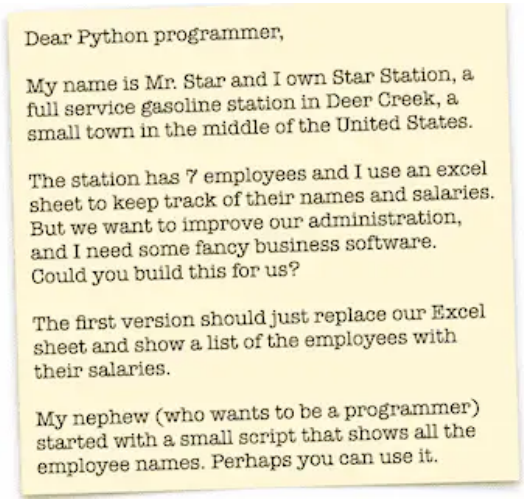
02. Software Design - Requirements

- This topic discusses how we can use software design and OOP to solve problems.
- We have clients who request us to build software: the clients can be your boss, users, or even ourselves.
- We design and build high-quality software based on the request.

Clients request us to build software.

Mr. Star's Email

- A business owner, Mr. Star, emails us.



Dear Python programmer,

My name is Mr. Star and I own Star Station, a full service gasoline station in Deer Creek, a small town in the middle of the United States.

The station has 7 employees and I use an excel sheet to keep track of their names and salaries. But we want to improve our administration, and I need some fancy business software. Could you build this for us?

The first version should just replace our Excel sheet and show a list of the employees with their salaries.

My nephew (who wants to be a programmer) started with a small script that shows all the employee names. Perhaps you can use it.

Requests

- The station has seven employees.
- He needs to keep track of names and salaries.

NAME	SALARY
Vera	2000
Chuck	1800
Samantha	1800
Roberto	2100
Joe	2000
Dave	2200
Tina	2300

Prototype

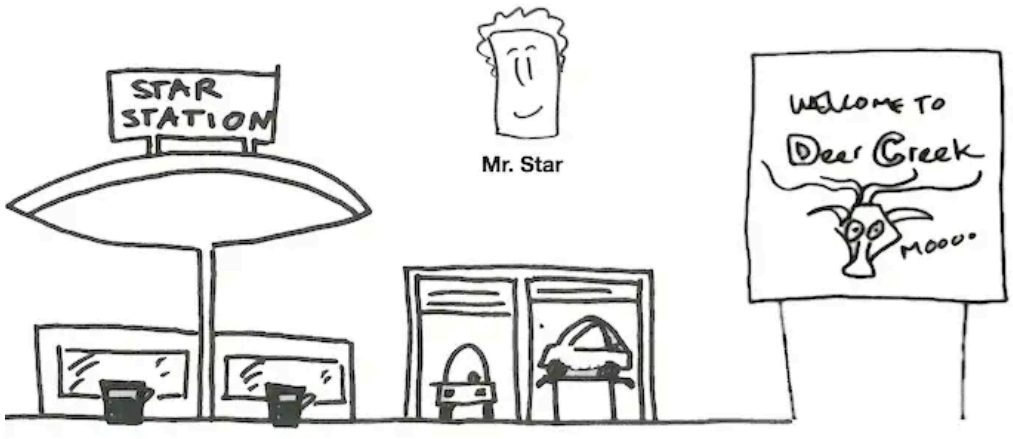
- In short, he wants to replace Excel sheets.
- His nephew (a wannabe software engineer) has already made a small script (prototype).

We have a user request, which we translate into requirements.

