

Load.in

**Using AI and Computer Vision
to give your move a game plan.**

Team Yellow
Design Presentation
Old Dominion University
12/2/2020

1

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Team Yellow



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Backend Developer



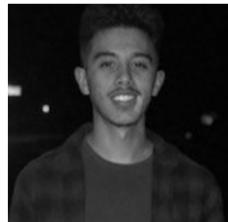
Lance Perdue
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Front End Developer



Byron Aquilino
Full Stack Developer



Daniel Reyna
Backend Developer



Chris Miller
Front End Developer



Paul Rodriguez
Front End Developer



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“Do It Yourself” movers lack the expert knowledge required to handle the logistics of their move.



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Do it Yourself Moving

- Professional movers reduces the time but increases cost
- DIY reduces the cost but decreases efficiency

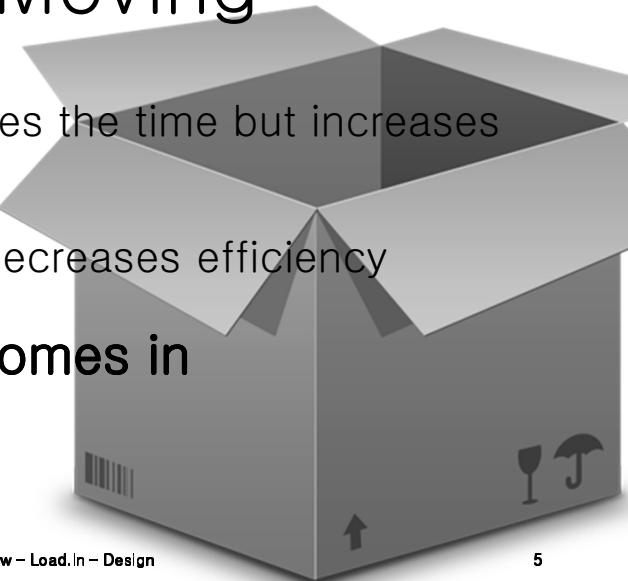
This is where Load.in Comes in



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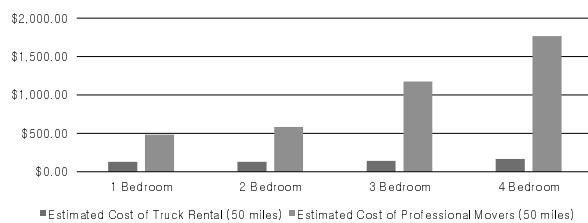
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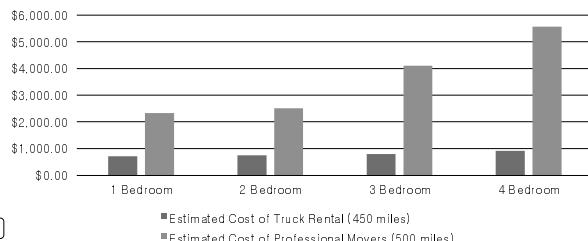
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Professional Movers are Costly

Professional Movers vs. DIY Moving:
Short Distance



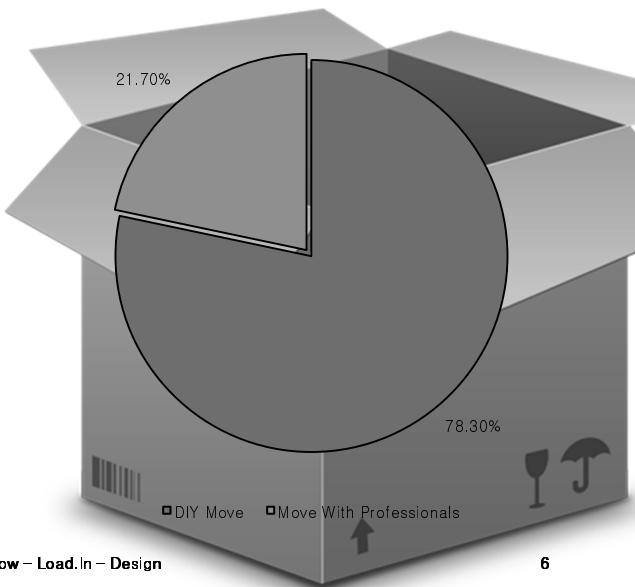
Professional Movers vs. DIY Moving: Long Distance



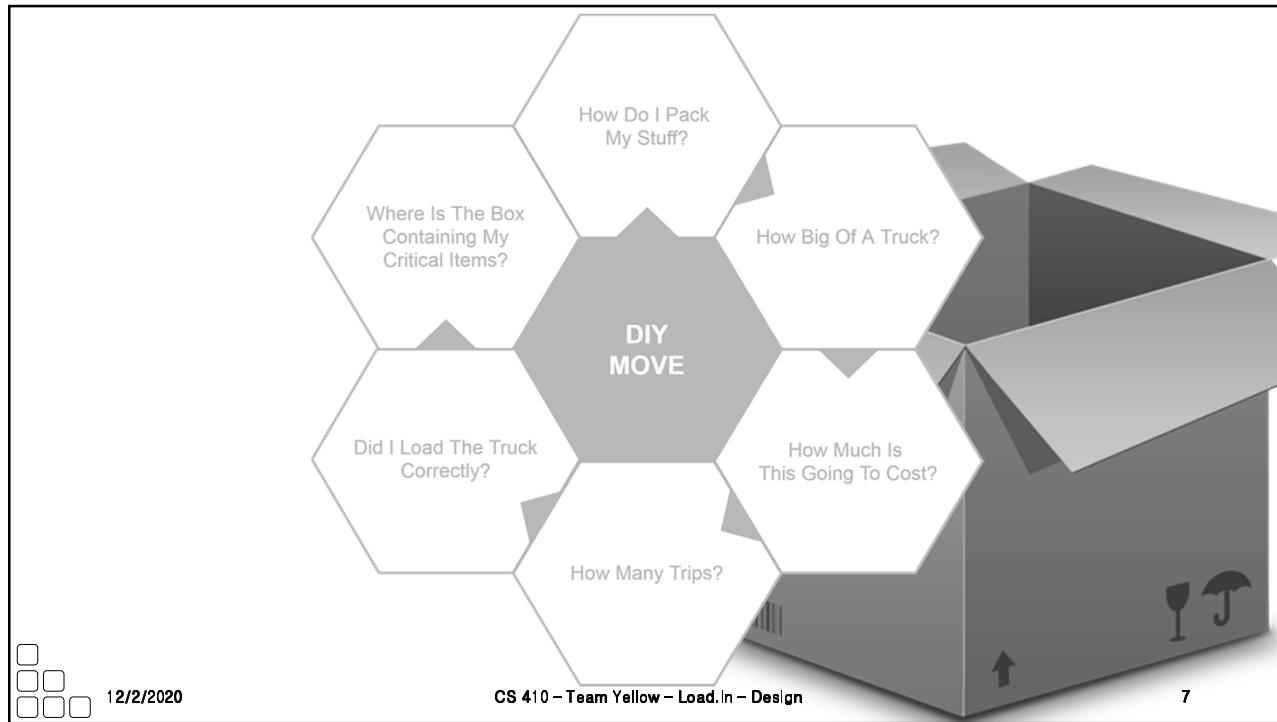
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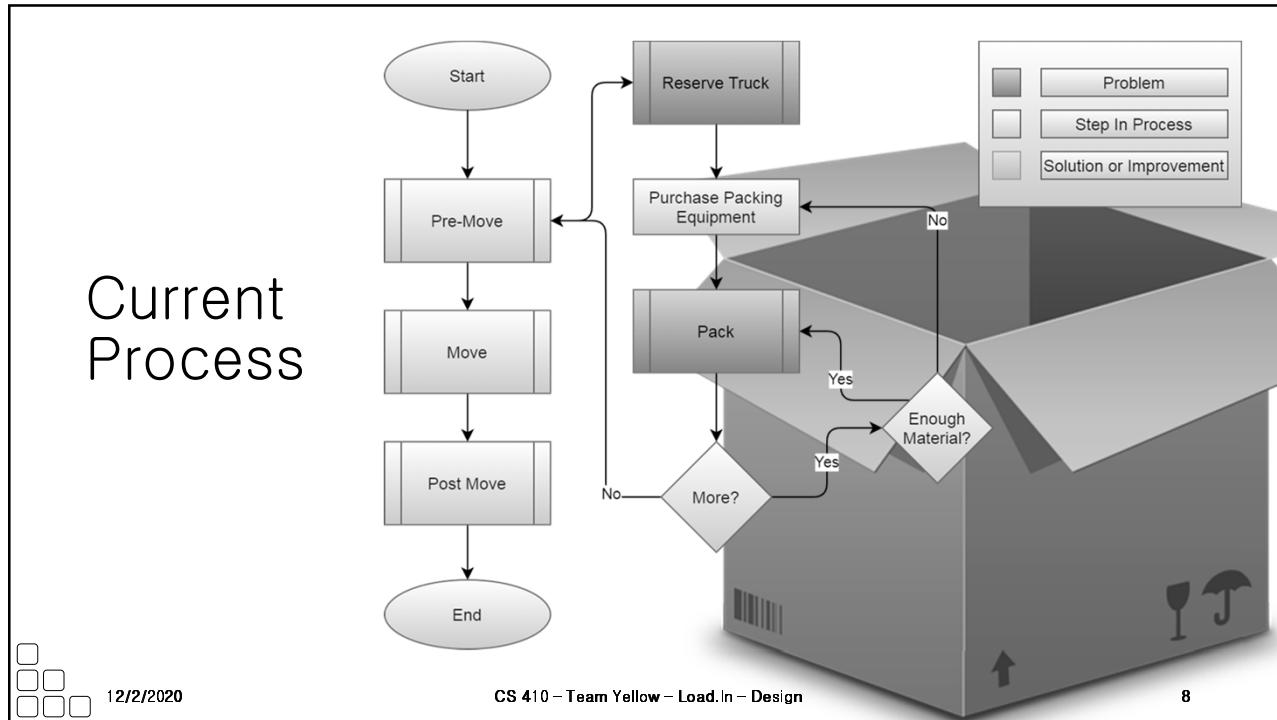
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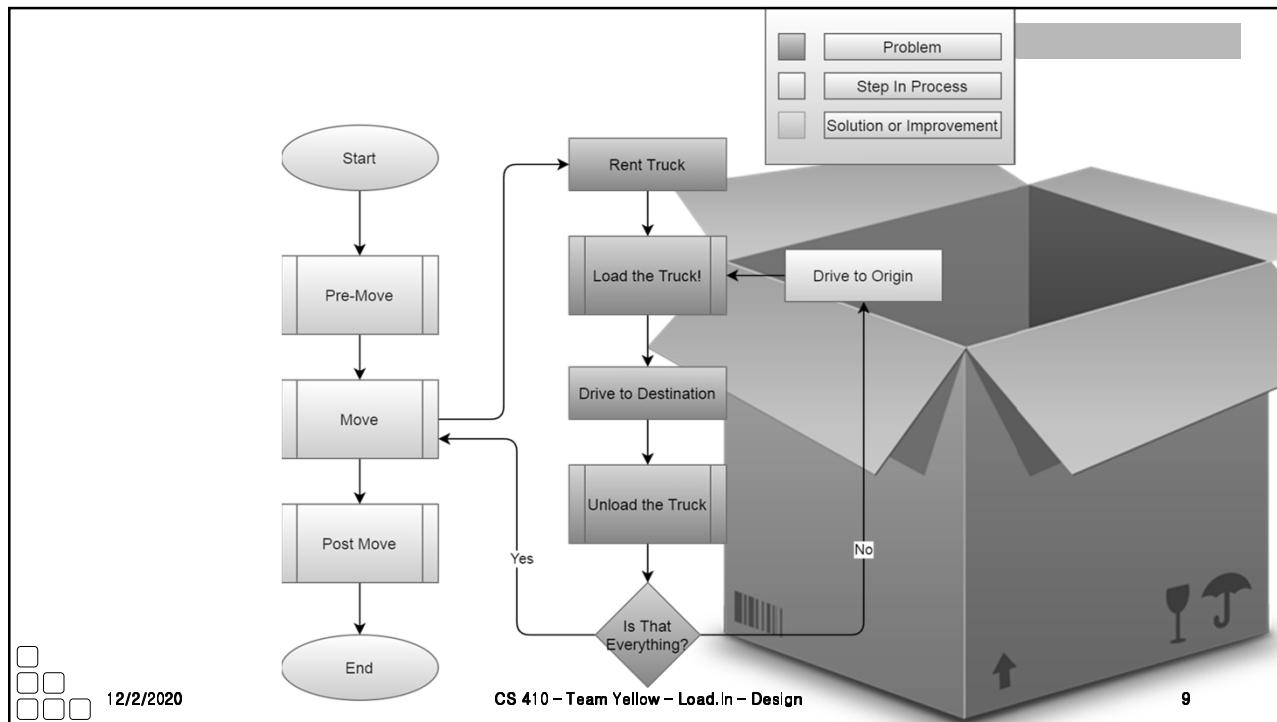
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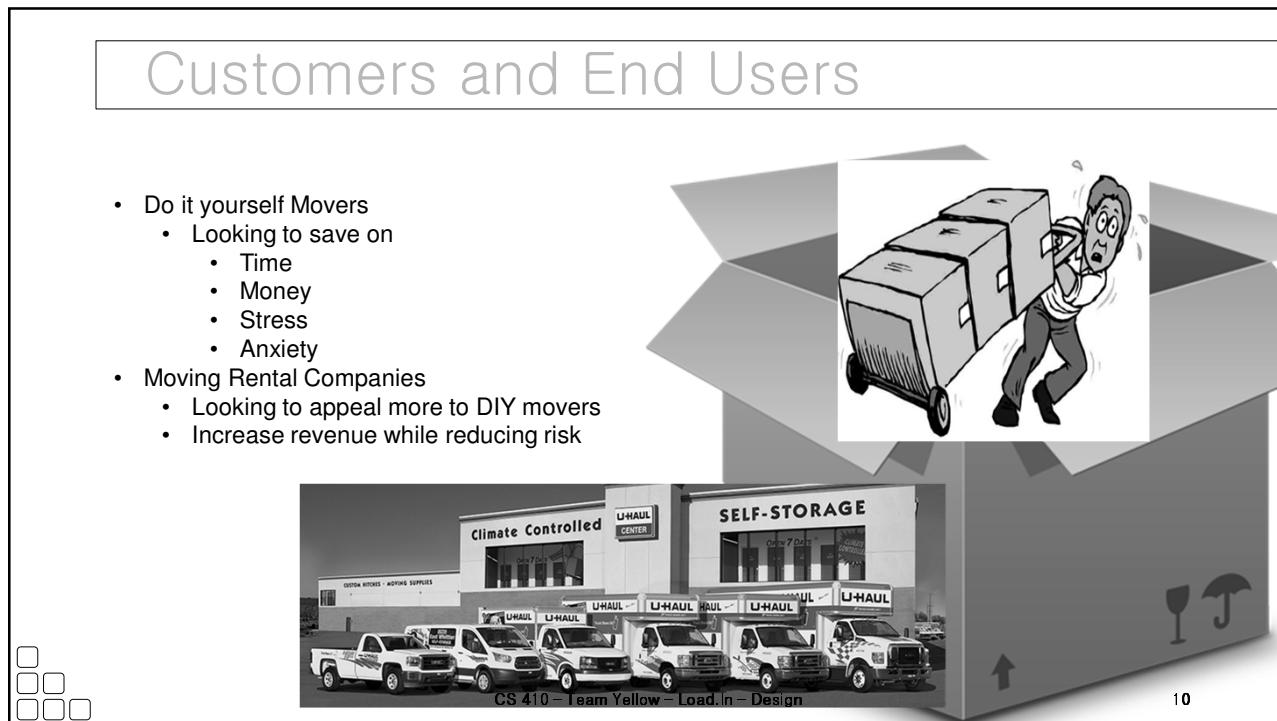
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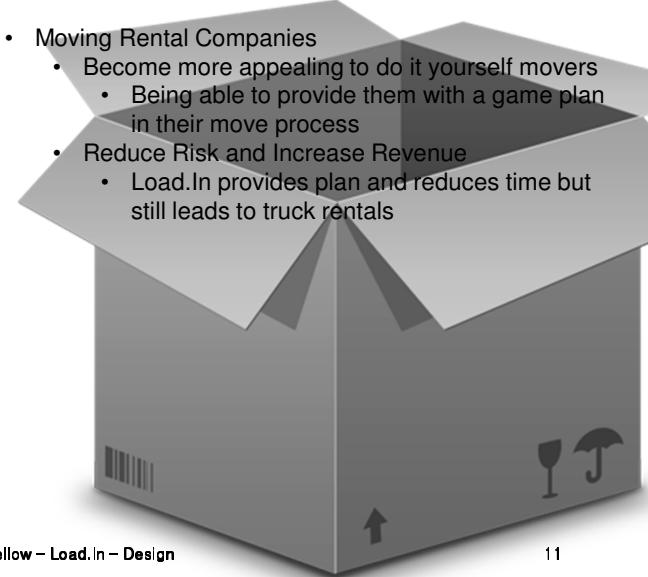
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Benefits to Customer

- Do It Yourself Mover
 - Being shown how to
 - Pack boxes for increased organization
 - Properly load their truck for increased efficiency
 - Being provided with expert advice
 - Database full of tips that a user can search through with keywords
 - Live-chat support for questions not answered through the tips
 - Saving of Time and Money
 - Increased efficiency will lead to less trips and materials used
 - Peace of Mind
 - Fragile items being safely transported



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User Roles



Mover

- Do it yourself mover
- Looking to reduce the cost and time needed to move



Move Expert

- Expert in the moving industry
- Provides tips and advice to DIY movers



Rental Company Representative

- Employee of a moving rental company
- Can provide customer with rental truck and materials



