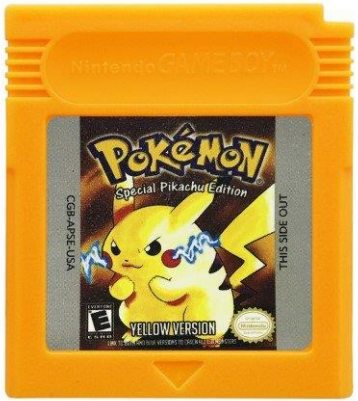
CSci 3081W: Program Design and Development

Lecture 15 – Deployment

History

Black box (ex. physical ATM)

Cartridges, cassettes, floppy disks, CD/DVD, flash drives



History

Internet – enabled users to be able to download software without a hard copy (as well as installation, updates, etc)

Deployment

General process that can be modified

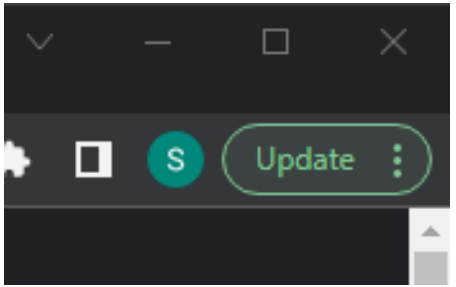
Activities within the deployment process

Can be handled by producer, consumer, or both

Deployment

Who deploys the software?

Depends!
Examples:
- The user clicks update
- DevOps: deployment/release coordinator(s)



Deployment Environment

Also known as “tiers”

A system or set of subsystems where a program or software is deployed and executed

In simple cases, you could have just a single environment

In industrial use/complex cases, the development environment and production environment are separated
- development environment - where the changes are made originally
- production environment - what the clients or users end up using
- usually there are stages in between
- allows phased deployment (aka rollout), testing, and rollback in case of bugs/issues

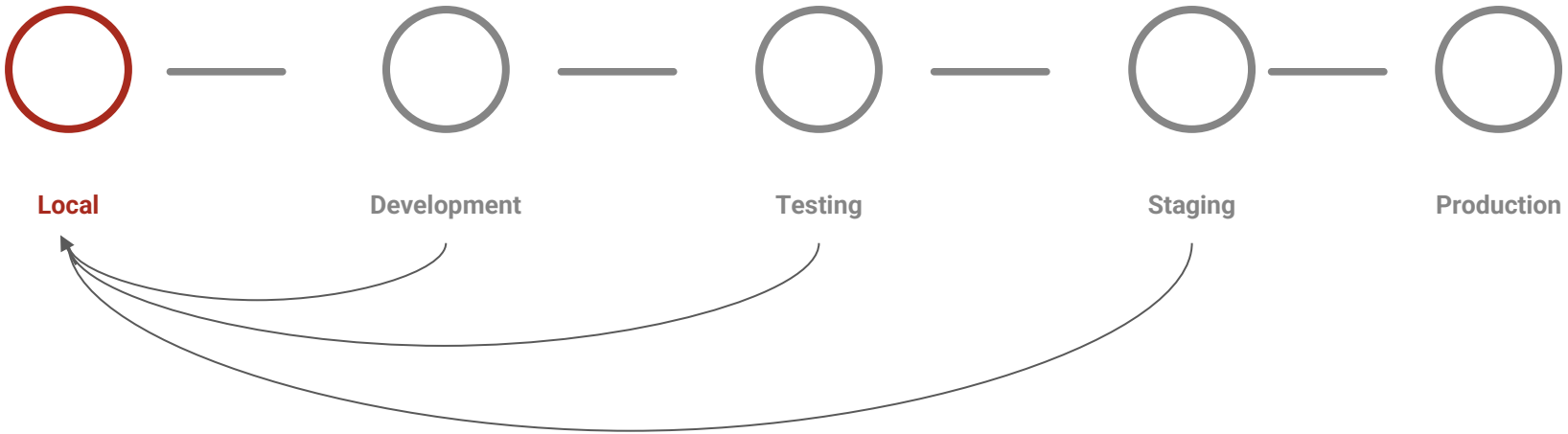
Deployment Environments

Environment Name	Description
Local	Developer's desktop/workstation
Development	Development server acting as a sandbox where unit testing may be performed by the developer
Testing	The environment where interface testing is performed
Staging/Pre-production/External-Client Acceptance	Mirror of production environment
Production	Serves end-users/Client