Business Logic

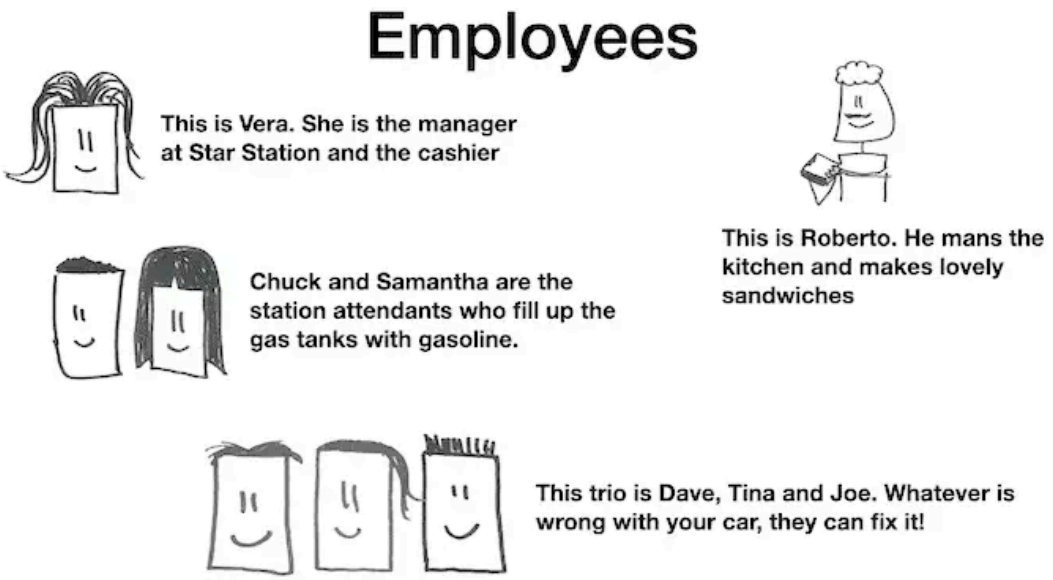
- The first step is to understand the business logic
- Without a proper understanding of business logic, we cannot design software.
- The business logic is also called `domain knowledge`.

- We can understand the business logic.
- We need to build software that tracks the names and salaries of employees.



The Request Details

- We have an Excel spreadsheet with all the information.



In the Real-World Situation

- We may not have well-defined requirements.
- It is because, **clients do not know what they need or want**: It is called: "unknown unknowns".
- However, we need to make requirements for designing software.

Unknown unknowns to known unknowns

- When they see the software, they begin to realize what they did not know.
- By building the software, we also begin to realize what we did not know.

Expect changes

- We should start expecting the requirements to change.
- We should build software that is designed to be changed.
- We should keep working with clients to get feedback.

Business Logic and Requirements

- It is not possible to deliver what users need without correct requirements.
- We must understand the system's business logic (problem domain) to obtain the correct requirements.

Business Logic in the Age of AI

- With vibe coding, anybody can make code.
- So, the shift is from implementation to design and architecture.
- Software engineers should also be experts in business logic.

Warning About Starting Without Requirements

- When we start a software project **without requirements** or a good understanding of business logic, we will be in deep trouble sooner or later.

- In this request for salary tracking software from Mr. Star, we can understand the business logic.
- We can translate Mr. Star's email into requirements.

Requirements

- Requirements are a set of descriptions of user requests.
- Requirements are the communication tool: clients and software engineers can agree upon the software to be delivered.

```
Requirements Version 1

– The software shows a list of the employees
with their salaries.
```

- According to this requirement, if we build software that shows a list of employees with their salaries, we will solve the problem.

User Stories

- However, the description is not accurate enough.
- We have a better way of writing down requirements with **user stories**.
    - It has the format: As a [WHO], I want [WHAT], so that [WHY].

- It identifies three pieces of information: **who** (line 1), **what** (line 2), and **why** (line 3) of the requirement.
- Now we are ready to start.

```
Requirements Version 2

1. As a "manager,"
2. I want to "see a list of the employees with their salaries,"
3. so that "I can easily understand what is going on."
```

Prototype (Version 0)

- Even though we have the requirements in the form of `User stories`, we still don't know what we don't know.
- We make version 0 software (prototype) to know what we don't know.

> GitHub repository
> ase420/code/OOP/v0-prototype

prototype-v1.py

- Marty already made a prototype.
- Marty does not know software design, so he made code with some smell.

```
1   names = ["Vera", "Chuck", "Samantha",
2            "Roberto", "Joe", "Dave", "Tina"]
3   salaries = [2000, 1800, 1800, 2100,
4                2000, 2200, 2300]
5
6   for n in names: print(n)
7   for s in salaries: print(s)
```

```
Vera
Chuck
Samantha
Roberto
Joe
Dave
Tina
2000
1800
1800
2100
2000
2200
```

- Marty already identified the problem in the code.

Dear Uncle,

this shows a list of your employees. And then it shows a list of all the salaries. Unfortunately I don't know how to connect the names and salaries and I'm late for school.

Your nephew,
Marty

Code smell

- Names and salaries are printed separately. There is no connection between the employee and their salary!

prototype-v2.py - Fixing the Connection

- We can address Marty's problem using the index.

```
1   count = len(names)
2   for c in range(count):
3       print(f"{names[c]}, ${salaries[c]}")
```

```
Vera, $2000
Chuck, $1800
Samantha, $1800
Roberto, $2100
Joe, $2000
Dave, $2200
Tina, $2300
```

We Hire Ringo, then What?

