DSF-R

Vienna 2018

Scaling R in the Cloud

with Azure Batch and Docker

Christoph Bodner & Thomas Laber

Post

AGENDA

	01	02	03
Topics	Who we are (obligatory marketing stuff…)	Scaling R with Azure	Case study
	Data Science@Post AG: - Overview: Post AG - Our team	Using: - AzureBatch and - Docker for development & production	doAzureParallel + Caret: - Distributed ML - Easy setup

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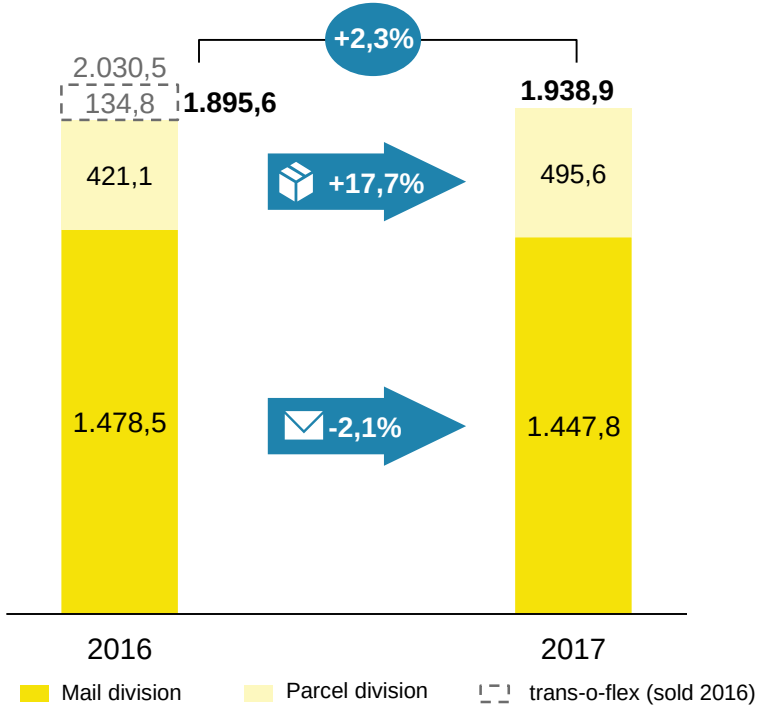
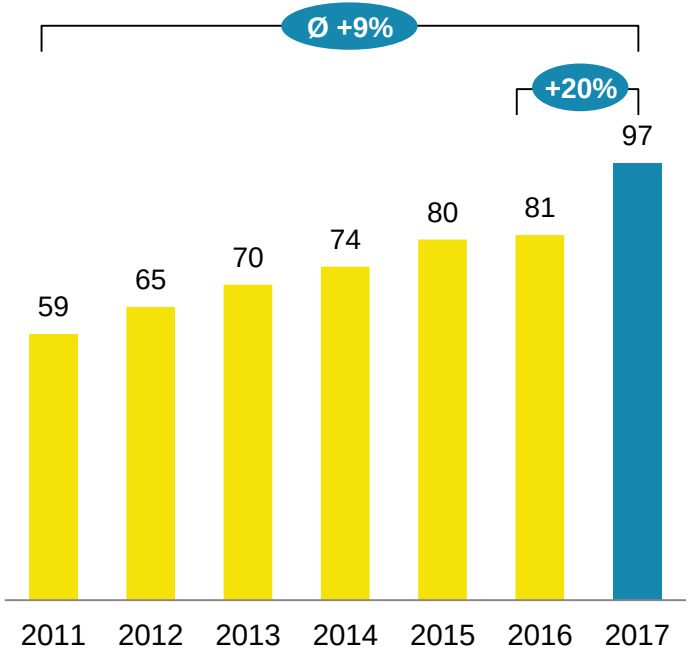
OVERVIEW: POST AG

COMPANY PERFORMANCE & PARCEL VOLUMES OVER TIME

SALES PERFORMANCE
mio EUR



PARCEL VOLUMES OF AUSTRIAN POST
mio parcels



OUR TEAM
PEOPLE WHO LIKE $\pi z^2 a$ IN EVERY FORM

Christoph Bodner

Lead Data Scientist

Quantitative Finance (WU)
Prev.: KPMG

Thomas Laber

Senior Data Scientist

Business Informatics (TU)
Prev.: Accenture

Martin Blöschl

Junior Data Scientist

Computational Intelligence (TU)

Raphael Pesl

Junior Data Scientist

Mathematics (TU)

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How can we run complex experiments quickly?

