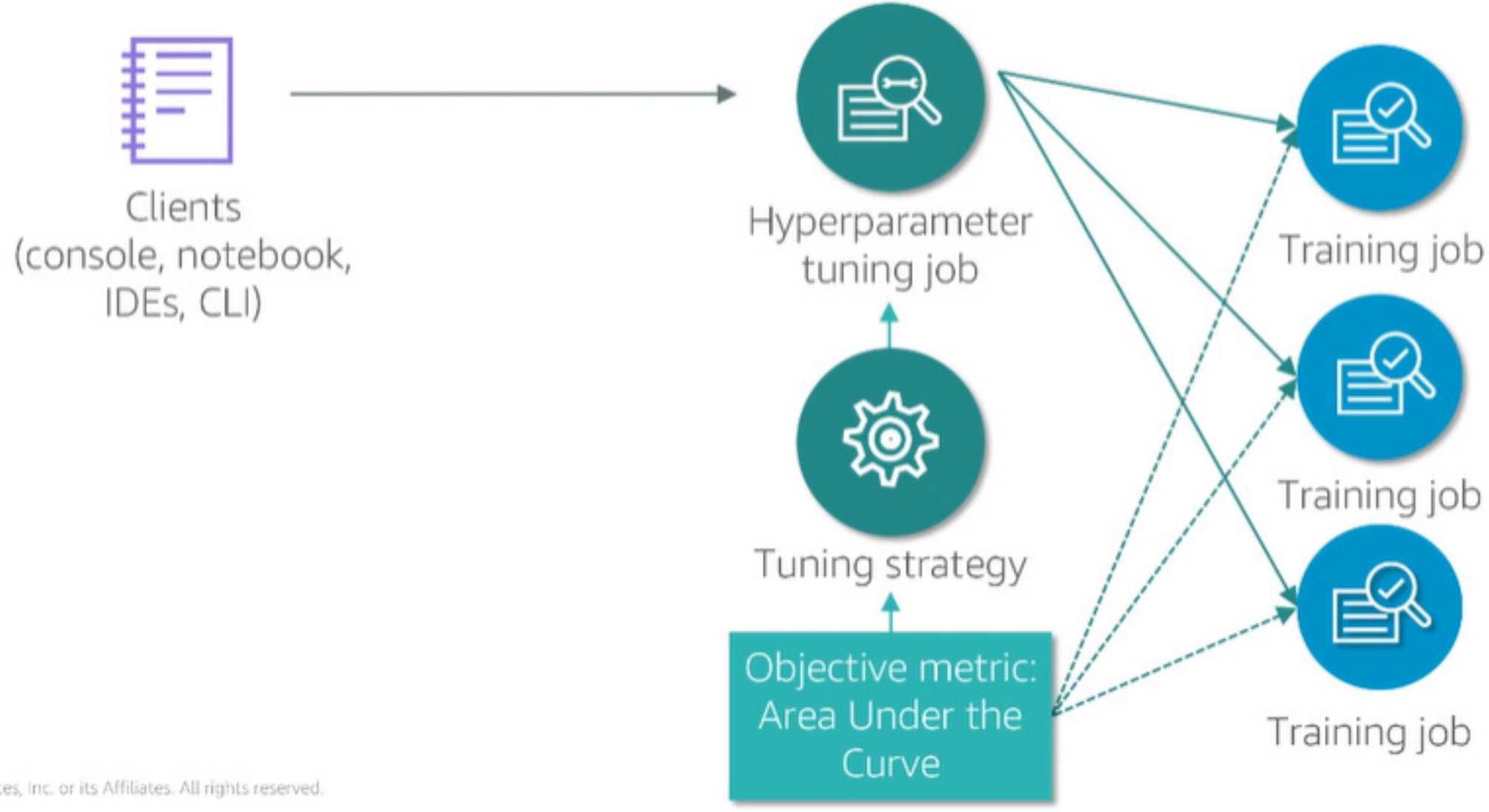

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Amazon SageMaker offers automated hyperparameter tuning

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Clients
(console, notebook,
IDEs, CLI)