- We hire a new employee, Ringo, so we need to **change** our software.
- But we forgot to add Ringo's salary to the salaries list.

```
1  # Added Ringo
2  names = ["Vera", "Chuck", "Samantha",
3            "Roberto", "Joe", "Dave", "Tina", "Ringo"]
4  # OOPS! Forgot to update salaries
5  salaries = [2000, 1800, 1800, 2100, 2000, 2200, 2300]
6
7  count = len(names)
8  for c in range(count):
9      print(f"{names[c]}, ${salaries[c]}")
```

Ringo

prototype-v3-bug.py - The Error

- And we get an error message.
- Maybe we can easily fix the problem from the error message.

```
Traceback (most recent call last):
  File "/code/prototype/v3-bug.py", line 6, in <module>
    print (f" {names [c]}, ${salaries[c]}")
IndexError: list index out of range
```

Python - The pitfall

- Some static language compilers could find this error when we compile the code.
- Unfortunately, Python is a dynamic language; it does not execute that checking.
- We can find the error only when we run the code.

prototype-v3-bugfix.py

We add Ringo's salary to the list and solve this issue.

```
1  names = ["Vera", "Chuck", "Samantha",
2           "Roberto", "Joe", "Dave", "Tina", "Ringo"]
3  salaries = [2000, 1800, 1800, 2100, 2000, 2200, 2300, 1900]
4
5  count = len(names)
6  for c in range(count):
7      print(f"{names[c]}, ${salaries[c]}")
```

```
Vera, $2000
Chuck, $1800
Samantha, $1800
Roberto, $2100
Joe, $2000
Dave, $2200
Tina, $2300
Ringo, $1900
```

Joe Quits, then What?

- Joe quits.
- So, we need to **change** our software again.
- But again, we forgot to delete Joe's salary.

Joe

```
names = ["Vera", "Chuck", "Samantha", "Roberto", "Dave", "Tina", "Ringo"]
salaries = [2000, 1800, 1800, 2100, 2000, 2200, 2300, 1900]

count = len(names)
for c in range(count):
    print(f"{names[c]}, ${salaries[c]}")
```

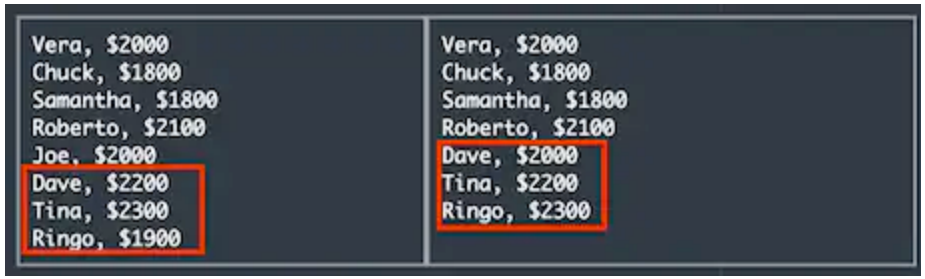
Code smell and the rule of three

- When one change impacts multiple parts of the code, it is a code smell.
- When we do the same thing three times, it is time to act.

prototype-v4-bug.py - Silent Bug

- When we check the output, we find something wrong.
- Problem: Dave shows Joe's salary ($2000), Tina shows Dave's salary ($2200), etc.

- We forgot to delete Joe from the salary list.
- This bug is **harder to find** than before because Python did not print out any error messages.



prototype-v4-bugfix.py

We deleted Joe's salary, and everything worked fine.

```
names = ["Vera", "Chuck", "Samantha", "Roberto", "Dave", "Tina", "Ringo"]
salaries = [2000, 1800, 1800, 2100, 2200, 2300, 1900] # fix
```

Change - the source of complexity

- Even when we finish our implementation, the problem domain keeps changing.
- We should make software in a way that can **meet changes effectively**.

Software Design - the tool for changes

- The current approach with separate lists is error-prone and hard to maintain.
- We need to design software to meet the changes.

More Changes are coming.

- Mr. Star likes the program but wants to add a **job title** to the report.

NAME	SALARY	JOB TITLE
Vera	2000	Manager
Chuck	1800	Attendant
Samantha	1800	Attendant
Roberto	2100	Cook
Dave	2200	Car Repair
Tina	2300	Car Repair
Ringo	1900	Car Repair

```
Vera, $2000, Manager
Chuck, $1800, Attendant
Samantha, $1800, Attendant
Roberto, $2100, Cook
Dave, $2200, Car repair
Tina, $2300, Car repair
Ringo, $1900, Car repair
```