Sagemaker for Production?

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What is AWS SageMaker

Definition AWS:

„**Amazon SageMaker** is a fully-managed service that enables data scientists and developers to quickly and easily build, train, and deploy machine learning models at any scale. **Amazon SageMaker** includes modules that can be used together or independently to build, train, and deploy your machine learning models.“

https://glaube-einfalt.de/2018/11/eierlegende-wollmilchsau-endlich-als-maskottchen-der-ekm-eingefuehrt/

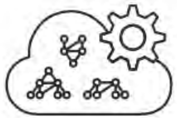
Functionality

- Notebooks
  - Jupyter notebook on specific instance type
  - Include Git Repos, Lifecycle configurations

- Training Jobs
  - Train a model using data from S3
  - Hyperparameter Tuning Jobs

- Inference
  - Inference Endpoints based on pretrained model artifacts located in S3

Notebook



Training

Inference

Levels of abstraction

Usage

- SageMaker Web UI
    - Click your Training jobs/ Endpoints
- High-level Python SDK
    - Commands like deploy(), fit() to be used in a SageMaker Notebook
- AWS SDK
    - Control the SageMaker API programmatically (cmp. boto3)

Algorithms

Build-in algorithms

- Provided by AWS

Own Container

- Build your own SageMaker compatible Docker container

High-level usage (Trainig job)

Code snipped from Udacity course boston housing example

```
container = get_image_uri(session.boto_region_name, 'xgboost')
xgb = sagemaker.estimator.Estimator(container, # The image name of the training container
                                    role,      # The IAM role to use (our current role in this case)
                                    train_instance_count=1, # The number of instances to use for training
                                    train_instance_type='ml.m4.xlarge', # The type of instance to use for training
                                    output_path='s3://{}/{}/output'.format(session.default_bucket(), prefix),
                                                                        # Where to save the output (the model artifacts)
                                    sagemaker_session=session) # The current SageMaker session
xgb.set_hyperparameters(max_depth=5,
                        eta=0.2,
                        gamma=4,
                        min_child_weight=6,
                        subsample=0.8,
                        objective='reg:linear',
                        early_stopping_rounds=10,
                        num_round=200)
s3_input_train = sagemaker.s3_input(s3_data=train_location, content_type='csv')
s3_input_validation = sagemaker.s3_input(s3_data=val_location, content_type='csv')

xgb.fit({'train': s3_input_train, 'validation': s3_input_validation})
```

https://github.com/udacity/sagemaker-deployment/blob/master/Tutorials/Boston%20Housing%20-%20XGBoost%20(Batch%20Transform)%20-%20High%20Level.ipynb

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Usage for Production

Discussion *SageMaker* vs. alternatives

- Development: *Notebooks* vs. Jupyter Notebooks on EMR, …
- Training: *Training jobs* vs. Fargate, EMR, …
- Inference:
    - Real-time: *Endpoints* vs. Fargate, ECS, …
    - Batch: *Batch transform jobs* vs. AWS Batch, …

Project Conditions

- Multiple models called multiple times to build single result (many model calls)
- Batch Mode and Real-time API
- Sklearn Pipelines with new experimental features (Versioning)

https://www.ccisjm.com/teamdiscussion/

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How to build your own SageMaker container

Local folder structure for scikit_bring_your_own example container:

Container/
- **Dockerfile**
- build_and_push.sh
- decision_trees/
  - nginx.conf
  - predictor.py
  - **serve**
  - **train**
  - wsgi.py

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How to build your own SageMaker container

Training preparations:

1) Upload Docker image to Elastic Container Registry (ECR)

docker build <image name>

docker tag <image name> *<repository name>*

docker push <repository name>

(*<repository name>* of form <account number>.dkr.ecr.<region>.amazonaws.com/<image name>:<tag>)

2) Load training data to S3

aws s3 cp <from location> <to location>

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How to build your own SageMaker container

In-container folder structure:

- /opt/ml/
  - input/
    - config/
      - hyperparameters.json
      - resourceConfig.json
    - data/
      - < channel_name: 'training'>
        - < input data >
  - model/
    - < model files >
  - output/
    - Failure/
- /opt/program/
  - < local_folder_name: 'decision_trees'>/

train

```python
prefix = '/opt/ml/'

input_path = prefix + 'input/data'
output_path = os.path.join(prefix, 'output')
model_path = os.path.join(prefix, 'model')
param_path = os.path.join(prefix, 'input/config/hyperparameters.json')

# This algorithm has a single channel of input data called 'training'. Since we run in
# File mode, the input files are copied to the directory specified here.
channel_name='training'
training_path = os.path.join(input_path, channel_name)

# The function to execute the training.
def train():
```

SageMaker training job (Web UI)

▼ training

Channel name

training

Dockerfile

```
COPY decision_trees /opt/program
WORKDIR /opt/program
```


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How does AWS use custom containers

Start **training** (e.g. using Python in a SageMaker Notebook)

```
import boto3
client = boto3.client('sagemaker')
client.create_training_job(
    TrainingJobName='DecisionTreeJob',
    HyperParameters={'_tuning_objective_metric': 'balanced accuracy'},
    AlgorithmSpecification={'TrainingImage': '', ...},
    RoleArn='',
    InputDataConfig=[{
        'ChannelName': 'training',
        'DataSource': {
            'S3DataSource': {'S3Uri': 's3://...', ...}
        }, ...
    }],
    OutputDataConfig={'S3OutputPath': 's3://...'},
    ResourceConfig={'InstanceType': 'ml.m4.xlarge', ... },
    StoppingCondition={'MaxRuntimeInSeconds': 3600}
)
```