Deployment Environments

Local Environment

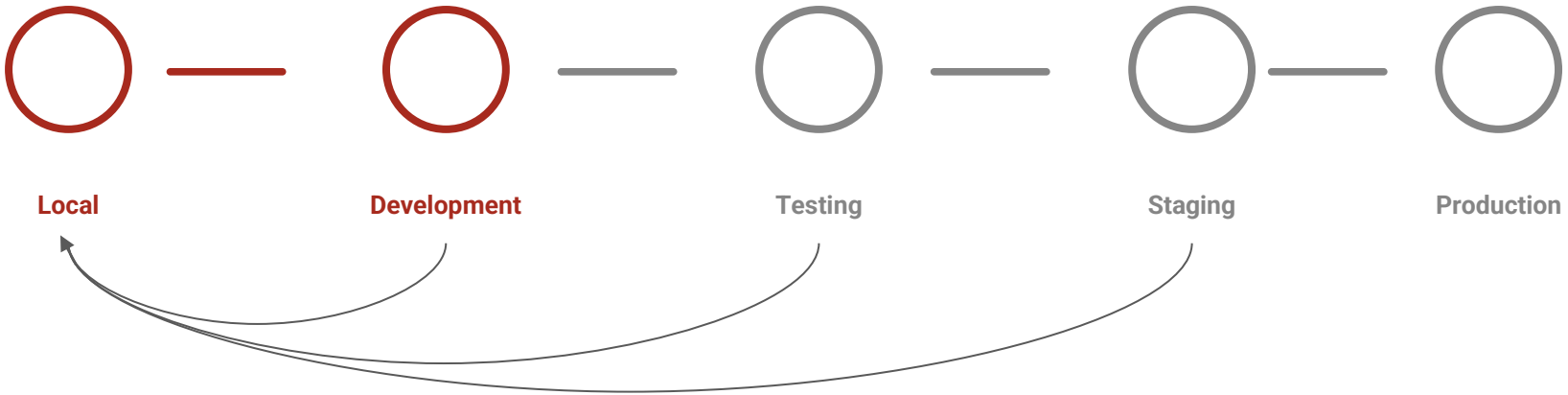
- **The place where developers code the features assigned to them for the sprint.**
- **Usually the place where your IDE exists.**



Deployment Environments

Development Environment

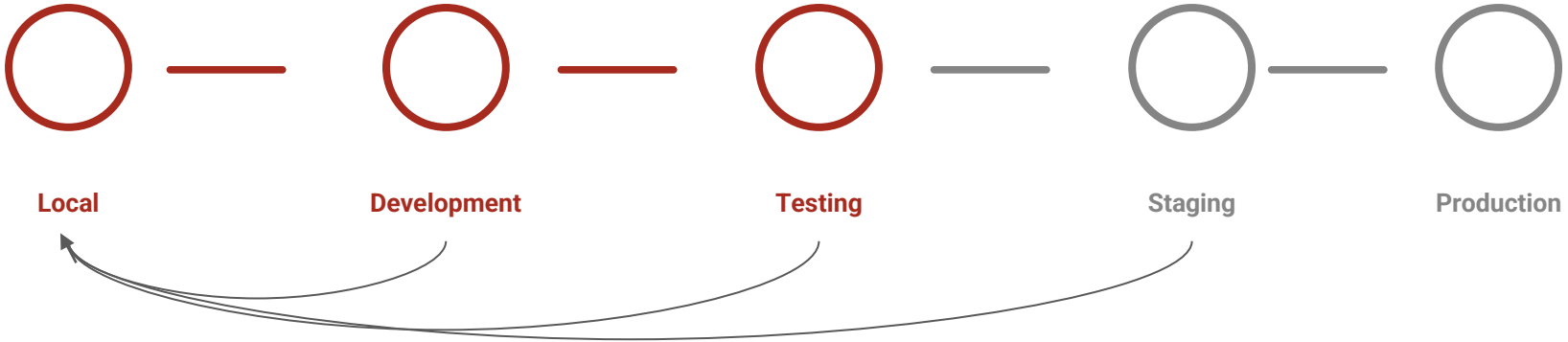
- **Colloquially known as ‘dev’ environment.**
- **A ‘sandbox’ environment where code is deployed to servers such that unit testing can be performed.**
- **For example: if there’s 10 features being developed simultaneously, then there should ideally be 10 different dev environments such that we can see how each feature behaves individually.**



