

Requirements and ML

Overview

- ML or data intensive systems vs traditional systems
- Software 2.0
- Requirements For ML
- ML For Requirements

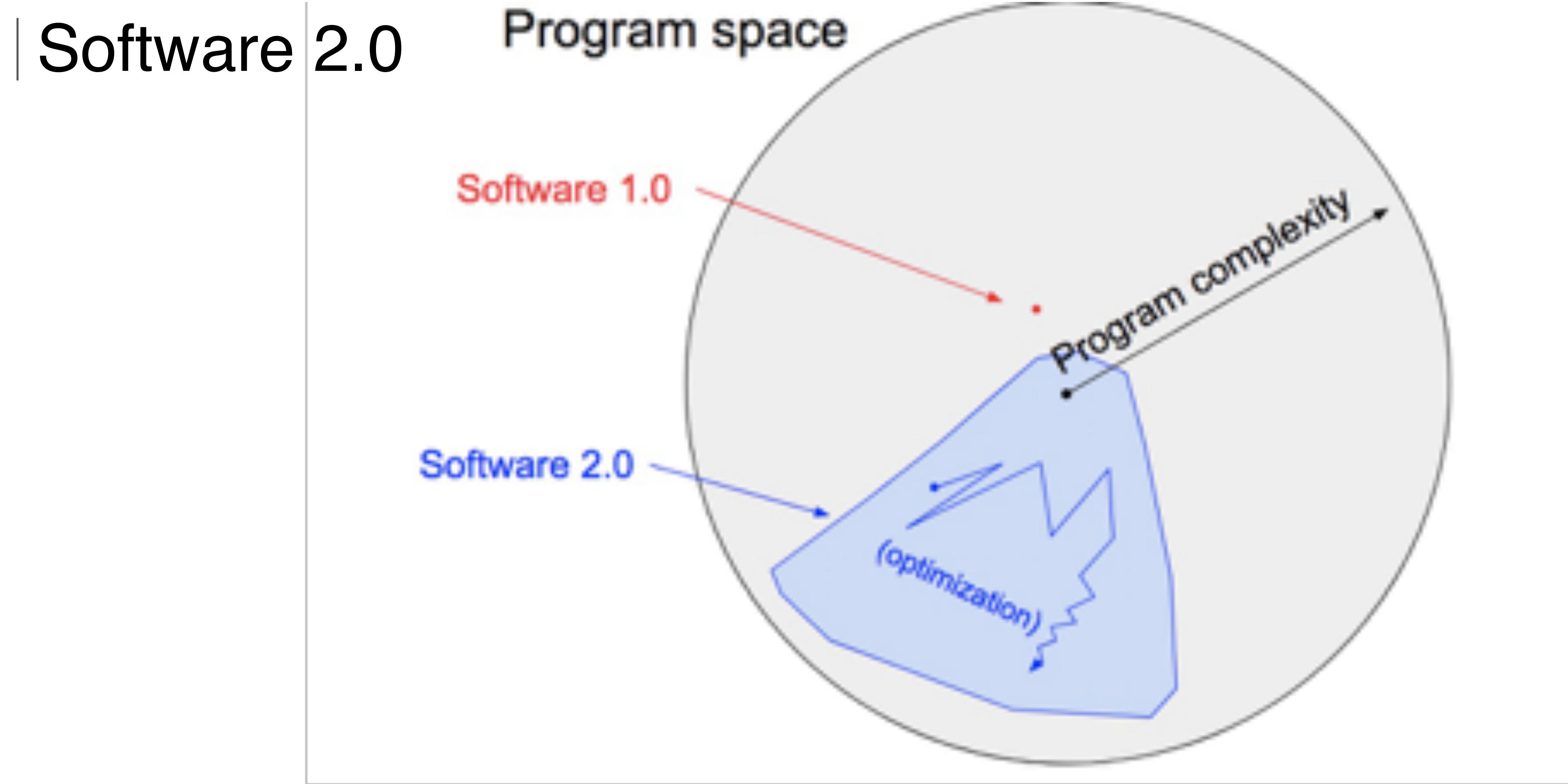
Software intensive systems

- Consider a robot. How do you tell the robot to get from A to B?
- Symbolic way: construct a model of the world. Program the robot with if/else rules to do path following.
- Connectionist/neural way: run the robot in many different paths and let it “learn” how to follow a path.