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User Roles



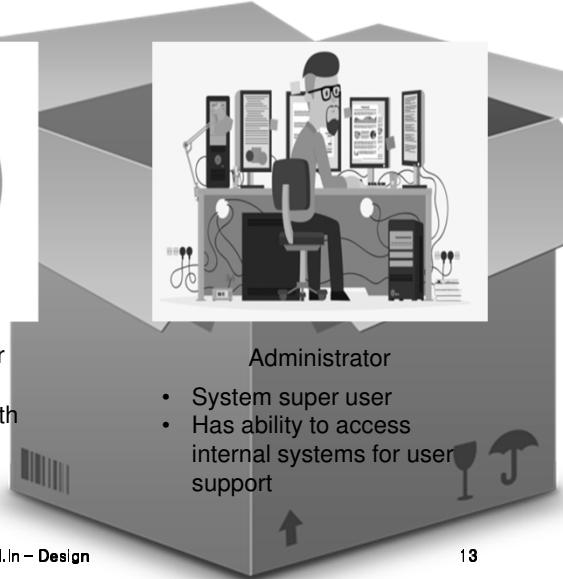
Website Visitor

- Do it yourself mover accessing website
- Looking for help on their move



Chat-Bot Manager

- User who communicates with customer when FAQ fails



Administrator

- System super user
- Has ability to access internal systems for user support

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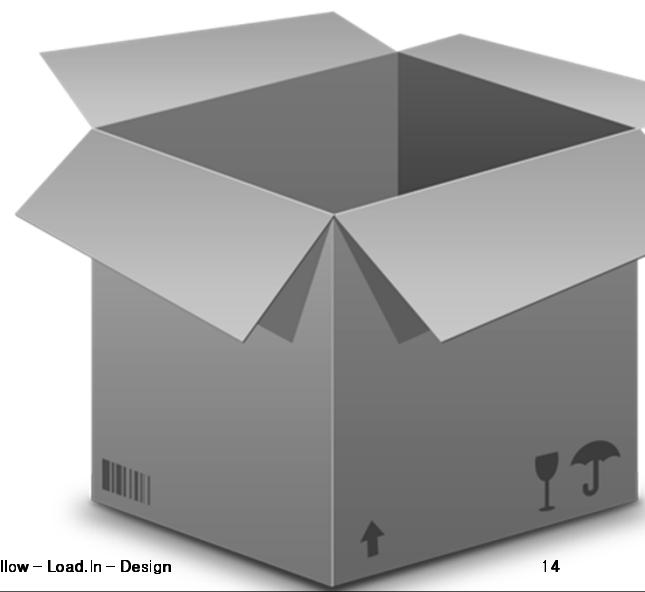
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User Roles



Tester

- Will assume any of the other roles
- Will input fake data to test systems for errors



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Load.In Gives Your Move a Game Plan

- Uses artificial intelligence and computer vision
- Provides
 - Expert-level instructions
 - Tips and tricks on moving day



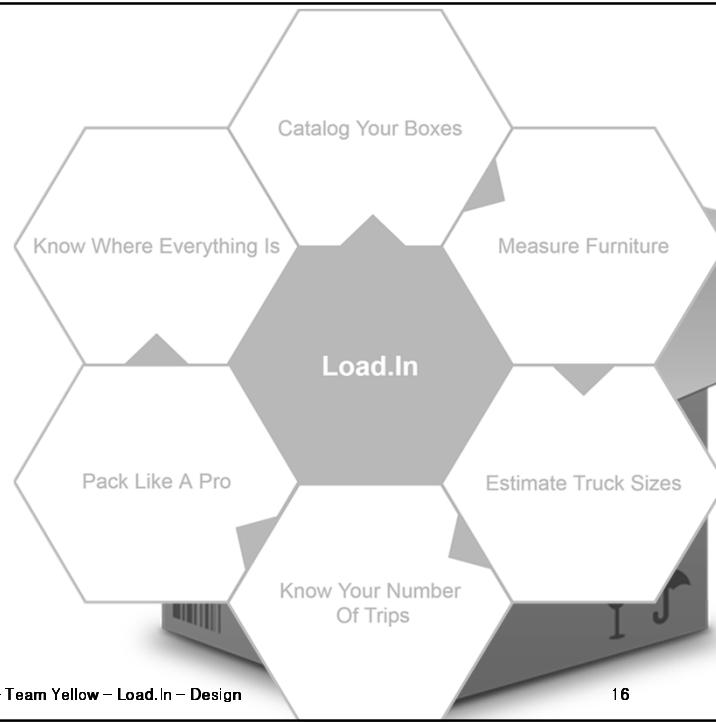
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What Can Load.In Do For You?



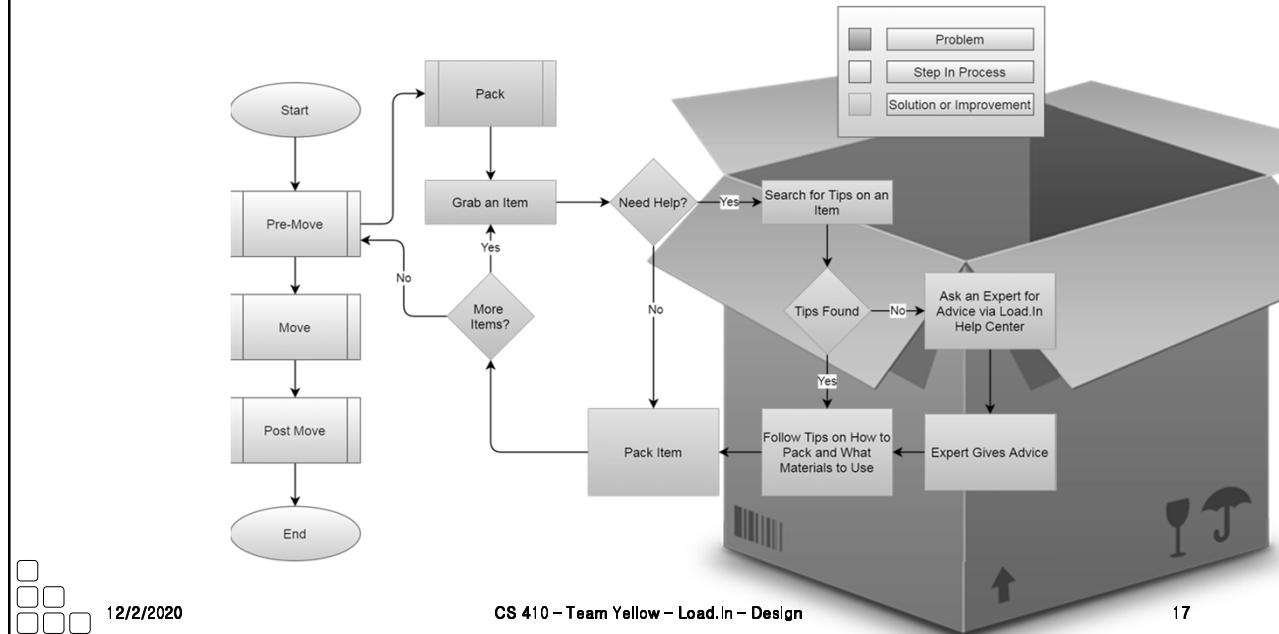
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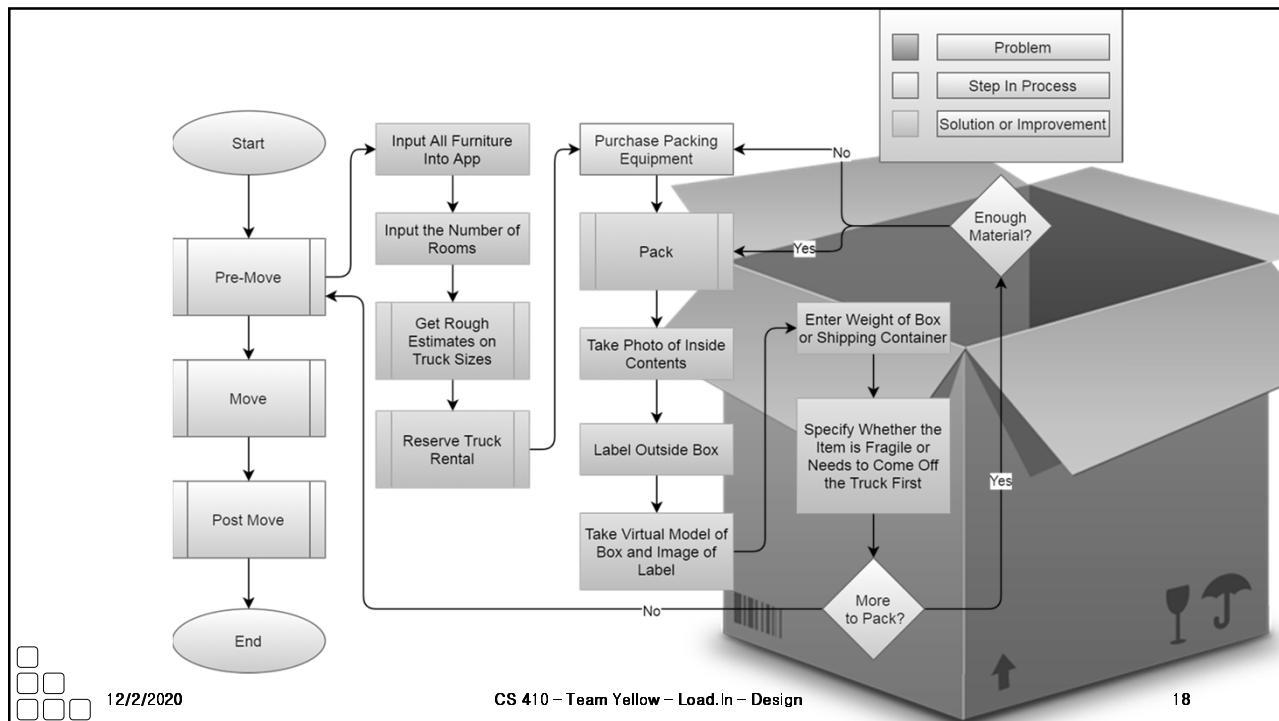
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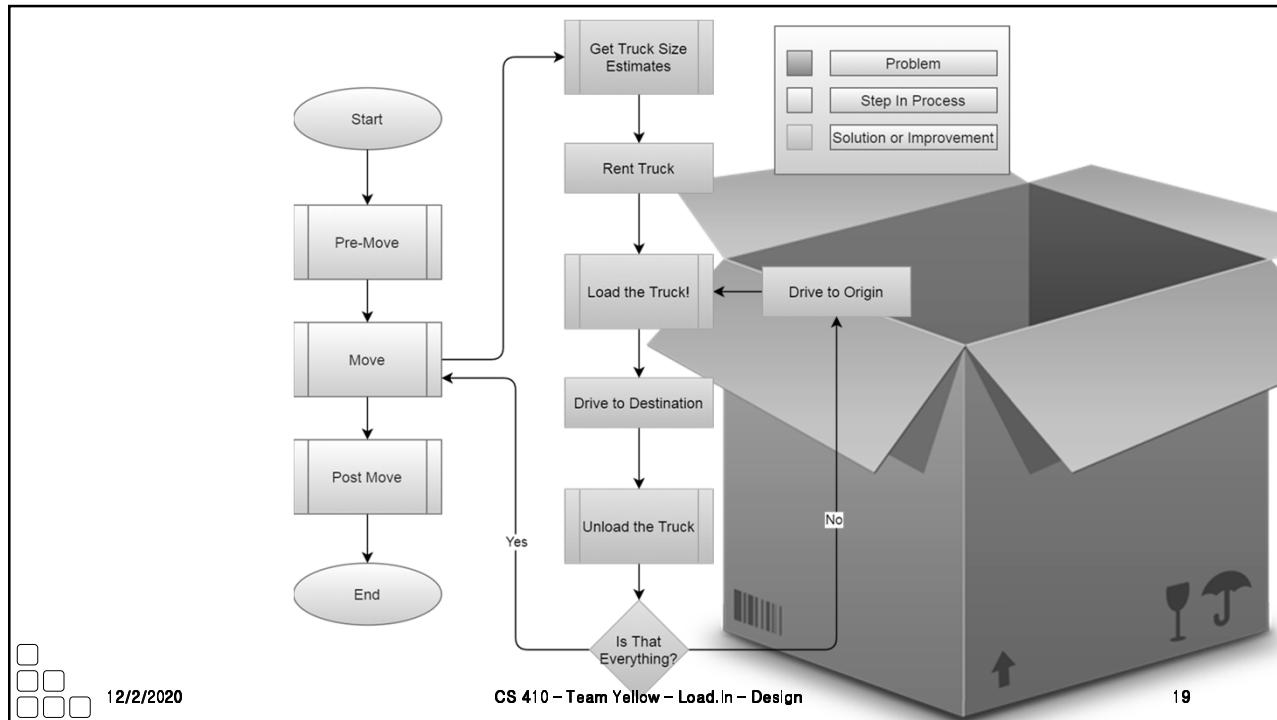
How Will the Solution Help?



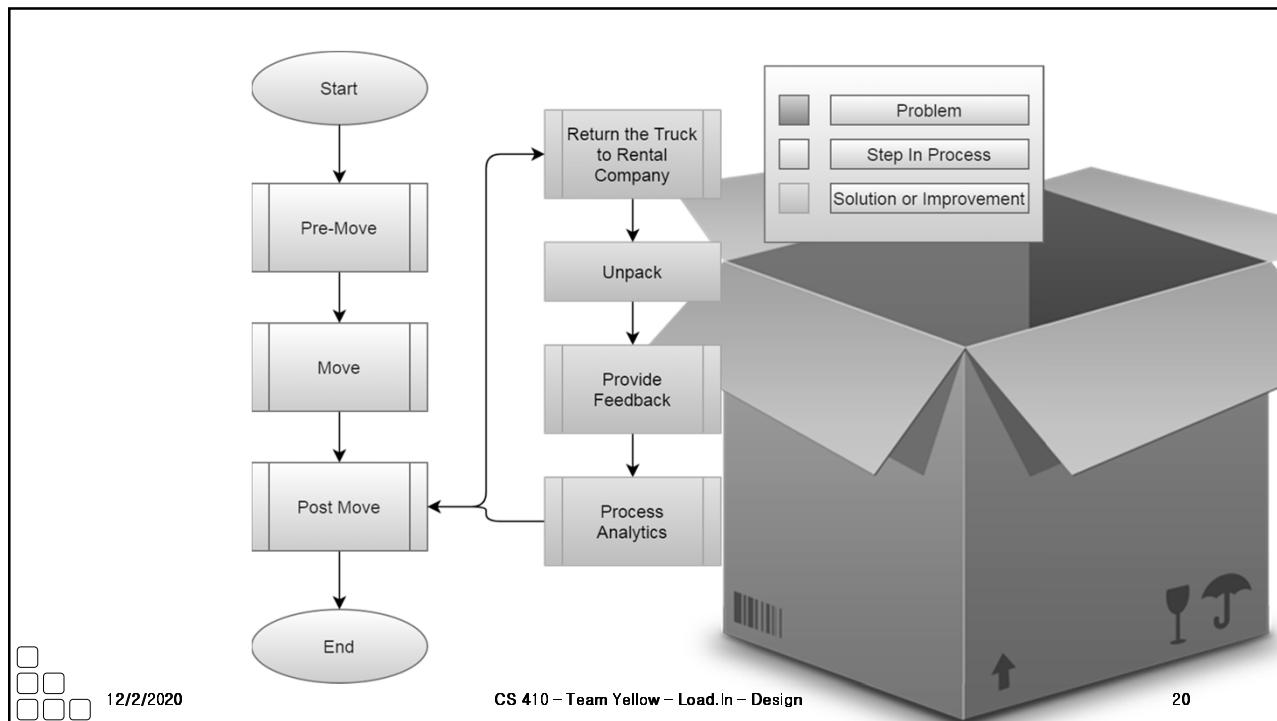
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What Load.In Will Do

- Assist in the packing process with **Expert Advice**
- **Catalog** with photos all boxes, furniture, and other items that are going to be placed in the truck
- **Generate instructions** for properly loading the truck based on weight distribution, item safety, best fit space utilization, and item(s) priority
- Use photos taken to Create a **3D model** of how everything should be expertly packed in the truck
- Will **provide location information** for different boxes and items within the truck using 3D model and cataloging
- Give **estimate** for appropriate rental **truck size** and **number of trips** dependent on truck size



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What Load.In Will Not Do

- **Sell or share personal info**
- **Keep photos long-term**
- **Read SMS messages**
- **Record audio**
- **Hold on to personal information permanently**



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Solution Deliverables



- Android App
- Distributed via android store
- Communication is HTTP REST API with backend



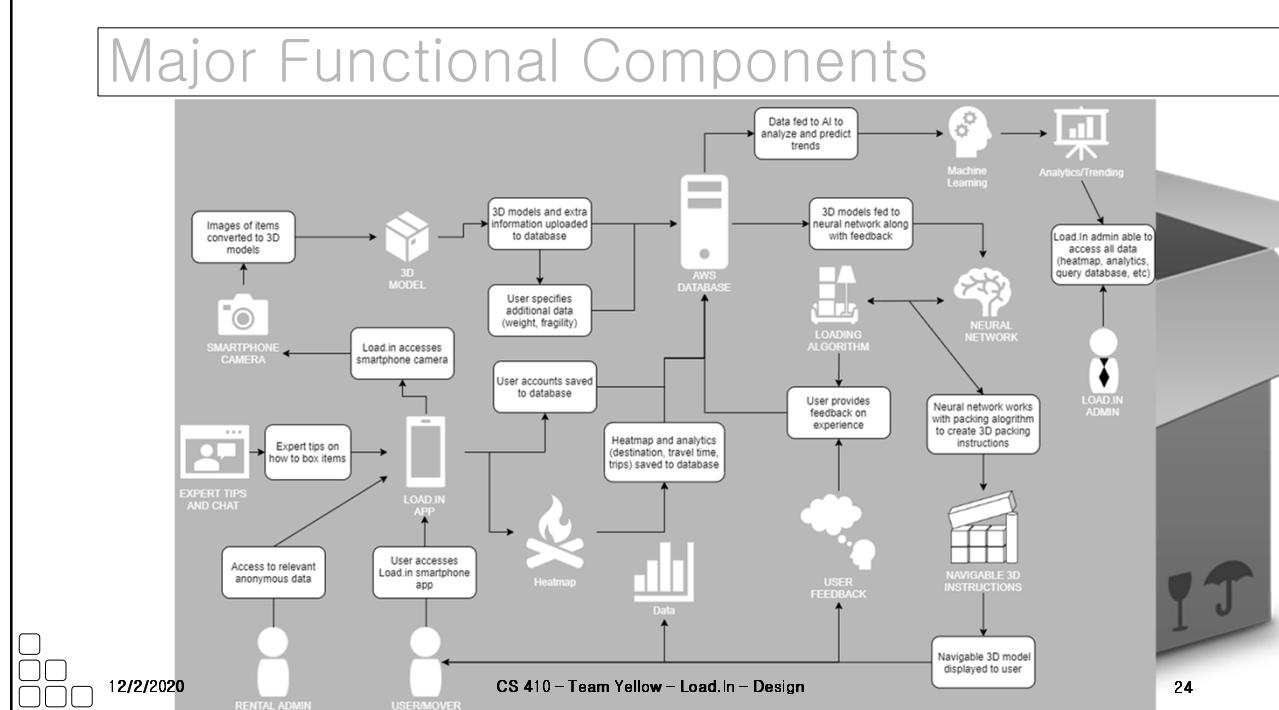
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Major Functional Components



