An Introduction to
Cloud Computing and Amazon Web Services

Luigi Libero Lucio Starace
luigiliberolucio.starace@unina.it

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Università degli Studi di Napoli “Federico II”, Naples, Italy

Cloud Computing

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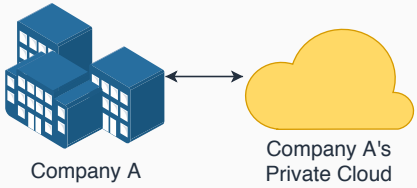
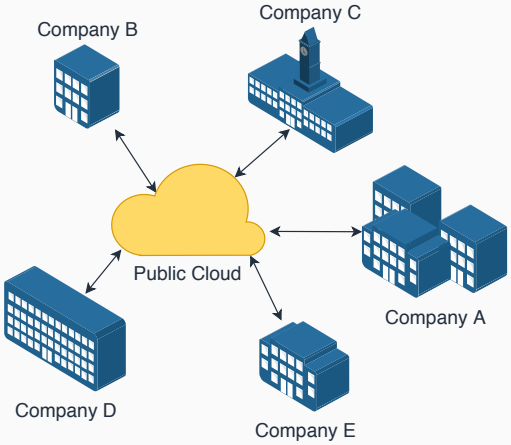
- **Private Cloud**



Private and Public Cloud

- Private Cloud
- Public Cloud



- Google

Google Cloud

- Google
- IBM

The bigwigs in Public Cloud

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- IBM
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  - they buy cloud services from different providers;
  - some of them also combine public and private clouds (**hybrid cloud** approach).

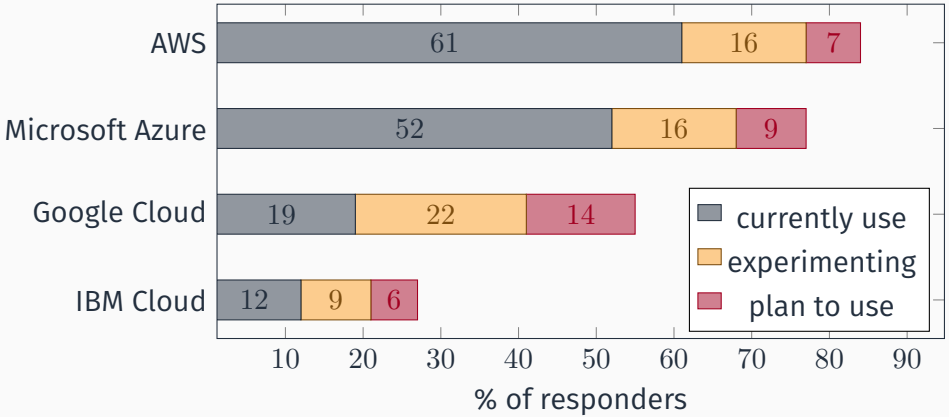

Figure 1: Public cloud adoption [Fle19]

Why might one use Cloud Computing?

Suppose you have a great business idea.

What steps do you take to start making money?

1. Estimate supply and demand;

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Starting a business: issues with the traditional approach

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4. Pay for what you use.

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- ✗ Trust the vendor?
- ✗ Dependant from a specific vendor?

The traditional approach lacks **Elasticity**.

- **What is Elasticity?**
  The ability to grow or shrink infrastructure resources dynamically as needed to adapt to workload changes, possibly in an autonomic manner.

Public Cloud

Public Cloud providers manage to offer services at very low prices, thanks to:

- Economies of scale.
- Reduced Hardware costs.
- **Huge** data centers.

Containerized data centers

https://www.ibm.com/us-en/marketplace/prefabricated-modular-data-center

Google data center in Hamina, Finland

https://www.google.com/about/datacenters/locations/hamina/

Microsoft's underwater data center

https://news.microsoft.com/innovation-stories/project-natick-underwater-datacenter/

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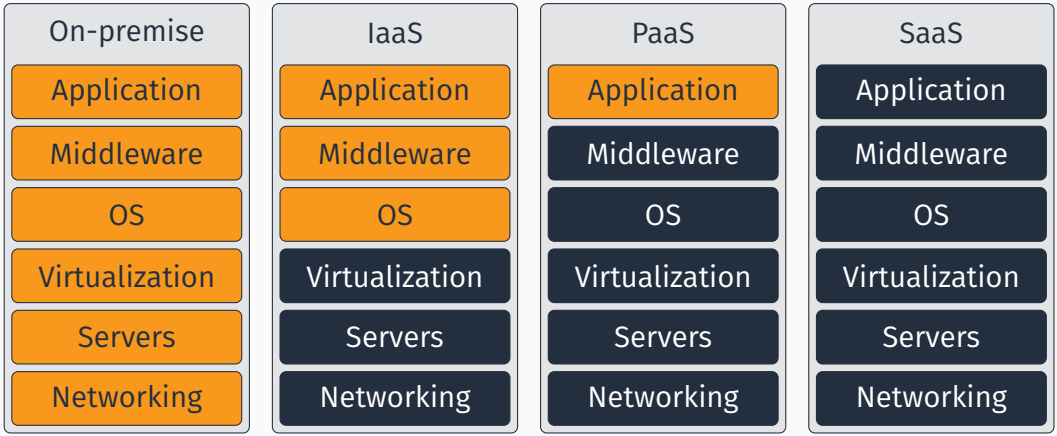
- **Infrastructure as a Service (IaaS)**
  The service vendor provides users access to computing resources such as servers, storage and networking.