Software 2.0

- Coined by Andrej Karpathy (ML, Tesla) - <https://karpathy.medium.com/software-2-0-a64152b37c35>
- Tesla windshield wiper system
- How does a Tesla know to not hit a car?
- When does a Tesla do poorly?
- How do you hack a self-driving car?





*We are at the edge of a revolution in **how** we build software
and **who** can “write” software”*

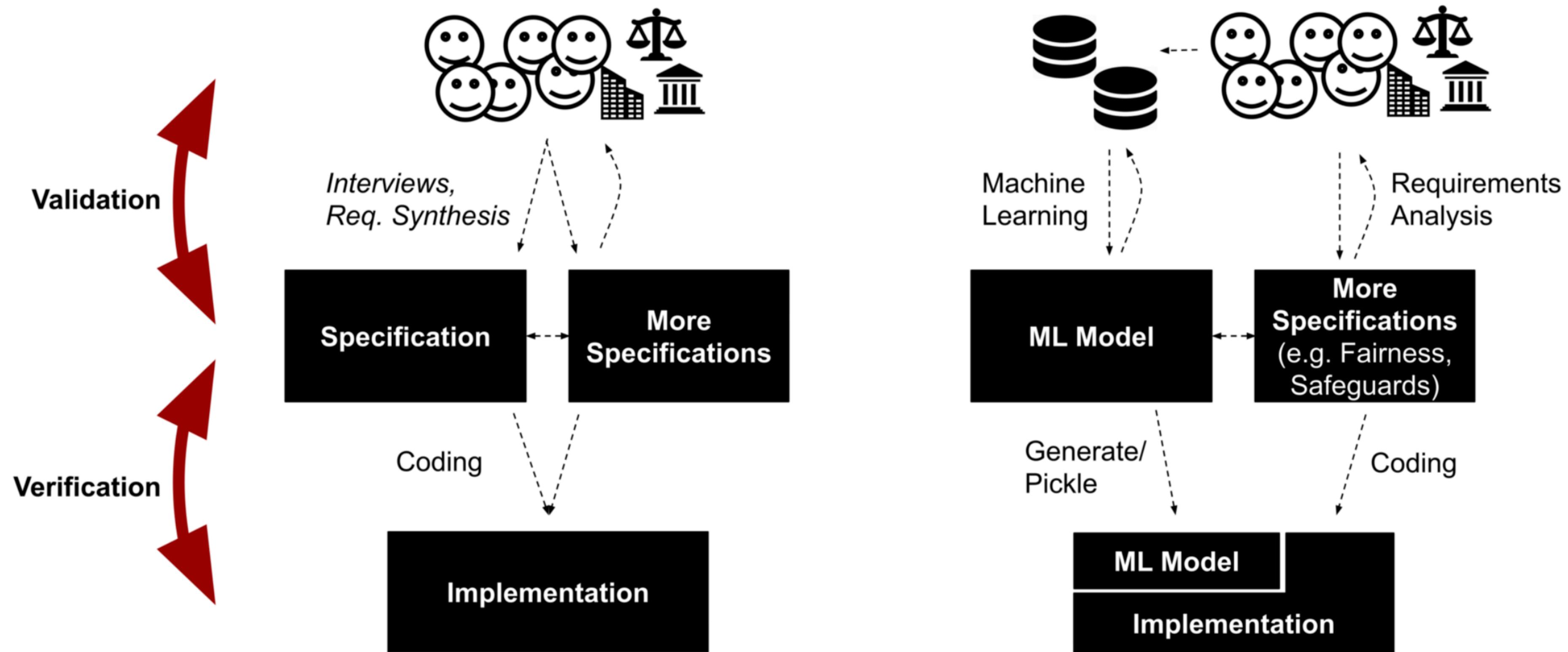


Requirements for ML (RE4ML)