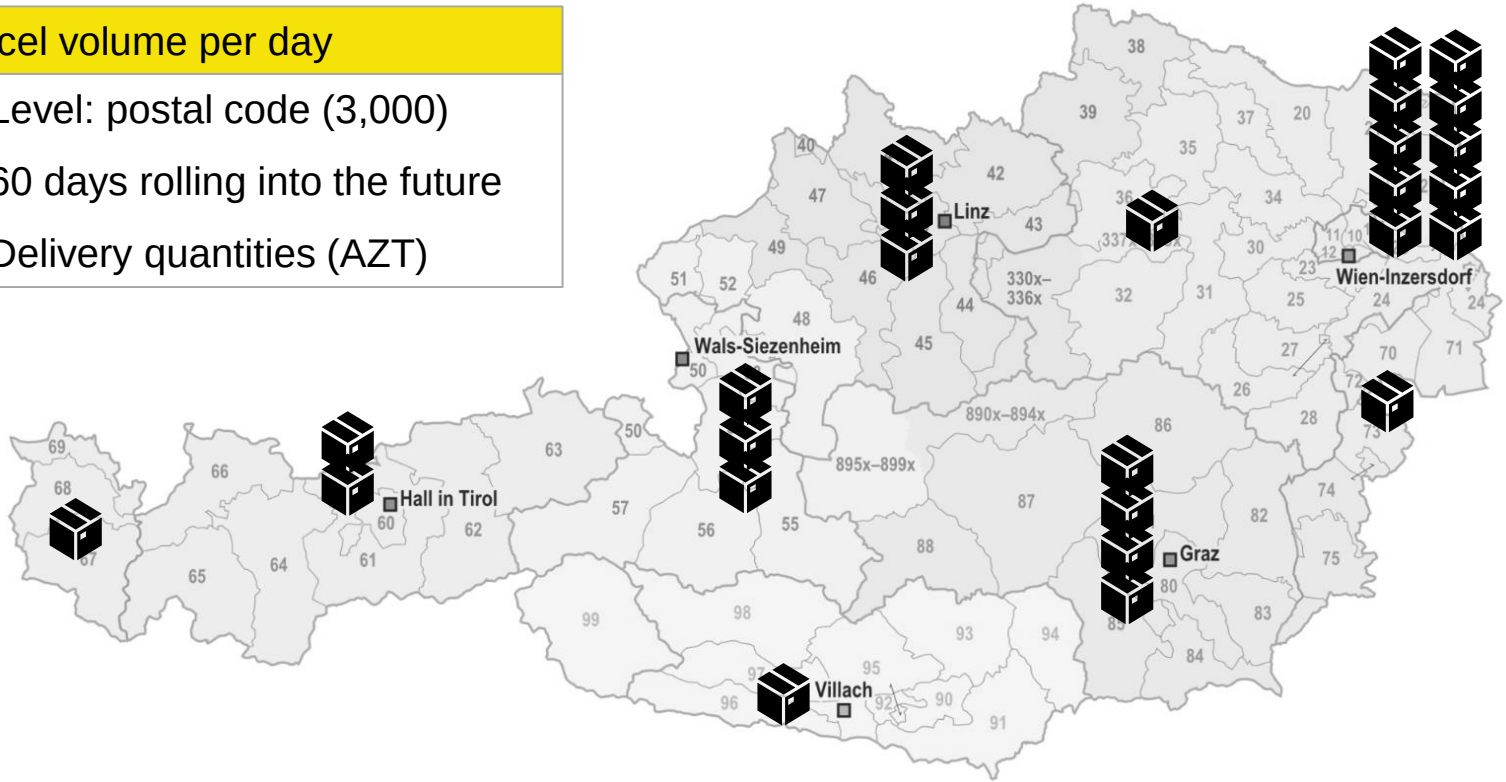
How can we put those models in production?

A SAMPLE PROBLEM

HOW MANY PARCELS WILL WE NEED TO DELIVER IN THE FUTURE?

Parcel volume per day

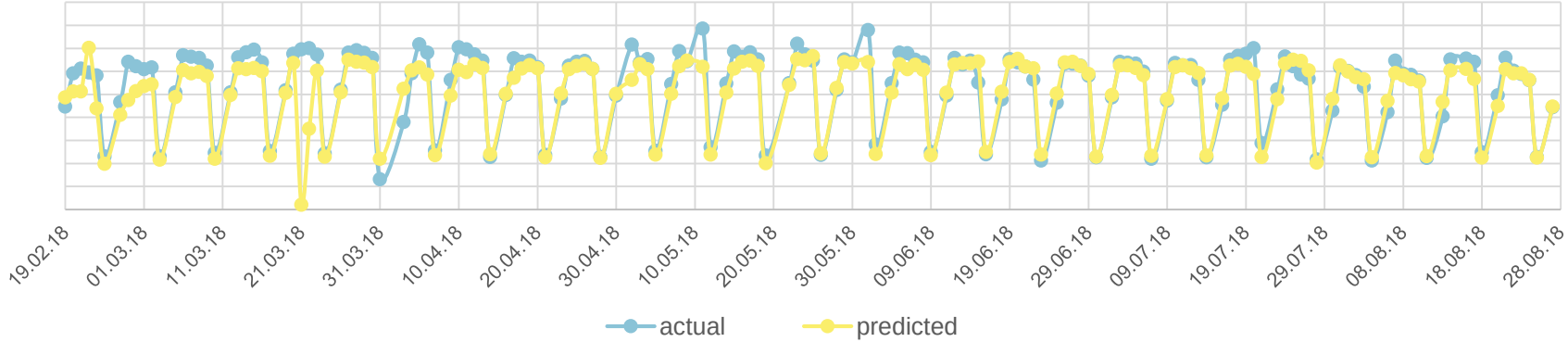
- Level: postal code (3,000)
- 60 days rolling into the future
- Delivery quantities (AZT)