Service Models: a visual comparison



AWS Infrastructure

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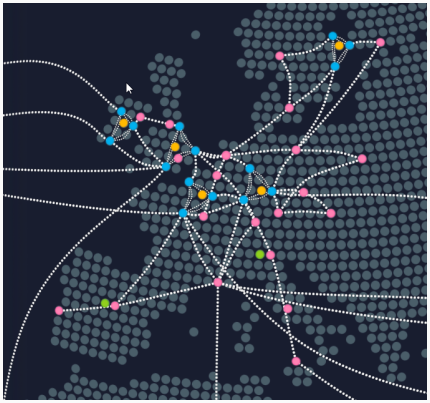

infrastructure.aws

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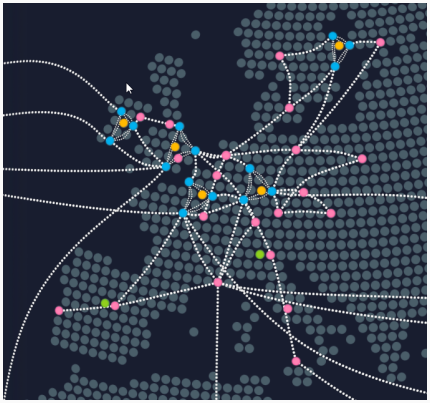

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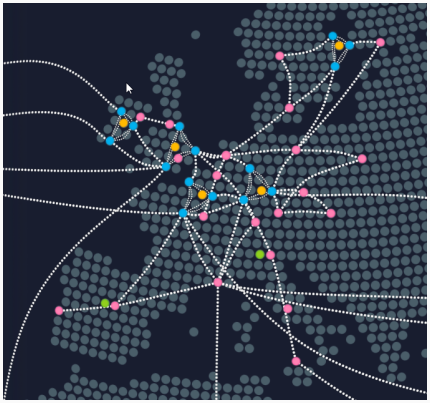

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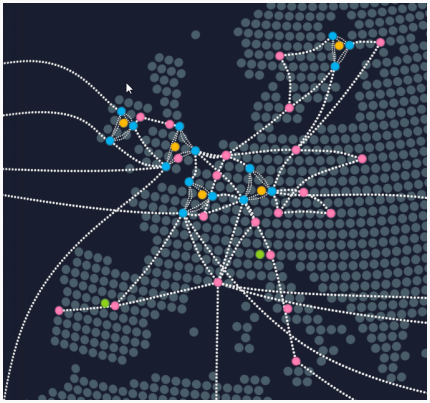
- 216 points of presence for effective caching and content delivery.



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Core AWS services

Amazon Web Services is a collection of cloud-based services.

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Periodic Table of Amazon Web Services

by @awsgeek

- Analytics
- Application Integration
- AR & VR
- AWS Cost Management
- Blockchain
- Business Applications
- Compute
- Customer Engagement
- Database
- Developer Tools
- End User Computing
- Game Tech
- Internet of Things
- Machine Learning
- Media Services
- Migration & Transfer
- Mobile
- Managment & Governance
- Network & Content Delivery
- Robotics
- Satellite
- Storage
- Security, Identity & Compliance

amazon A athena																						amazon S3 simple storage service	aws Sg storage gateway	
amazon Cs cloudsearch	aws Gs ground station														aws Wa well-architected tool	aws Lm license manager	amazon Et elastic transcoder	aws Mh migration hub	aws Am amplify	amazon V virtual private cloud	amazon Bs elastic block store	
amazon Mr elastic map reduce	aws G glue														amazon Cw cloudwatch	aws Mc management console	amazon Kv kinesis media streams	aws Ad application discovery service	aws Ag api gateway	amazon Cr cloudfront	amazon Fs elastic file system	
amazon Es elasticsearch	aws Lf lake formation	aws Ce cost explorer	amazon Ax alexa for business	amazon Cs elastic container service	aws L lambda	amazon Co connect	aws Cb codebuild	amazon Au aurora	amazon Ds relational database service	aws I iot core	aws Dd iot device defender	aws Ac auto scaling	aws Ms managed services	aws Mc elemental mediaconnect	aws Dm database migration service	aws Po pinpoint	amazon 53 route 53	amazon Fx fsx for lustre	
amazon K kinesis	aws Sf step functions	aws Bu budgets	amazon Ch chime	amazon Ks elastic container service for kubernetes	aws O outposts	aws Pi pinpoint	aws Cc codecommit	amazon D dynamodb	amazon Rs redshift	aws Os iot freertos	aws Dm iot device management	aws Cf cloudformation	aws Ow opsworks	aws Mv elemental mediaconvert	aws Ds datasync	aws As appsync	amazon Pl vpc privatelink	amazon Fw fsx for windows file server	
amazon Ka managed streaming for kafka	amazon Mq activemq	aws Cu cost & usage report	amazon Wm workmail	amazon Ls lightsail	aws Sa serverless application repository	amazon E simple email service	aws Cd codedeploy	amazon Do documentdb	amazon Ti timestream	aws Gg greengrass	aws Ev iot events	aws Ct cloudtrail	aws Ph personal health dashboard	aws Ml elemental medialive	amazon Sm server migration service	amazon Df device farm	amazon Am App Mesh	amazon Gl s3 glacier	
amazon R redshift	amazon N simple notification service	aws Ri reserved instance reporting	amazon C elastic cloud compute	amazon Ba batch	amazon Lb elastic load balancing	amazon Cs codestar	aws Cp codepipeline	amazon Ec elasticache	amazon Ms database migration service	aws 1c iot 1-click	aws Sw iot sitewise	aws Co config	aws Sc service catalog	aws Mp elemental mediapackage	amazon Sn snow family	amazon Ga global accelerator	amazon Cm cloud map	amazon Ba backup	
amazon Qs quicksight	amazon Q simple queue service	amazon Bc managed blockchain	amazon Au ec2 auto scaling	amazon Eb elastic beanstalk	aws Vm vmware cloud on aws	amazon Co correto	aws Cli command line interface	amazon Ne neptune	amazon Gl gamelift	aws An iot analytics	aws Tg iot things graph	aws Ct control tower	aws Sm systems manager	aws Ms elemental mediastore	aws Sf transfer for sftp	amazon Tg transit gateway	amazon Dc direct connect	amazon Sn snow Family	
aws Dp data pipeline	aws Ap appsync	amazon Su sumerian	amazon Cr elastic container registry	amazon F fargate	aws Rm robomaker	amazon C9 cloud9	aws Sd tools & sdks	amazon Ql quantum ledger db	amazon Ly lumberyard	aws Bu iot button	aws Dc iot partner device catalog	aws Cm console mobile app	aws Ta trusted advisor	aws Mt elemental mediatailor	amazon Wd workdocs	amazon Wo worklink	amazon Ws workspaces	amazon As appstream 2.0	