- What are requirements for a ML-based/connectionist system?
 - Are they different than conventional systems?
- Maybe ML is really just RE?
 - COMPAS: predict recidivism
 - Spec: IF age between 18–20 and sex is male THEN predict arrest (within 2 years)
 - ELSE IF age between 21–23 and 2–3 prior offenses THEN predict arrest
 - ELSE IF more than three priors THEN predict arrest
 - ELSE predict no arrest

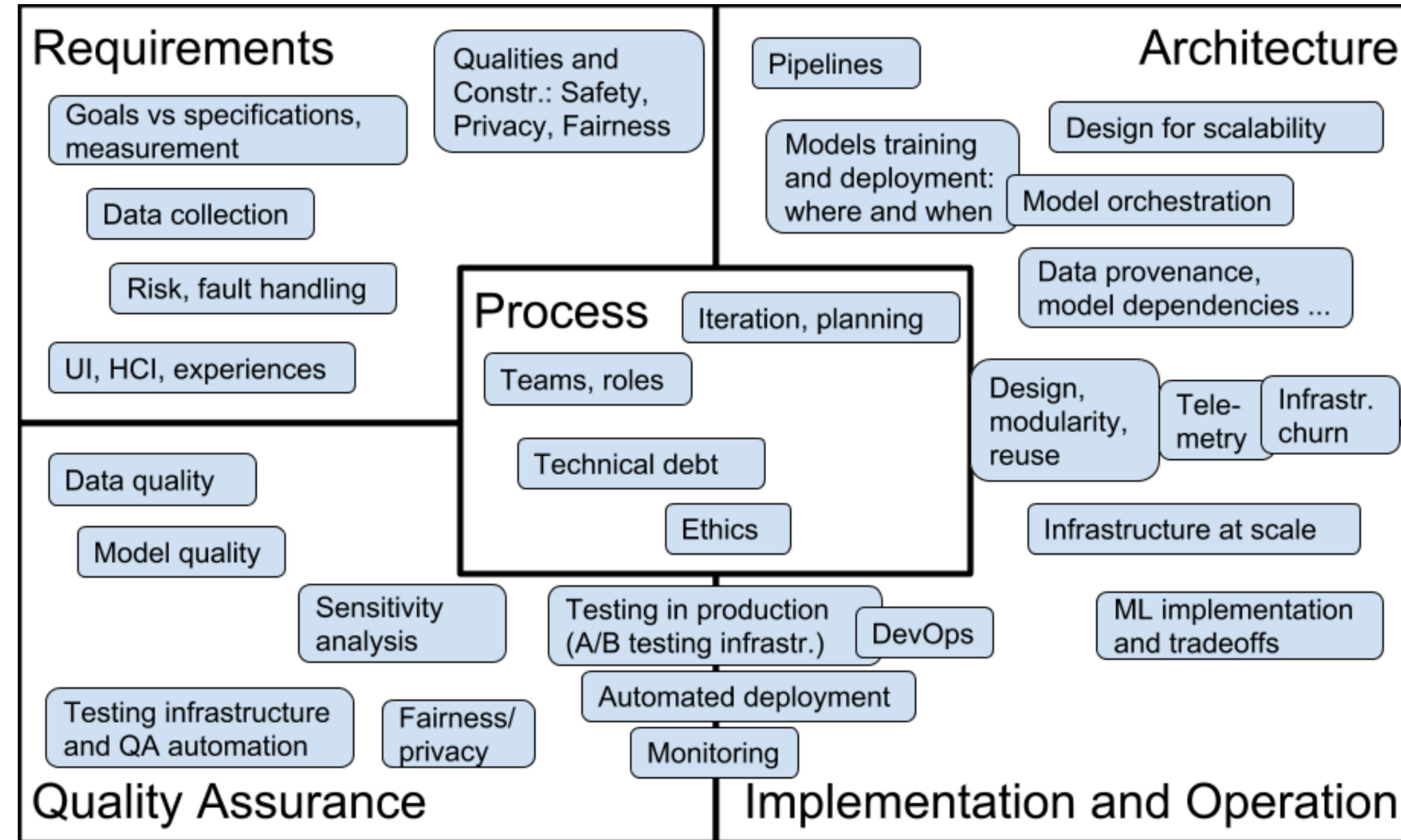
RE4ML

- So maybe a ML model is just a “learned” specification for the system?