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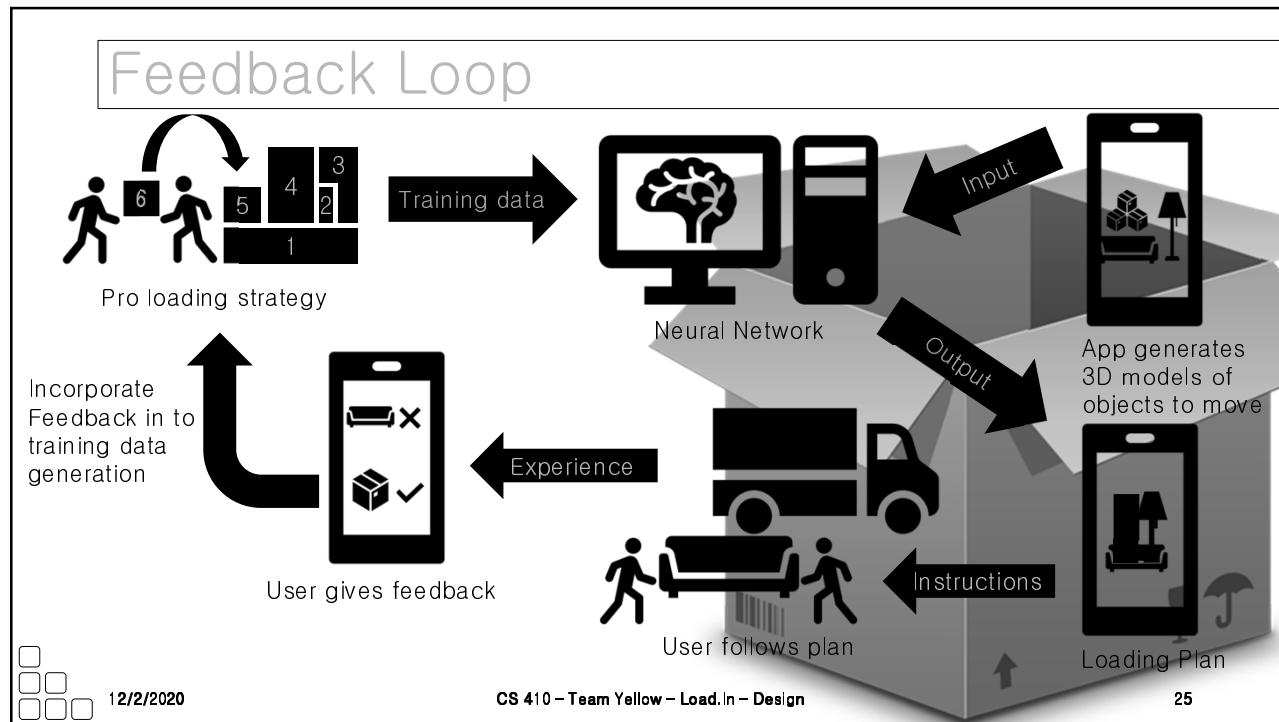
RENTAL ADMIN

USER/MOVER

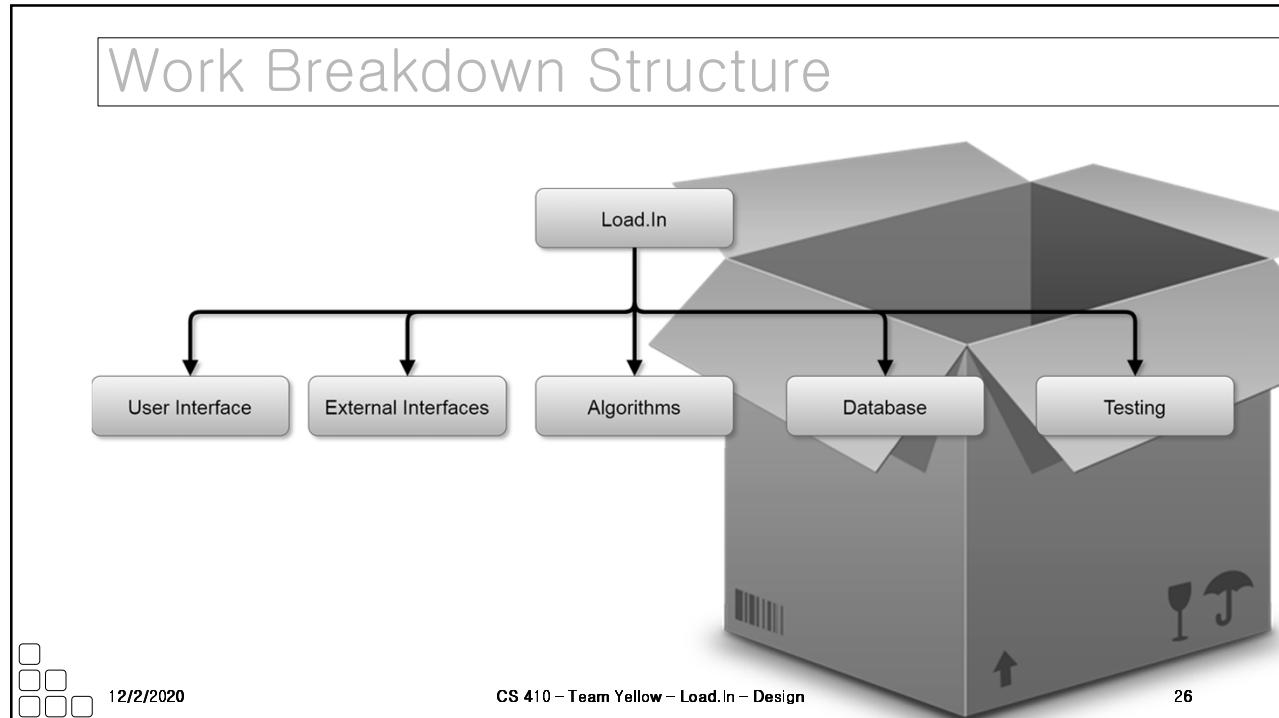
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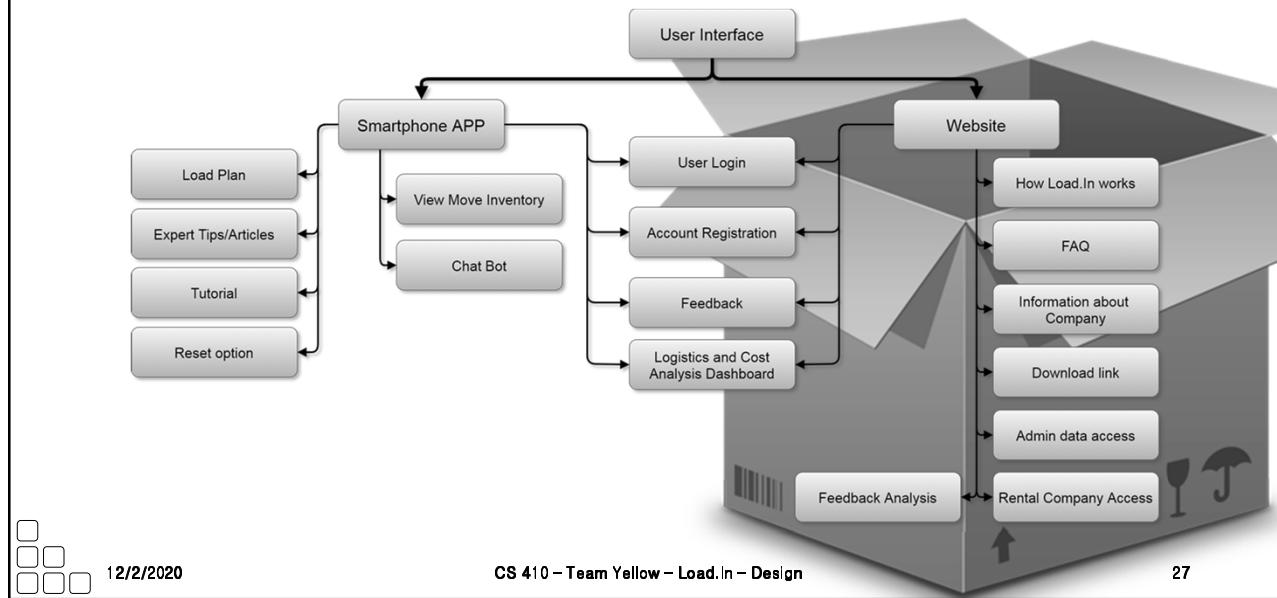


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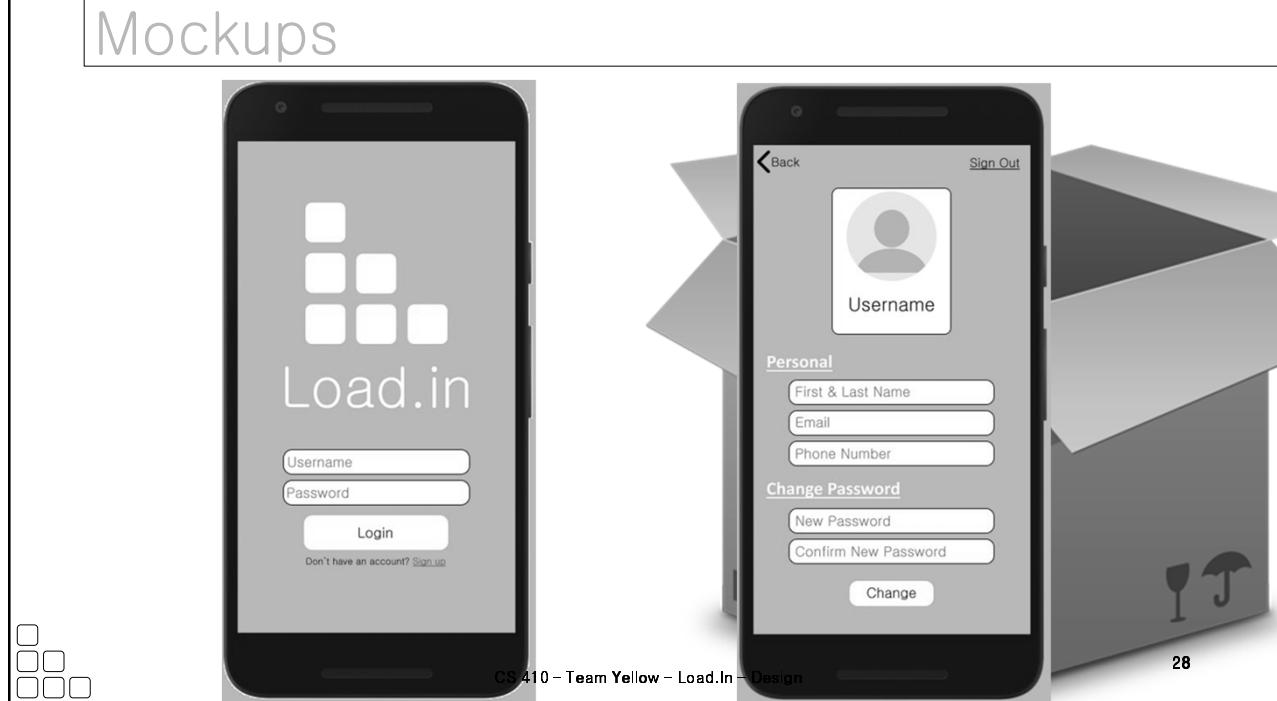
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User Interface

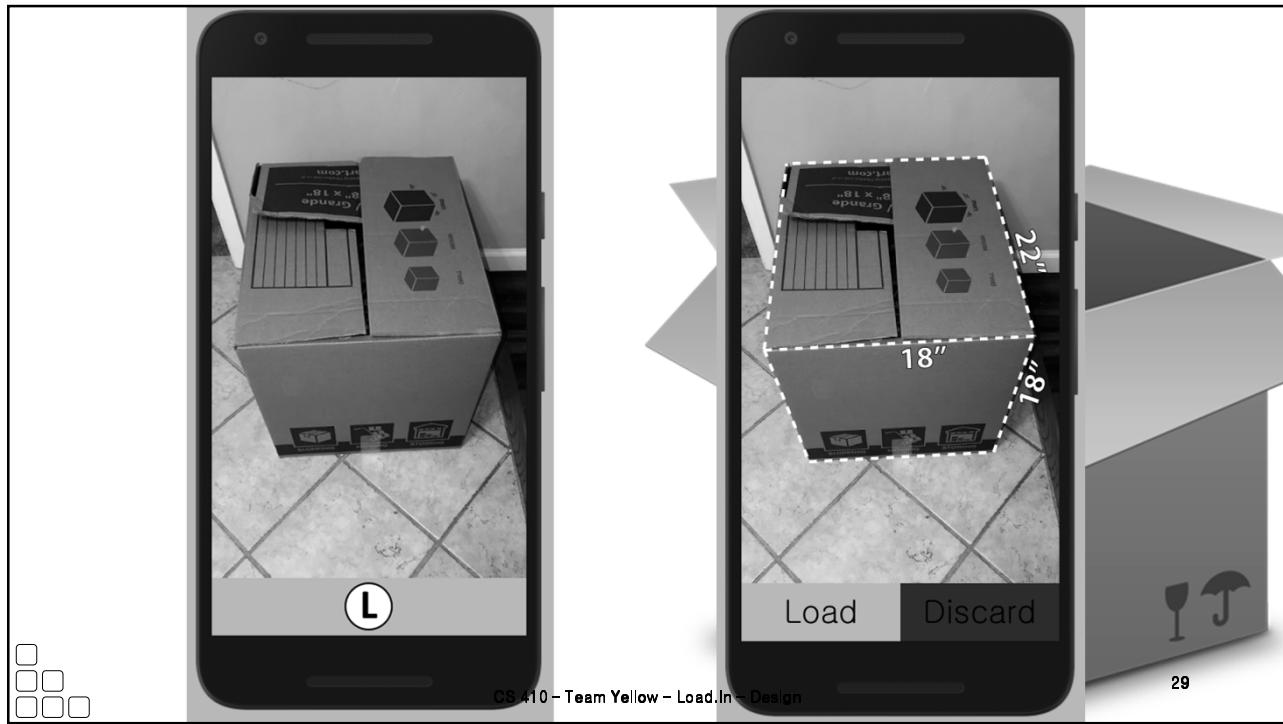


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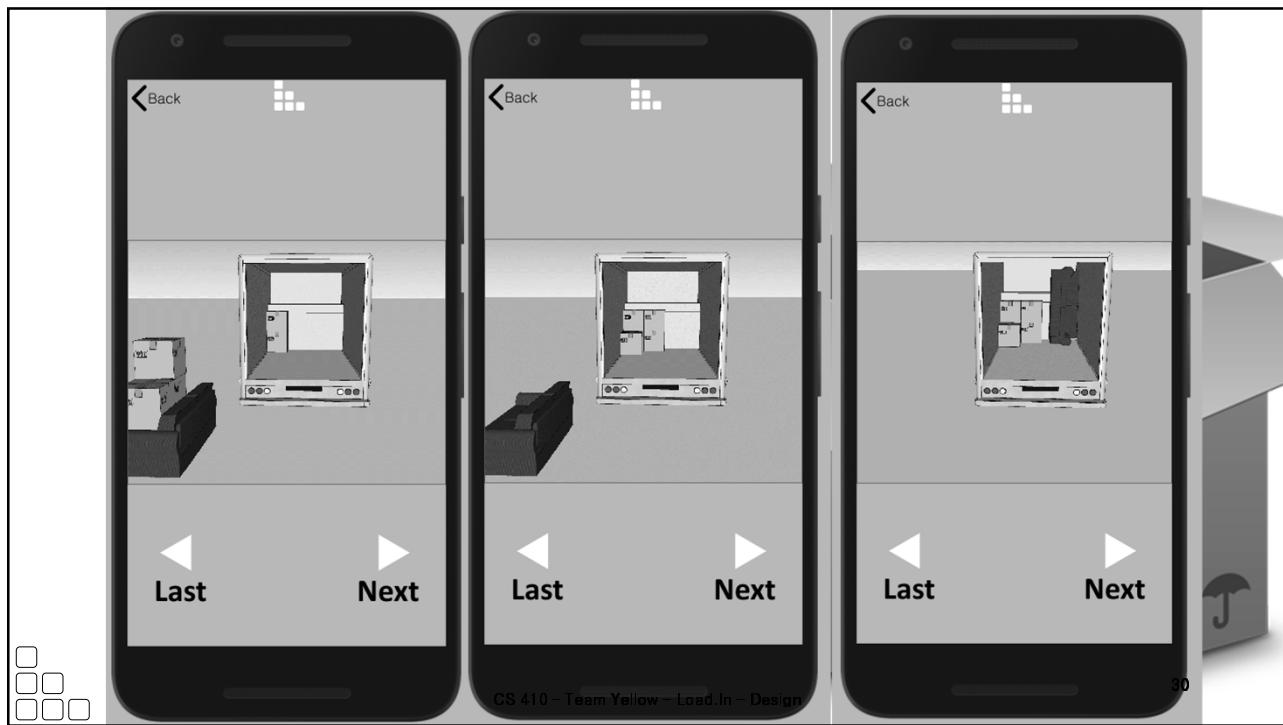
Mockups