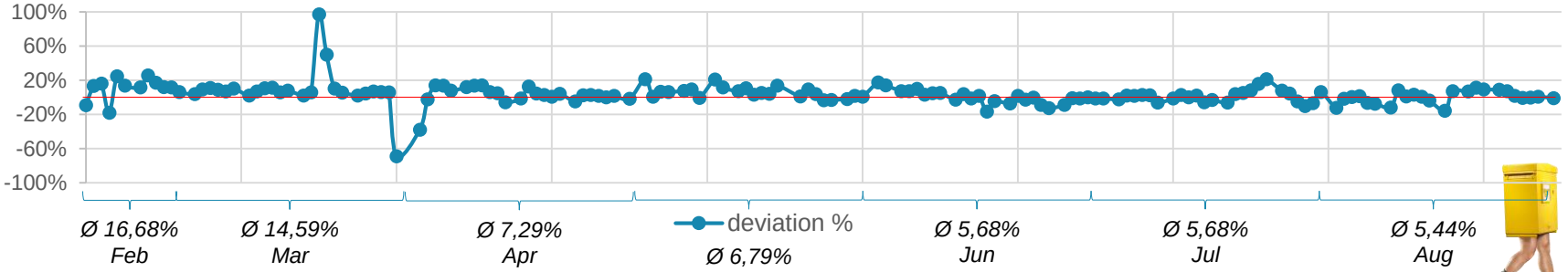
FORECASTING PERFORMANCE
7-DAYS-AHEAD

Performance

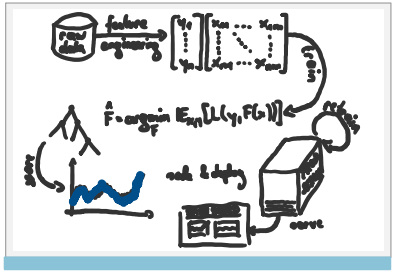
Parcel volumes per day Austria (7 days ahead)



Deviation in percent

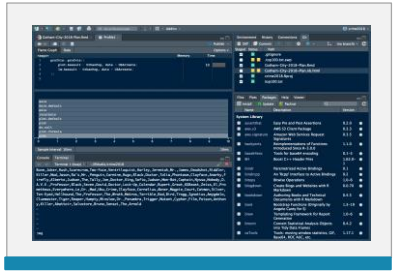


FROM EXPERIMENT TO DEPLOYMENT
OUR JOURNEY



Whiteboard phase

- Draft architecture
- Modeling strategy
- Everything seems easy☺

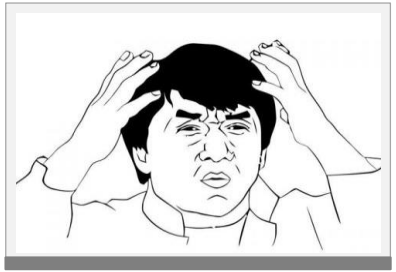


Experiment phase

- Build model on sample
- Model improves
- Happy Data Scientists

Deadline phase

- Model training takes too long
- Model gets simplified to speed up training
- Performance suffers