Hyperparameter tuning job

Tuning strategy

Objective metric: Area Under the Curve

Training job

Training job

Training job

Model name	Objective metric	Eta	Max_depth	…
Model3	0.8	0.7	6	…
Model1	0.75	0.09	5	…
…	…	…	…	…

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Your model is ready…

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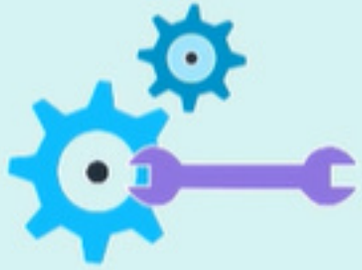
Trained Model



Tuned Model

Tested/Ready Model

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Deployment

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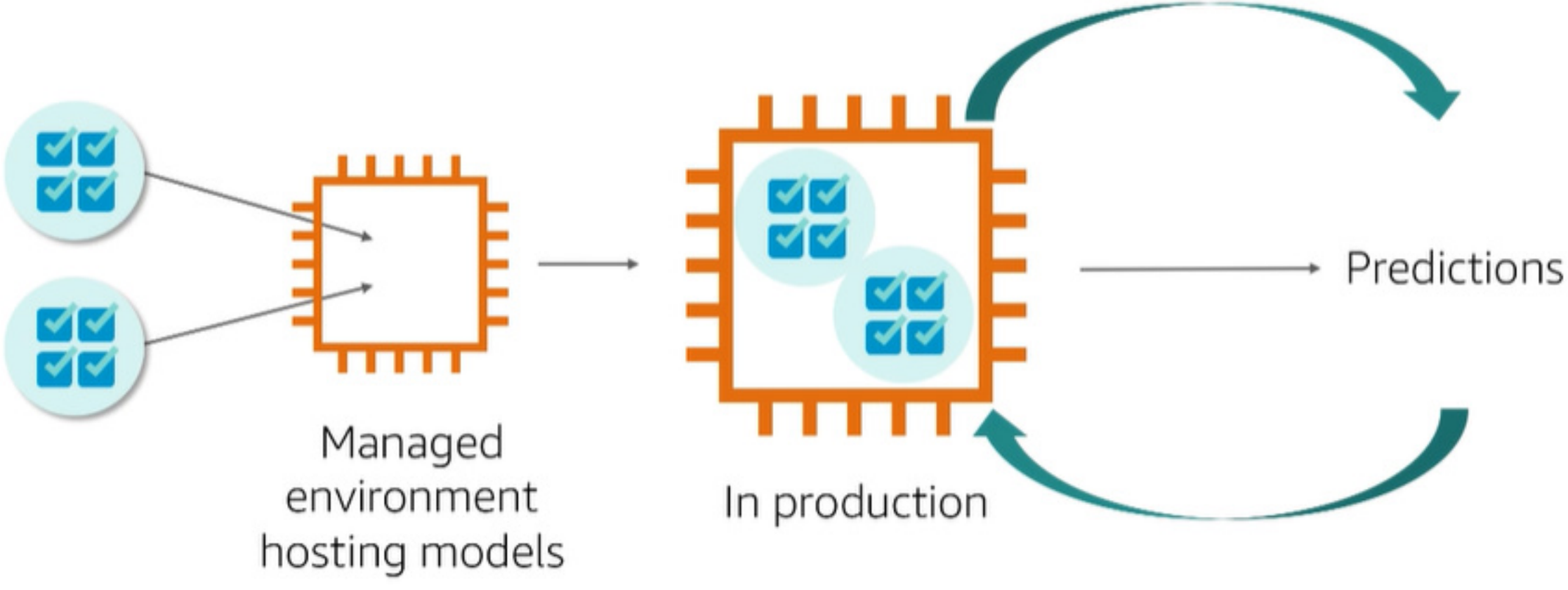
The goal of deployment



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Amazon SageMaker for Deployment

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Amazon Sagemaker

- Has a variety of deployment options
- Provides model hosting services
- Provides an HTTPS endpoint