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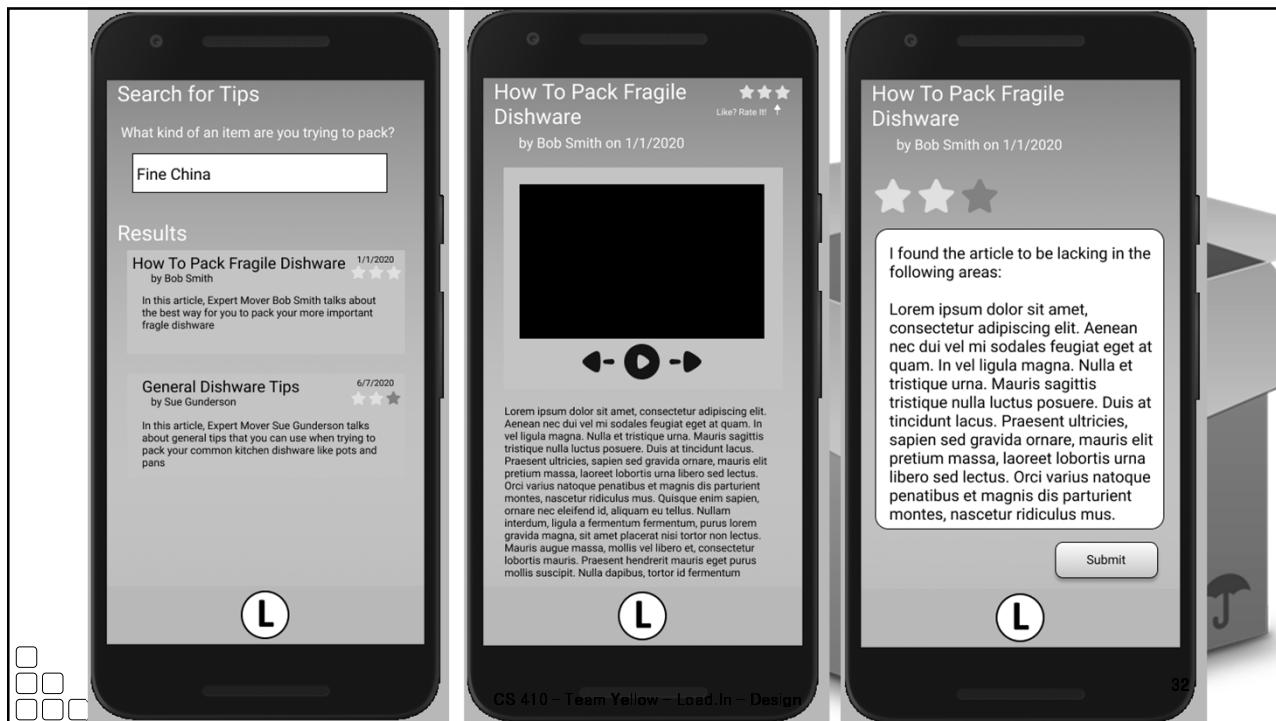
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Logistics Planner

Rental Timeframe: 1/1/2021 - 1/15/2021

Movers

Trucks

Estimations

Truck Type	Cost	# Trips	Move Time
7'10" x 5'2" x 1'9"	456.23	3	8:12:00
9'6" x 5'7" x 4'8"	589.23	2	6:12:00
9'11" x 6'4" x 6'2"	698.98	1	4:12:00

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Load.in Rental Management Dashboard

Welcome Back! Current Sync Status: Online

Company Profile: U-HAUL

Download Details

Current Truck Details

Truck	Dimensions	# Users Viewed	Avg. View Time	Avg. Rating	# Move Plans	Avg. Trip Length	Avg. Trips/Move	Avg. # Items Moved	Avg. % Items Fragile	Avg. Move Time
7'0" x 5'2" x 1'9"	24,123	9,323 Seconds	4.3/5.0	10,142	13.2 Miles	5	345	10%	05:50:15	
9'5" x 5'7" x 4'8"	100,221	10,731 Seconds	4.8/5.0	50,142	23.2 Miles	2	789	36%	03:15:15	
9'11" x 6'4" x 6'2"	912,132	15,671 Seconds	3.8/5.0	512,132	123.1 Miles	2	902	23%	8:30:15	
10' x 7'7" x 7'2"	342,214	12,731 Seconds	4.9/5.0	732,211	150.20 Miles	1.3	1021	19%	13:15:15	

Number of Users Viewed

Rentals

Predicted Move Hotspots

Feedback

11/2/2020 Bob Smith, VA ★★★

Love your site and appreciate the easy booking process. Your movers were great. Please note that we had to cancel our move due to a last minute change in our plans. I would highly recommend this company.

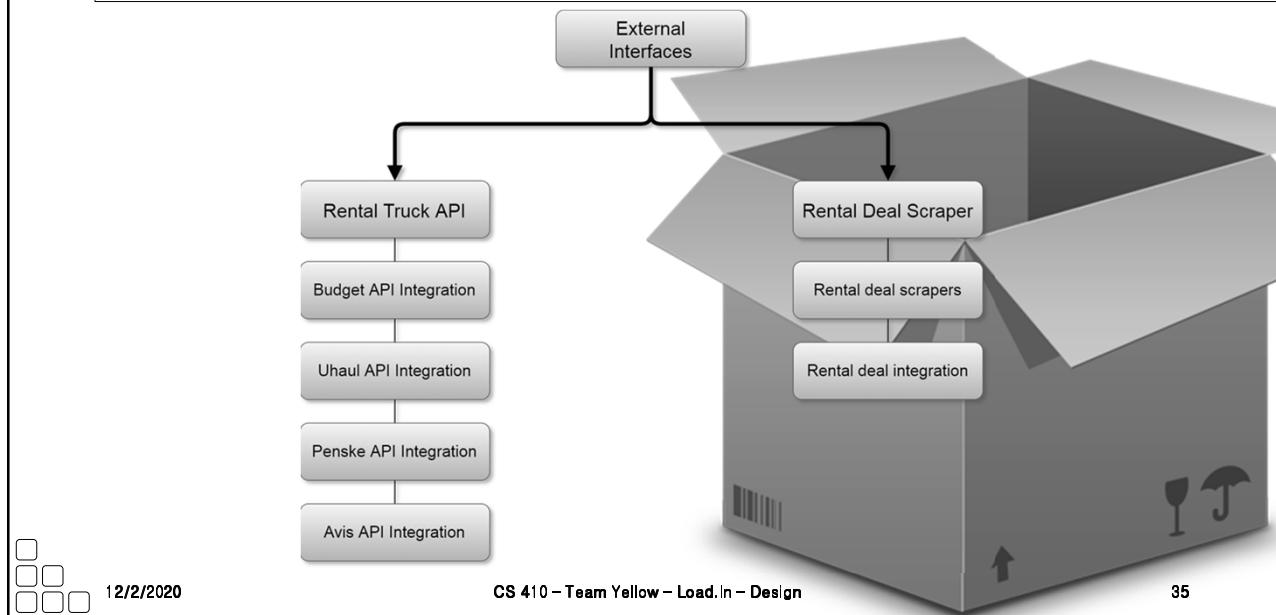
11/3/2020 Greg Cooper, MD ★★★★

Love your site and appreciate the easy booking process. Your movers were great. Please note that we had to cancel our move due to a last minute change in our plans. I would highly recommend this company.

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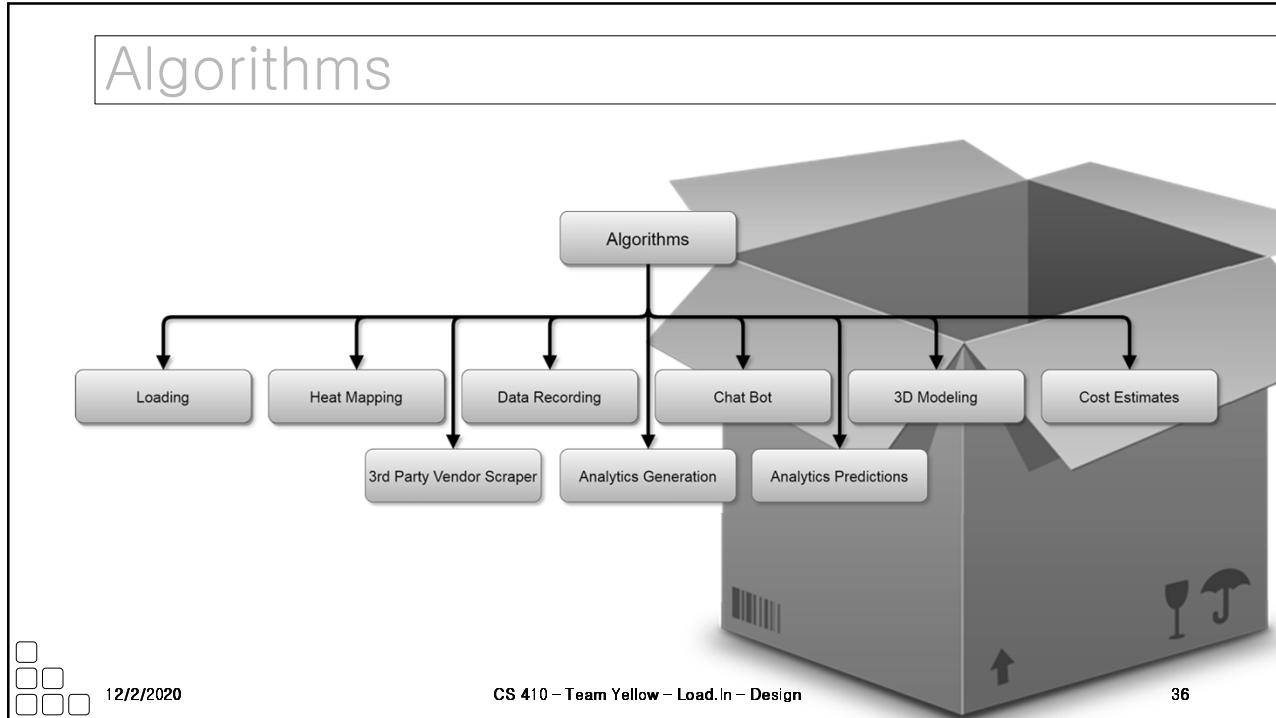
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External Interfaces



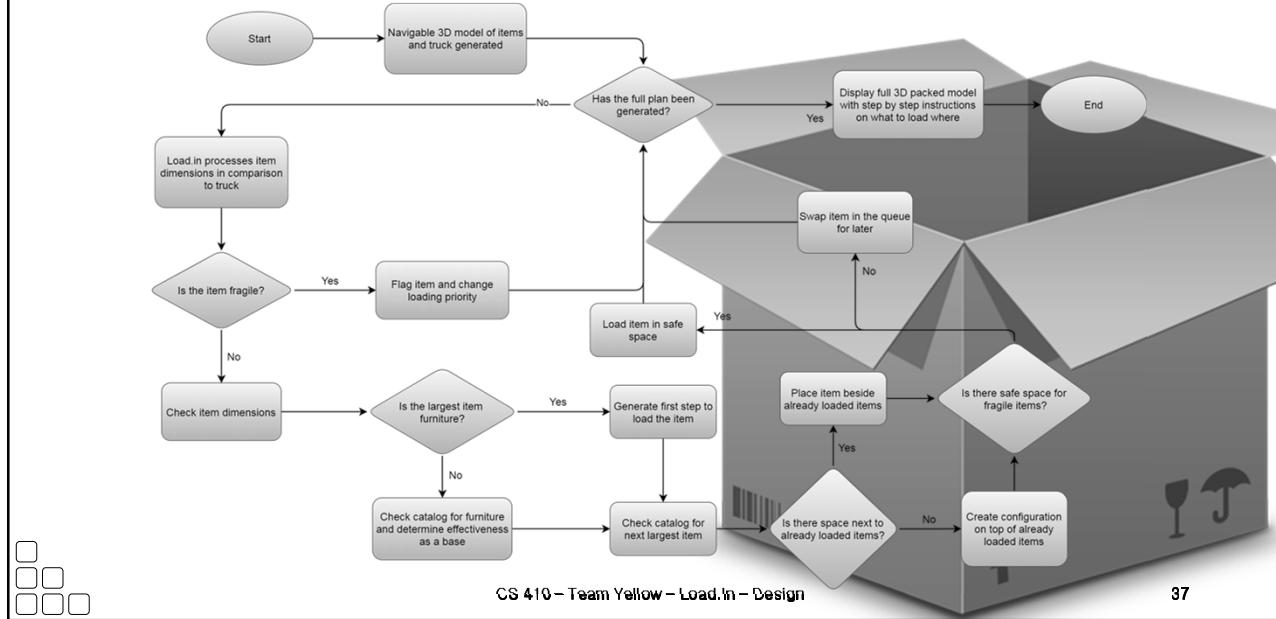
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Algorithms



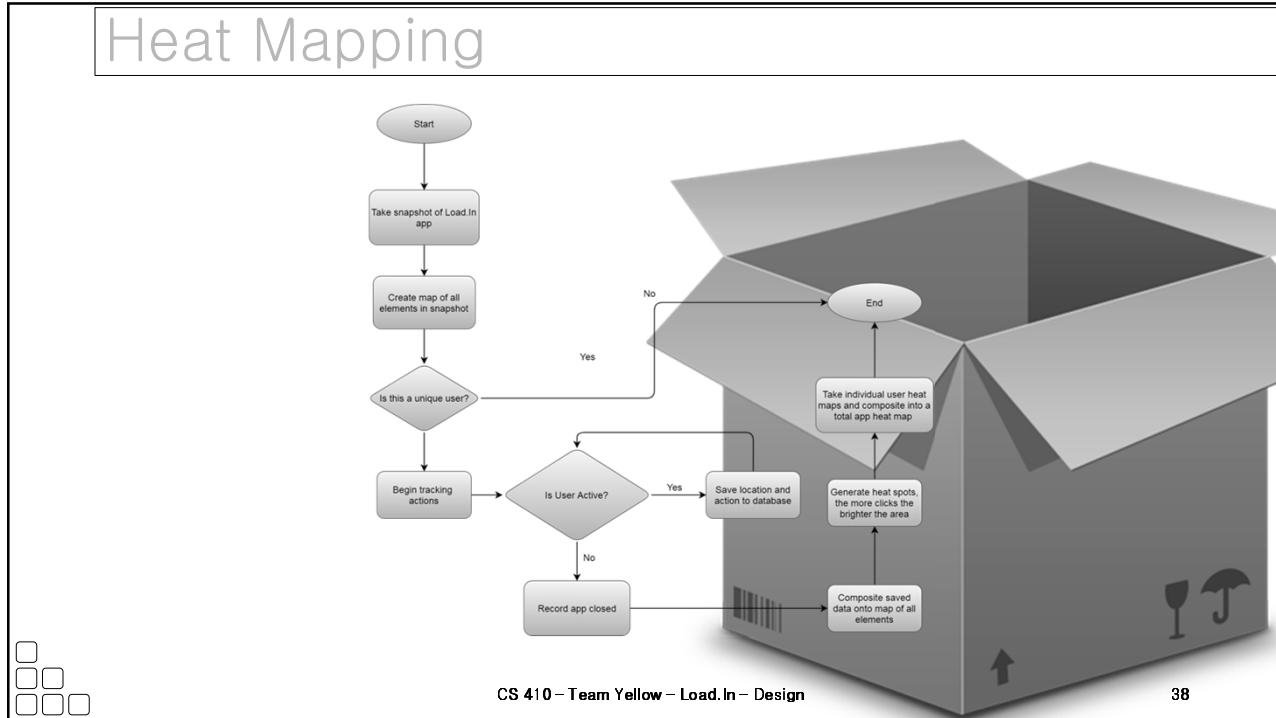
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Loading Algorithm



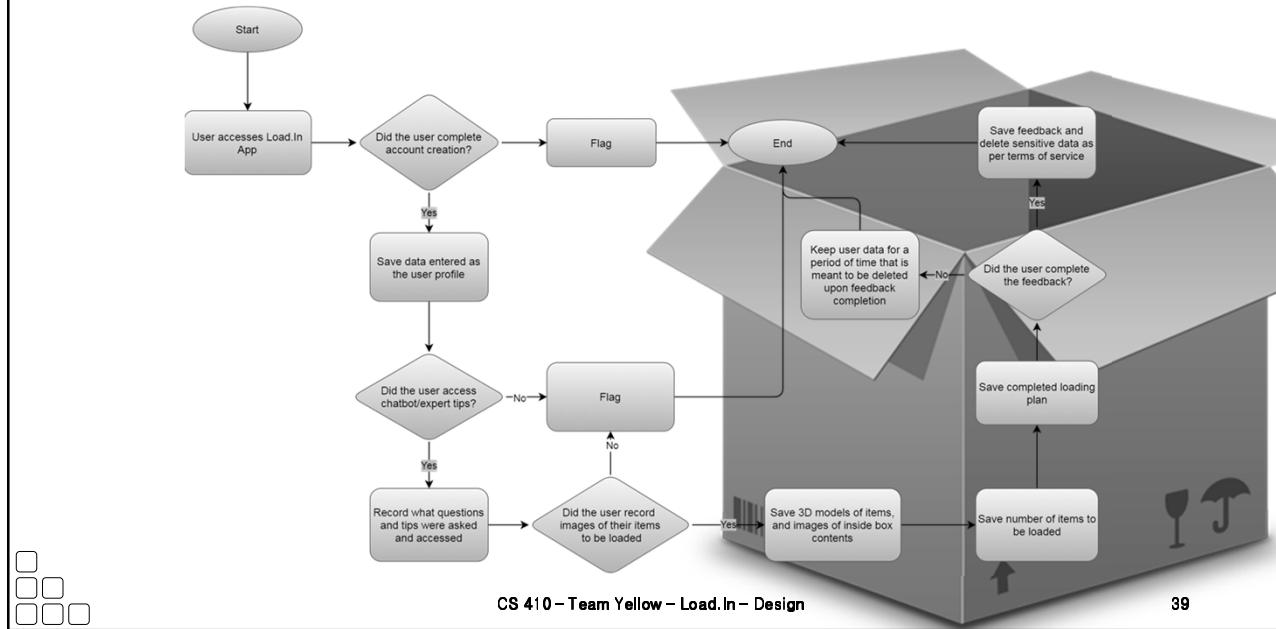
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Heat Mapping