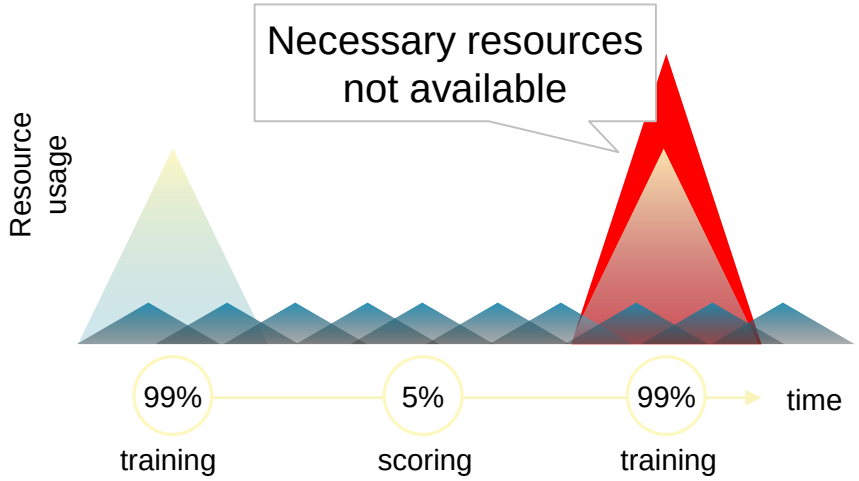


Deployment phase

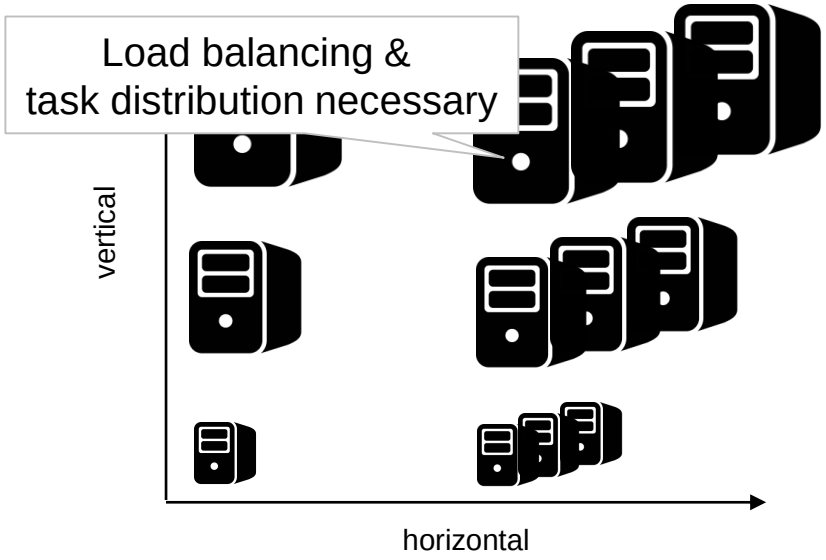
- Dev != Prod
- Server procurement slow
- Server not powerful enough for training
- Server too powerful for scoring

PROBLEMS WE ENCOUNTERED
SCALING COMPUTE RESOURCES ON DEMAND

Resource utilisation



Scaling options

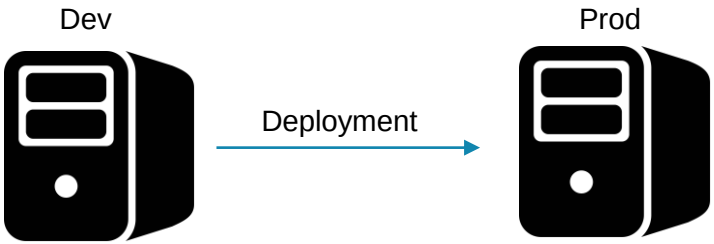


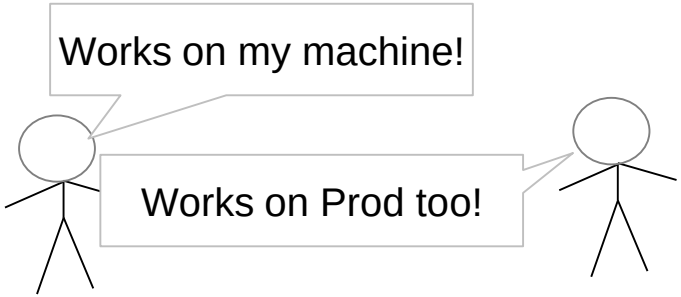
We want to be able to elastically scale **up** and **out** to meet our needs

DEPLOYMENT WAS A PAIN …
DEV-PROD DISPARITY

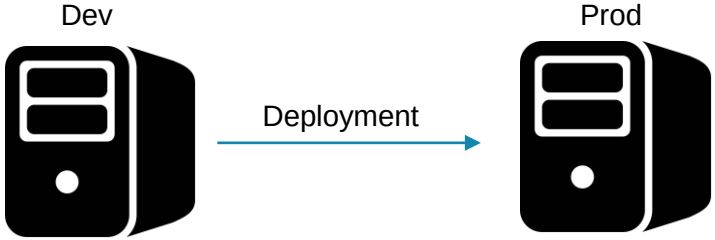
Post

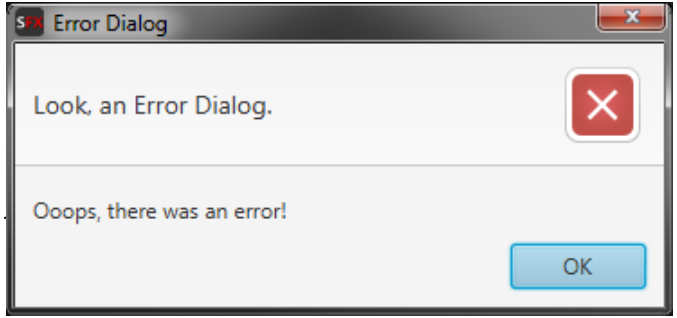
Happy Path Deployments





~~Happy Path~~ Deployments





▶ Keeping Dev and Prod aligned is hard even with best intentions

How can we fix these problems?