Machine Learning as Requirements Engineering

ML and Software Engineering



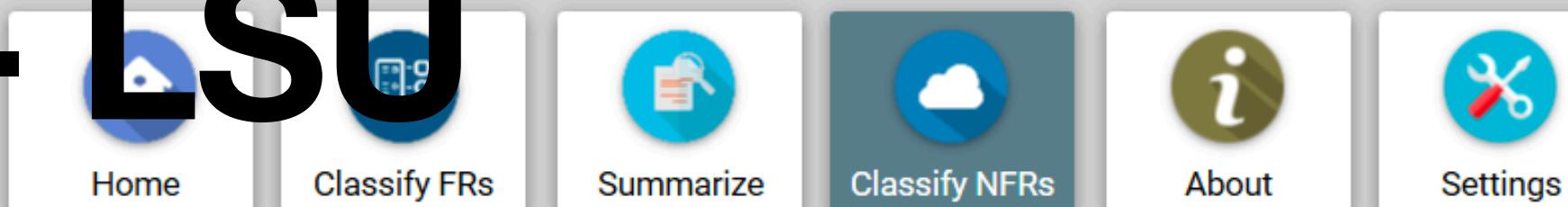
ML4RE

- We can leverage ML to help do requirements
 - Use NLP to find new requirements or detect problems
 - Use neural networks to find new requirements
 - Use SSBSE to find optimal configurations

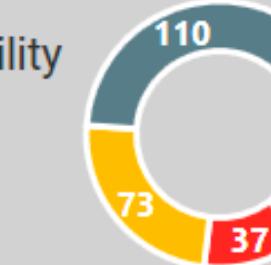
NLP for requirements gathering

- Consider App Store reviews (show App Store)
- We can download these (show JSON)
- What should we do with this rich dataset?
- <https://mast.informatik.uni-hamburg.de/app-review-analysis/>

MARC - LSU



Dependability
Performance
Supportability



Save NFR Results

Indicator Terms Settings

Select Indicator Terms List

Default List

Custom List

Browse



Classify

Dependability : CNN

Guys, ya gotta great thing going here, my issue, of late, the app seizes. And I'm not sure why. Fix this expeditiously or I'll delete, delete, delete. Your move. 🤪

PS: Once you've repaired this nightmare, I'll re-review your app with an incredible and positive renouncement. Ya dig? 😊

The app works sometimes. It hangs up and crashes frequently. I am on the latest iOS and latest app version and it still happens. Makes it unusable some days...

Had the same issue as everyone else. glitchy & unresponsive ann I uninstalled it & reinstalled it works great again for now!!!

Performance : CNN

I can't believe how many people rate this app based on political slant - but this is just about the app itself. I hate it. I had hoped this would be an improvement over

Every time I open the app, it locks up within 10-15 seconds on my iPad (no issue on iPhone). I have to close the app. If I go to an article from a notification, no prc

Afternoon, I enjoy the app very much but every time I get a notification and try to view the app, it opens, then freezes and crashes.

Now that I've downloaded the most recent update the app freezes as soon as I open it. You can't swipe or anything. Maybe you should test your apps before you re

Supportability : CNN

The app works sometimes. It hangs up and crashes frequently. I am on the latest iOS and latest app version and it still happens. Makes it unusable some days...

The app has not worked on my iPhone since I installed iOS 12. Now I have the iPhone Xs Max with iOS 12 and it still doesn't work!

It so nice to have the CNN news available on internet, even though I currently live in Dominican Republic. I miss waking up at 8am to watch it on my television in th

This app freezes and crashes on iOS 12 when installed on an iPhone Xs Max

Usability : CNN

I can't believe how many people rate this app based on political slant - but this is just about the app itself. I hate it. I had hoped this would be an improvement over

The app works sometimes. It hangs up and crashes frequently. I am on the latest iOS and latest app version and it still happens. Makes it unusable some days...