Deployment Environments

Testing Environment

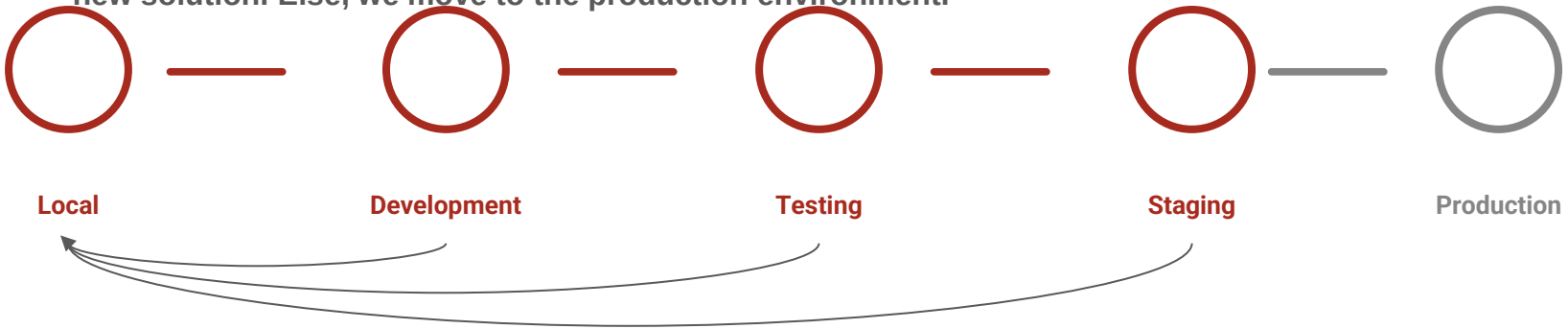
- **The environment where interface testing is performed**
- **All the features that were developed individually are combined into one ‘release’ so that their effects can be scrutinized together by the QA (Quality assurance) team by testing different workflows as well as checking how things work together at scale**
- **For eg: the 10 different features developed in the last sprint are all merged together in Github and their combination is now deployed to a testing environment where the QA team makes sure that none of the existing features are impacted by the changes made as well as none of the changes interfere with other changes made during the same sprint.**



Deployment Environments

Staging Environment

- **This environment imitates the production environment.**
- **The ‘release’ is deployed to the staging environment so that clients can check if the changes/features look okay.**
- **Integral part of the Agile process.**
- **If you aren’t developing for a specific client, it’s still good to see how your release behaves in an environment that best resembles production**
- **Eg: The features developed over the last sprint are now shown to the client where they can green flag/red flag changes based on their liking. If a change gets red flagged we go back to the local environment to develop a new solution. Else, we move to the production environment.**