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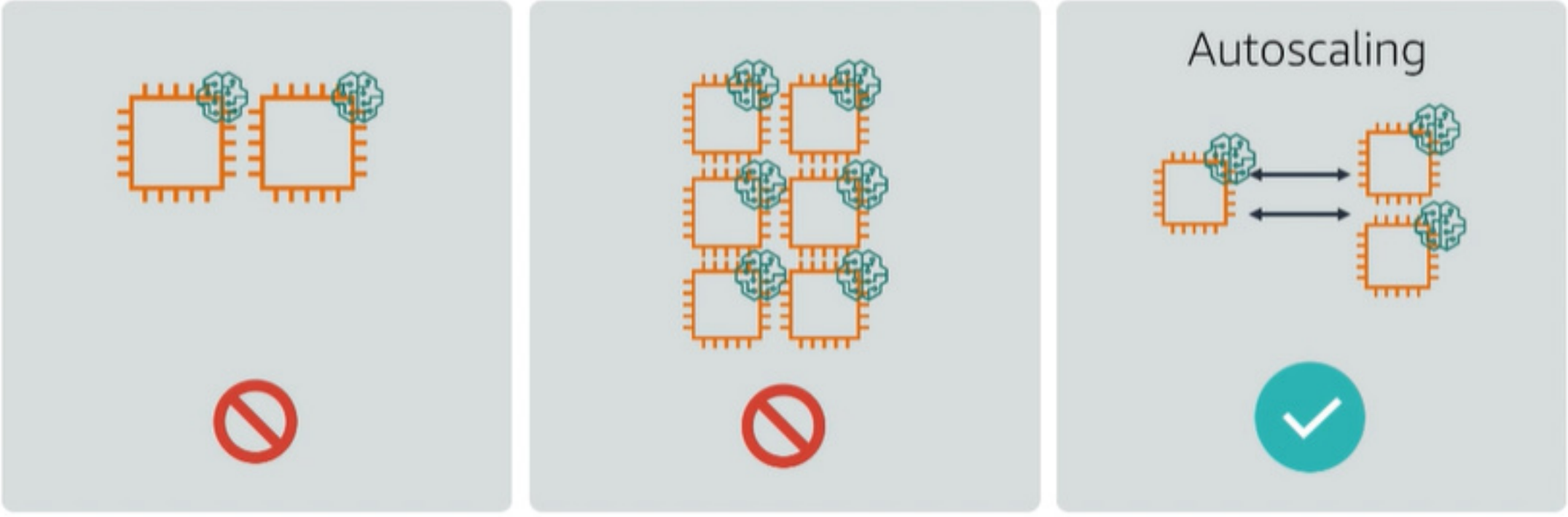
Enable autoscaling



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Consider GPU

Deep learning models require high power GPU instances for training, but inferences against the deep learning models do not typically need the full power of a GPU.

- **Amazon Elastic Inference** enables you to attach low-cost, GPU-powered acceleration to Amazon EC2 and Amazon SageMaker instances to reduce the cost of running deep learning inferences

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Creating a good baseline

Without SageMaker, you are responsible for:

- Creating the AMI (Amazon Machine Image) containing your model artifact
- Launching one or more EC2 instances with this AMI
- Configuring the autoscaling options necessary to scale

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Batch vs. Real time inferences

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On-demand as a batch	Endpoints available 24/7
• Model available periodically • Predictions are asynchronous • Dataset has multiple rows • Results available on a scheduled basis when the job's done	• Model available all the time • Predictions are synchronous • Single observation of data • Results available as users interact in real time

Vs.