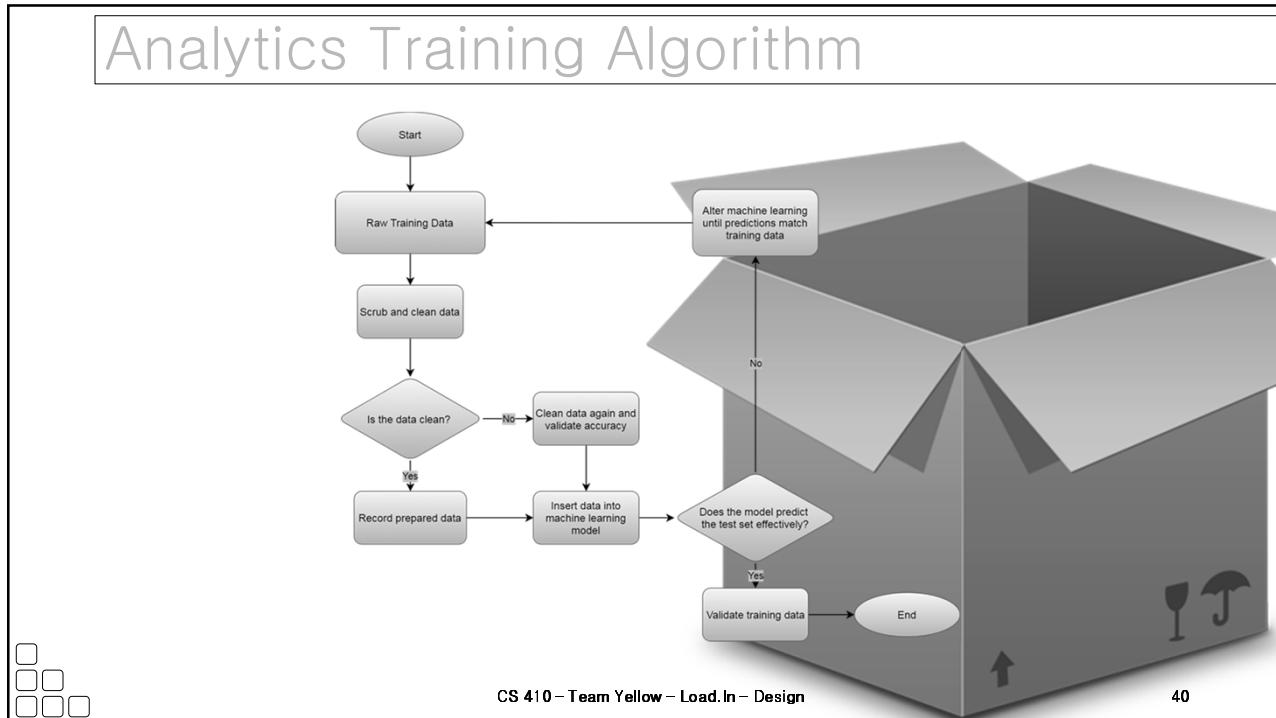
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Data Recording Algorithm



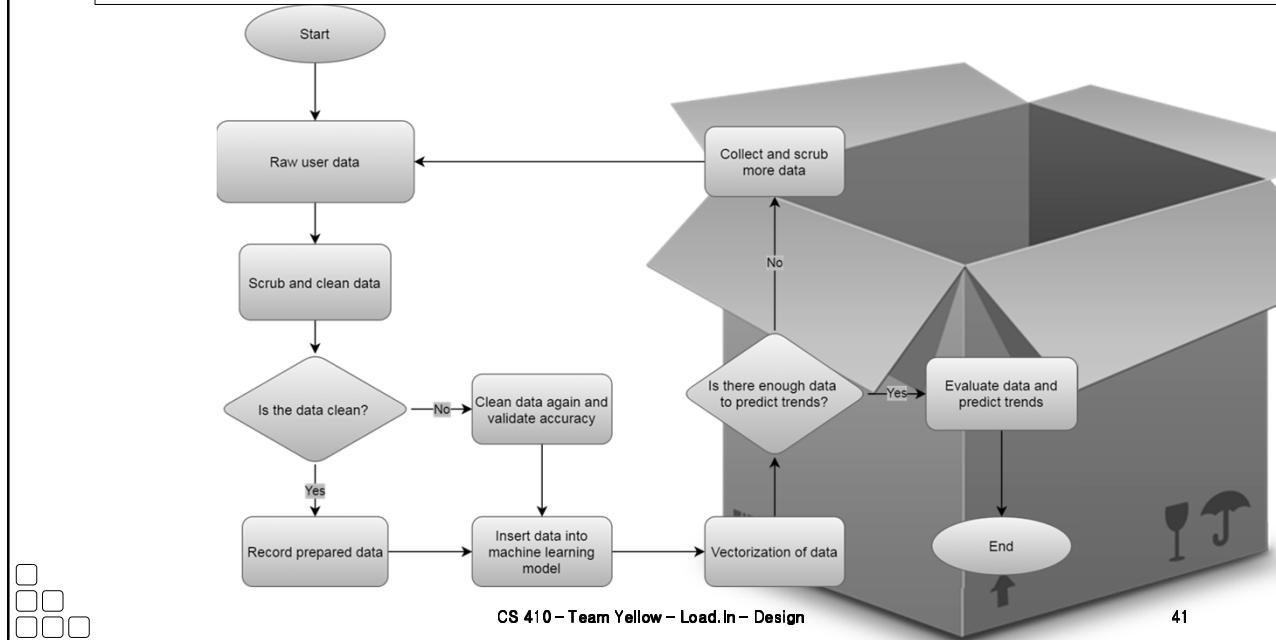
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Analytics Training Algorithm



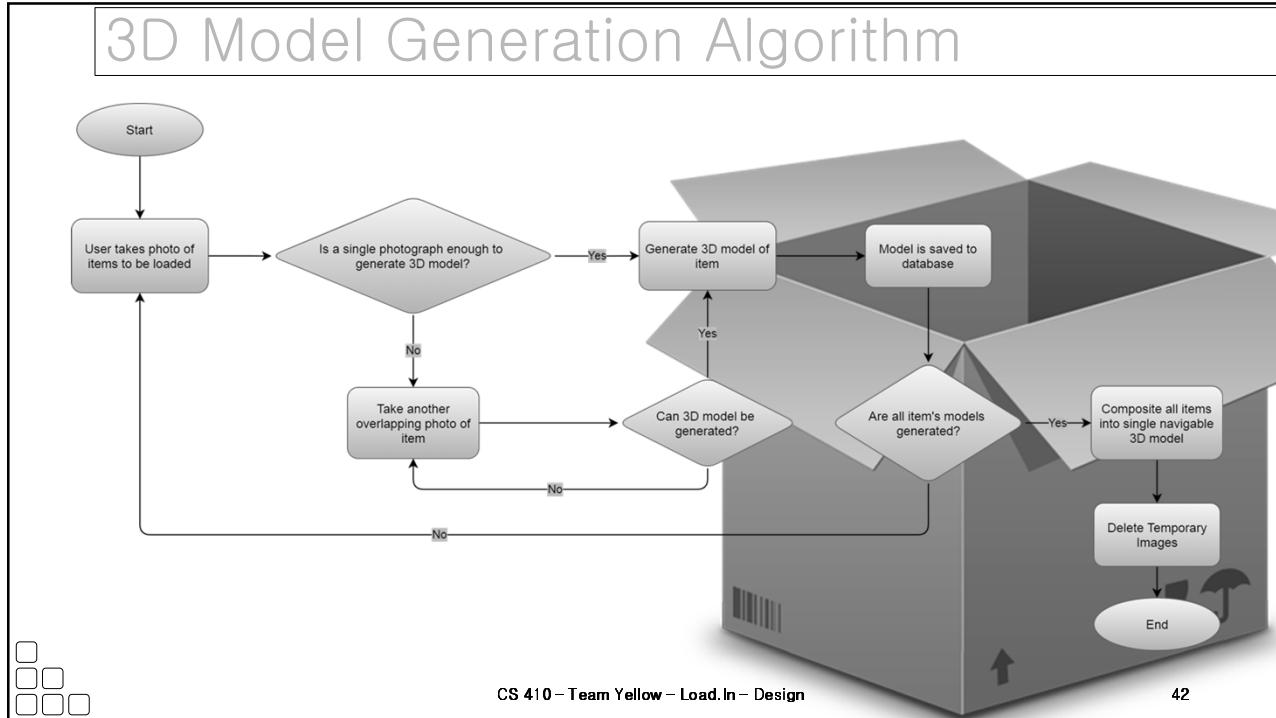
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Analytics Prediction Algorithm



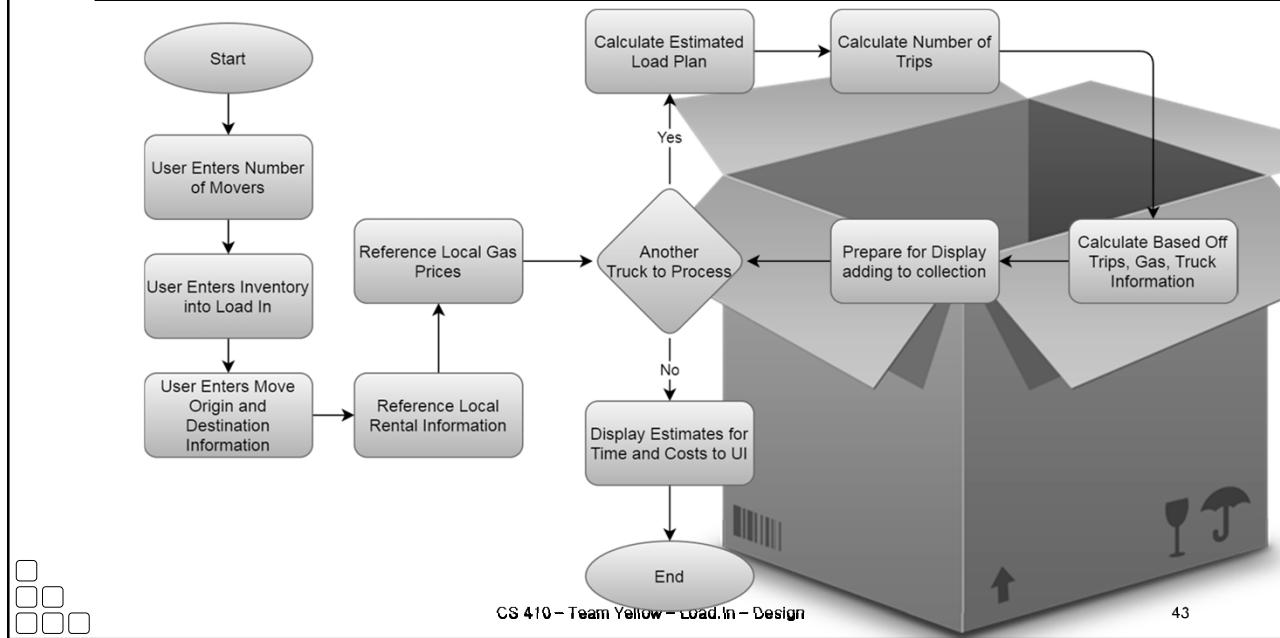
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3D Model Generation Algorithm



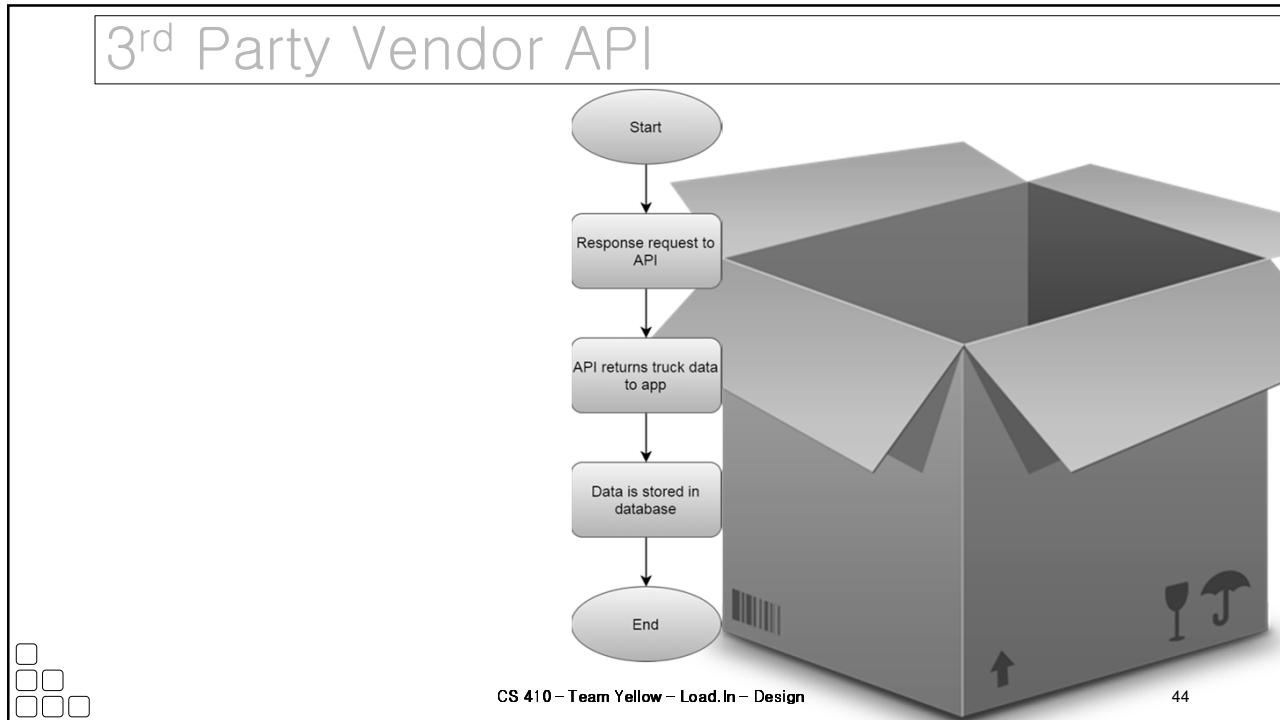
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Cost Estimation



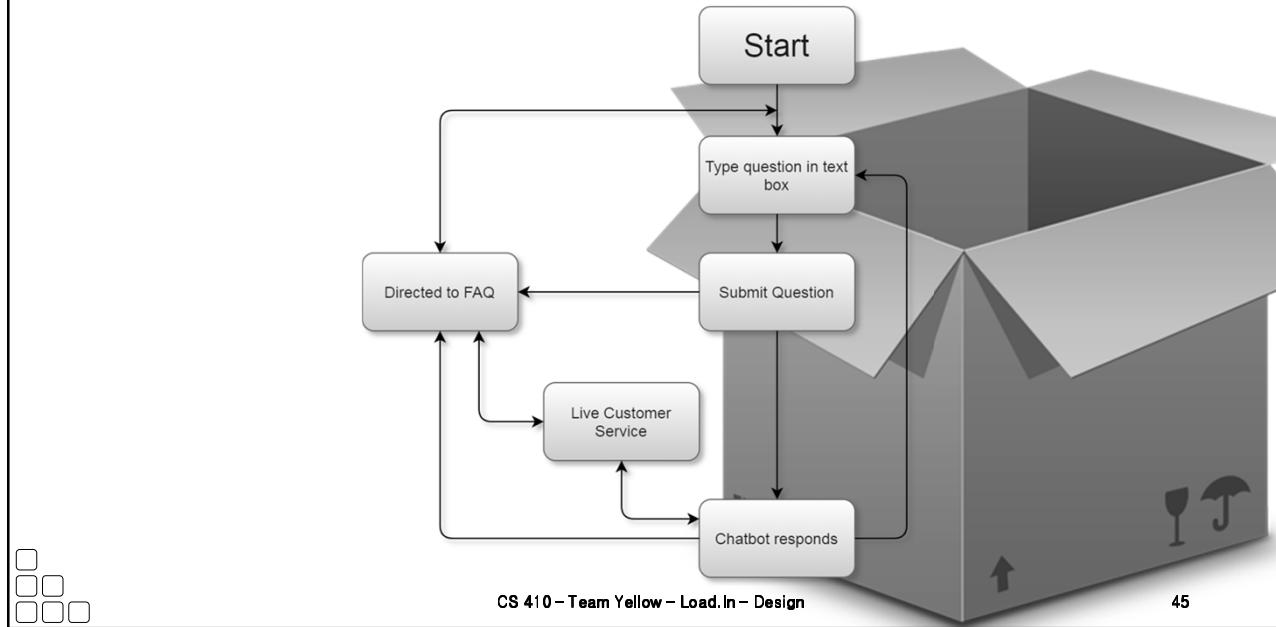
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3rd Party Vendor API



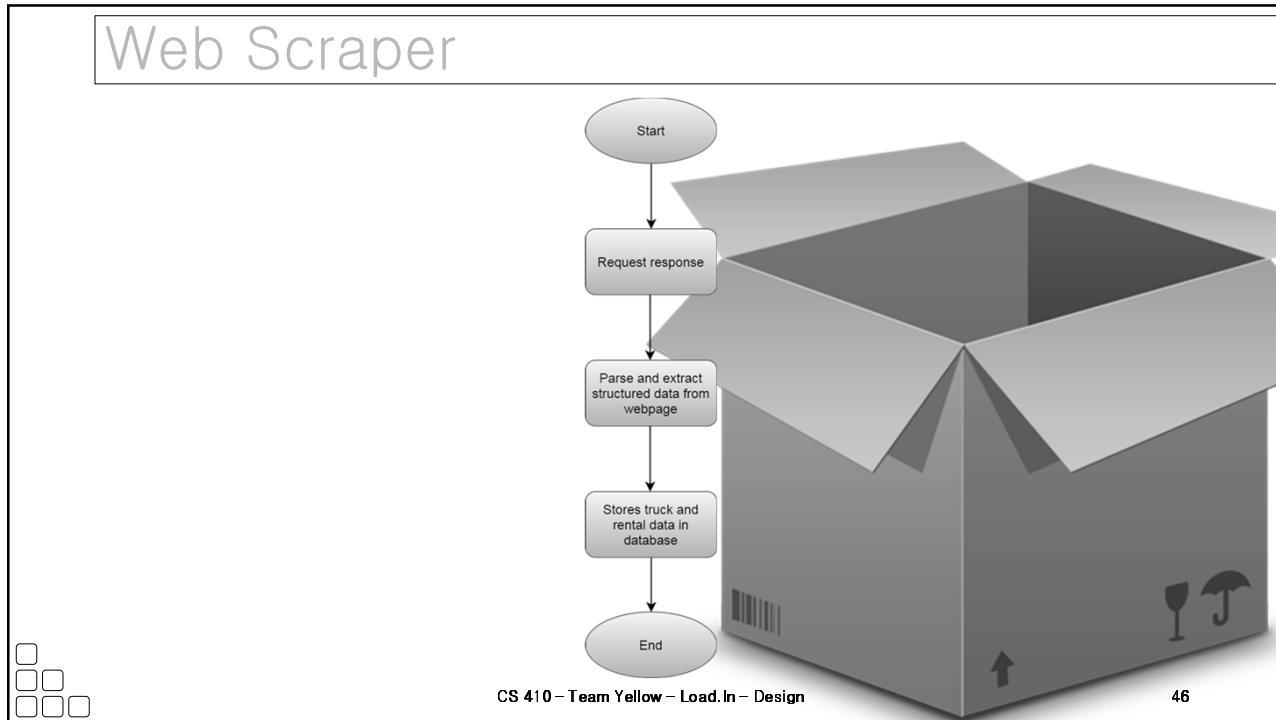
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Chat Bot Algorithm