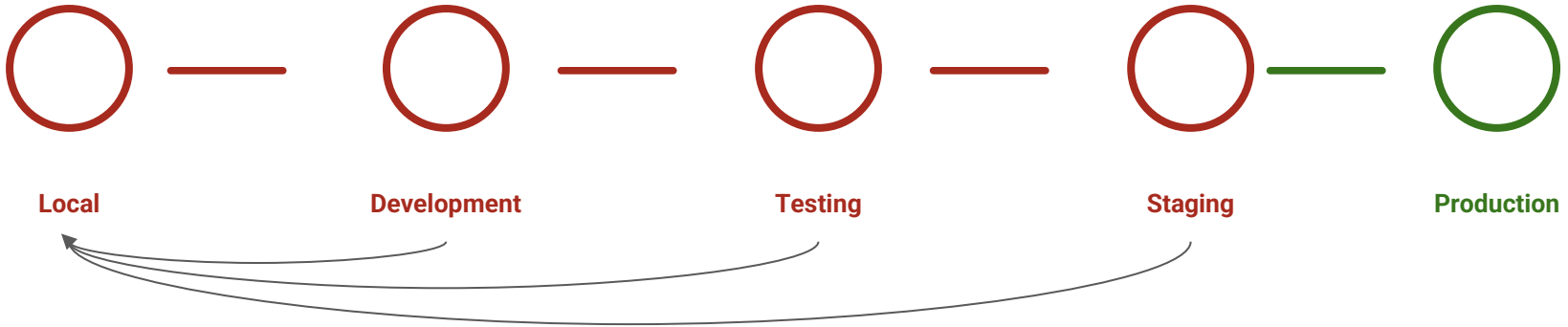


Deployment Environments

Production Environment

- **The actual environment where code is run such that it generates revenue for the company.**
- **Outages/mistakes often impact revenue, hence the previous environments in this process.**
- **Eg: In our day to day lives we only interact with production environments. www.youtube.com, www.gmail.com, etc. are all production environments.**

The entire process of running the changes on all the different environments usually happens over a week. This is after the developer has already coded the changes/features.



Hotfixes

Problem:
Imagine that you’re in production and there’s an important bug that needs to be fixed immediately

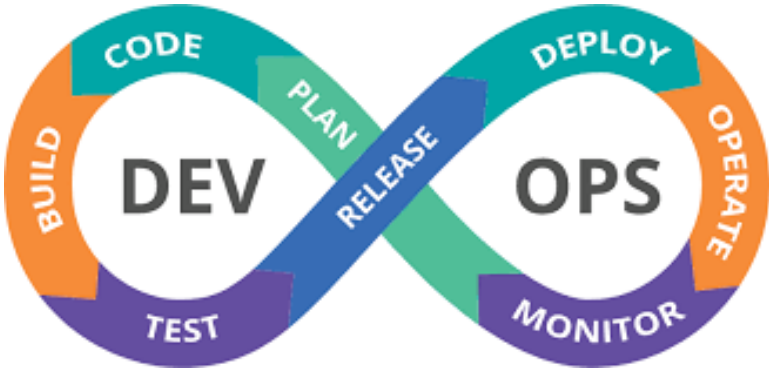
Solution:

- local
- testing
- production

Intro to DevOps

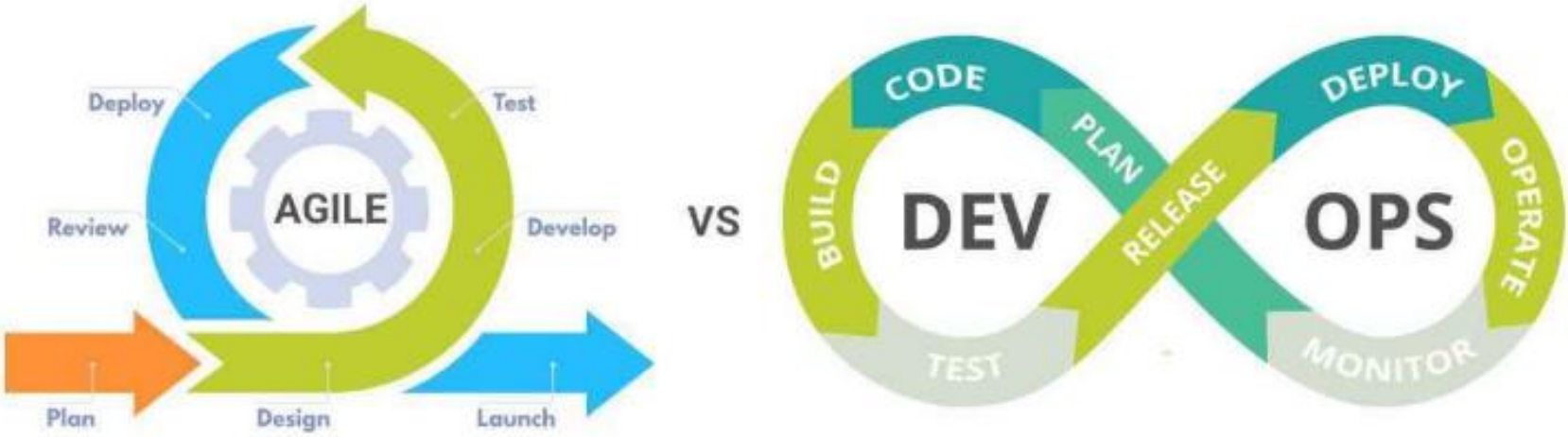
- Partnership between Development and Operations teams (dev and ops)
    - Enables code deployment and production to be more rapid and automated
    - Before DevOps, these teams worked independently from one another