amazon Sm sagemaker	amazon Co comprehend	amazon Ei elastic inference	amazon Fc forecast	amazon Lx lex	amazon Pe personalize	amazon Po polly	amazon Rk rekognition	amazon Gt sagemaker ground truth	amazon Tx textract	amazon Tr translate	aws Ta transcribe	aws Dl deep learning amis	aws Dl deeplens	amazon Dr deepracer	aws If inferentia	amazon Mx apache mxnet on aws	aws Tf tensorflow on aws	
aws Im identity & access management	aws Cd cloud directory	amazon Co cognito	amazon Gd guardduty	aws I inspector	amazon M macie	amazon Ar artifact	aws Cm certificate manager	aws Hs cloudhsm	aws Ds directory service	aws Fm firewall manager	aws Km key management service	aws O organizations	aws Sm secrets manager	aws Sh security hub	aws S shield	amazon Ss single sign-on	aws Wf web application firewall	

Core AWS services

Computing and Storage

Amazon Elastic Compute Cloud (EC2)

- (Virtual) Servers on demand

EC2 pricing web
Azure: Virtual Machines web
Google Cloud: Compute Engine web

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- Elasticity **not** included!

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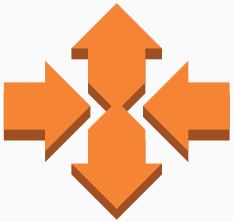

Azure: Virutal Machine Scale Sets web
Google Cloud: Load Balancing web

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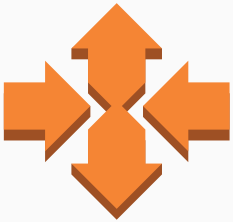
- Scale your application manually, on a scheduled basis or on demand



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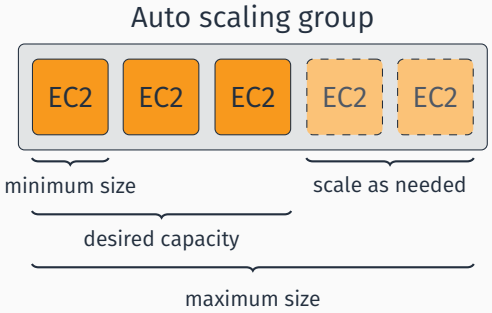
Amazon EC2 Auto Scaling: details



Amazon Elastic Load Balancing (ELB)

- Distributes incoming traffic across multiple EC2 instances

Azure: Load Balancer web

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- Distributes incoming traffic across multiple EC2 instances
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  - Execution time

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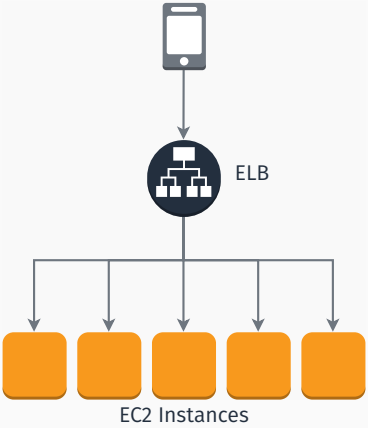

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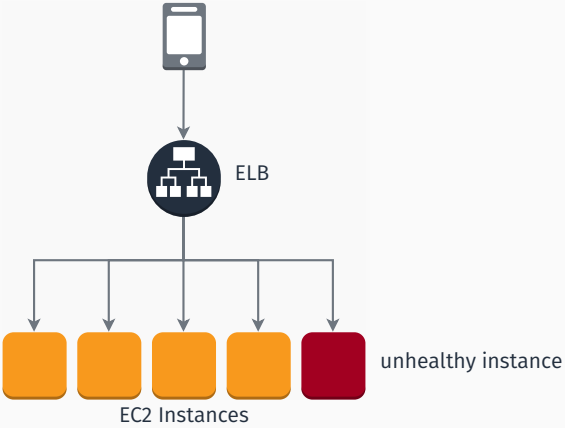