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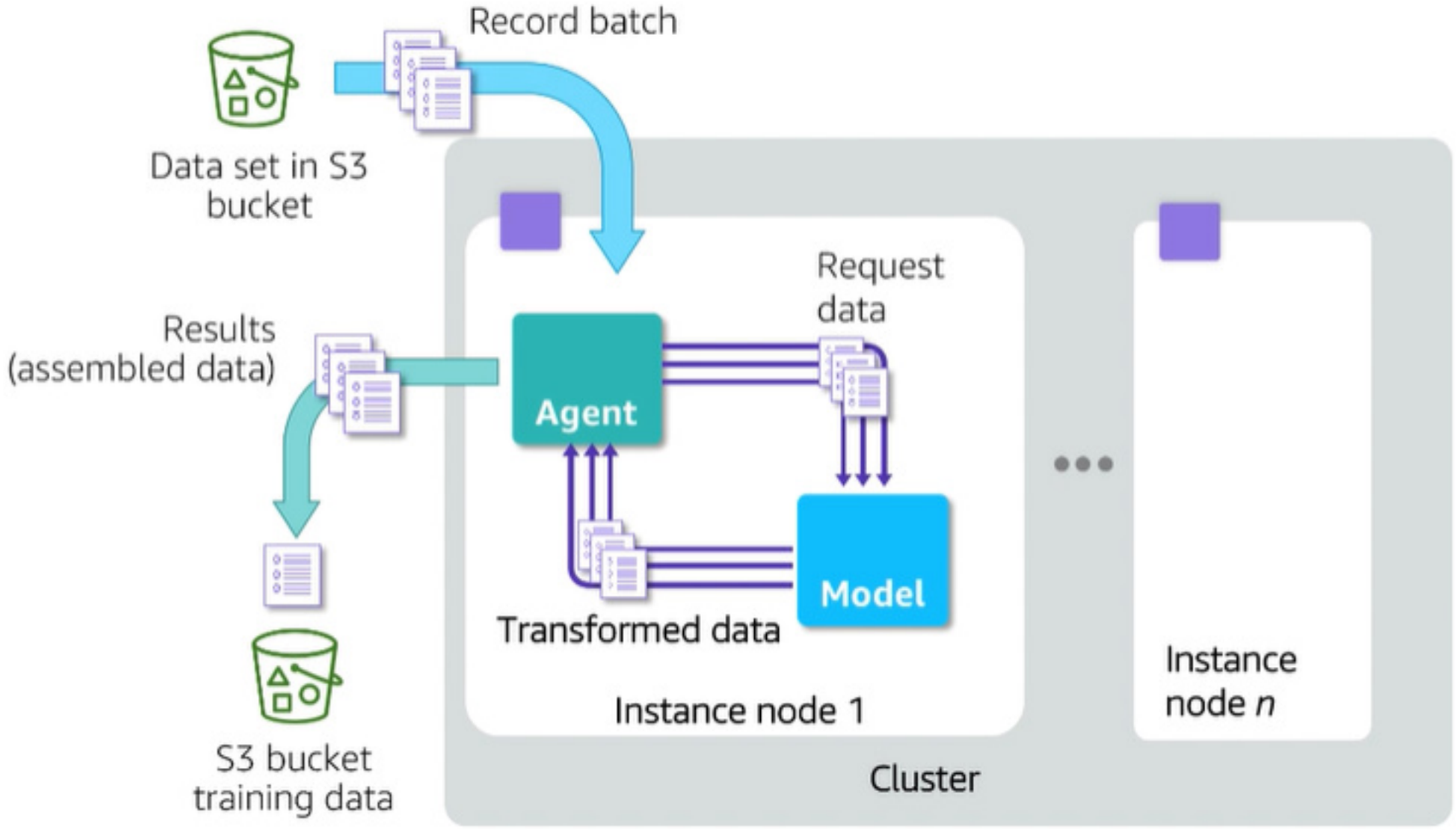
Getting predictions on a scheduled basis