HOW CAN WE SOLVE OUR PROBLEMS?
WE HAVE A LONG WISH LIST

Post

Our wish list:

deploy automatically
scale compute
elastically
No vendor lock-in
uniform
architecture
Easy scheduling
Job Management Portal
eliminate dev-prod disparities
cheap
FPGAs
Easy management
no dependencies
GPUs
programming
language agnostic

Solutions we considered:

We have two dominant stacks:

- Microsoft .net + Azure
- SAP

Since we have SAP and .net/Azure support in-house, we looked primarily at these two stacks.

SCALE R WITH AZURE BATCH
DEVELOPMENT & PRODUCTION WORKLOADS

Post

Azure Container Registry

Gated checkin triggers:

Container 1

Container 2

...

Container n

Pull image

Build

Test

Publish

Gitflow Struktur

Hot Fix

Master/Prod

Release

Dev

Feature branches

Gated Checkin

Gated Checkin

Commit

Merge

Container Orchestration & Deployment

AZ Batch:
- doAzureParallel
- aztk

Container

Specify jobs

ETL + Storage

SQL

Write results:
- models
- scores

Job Agent & autoscaling

Batch Explorer

Start compute cluster

Data Scientist 1

Data Scientist 2

SOLUTIONS WE CONSIDERED
COMPARISON

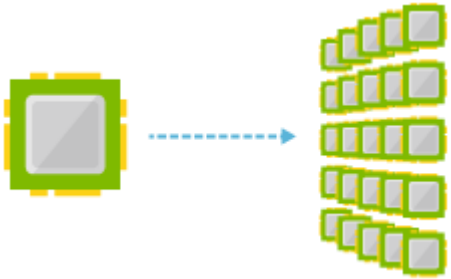
Also take a look at Azure Databricks for Spark workloads

This looks very promising

	Cloud vs. On-Premise Solution			
	Azure ML Studio	Azure ML Workbench	Azure Batch	SAP HANA (PAL)
Supported Languages	R/Python	Python	All	R (Python)
Supports GPUs		Yes	Yes	No
Dev-Prod parity	Easy	Easy	Easy	Hardish
R package available	AzureML	-	doAzureParallel	-
Independent upgrades	partially	partially	Yes	partially
Elastic scaling	-	Yes	Yes	No
Scheduling included	No	No	Yes	Yes
SCORE				

AZURE BATCH OVERALL WINNER

FLEXIBLE, HIGH VALUE/MONEY AND LOW VENDOR LOCK-IN

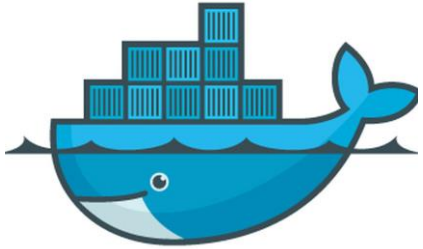


Scale up and out

Specify node sizes and types, e.g. GPU/CPU, RAM and get large discount on low-prio nodes

Scheduling integrated

Specify job schedule and resize pool based on number of outstanding tasks



Docker support

Dev and Prod parity
Fits into CD pipeline

Source images: Microsoft and Docker homepage

DOCKER BRIEFLY EXPLAINED
BUILD ONCE – RUN ANYWHERE

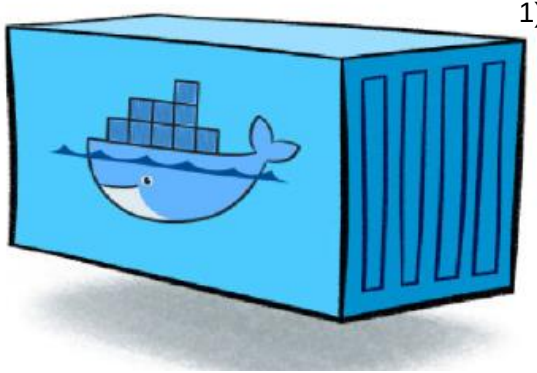
Example Dockerfile

```
## Description: https://hub.docker.com/r/rocker/tidyverse/
FROM rocker/tidyverse

# Install your R package
## Copy R package to docker
RUN mkdir -p /usr/r_package
COPY . /usr/r_package

## Install package dependencies
RUN r -e 'devtools::install_deps(pkg = "/usr/r_package/", dependencies = T)'
## Roxygenize
RUN r -e 'devtools::document(pkg = "/usr/r_package/")'
## Install package
RUN R CMD INSTALL /usr/r_package
```