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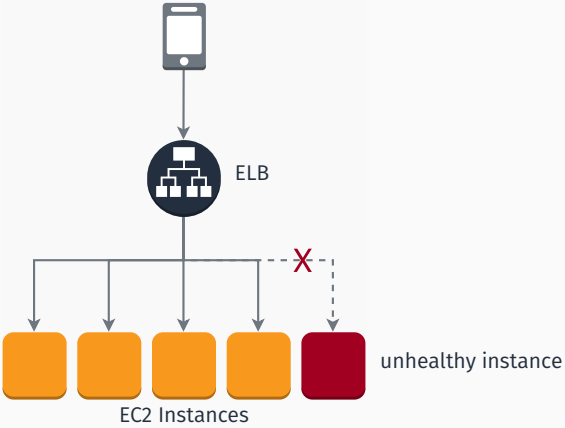

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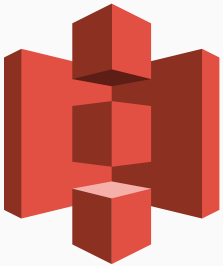

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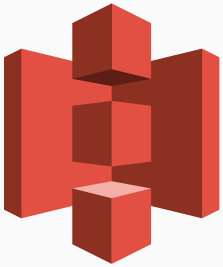
- Glacier
  - Durable and cheap long-term storage.

Amazon Simple Storage Service (S3)

- *store and retrieve any amount of data from anywhere*



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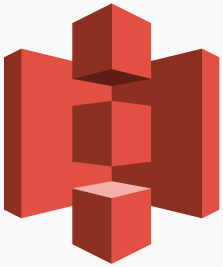

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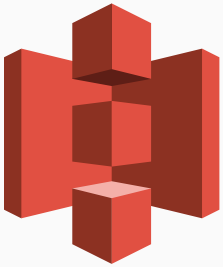

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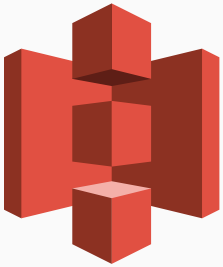

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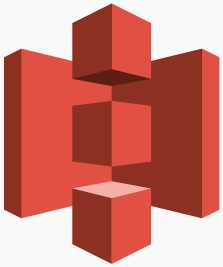

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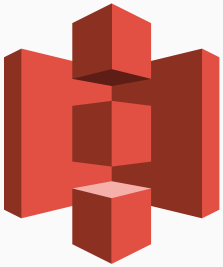

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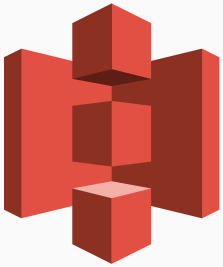

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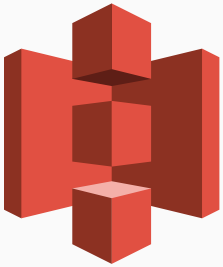
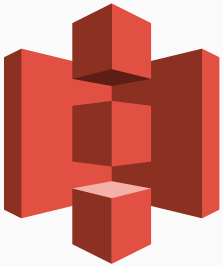
  - Infrequent Access
  - One zone-Infrequent Access



Amazon Simple Storage Service (S3)

- *store and retrieve any amount of data from anywhere*
- 99.999999999% durability (nine nines!)
- Data is distributed across a *minimum* of three availability zones
- A logical unit of storage is a *bucket*
- Multiple storage classes
  - Standard
  - Infrequent Access
  - One zone-Infrequent Access
  - Amazon Glacier



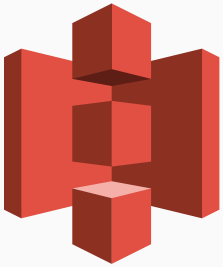
Pricing:

Storage class	Storage (per month)	Retrieval (per 1K req.)
Standard	$0.022 per GB	$0.0004
Infrequent access	$0.0125 per GB	$0.001
IA single zone	$0.01 per GB	$0.001
Glacier	$0.004 per GB	$0.0004

Table 1: S3 pricing (Ireland)

Amazon Simple Storage Service (S3) - more

- Well-integrated with other services



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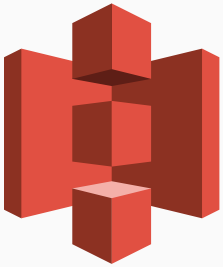

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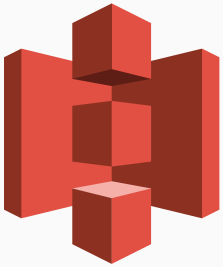

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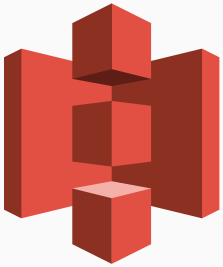

Amazon Simple Storage Service (S3) - more

- Well-integrated with other services
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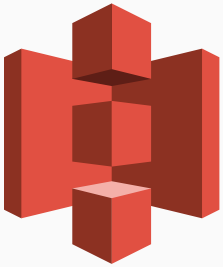
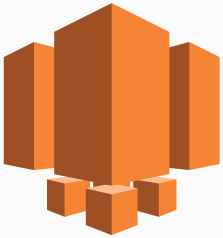
- REST API
- Can be used to host static websites



Amazon Lightsail

- A lightweight, simplified offer



Websites: EC2 Lightsail

Amazon Lightsail

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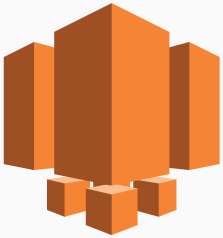