- Principles: flow, feedback, and continuous learning



DevOps and Agile

- Not mutually exclusive

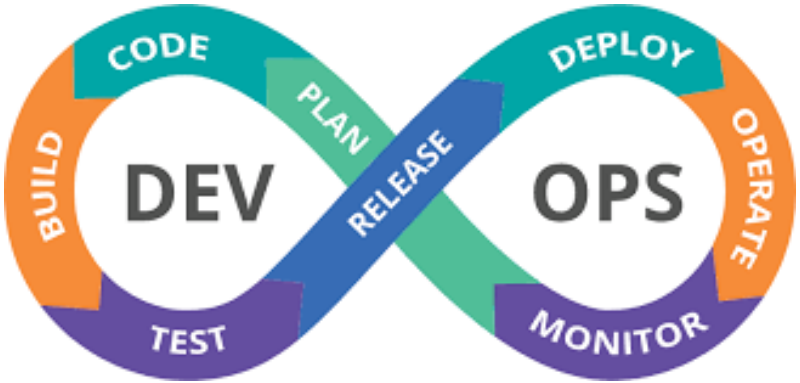


DevOps and Agile

	DevOps	Agile
Philosophy and Focus	- Rooted in stability, consistency, and planning - Seeks to identify new ways to improve and streamline processes - Focuses on maximizing efficiency, identifying programmable processes, and increasing automation	- Centers around adaptability and keeping pace with customer needs and expectations - Features are described as user stories, placing the focus on the individual user, what they need, and why
Scope	- Represents the intersections of development, operations, and quality assurance - Cross-disciplinary teams unite and collaborate in the development and delivery of software	-Specific to the development team, its productivity, and its progress toward completing the project at hand -Development is completed in incremental sprints, and software delivery, deployment, or ongoing maintenance of each release is managed by different teams
Manifestations	- Continuous integration - Continuous delivery - Continuous deployment	- Scrum - Kanban - Extreme programming - and others (crystal, lean, DSDM, etc.)