Getting predictions in real time
Create an HTTPS endpoint

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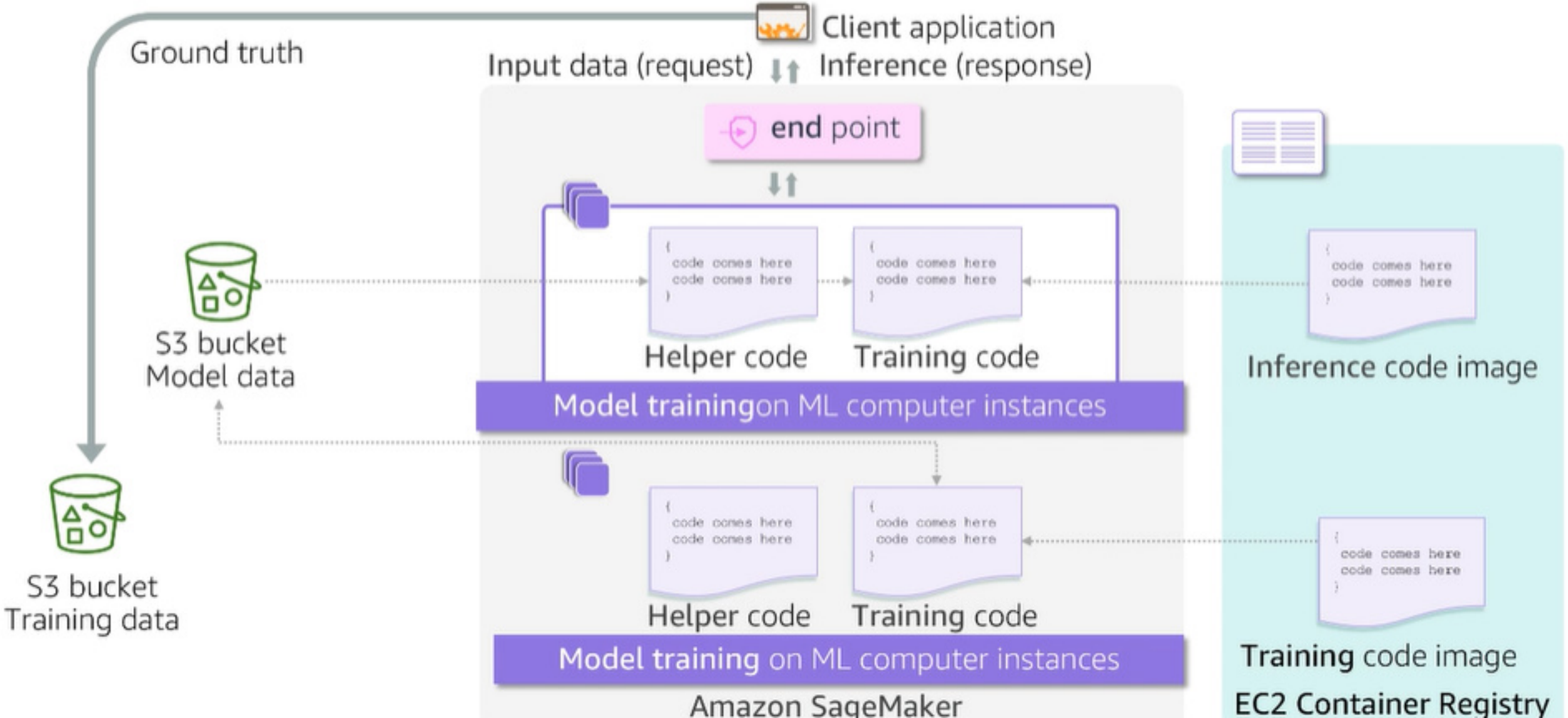

When to use batch transform

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Use batch transform when you:

- Want to get inferences for an entire dataset and index them to serve inferences in real time
- Don't need a persistent endpoint that applications (for example, web or mobile apps) can call to get inferences
- Don't need the subsecond latency that Amazon SageMaker hosted endpoints provide
- Additionally, you can also use batch transform to preprocess your data before using it to train a new model or generate inferences.

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Amazon SageMaker inference pipelines

- Pass raw input data
- On batch or real-time inference requests
- Use with built-in or custom algorithms

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What are my next steps?

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Learn at your own pace

Expand your cloud security skills with our self-paced digital course, Amazon SageMaker: Build an Object Detection Model Using Images Labeled with Ground Truth.

Learn from AWS experts

Build your cloud security skills with our classroom courses, *Practical Data Science with Amazon SageMaker*.

Ramp-Up Guides

Our Machine Learning *Ramp-Up Guide* offers many resources to help build your knowledge of Machine Learning in the AWS Cloud.

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