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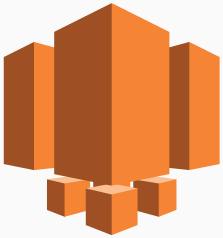

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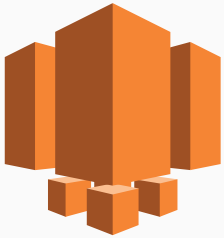

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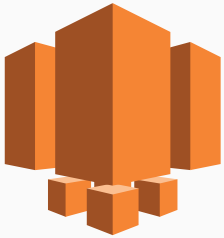

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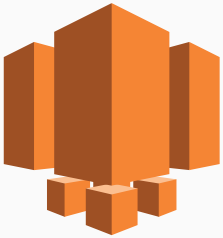

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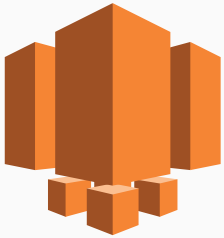

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Amazon Elastic Beanstalk

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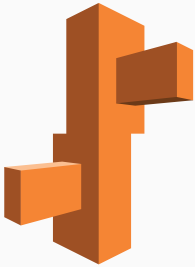

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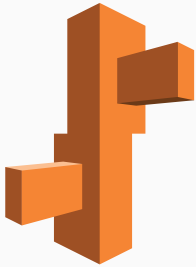
- Easy-to-use service to deploy web apps



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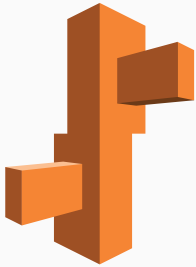

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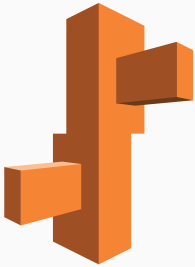

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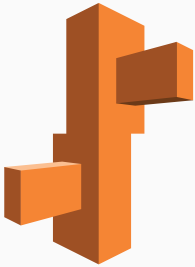

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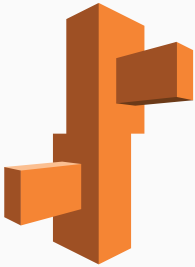

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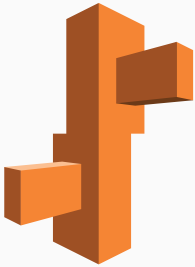
- Customizable
- Free of charge. Pay only for the AWS resources you use.



Core AWS services

Database services

Relational Database Service (RDS)

- Set up, operate a relational database in the cloud.

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  - Amazon Aurora

- DynamoDB
  - *Fast and flexible NoSQL database service for any scale.*

Non Relational Database Services

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- ElastiCache
  - In memory data store.
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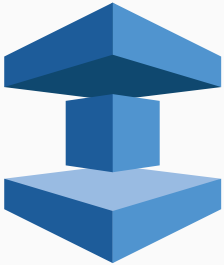


Non Relational Database Services

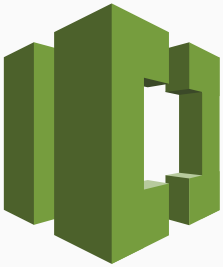
- DynamoDB
  - *Fast and flexible NoSQL database service for any scale.*
- ElastiCache
  - In memory data store.
  - Supports memcached, Redis
- Neptune
  - Graph database service
  - Supports RDF, SPARQL, ...

Core AWS services

Developer Tools

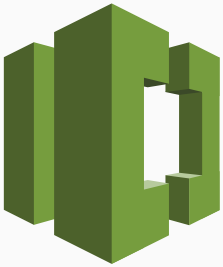
Developer Tools

- CodeCommit



Developer Tools

- CodeCommit
  - Managed, scalable, private *git* server



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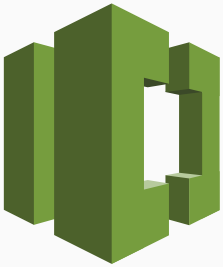
  - Pricing based on active users (5 free, 1$ for each additional user)



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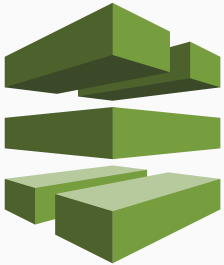

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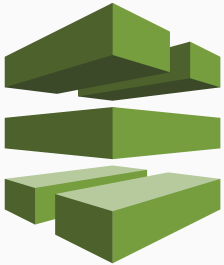

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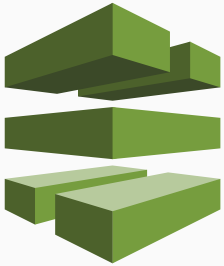

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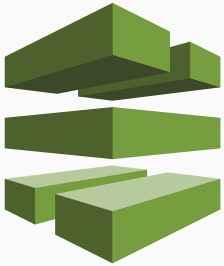