Promotes racism. Spreads hate against law enforcement. Twists truth or doesn't report stories they don't like. Most biased nonsense that calls itself news

It is listed as a single-sign-on app and even after prompting for permission to access my PlayStation Vue subscription live video comes up as a "free preview" each :

- <https://github.com/seelprojects/MARC-3.0>

NLP for Quality Checks

- As you've seen, requirements are non-trivial to write properly.
 - Ambiguity, vagueness, inconsistency, etc.
- Two approaches:
 - **Symbolic:** detect violations of structured NL
 - **NLP:** looks for ambiguity or other violations based on syntax analysis
- E.g., AQUSA tool (<https://github.com/RELabUU/aqua-core>)
 - Lucassen, G., Dalpiaz, F., van der Werf, J.M.E.M. et al. Improving agile requirements: the Quality User Story framework and tool. Requirements Eng 21, 383–403 (2016). <https://doi.org/10.1007/s00766-016-0250-x>

Table 1 Quality User Story framework that defines 13 criteria for user story quality: details

Criteria	Description	Individual/set
<i>Syntactic</i>		
Well-formed	A user story includes at least a role and a means	Individual
Atomic	A user story expresses a requirement for exactly one feature	Individual
Minimal	A user story contains nothing more than role, means, and ends	Individual
<i>Semantic</i>		
Conceptually sound	The means expresses a feature and the ends expresses a rationale	Individual
Problem-oriented	A user story only specifies the problem, not the solution to it	Individual
Unambiguous	A user story avoids terms or abstractions that lead to multiple interpretations	Individual
Conflict-free	A user story should not be inconsistent with any other user story	Set
<i>Pragmatic</i>		
Full sentence	A user story is a well-formed full sentence	Individual
Estimatable	A story does not denote a coarse-grained requirement that is difficult to plan and prioritize	Individual
Unique	Every user story is unique, duplicates are avoided	Set
Uniform	All user stories in a specification employ the same template	Set
Independent	The user story is self-contained and has no inherent dependencies on other stories	Set
Complete	Implementing a set of user stories creates a feature-complete application, no steps are missing	Set

Fig. 5 Example report of a defect and warning for a story in AQUSA

Duke University Evaluation - 48

[Reupload stories](#)

[Delete project](#)

[Re-analyze project](#)

33 total issues	0 minor issues
15 errors	0 false positives
18 warnings	20 perfect stories

#1 As a collection manager or cataloger, I want to be able to see who last edited a record and when.

Not atomic

A user story should consist of only one feature, avoid using conjunctions such as and or &

Suggestion: As a collection manager **or** cataloger, I want to be able to see who last edited a record **and** when.

#3 As a Collection Manager, I want my collection to be discoverable in the Catalog.

Irregular format

This user story its format deviates from the format used by the majority of your user stories

Suggestion: Use the most common template: As a, I want to, So that

#4 As a End User, I want to be able to see the physical context of an Item in a digital collection (i.e. See inside this folder; EAD)