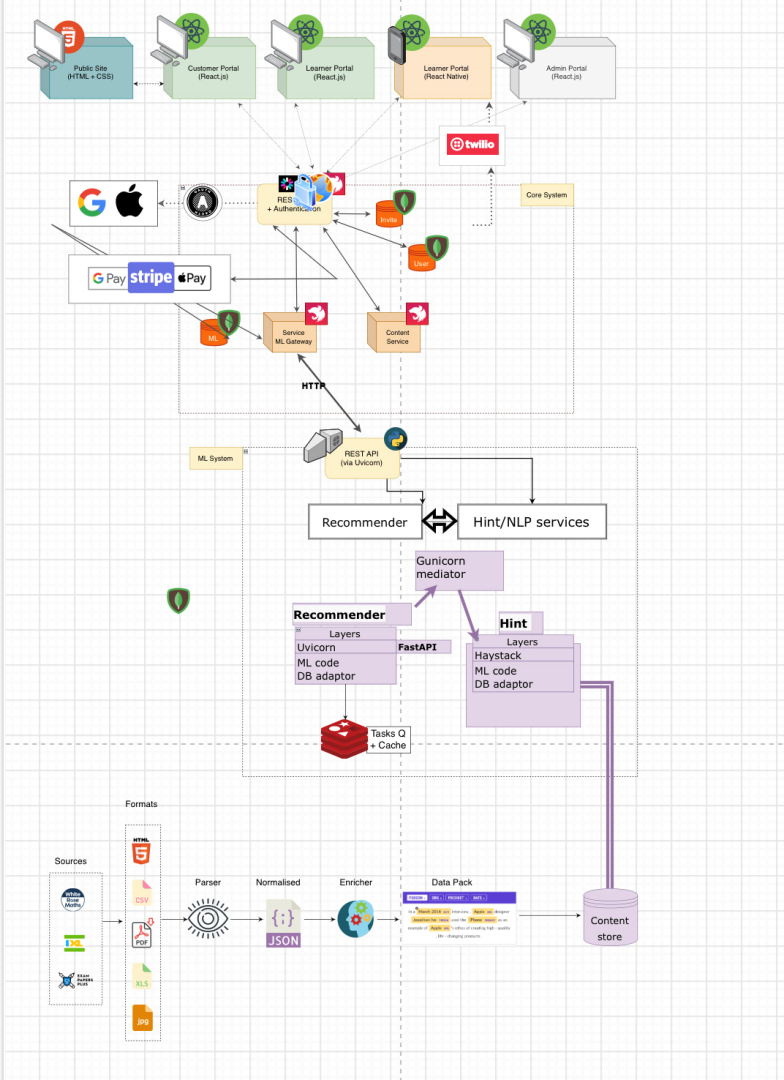
Additional Reading

- DevOps:
  - https://itrevolution.com/product/the-devops-handbook-second-edition/
  - https://learn.microsoft.com/en-us/azure/devops/?view=azure-devops



Machine learning deployment

- Deploying ML models is usually quite different than other kinds of software
- Unsure how ML models will behave in production
- Rollout ML models in multiple deployment methods



Machine learning deployment

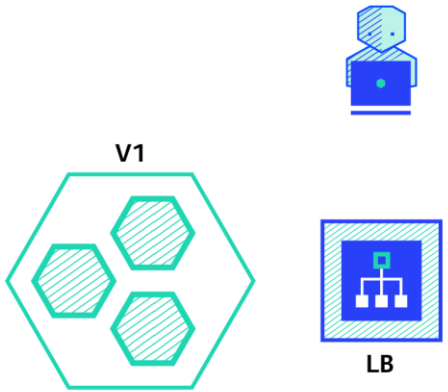
- Recreate: Version A is terminated then Version B gets rolled out
- Ramped (incremental): Version B slowly (incrementally) gets rolled out while replacing Version A
- Blue/Green: Version B gets released with Version A then traffic gets switched from A to B
- Canary (A/B): Version is released to a subset of users (under a specific condition) then eventually goes to all users
- Shadow: Version B and Version A both receive traffic and B doesn’t impact the response

Recreate

- Shut down Version A
- Deploy Version B while A is off

- Implies downtime

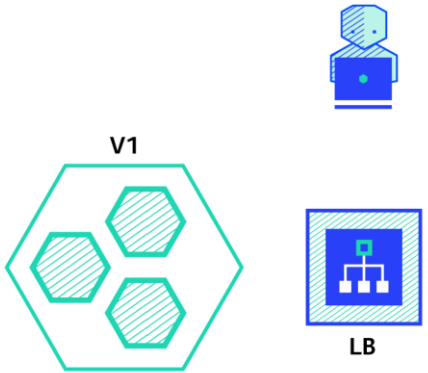
- Pros: easy to setup, state is entirely renewed
- Cons: downtime



Ramped

- Roll out one instance at a time with replacement of old instances

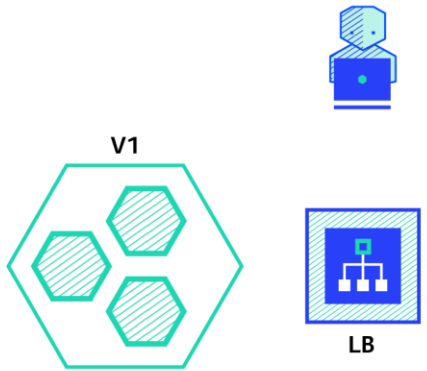
- Pros: easy to setup, version is slowly released across instances, convenient for stateful applications that can handle the rebalancing of data
- Cons: rollout (and potential rollback(s)) can take time, supporting multiple APIs is difficult, no control over traffic



Blue/Green

- Version B is deployed with Version A with the same number of instances. After some testing, Version A is switched to Version B

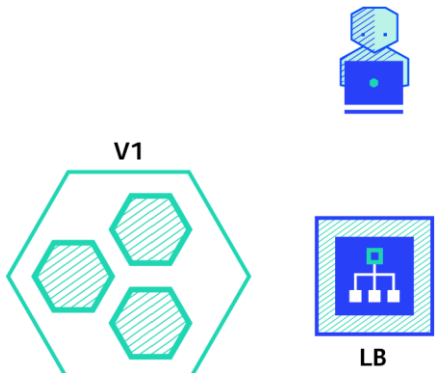
- Pros: instant rollout (or rollback), no versioning issues
- Cons: expensive (double the cost), requires proper testing of an entire platform, handling stateful applications is difficult



Canary

- Weighted split between Version A and Version B. For example, 10% to B, 90% to A.