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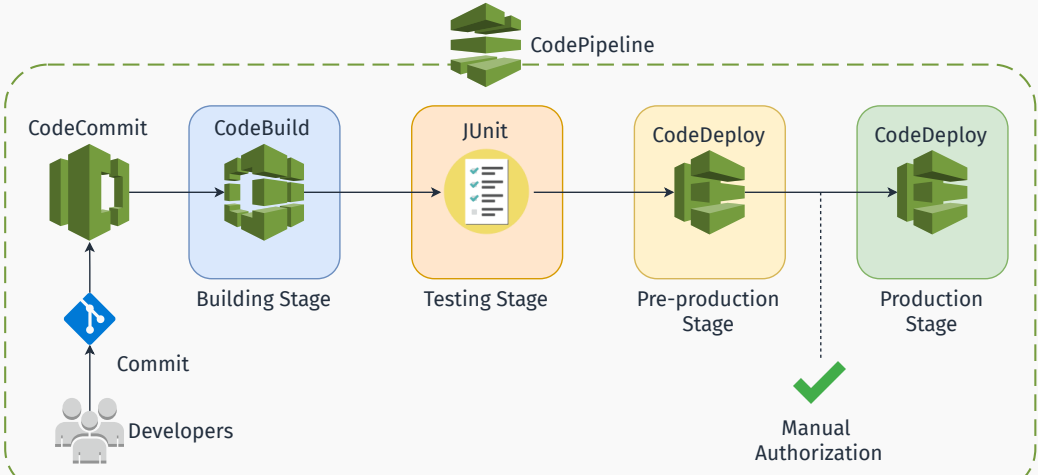

Interested in CI/CD on AWS? Check these out:

- *Practicing Continuous Integration and Continuous Delivery on AWS* (whitepaper) [Ama17]
- *Set up a Continuous Deployment Pipeline using AWS CodePipeline* [Amaa]
- *Tutorial: Create a Four-Stage Pipeline* [Amab]

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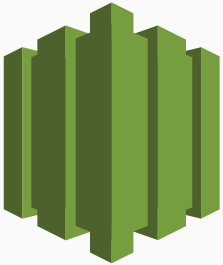

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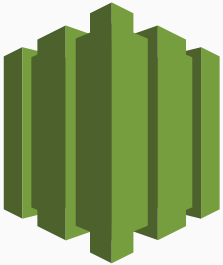

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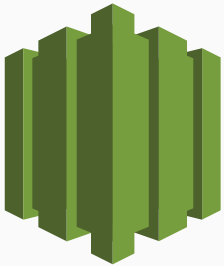

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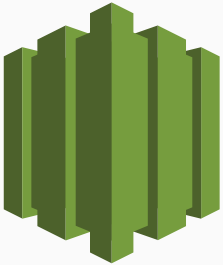

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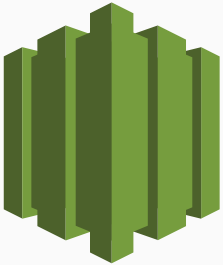

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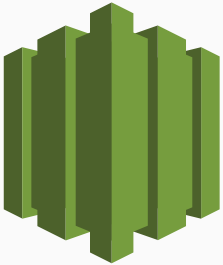

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Core AWS services

Data Analysis

Amazon Athena

- Run SQL-like queries on S3-stored data in seconds;

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- You are charged for the number of bytes scanned per query, rounded up to the nearest megabyte, with a 10MB minimum per query. Scanning 1TB costs 5$.

Amazon Athena

Amazon EMR (Elastic MapReduce)

- Easily Run and Scale Big Data Frameworks such as Apache Spark and Hadoop;

Amazon EMR

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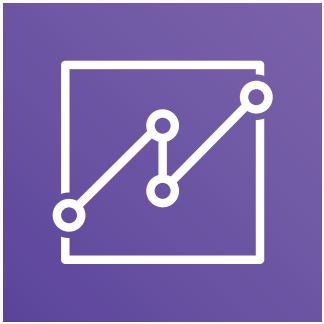
Amazon EMR

Amazon QuickSight

- Business Intelligence service that makes it easy to deliver insights to everyone;



Amazon QuickSight

QuickSight overview (Youtube)

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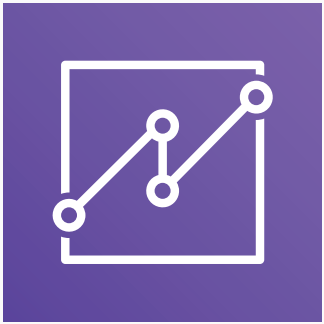
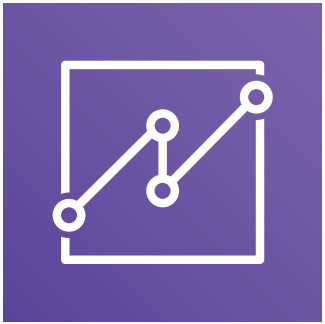


Amazon QuickSight

QuickSight overview (Youtube)

Amazon QuickSight

- Business Intelligence service that makes it easy to deliver insights to everyone;
- Load data from anywhere;
- You pay a per-session rate (from 0,30$ per session up to 5$ a month);



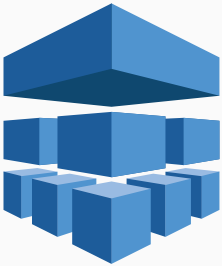
Amazon QuickSight

QuickSight overview (Youtube)

Core AWS services

Machine Learning: application services

- Amazon SageMaker



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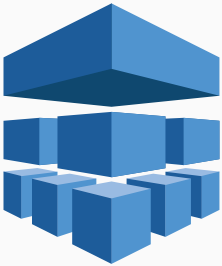

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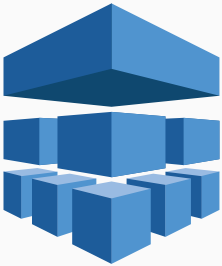
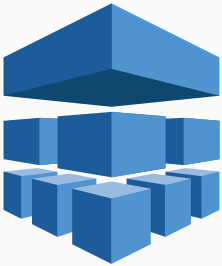