Not minimal

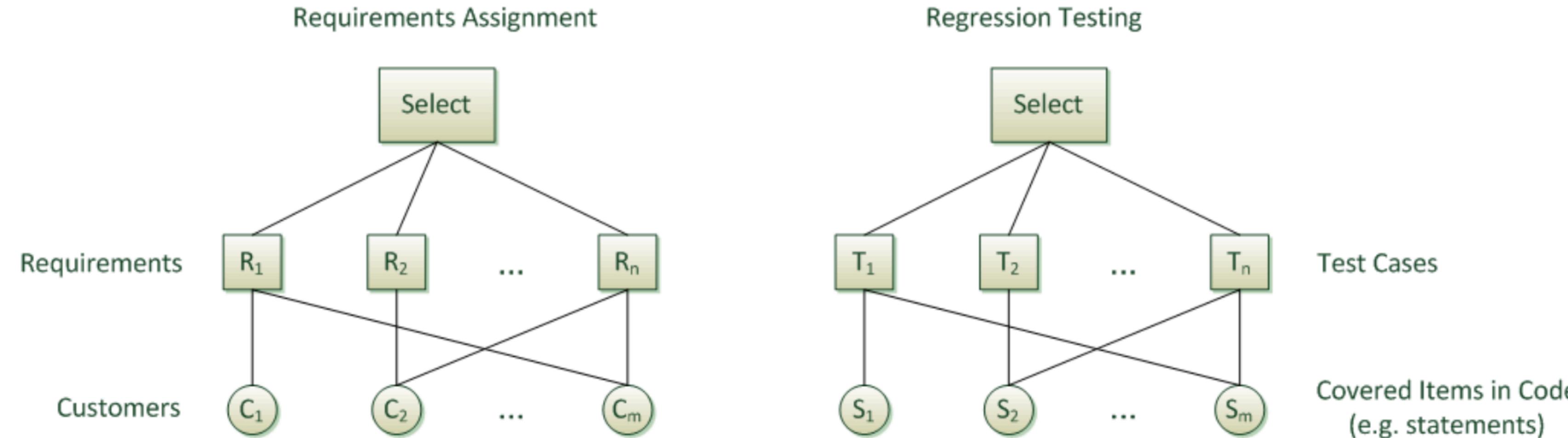
User stories should not include additional information hidden in brackets.

Suggestion: As a End User, I want to be able to see the physical context of an Item in a digital collection (i.e. **see inside this folder; ead**)

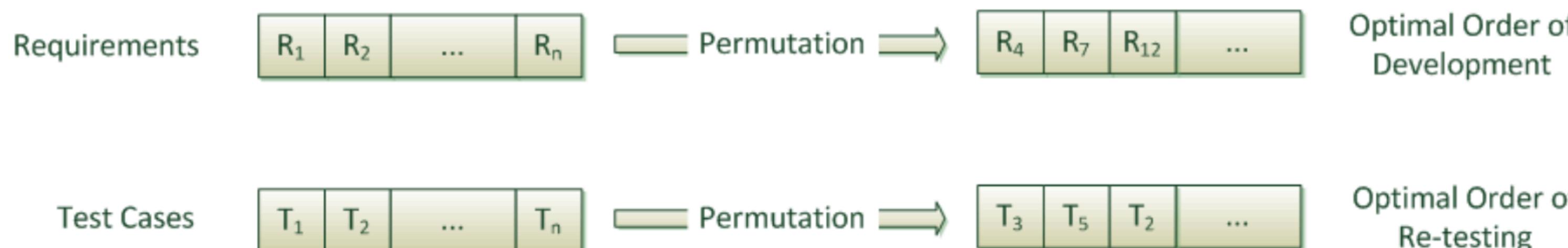
ML for the Next Release Problem

- Prioritizing requirements over many dimensions (cost, importance, dependencies, safety, etc.) is a multi-criteria optimization problem
 - Thus, no good optimal solutions exist (assuming P!=NP)
- Heuristic search can be one approach that is effective for the Next Release Problem (Bagnall, 2001).
- Each customer, i , will have a set of requirements, $R_i \subset R$; and a weight, w_i in positive integers; which is a measure of the customer's importance to the company.

Selection Problems



Prioritization Problems



From: “Search Based Software Engineering: Techniques, Taxonomy, Tutorial” by Mark Harman¹, Phil McMinn², Jerffeson Teixeira de Souza³, and Shin Yoo¹

Summary

- Early days of ML-driven software development
- Still unclear how RE4ML will shape up but requirements are universal (unlike, say, design patterns)
- Many cool new ML4RE tools - at all stages of the RE cycle (elicit, analyze, model, specify, verify)
- Knowledge of the ML specifics can be a skill differentiator for these jobs.

Midterm 2

- Same format as Midterm 1
- 75 mins
- Double sided “paper for recollection assistance”
- Primarily on material *since* midterm 1
- Office hours Friday on Teams, and Sunday 12pm-1pm on Teams