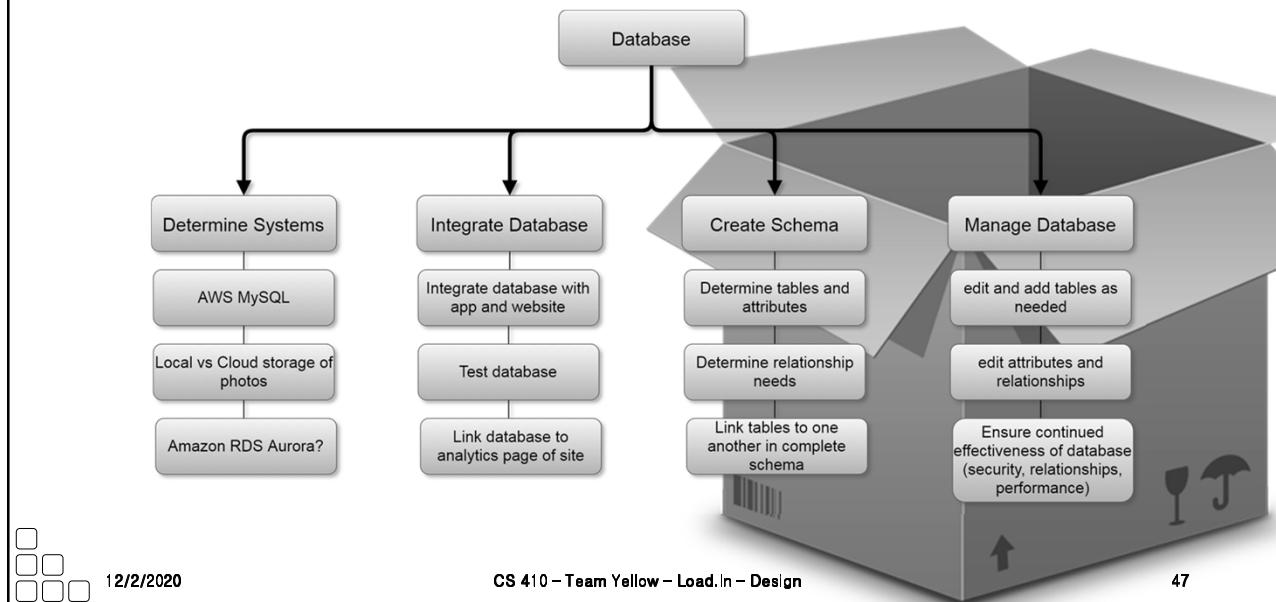
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Web Scraper



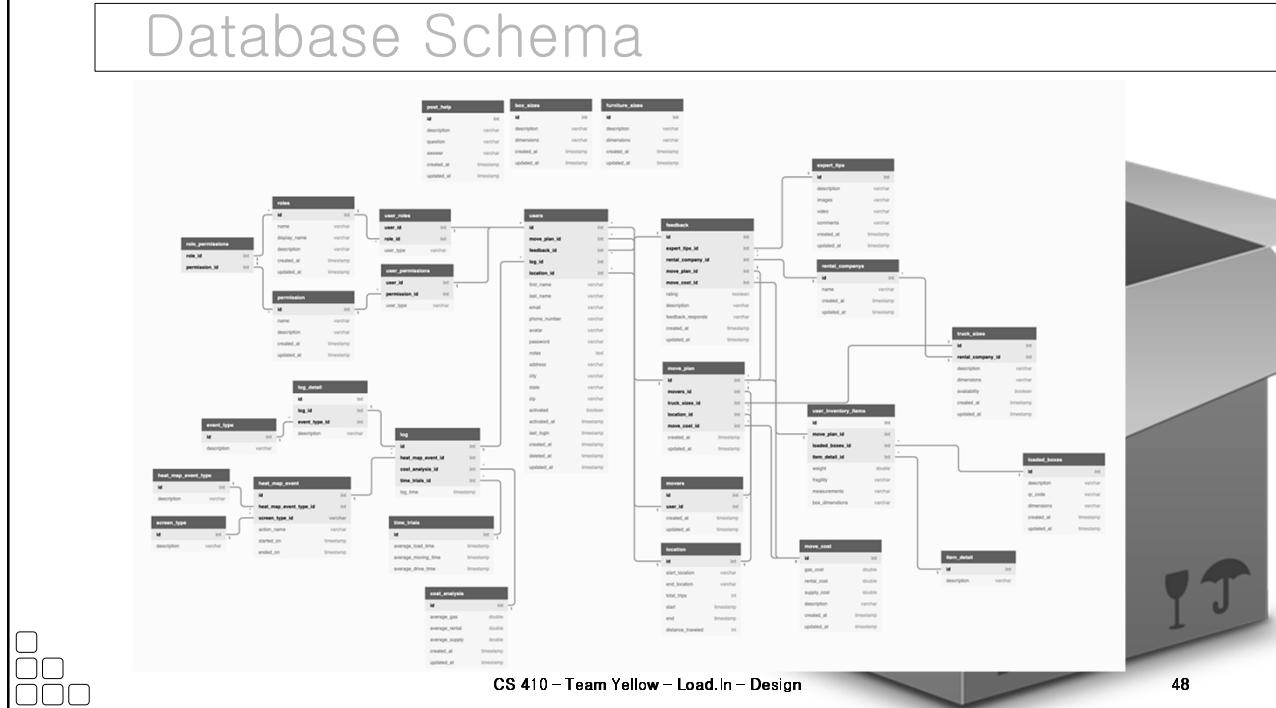
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Database



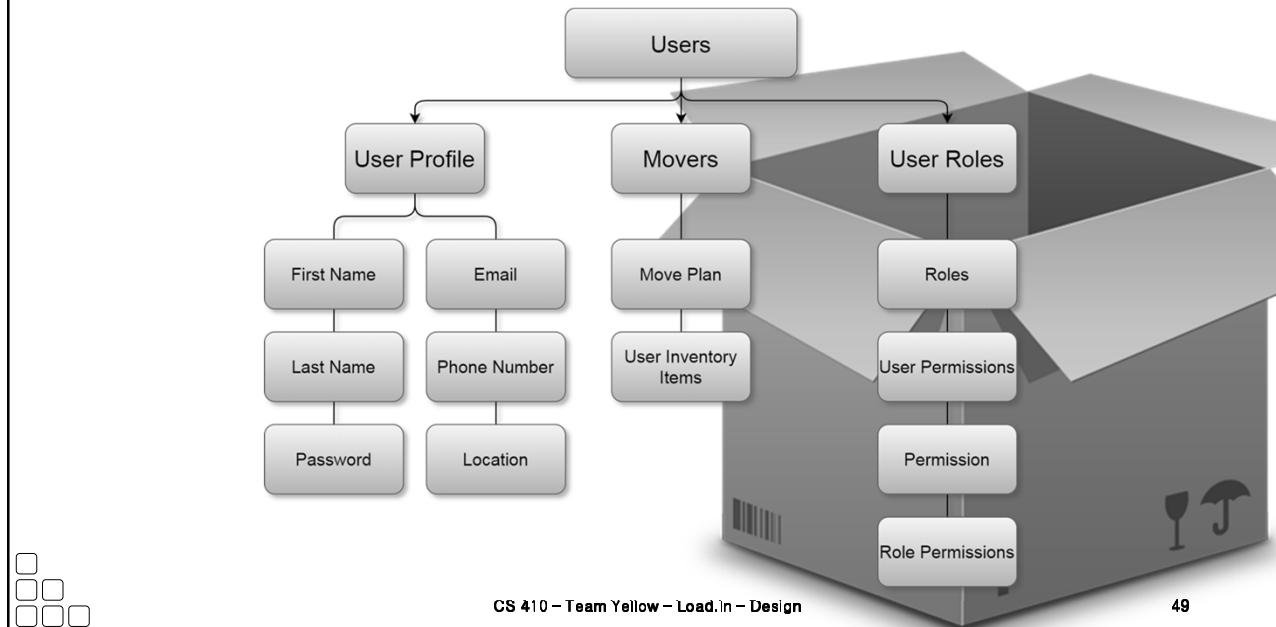
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Database Schema



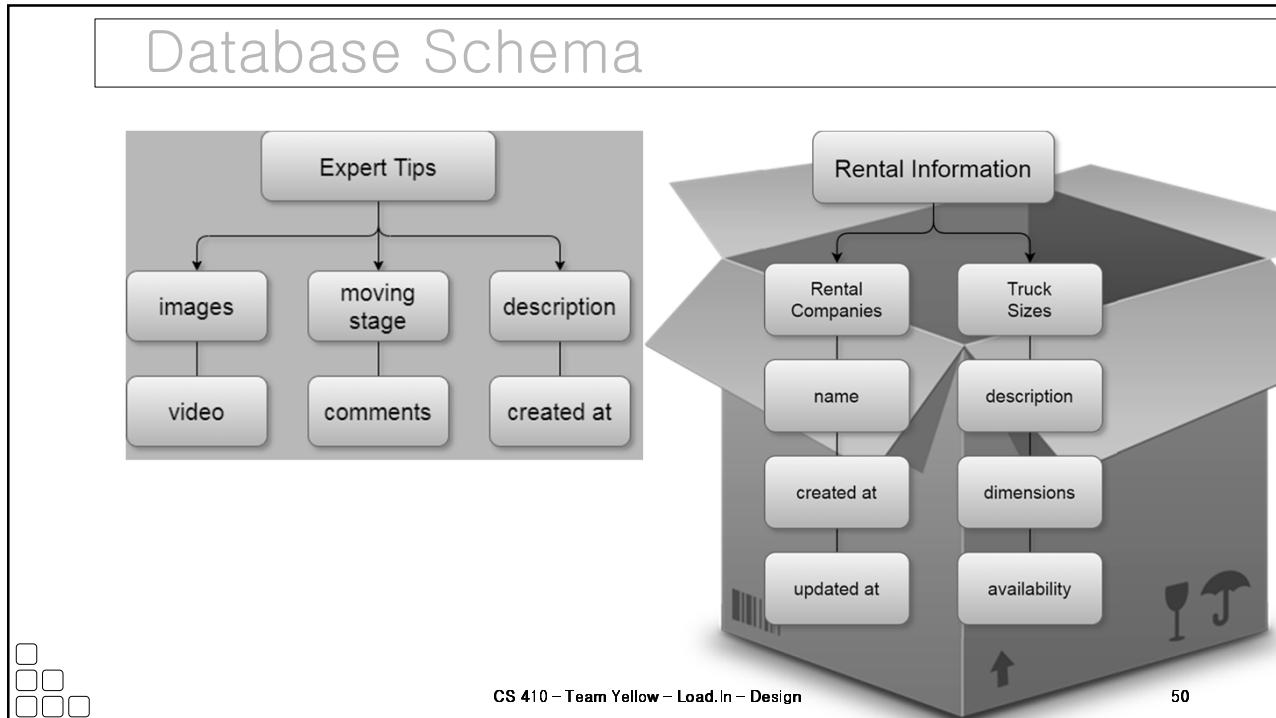
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Database Schema

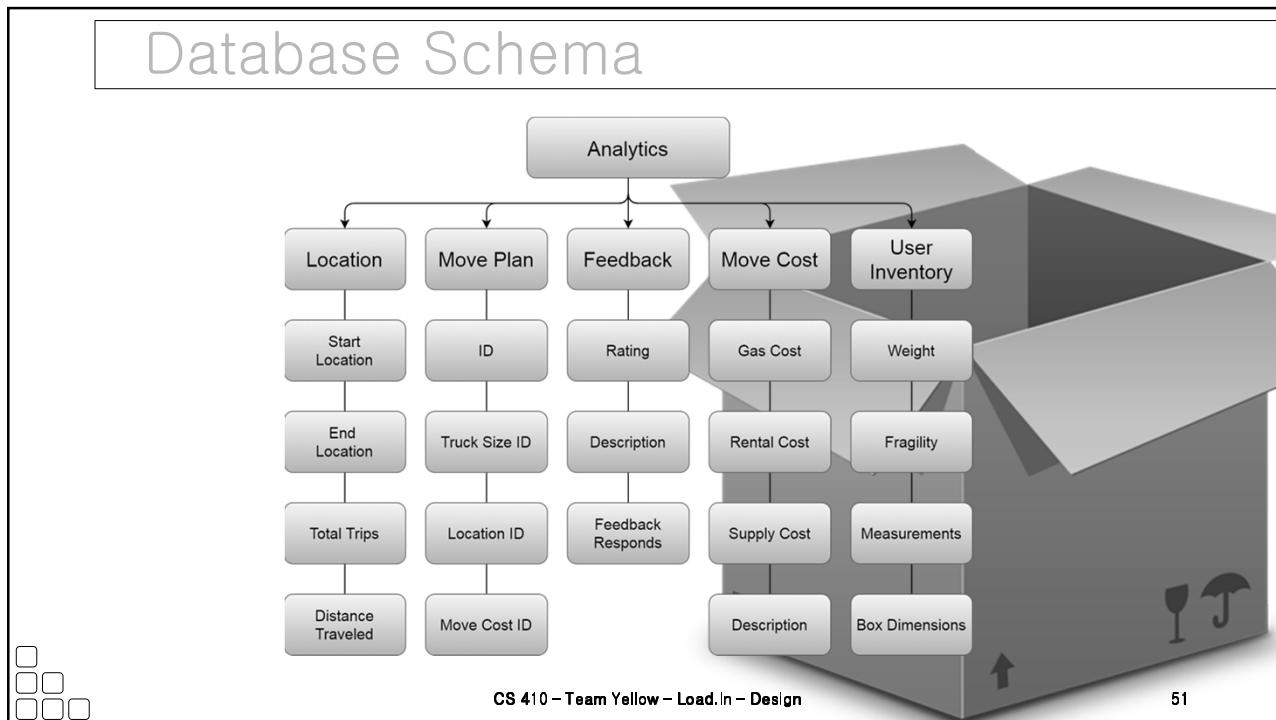


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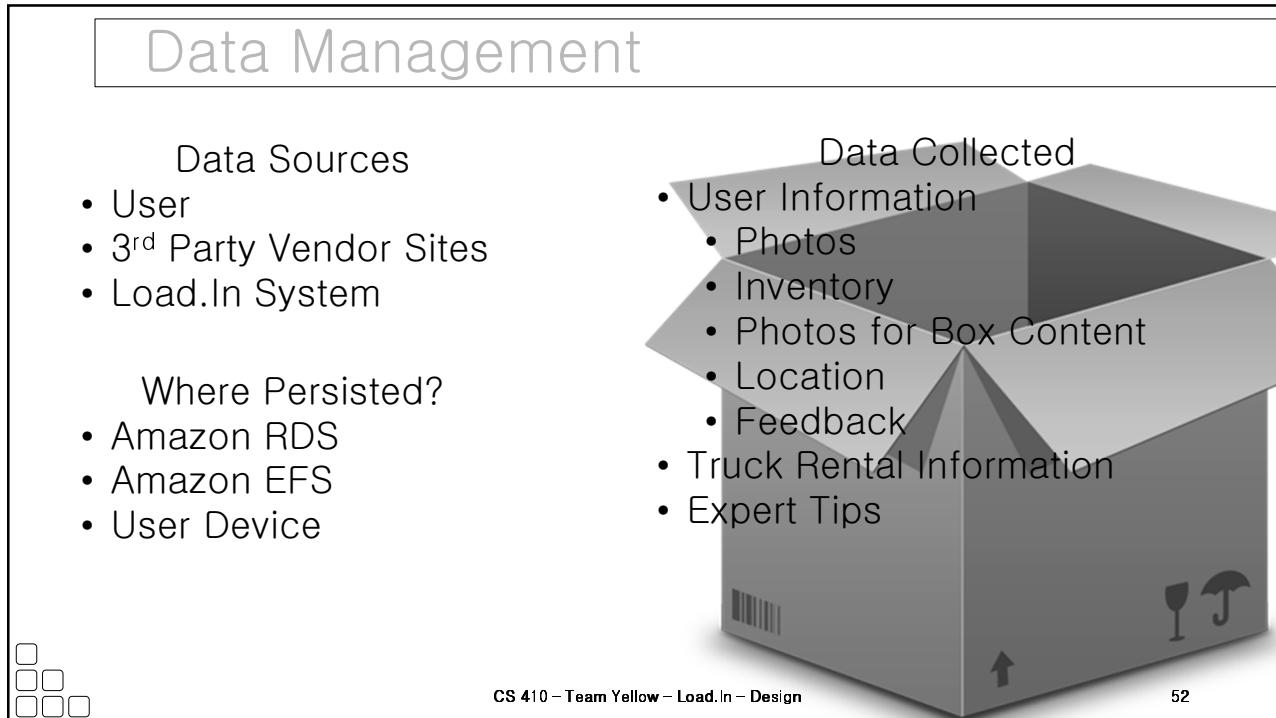
Database Schema