R image used

Here we install our package

Build Container



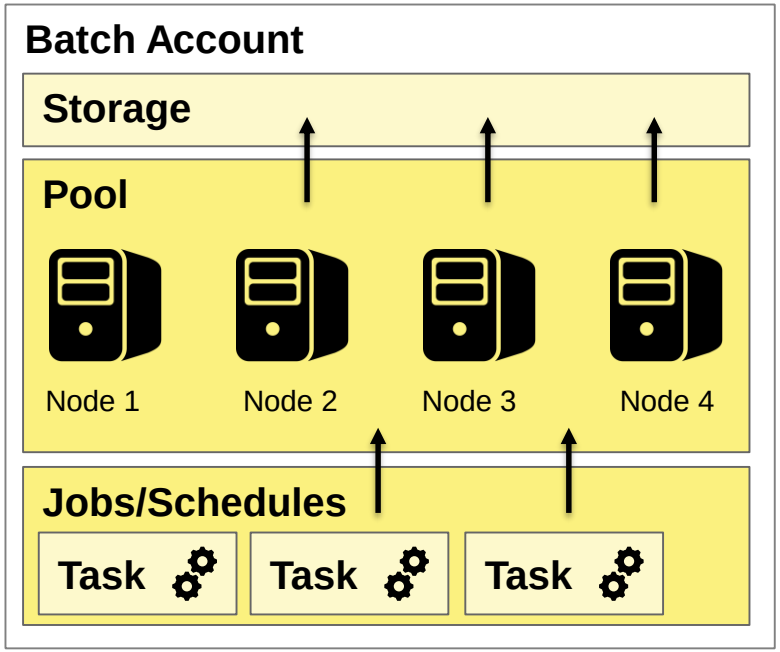
1)

Container can be deployed to docker runtime in production: Dev = Prod (mostly☺)

Source image: 1) https://stephenafamo.com/blog/understanding-docker-containers/

AZURE BATCH
CONCEPTS

Components overview



Description

Pool …… Definition of compute resources
- Node number/type
- Container settings
- Autoscaling
- Task number per node

Schedule … Recurring job for a pool
- Job specification

Job …….. Contains pool and task specs
- Job manager task

Task ……. Work specification
- Command line
- upload options

AZURE BATCH
SETUP OVERVIEW

Pool configuration

```python
# setup batch pool
def create_pool(batch_service_client, pool_id):
    image_ref_to_use = batch.models.ImageReference(
            publisher='microsoft-azure-batch',
            offer='ubuntu-server-container',
            sku='16-04-lts',
            version='latest'
            )

    # Private docker repo specification
    container_conf = batch.models.ContainerConfiguration(
        ...
     )

    # create pool specs with pre-fetched images
    new_pool = batch.models.PoolAddParameter(
        id=pool_id,
        virtual_machine_configuration=batch.models.VirtualMachineConfiguration(
            image_reference=image_ref_to_use,
            container_configuration=container_conf,
            node_agent_sku_id='batch.node.ubuntu 16.04'),
        vm_size=_POOL_VM_SIZE,
        max_tasks_per_node=_MAX_TASKS_PER_NODE
        enable_auto_scale=True,
        auto_scale_evaluation_interval='PT5M',
        auto_scale_formula= "some formula for node type and count"
    )

    # submit pool creation to azure batch
    batch_service_client.pool.add(new_pool)
```