- Pros: release for a subset of users, fast rollback, good for collecting error rates and performance monitoring
- Cons: slow rollout

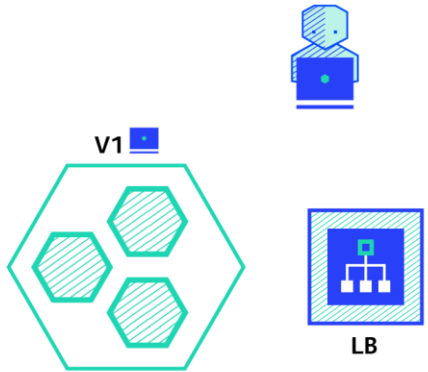


A/B

- Routes a subset of users to Version B depending on some specific condition. Usually used for making business decisions based on statistics

- Sample conditions: geolocalization, language, browser version, OS, cookie data, etc.

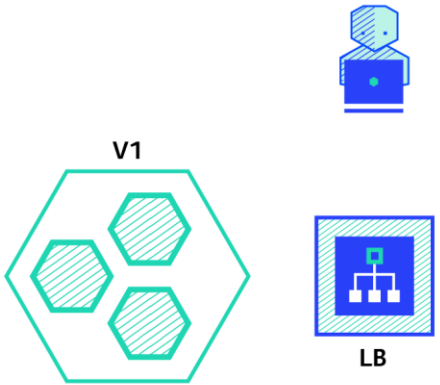
- Pros: can run several versions in parallel, full control over traffic distribution
- Cons: need a smart load balancer, hard to troubleshoot unless you have distributed tracing



Shadow

- Version A and Version B are both released. Version A’s incoming requests are forked and sent to Version B.

- Pros: performance testing, no impact on user, no rollout until stability and performance meet requirements
- Cons: expensive (double the cost), potentially complex to setup



ML Deployment Conclusion

- Multiple ways to deploy a new version of an application – dependent on needs and money
- Development/Staging environment → recreate or ramped
- Production environment → ramped or blue/green
- Blue/green and shadow are expensive
- If there’s little confidence → shadow, canary, A/B

ML Deployment Strategies

Strategy	ZERO DOWNTIME	REAL TRAFFIC TESTING	TARGETED USERS	CLOUD COST	ROLLBACK DURATION	NEGATIVE IMPACT ON USER	COMPLEXITY OF SETUP
RECREATE version A is terminated then version B is rolled out	✗	✗	✗	■□□	■■■	■■■	□□□
RAMPED version B is slowly rolled out and replacing version A	✓	✗	✗	■□□	■■■	■□□	■□□
BLUE/GREEN version B is released alongside version A, then the traffic is switched to version B	✓	✗	✗	■■■	□□□	■■□	■■□
CANARY version B is released to a subset of users, then proceed to a full rollout	✓	✓	✗	■□□	■□□	■□□	■■□
A/B TESTING version B is released to a subset of users under specific condition	✓	✓	✓	■□□	■□□	■□□	■■■
SHADOW version B receives real world traffic alongside version A and doesn't impact the response	✓	✓	✗	■■■	□□□	□□□	■■■

Deployment


MY COWORKERS WATCHING ME DEPLOY A "SMALL FIX" ON A FRIDAY
Get ready everyone, he's about to do something stupid.

Deployment


DEPLOYING ON A FRIDAY
ON CHRISTMAS EVE
IT'S JUST A SMALL CHANGE
NOTHING COULD GO WRONG
imgflip.com

Deployment


We require a pull request for every change
We require a second pull request when merging same change to master
We need 3 people to sign off on every pull request (team is 6)
Build still breaks after deploying to dev environment
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DevOps


Software
Team
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DEVOPS
AI ENGINEER
HOW DOES IT RUN?
IT'S A REINFORCEMENT LEARNING MODEL BASED ON PYTORCH
NO, HOW DO YOU RUN YOUR CODE?
ON GOOGLE COLAB, BUT IT'S IN PYTHON
I MEAN, HOW CAN YOU ACTUALLY RUN IT?
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