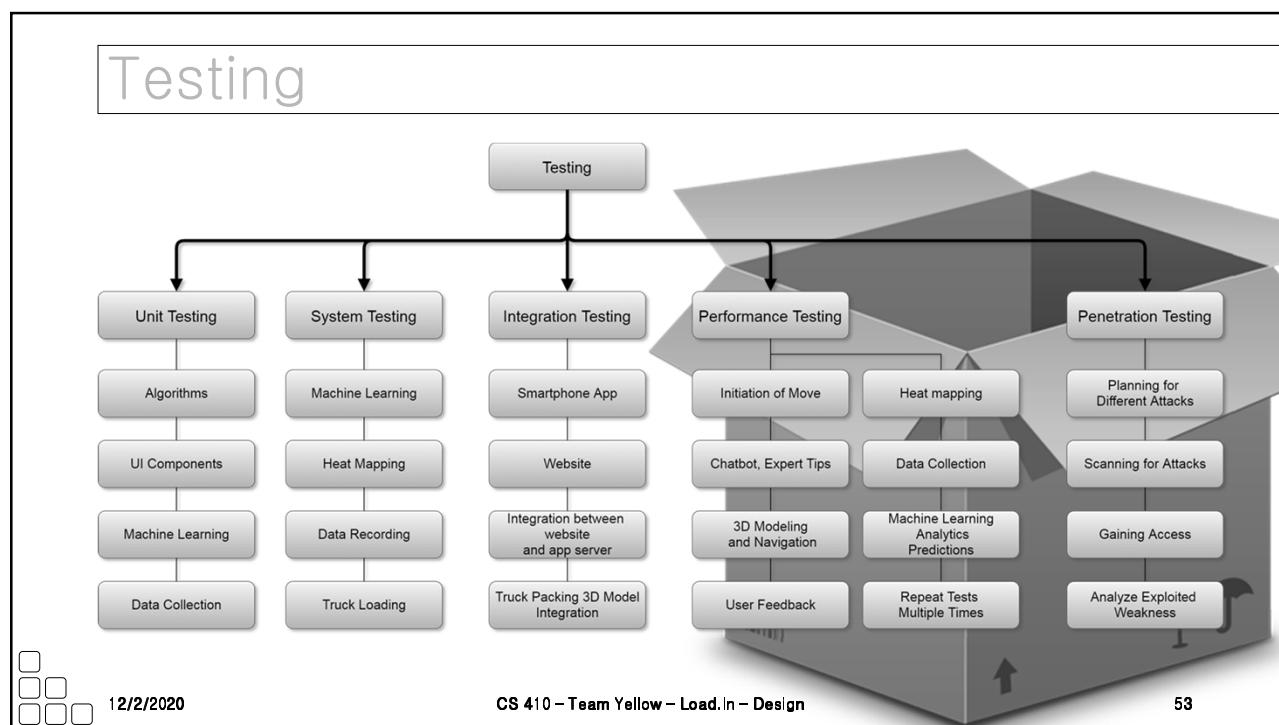
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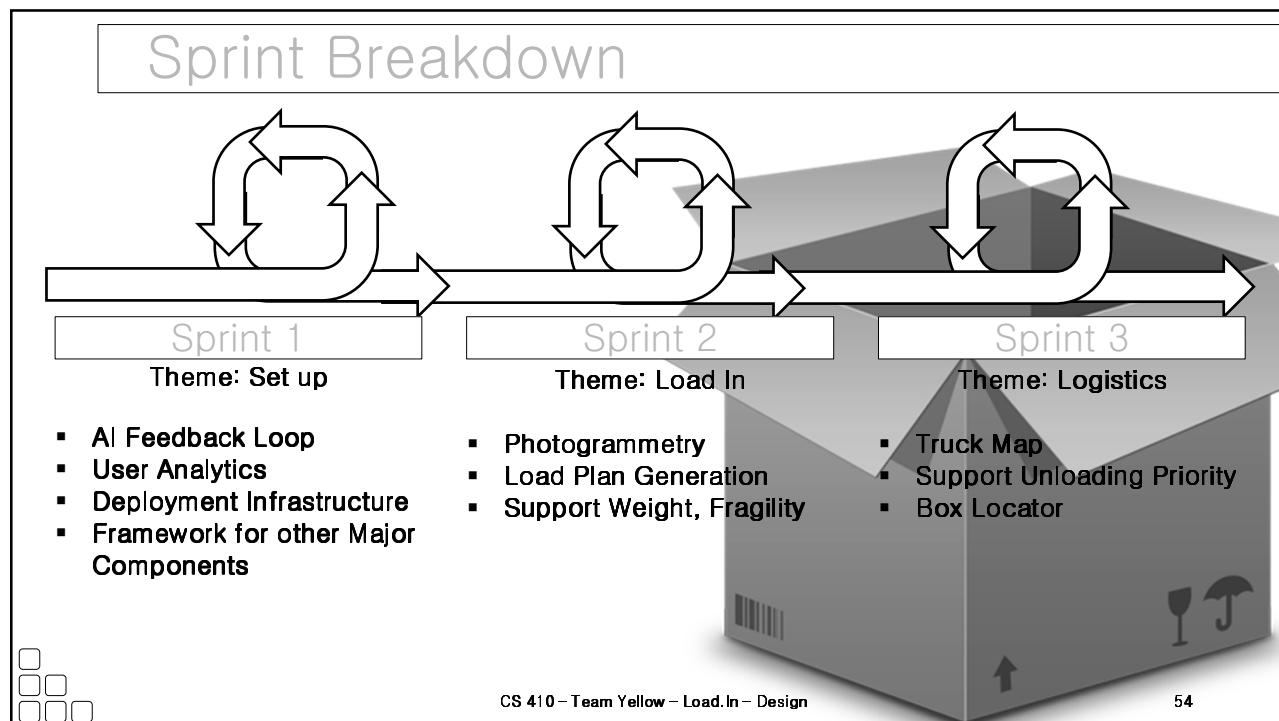
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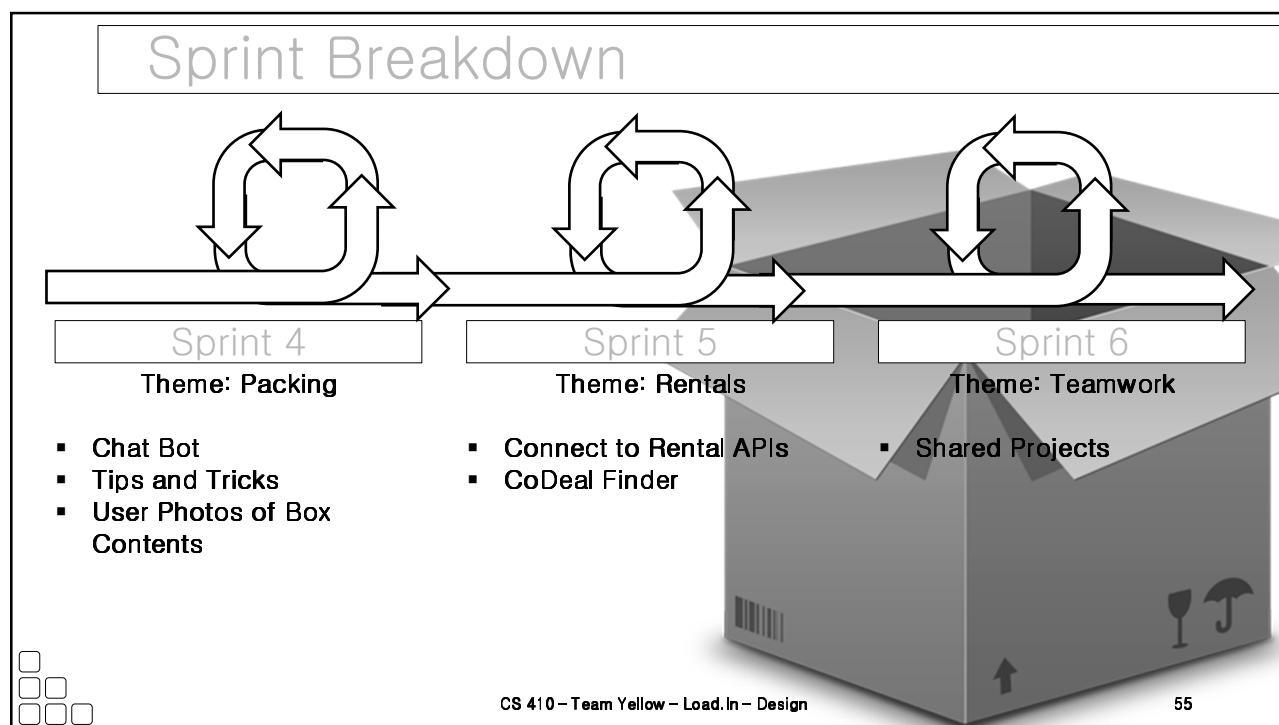
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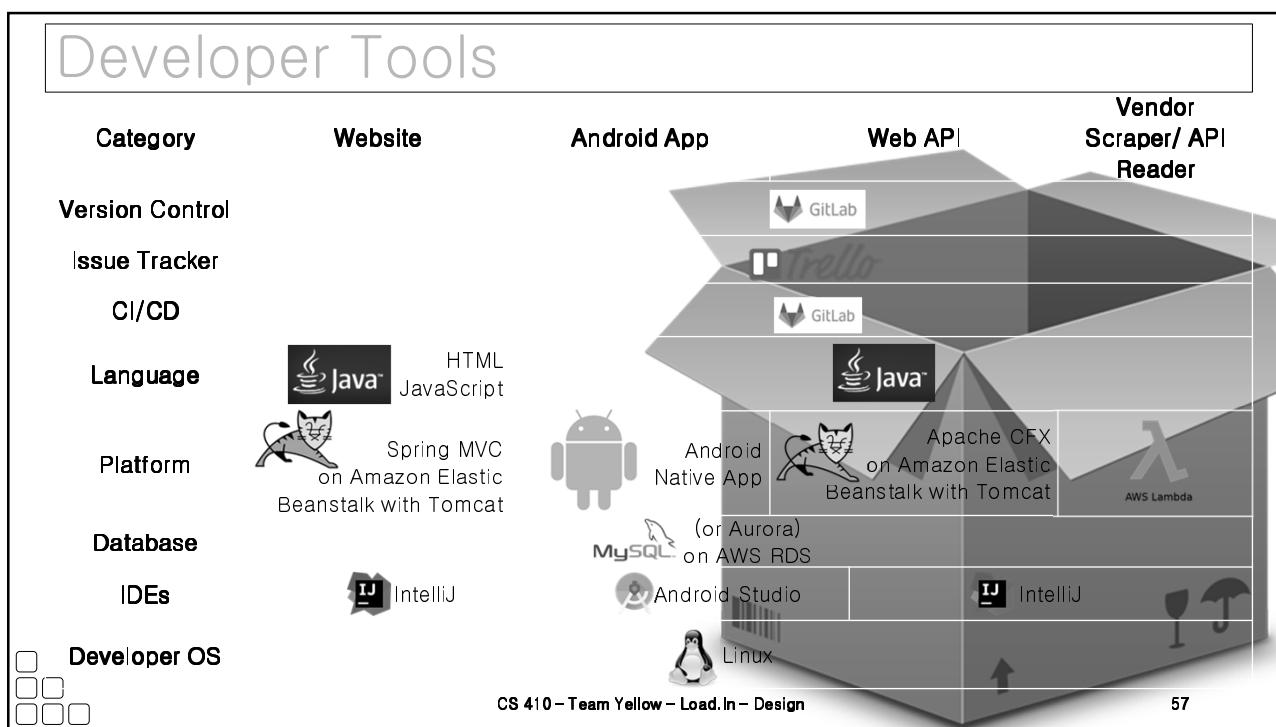
Hardware Requirements

Smartphone Client		Computer Client	
Specification	Estimated Targeted Value		
Operating System	Android 4.4 (KitKat)		
RAM	4GB RAM		
CPU	8 Core @ 1.8Ghz per core		
Storage	At least 2 GB internal storage for cache for images and rendered model data 1GB reserved cache for 3D Models		
	Target is 100 cached photos $100 * 55.84 \text{ Mb per photo} = 5,584 \text{ Mb} \sim 698 \text{ MB}$		
Cellular Connectivity	4G Cellular up to 15 Mbps		
Wireless	2.4 GHZ @ Wireless N with min 150 Mbps		
Internet Connectivity	30 Mbps		
Camera	Single camera lens @ 12 Megapixel		
Photo Size	4290x2800 (~12MP) PNG Compression Approx. 6.98 MB per photo or 55.84 Mb per photo		
Photo Transmission Time	< 3 Second @ 30 Mbps Internet Speed < 6 Seconds @ 15 Mbps Cellular		
		RAM	4GB RAM
		CPU	2 cores @ 2GHZ
		Storage	1 GB Cache for images and website content
		Wireless	2.4 GHZ @ Wireless N with min 150 Mbps
		Internet Connectivity	30 Mbps

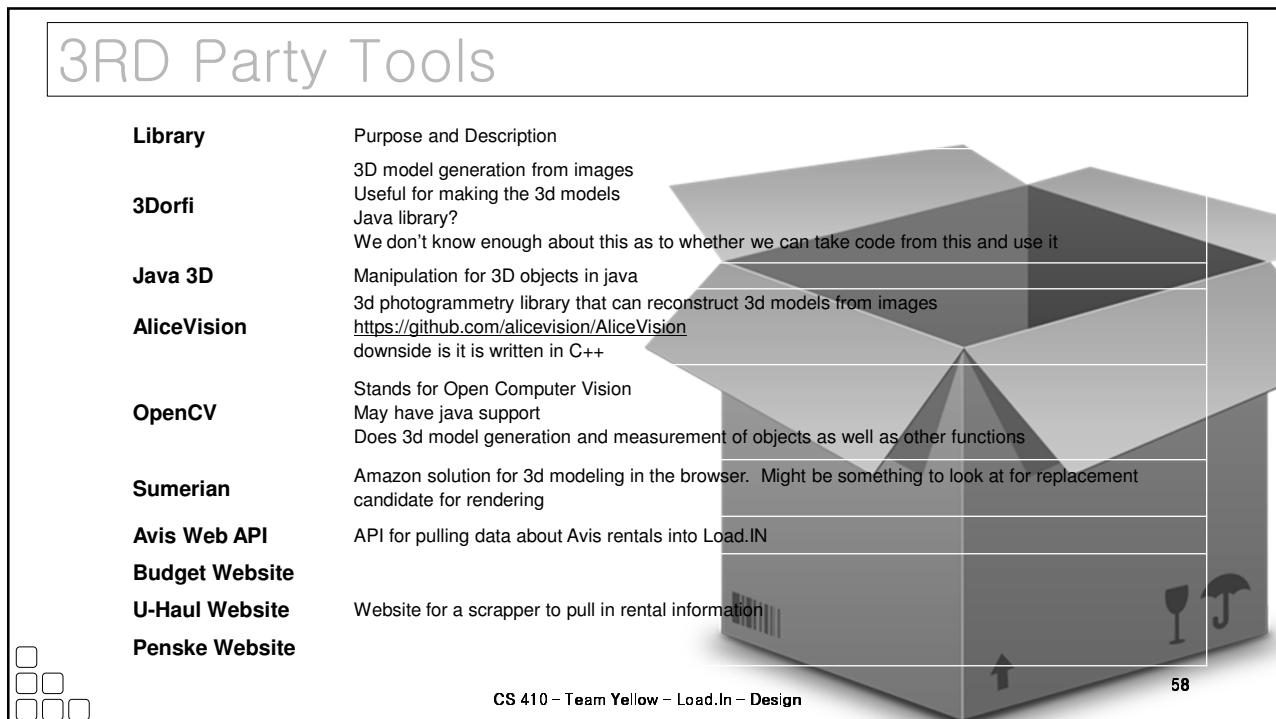
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Technical Risks

PROBABILITY						
SEVERITY		Very Low	Low	Medium	High	Very High
Very High						T-1
High					T-2	
Medium				T-3		
Low						
Very Low						

Acceptable: Risk is acceptable level.
Permissible: Risk is okay for now and can be fixed at a later date.
Considerable: Risk is noted and will be fixed in the next iteration.
Catastrophic: Product is placed on hold until issue is fixed.

- T-1: Current technology involving computer vision is a challenge.
- T-1 Mitigation: Conduct a prototype to mitigate risk of critical errors upon release.
- T-2: Artificial Intelligence prone to error due to insufficient training data.
- T-2 Mitigation: Implementing a feedback loopback in the beta phase with test users.
- T-3: Challenge to obtain accurate and timely feedback.
- T-3 Mitigation: Implement a feature for users to give feedback if the application operated correctly after completing a move.



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Customer Risks

PROBABILITY						
SEVERITY		Very Low	Low	Medium	High	Very High
Very High						
High		C-1				
Medium		C-2	C-3			
Low					C-4	
Very Low						

Acceptable: Risk is acceptable level.
Permissible: Risk is okay for now and can be fixed at a later date.
Considerable: Risk is noted and will be fixed in the next iteration.
Catastrophic: Product is placed on hold until issue is fixed.

- C-1: End user is inexperienced with the application.
- C-1 Mitigation: Implement a tutorial on how to use the application and provide a help feature.
- C-2: End user finds UI challenging to operate.
- C-2 Mitigation: Implement analytics for tracking when a user stop using the application.
- C-3: End users are not satisfied with the recommendations of the application.
- C-3 Mitigation: Implement a customer feedback feature that allows the users to disclose his/her issues with the applications.
- C-4: End user doesn't follow the guidelines of the application.
- C-4 Mitigation: Implement a feature that allows the user to repeat/reset certain steps in the application as they progress.



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Security Risks

		PROBABILITY				
		Very Low	Low	Medium	High	Very High
SEVERITY	Very High					
	High					
	Medium					
	Low	S-1,S-2				
	Very Low					

Acceptable: Risk is acceptable level.
Permissible: Risk is okay for now and can be fixed at a later date.
Considerable: Risk is noted and will be fixed in the next iteration.
Catastrophic: Product is placed on hold until issue is fixed.

- S-1: End user want to ensure the pictures taken of personal information doesn't fall into the wrong hands.
- S-1 Mitigation: During the feedback stage after a move, have the end user have the ability to delete personal information collected during the move.
- S-2: End user wants to ensure his/her data isn't being collected for nefarious purposes.
- S-2 Mitigation: Allow the end user to opt out of the analytics program inside of the user settings and disclose what his/her data is being used for.



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Conclusion

- DIY Movers are faced with many logistical difficulties
 - Properly loading truck
 - Protecting valuables
 - Finding the best deal
 - Keeping track of every box
 - All during an already stressful life event!