Pool base image

Here using Python SDK

Docker image & autoscaling

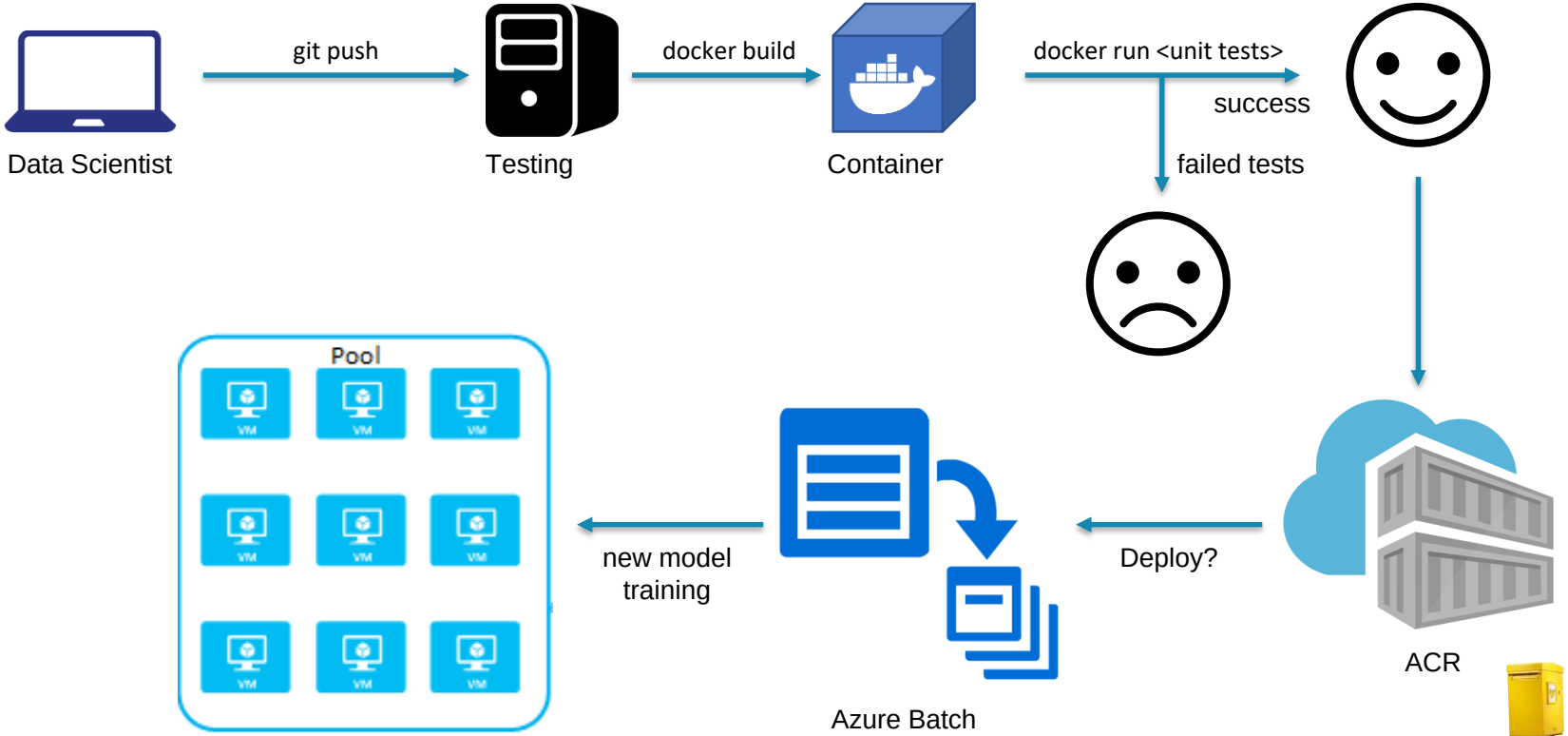
Job Manager Task

```python
        job_manager = batchmodels.JobManagerTask(
            id=_AZ_JOB_MANAGER_ID,
            command_line=_JOB_MANAGER_CMD,
            container_settings=task_container_conf,
            authentication_token_settings=batchmodels.AuthenticationTokenSettin
                access=[batchmodels.AccessScope
                ),
            environment_settings=[
                ...
                ],
            kill_job_on_completion=True,
            run_exclusive=False
        )

        job_spec = batchmodels.JobSpecification(
            pool_info=batchmodels.PoolInformation(pool_id=_POOL_ID),
            display_name='test_schedule',
            #on_all_tasks_complete='noaction',
            job_manager_task=job_manager,
            #common_environment_settings=No
        )

        schedule = batchmodels.Schedule(
            recurrence_interval='PT1M'
        )

        job_schedule = batchmodels.JobScheduleAddParameter(
            id=_JOB_SCHEDULE_ID,
            schedule=schedule,
            job_specification=job_spec
        )

        # submit job schedule creation
        batch_client.job_schedule.add(job_schedule)
```