What happens in the backround:

› Start specified instance -> pull and run Docker image from ECR
› Load training data from S3 to container location
› Start **train** script which trains the Model -> writes pickeled model artifact to output folder
› Load model artifact to S3 location in compressed format

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How does AWS use custom containers

Create custom Sagemaker Endpoint for Inference

```
# create SageMaker model (from training artifacts, code)
model_name = training_job_name + "-model"
primary_container = {
    "Image": container,
    "ModelDataUrl": model_artifacts
}
model_info = session.sagemaker_client.create_model(
                                ModelName = model_name,
                                ExecutionRoleArn = role,
                                PrimaryContainer = primary_container)
# create endpoint config from model
endpoint_config_name = "boston-xgboost-endpoint-config-" + strftime("%Y-%m-%d-%H-%M-%S", gmtime())
endpoint_config_info = session.sagemaker_client.create_endpoint_config(
                            EndpointConfigName = endpoint_config_name,
                            ProductionVariants = [{"InstanceType": "ml.m4.xlarge", "ModelName": model_name,...}])
#create endpoint from endpoint config
endpoint_name = "boston-xgboost-endpoint-" + strftime("%Y-%m-%d-%H-%M-%S", gmtime())
endpoint_info = session.sagemaker_client.create_endpoint(
                    EndpointName = endpoint_name,
                    EndpointConfigName = endpoint_config_name)
```

What happens in the backround:

› Start specified instance and pull and run Docker image from ECR

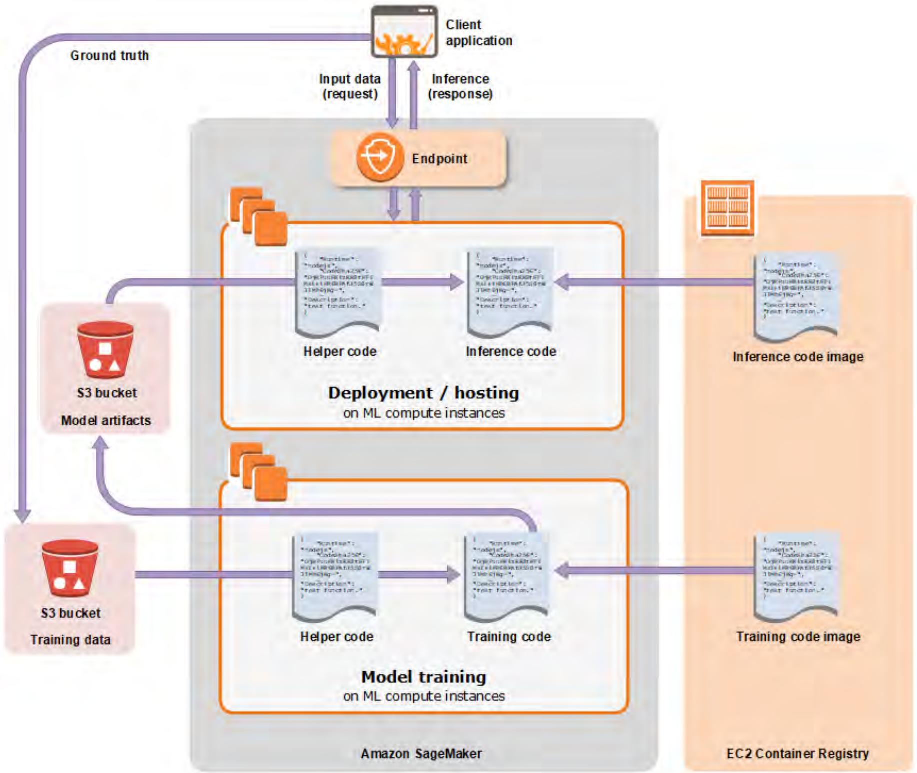
› Load model artifact from S3 to container location

› Start **serve** script which starts the inference server

› (Shutdown endpoint when not longer in use)

https://github.com/udacity/sagemaker-deployment/blob/master/Tutorials/Boston%20Housing%20-%20XGBoost%20(Deploy)%20-%20Low%20Level.ipynb

What this tells us about SageMaker



https://docs.aws.amazon.com/sagemaker/latest/dg/how-it-works-training.html

News AWS re:Invent 12.2019

Amazon **SageMaker Studio** (currently only available in us-east-2)

- SageMaker **Notebooks**: switch hardware
- Sagemaker **Processing**: Run preprocessing, postprocessing, evaluation jobs
- SageMaker **Experiments**: Organize, track, compare Processing Jobs
- SageMaker **Debugger**: Save internal model state at periodic intervals
- SageMaker **ModelMonitor**: Detect quality deviations, receive alerts for deployed models
  - Infer schema based on training data
  - Automatically fetch statistics (for pre-build containers)
- SageMaker **Autopilot**: Automatic preprocessing, algorithm selection, model tuning, …
  - Generates python code
  - Automatic hardware configuration

What I did not told you

- Everything is running on a dedicated instance (choose wisely)
- SageMaker heavily interacts with Cloudwatch (hyperparameter tuning, …)
- Clustermode is possible for training as well as for inference
- You can chain your containers (preprocessing -> inference -> postprocessing)
- There is not only plain python available for Notebooks
    - R
    - Spark
    - MXNet
    - Tensorflow
    - PyTorch

Conclusion

- Fast way of getting started
- Tons of supplementary material (hard to get an easy overview)
- Suitable way of training models
- PoC Endpoints available
- Rapid development of new features for SageMaker

Discussion

› In which cases might SageMaker already be sufficient for use in real products?
› What else would be necessary?
› ...?

Vielen Dank

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