- Amazon SageMaker
  - Preconfigured for Tensorflow, MXNet...
  - Build, Train and Deploy phases
  - Pay based on build time, train time and hosting time



- Comprehend (for NLP) website

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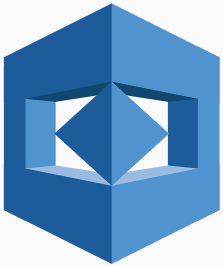
- Rekognition (Visual Analysis) website



Machine Learning: application services

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- Translate

- Comprehend (for NLP) website
- Rekognition (Visual Analysis) website
- Translate
- Polly (text-to-speech)

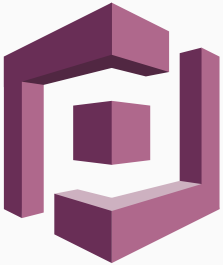
Machine Learning: application services

- Comprehend (for NLP) website
- Rekognition (Visual Analysis) website
- Translate
- Polly (text-to-speech)
- Transcribe (speech-to-text)

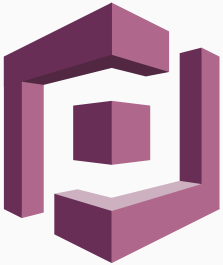
Core AWS services

Miscellanea

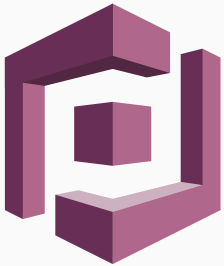
- Cognito



- Cognito
  - Sign-up and authentication



- Cognito
  - Sign-up and authentication
  - Federated identities



- Cognito
  - Sign-up and authentication
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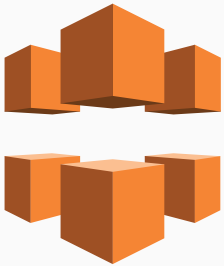
- CloudFront



- Cognito
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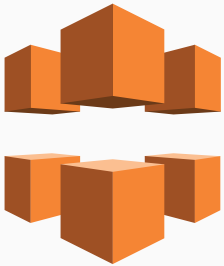
- CloudFront
  - Content Delivery Network



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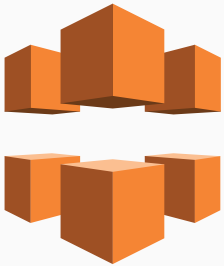

Miscellanea

- Cognito
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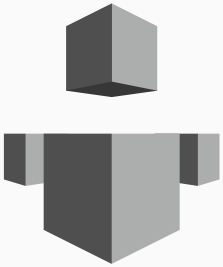
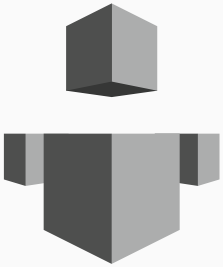
- Mechanical Turk



Amazon MechanicalTurk

- ???



The Turk

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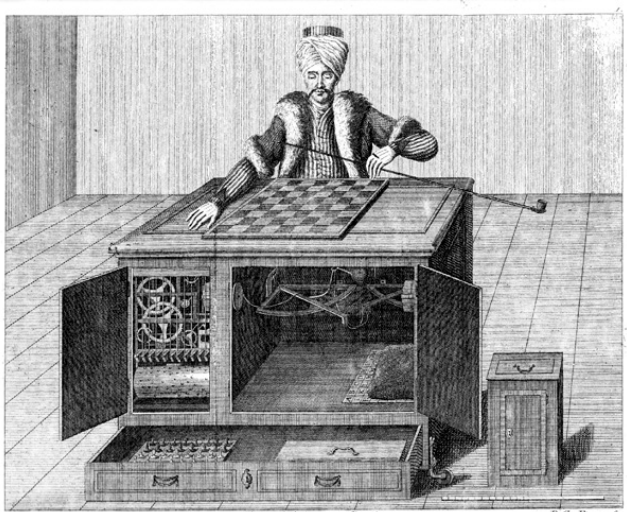
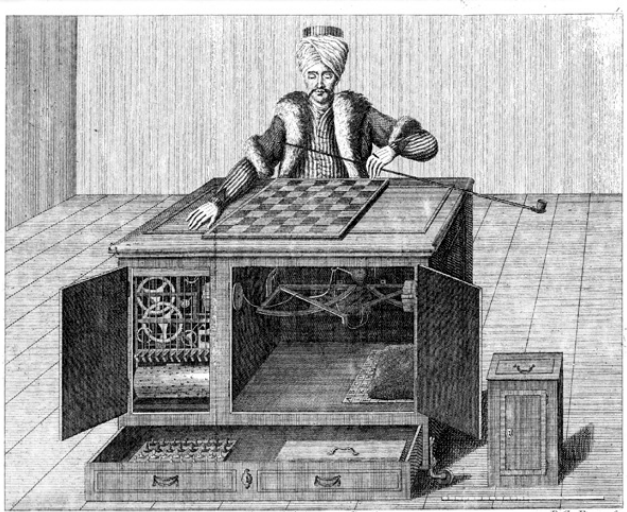


The Turk

The Turk was a chess-playing automaton built in 1770. Obviously it was a fraud.