Command to run

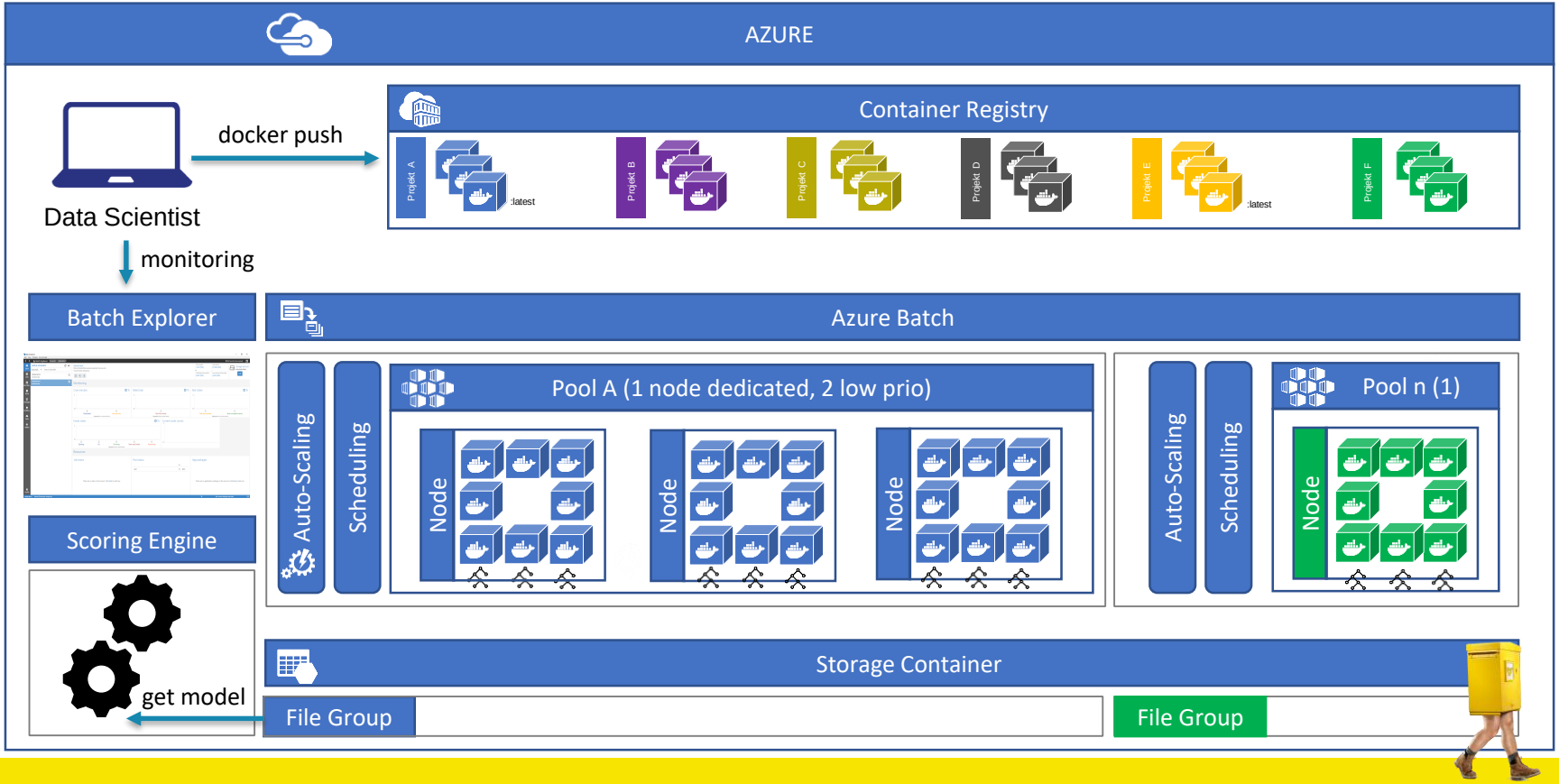
Job schedule bundles everything

VSTS
CONTINUOUS DELIVERY PIPELINE (SIMPLIFIED)



OUR STACK

WE ARE CURRENTLY BUILDING A HPC ENVIRONMENT



MONITORING BATCH JOBS
WITH BATCH EXPLORER

Overview

Currently active jobs

Status of your pools

Output from your jobs

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OPEN ISSUES

SECURITY & EVALUATING DIFFERENT REAL-TIME SCORING OPTIONS

Security

- ~~Secret management with KeyVault~~
- ~~Azure Active Directory integration~~
- ~~VNET integration of pools~~
- Docker security best practices audit/check
- Disable public endpoints

Real-time scoring options

- Using AzureML Studio
- Using Azure Model Management
- Kubernetes Cluster
- Azure Functions
- Azure Container Instances + Logic Apps
- …

What we are currently looking into

A bit of work is still open, but we plan to have everything wrapped up end of September

Case Study: Caret + Azure

LET'S DO A QUICK CASE STUDY
CARET + DOAZUREPARALLEL

What we will show you:

- How to setup a Batch Account in Azure
  - Things to consider: VNET, AAD, region…
- Download BatchExplorer
- Get credentials
- Switch to R:
  - Using a custom Docker image
  - Train models in parallel using caret+doAzureParallel as backend

SUMMARY
AZUREBATCH OFFERS EFFICIENT AND FLEXIBLE HPC

Development

- Use doAzureParallel to test multiple models quickly
- Create Docker container for your colleagues to use
- Push to container registry

Production

- Use container image from development
- Setup schedule and cluster specification
- Configure autoscaling and
- Violá ☺

▶ You get a cost efficient, flexible and scalable architecture for your team

Thank you for your attention!

Any questions?

You can contact us at:

- linkedin.com/in/christoph-bodner
- linkedin.com/in/thomas-laber/