- Load.In will provide customized expert instructions
 - Truck loading instructions based on photogrammetry
 - Cost minimization based on input data
 - Map of truck available to assist in finding boxes
 - Provide unique insights to moves due to captured analytics

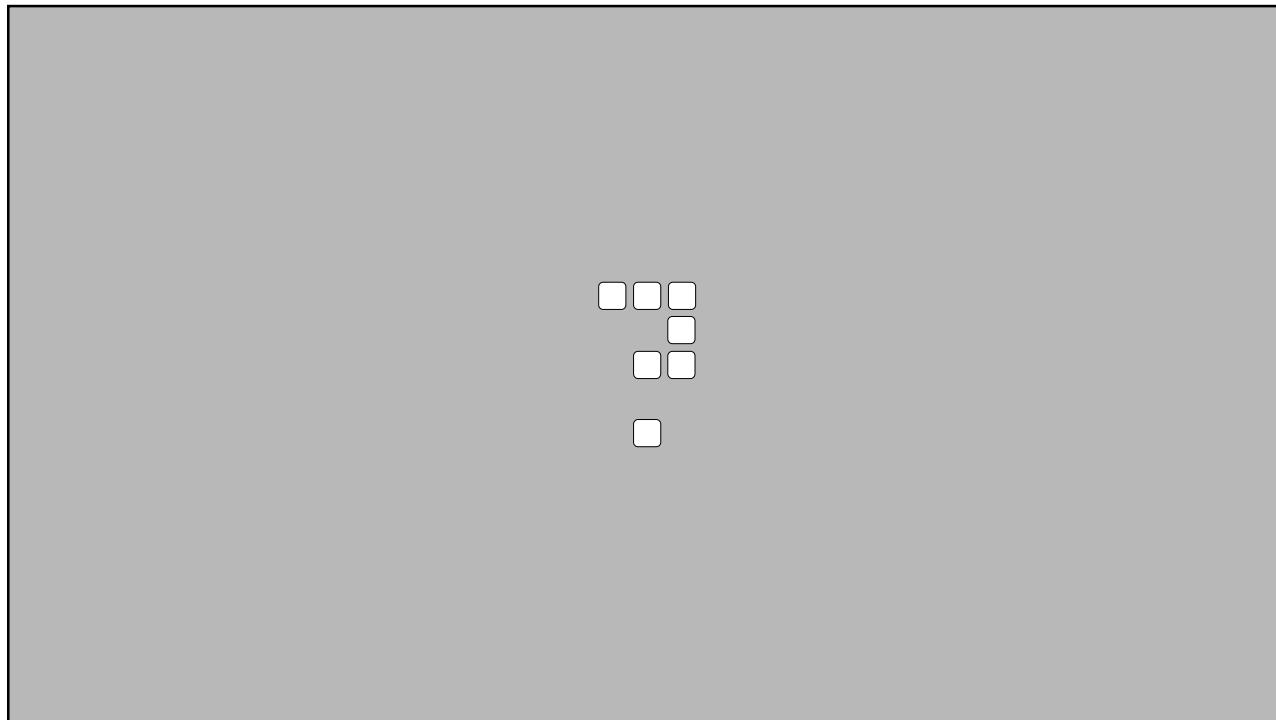


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Glossary

*All definitions are sourced from Wikipedia

Photogrammetry

Photogrammetry is the science and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant imagery and other phenomena.

Algorithm

A finite sequence of well-defined, computer-implementable instructions, typically to solve a class of problems or to perform a computation.

Professional movers

Professionals who move all your belongings for you from one place to another.

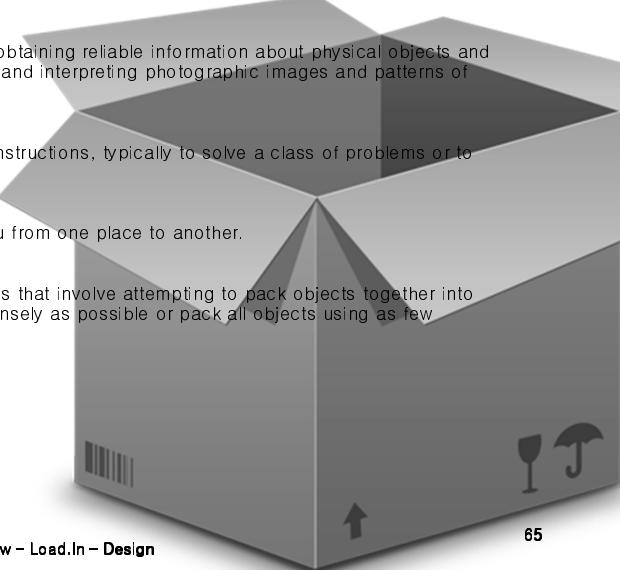
Packing problems

Are a class of optimization problems in mathematics that involve attempting to pack objects together into containers. The goal is to either pack a single container as densely as possible or pack all objects using as few containers as possible.



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Appendix – Specifications

Cloud - Blob Storage

Specification	Estimated Targeted Value
Platform	Amazon EFS (Elastic File System)
Storage Requirements	Assuming 500,000 persisted moves at 200 photos for inventory 1 photo = 55.84 Mb 200 photos = 11,168 Mb @ 500,000 Customers 6.226×10^5 TB
Iops	Capable of max 100,000 * 55.84 Mb in under 5 seconds (be able to store a photo for 100,000 simultaneous moves in under 5 seconds) Approx. 139.6 GB/s

Cloud - SQL

Specification	Estimated Targeted Value
Platform	Amazon RDS (Relational Database System) Or Aurora?
Vendor	MySQL
Memory	128GB with scale up capabilities
Storage Requirements	Assuming 20 MB per customer of raw SQL data Approx. 10 TB database Minimum size @ 500,000 customers
CPU	128 cores @ 4GHZ
Iops	Assuming 100,000 simultaneous users $100,000 \times 0.5$ MB retrieved data/sec = 50GB capability of data retrieval (depends on the database Iops as well)

Cloud – Web Services/API

Specification	Minimum Targeted Value
Platform	Amazon Elastic Beanstalk
Memory	64GB with scale up capabilities
Storage Requirements	100 MB < All Target Compiled Files < 500 MB
CPU	32 cores @ 4GHZ with auto scale up capabilities
Iops	Assuming 100,000 simultaneous users 100,000 * 0.5 MB retrieved data/sec = 50GB capability of data retrieval (depends on the database Iops as well)



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Appendix – Specifications

Cloud - Web Application

Specification	Minimum Targeted Value
Platform	Amazon Elastic Beanstalk
Memory	32GB with scale up capabilities
Storage Requirements	100 MB < All Target Compiled Files < 500 MB
CPU	16 cores @ 4GHZ with auto scale up capabilities
Iops	Assuming 20,000 simultaneous users 20,000 * 0.1 MB retrieved data/sec = 2GB /sec capability of data retrieval

Cloud – Vendor AP Bridge

Specification	Minimum Targeted Value
Platform	Amazon Lambda
Memory	16GB with scale up capabilities
Storage Requirements	10 MB < All Target Compiled Files < 50 MB
CPU	8 cores @ 4GHZ with auto scale up capabilities
Iops	Assuming 1 GB of data from each rental vendor @ 4 vendors 4GB data in < 30 seconds = 133 MB/s

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Appendix Data Management

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Data Collected	Source	Persisted	When Removed	Storage Location
User Information	User	Yes	--	DB
Truck Rental Information	3 RD Party Web API 3 RD Party Website			
Photos for 3D Model Generation	User	Temporarily	After 3D Model Generation Completed	EFS and User Device
Photos for Box Content				
Move Inventory	System	Temporarily	Triggers: • After Move Completed and Feedback Submitted • Manual Deletion • After Period of Time After Move Ended	User Device
Load Plan				
User Location Information	User	Yes	--	DB
Anonymous Move Analytics				
App Usage Information	Move Expert	Yes	--	DB
Feedback				
Expert Tips				

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Appendix A1 – User Stories (Mover)

- As a mover I need to be able to reset my own password.
- As a mover I need to be able to unlock my account via email when I have entered too many incorrect passwords.
- As a mover I need to be able to share my move plan with those who are helping me.
- As a mover I need to be able to create and delete a move plan.
- As a mover I need to be able to measure my items.
- As a mover I need to be able to reserve and rent a truck.
- As a mover I need to be able to see a catalogue of all my items.
- As a mover I need to be able to ensure specific items are within reach.



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- As a mover I would like to have QR codes to help me organize my boxes
- As a mover I would like to be able to access a tutorial on how to use Load.In.
- As a mover I would like to be able to access a database of commonly found household items.
- As a mover I would like to be able to enter a preference on vehicle I would like to rent.
- As a mover I would like to be able to access tips if I encounter a problem.
- As a mover I would like to be able to rate my experience.
- As a mover I would like to be able to provide feedback.

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Appendix A2 – User Stories (Website Visitor)

- As a website visitor I need to be able to see how Load.In works.
- As a website visitor I need to be able to see why I should use Load.In.
- As a website visitor I need to be able to make a user account.
- As a website visitor I need to be able to reset my password.
- As a website visitor I need to be able to download Load.In



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- As a website visitor I would like to be able to see a Frequently Asked Questions (FAQ) about Load.In
- As a website visitor I would like to be able to see who created Load.In.
- As a website visitor I would like to be able to see the about information for Load.In
- As a website visitor I would like to be able to subscribe to a mailing list.

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Appendix A3 – User Stories (Move Expert)

- As a move expert I need to be able to reset my own password.
- As a move expert I need to be able to unlock my account through email.
- As a move expert I need to be able to create an article about packing.
- As a move expert I need to be able to see ratings on my articles.
- As a move expert I need to be able to see questions asked by movers.
- As a move expert I need to be able to respond to questions asked by movers.
- As a move expert I need to be able to provide video instructions of loading.

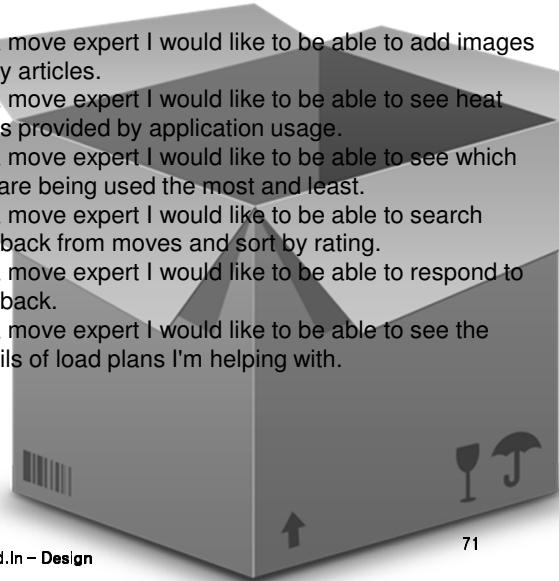
- As a move expert I would like to be able to add images to my articles.
- As a move expert I would like to be able to see heat maps provided by application usage.
- As a move expert I would like to be able to see which tips are being used the most and least.
- As a move expert I would like to be able to search feedback from moves and sort by rating.
- As a move expert I would like to be able to respond to feedback.
- As a move expert I would like to be able to see the details of load plans I'm helping with.



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Appendix A4 – User Stories (Rental Company)

- As a RAC I need to be able to access anonymous data.
- As a RAC I need to be able to see start and end move locations.
- As a RAC I need to be able to see when the vehicles are rented compared to moving date.
- As a RAC I need to be able to see what percentage of items are fragile.
- As a RAC I need to be able to see what type of items are being moved.
- As a RAC I need to be able to see the status of rental deals being offered through web API connected to Load.In.
- As a RAC I need to be able to provide feedback on my experience.

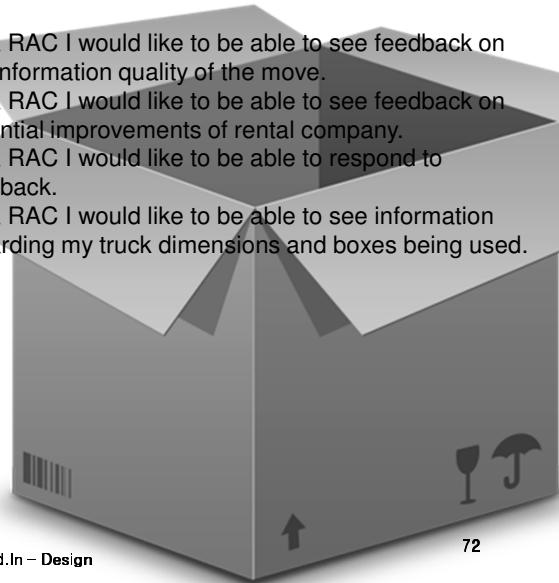
- As a RAC I would like to be able to see feedback on the information quality of the move.
- As a RAC I would like to be able to see feedback on potential improvements of rental company.
- As a RAC I would like to be able to respond to feedback.
- As a RAC I would like to be able to see information regarding my truck dimensions and boxes being used.



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Appendix A5 – User Stories (Chat Bot Admin)

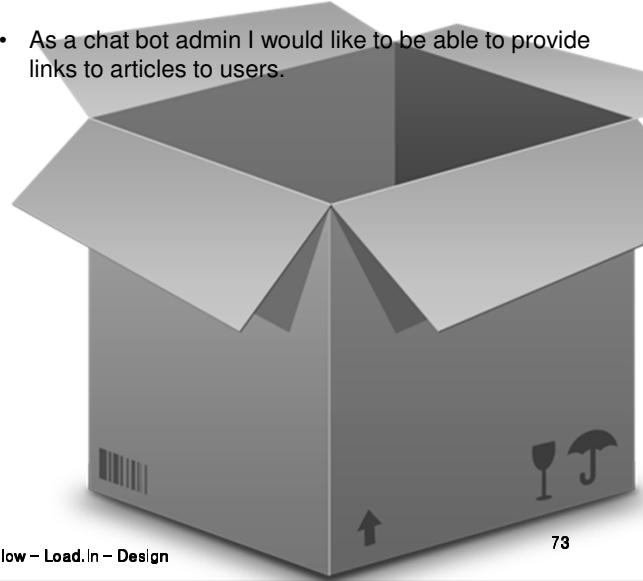
- As a chat bot admin I need to be able to read questions submitted by a user.
- As a chat bot admin I need to be able to provide detailed responses to the user.
- As a chat bot admin I need to be able provide answers to all questions movers may have.
- As a chat bot admin I need to be able to maintain my state as the user scans the FAQ and my output.

- As a chat bot admin I would like to be able to provide links to articles to users.



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Appendix A6 – User Stories (Administrator)

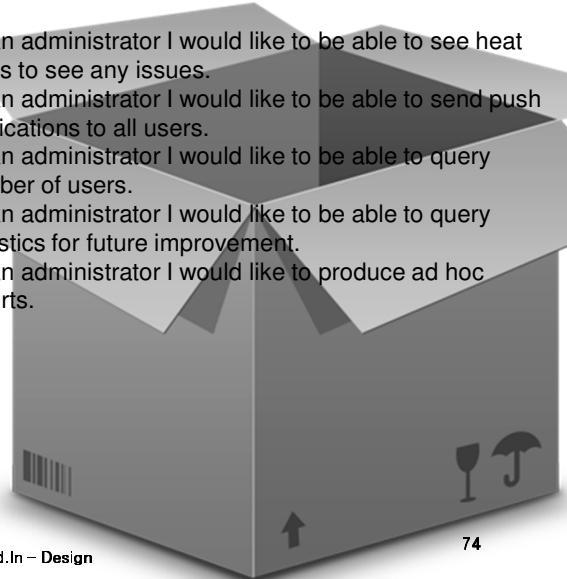
- As an administrator I need to be able to see system logs.
- As an administrator I need to be able to receive notifications on if thresholds have been met.
- As an administrator I need to be able to create and delete user accounts.
- As an administrator I need to be able to edit user information and privileges.
- As an administrator I need to be able to see any errors the system is producing.
- As an administrator I need to be able to back up the entire database.

- As an administrator I would like to be able to see heat maps to see any issues.
- As an administrator I would like to be able to send push notifications to all users.
- As an administrator I would like to be able to query number of users.
- As an administrator I would like to be able to query statistics for future improvement.
- As an administrator I would like to produce ad hoc reports.



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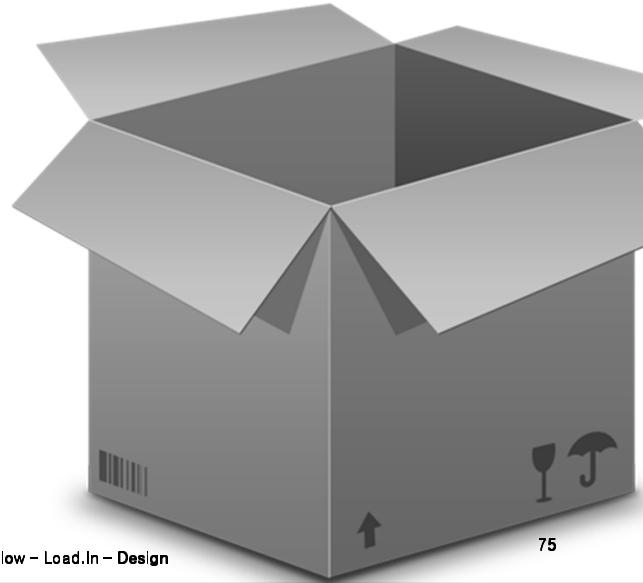
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Appendix A7 – User Stories (Tester)

- As a tester I need to be able to enter fake data to test edge cases.
- As a tester I need to be able to see how the application responds if I purposely do not follow my Load plan.
- As a tester I need to be able to enter the truck rental system to enter test data.
- As a test I need to be able to ask the chatbot non-typical questions.
- As a tester I need to be able to provide feedback to developers.
- As a tester I need to be able to tell the programmers they write spaghetti code. >:(



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Loading Can Be a Major Issue

- Poor loading can cause
 - Property damage
 - Car accidents
- An estimated **50,000** accidents related to trailer towing occur each year.



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Hayesbc.com

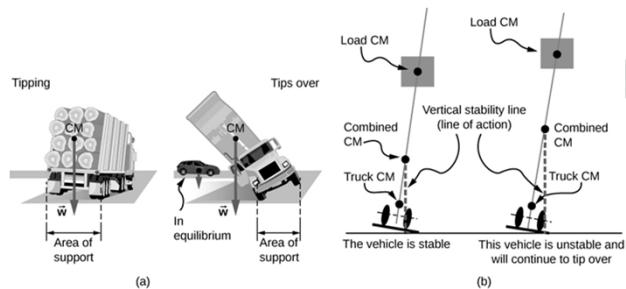
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Major Truck Loading Considerations

Weight distribution



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Protecting fragile items



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PenskeTruckRental.com

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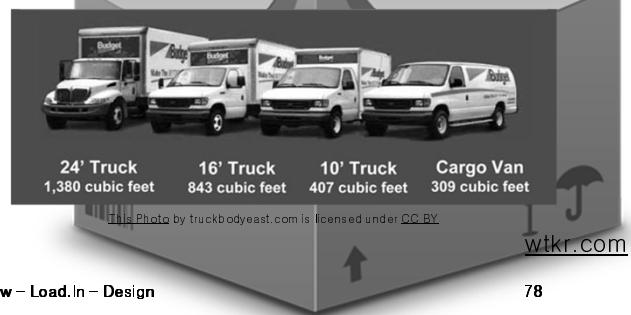
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Figuring Out What to Rent is Hard!

- *Accurately* determining
 - How big of a truck to get
 - How many trips a move will take
 - ...is difficult.
- Rental Truck companies base their business model on this!



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