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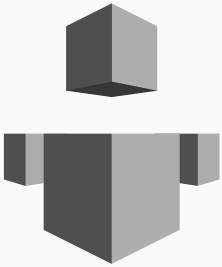
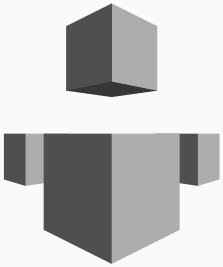


Amazon MechanicalTurk

- Human Intelligence through an API



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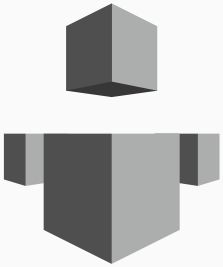

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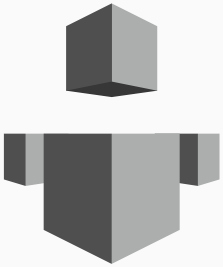
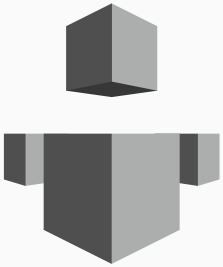


Amazon MechanicalTurk

- Human Intelligence through an API
- Create HIT (Human Intelligence Task)
- Elastic, on-demand workforce
- Available 24/7



Practice time!

Scenario

- You just had a million dollar idea.

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Scenario

- You just had a million dollar idea.
- Your web application is finished. It looks great and works like a charm.
- You're ready to start earning some dough!

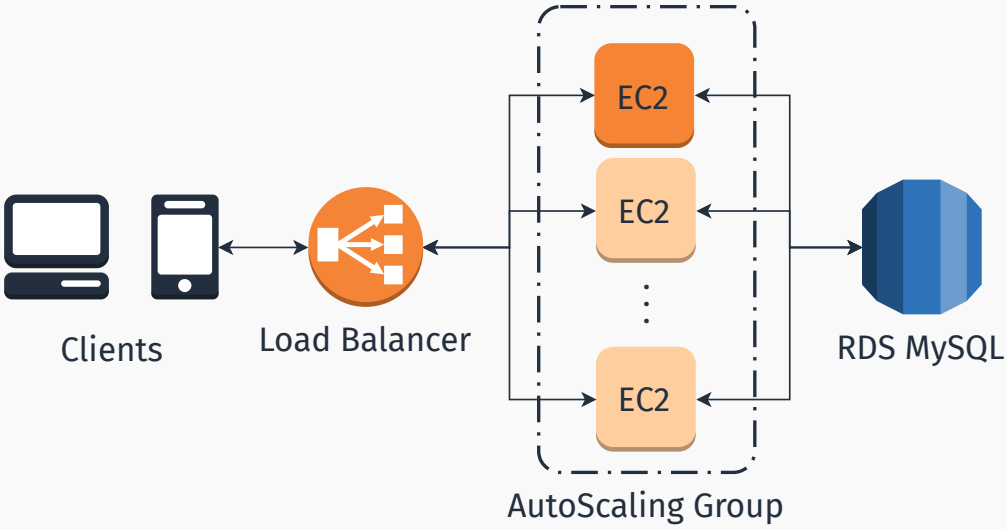
About the web app

The web app is built with a classic LAMP stack:

- Linux
- Apache web server
- MySQL relational database
- PHP

How would you do it?

Proposed architecture



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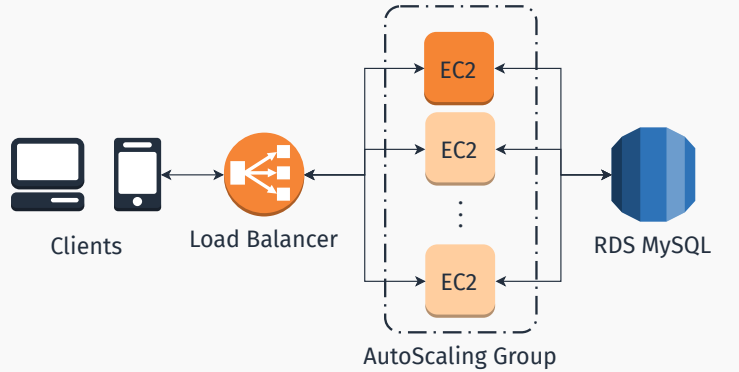

- Is this *really* scalable?

Take Home Messages

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- Cloud computing and service models

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- A cloud architecture for a classic web application on AWS

Any questions?

References I

[Amaa] Inc. Amazon Web Services. *Set up a Continuous Deployment Pipeline using AWS CodePipeline*. URL: *https://aws.amazon.com/it/getting-started/tutorials/continuous-deployment-pipeline/* (visited on 06/10/2018).

[Amab] Inc. Amazon Web Services. *Tutorial: Create a Four-Stage Pipeline*. URL: *https://docs.aws.amazon.com/codepipeline/latest/userguide/tutorials-four-stage-pipeline.html* (visited on 06/10/2018).

References II

[Ama17] Inc. Amazon Web Services. *Practicing Continuous Integration and Continuous Delivery on AWS*. Tech. rep. June 2017. URL: *https://d1.awsstatic.com/whitepapers/DevOps/practicing-continuous-integration-continuous-delivery-on-AWS.pdf* (visited on 06/01/2018).

[Fle19] Flexera. *Cloud Computing Trends: 2019 State of the Cloud Survey*. Feb. 27, 2019. URL: *https://www.flexera.com/blog/cloud/2019/02/cloud-computing-trends-2019-state-of-the-cloud-survey/* (visited on 03/21/2020).