Friedrich-Alexander-Universität
Technische Fakultät

Department of Computer Science
Computer Science 6
(Data Management)

Knowledge Discovery in Databases with Exercises
Summer Semester 2025

Exercise Sheet 3:
Frequent Patterns

About this Exercise Sheet

This exercise sheet focuses on the content of lecture *6. Mining Frequent Patterns, Associations and Correlations*.

It includes both a practical data science exercise (Exercise 1) and theoretical exercises on Apriori (Exercise 2) and FP-growth (Exercise 3).

The exercise sheet is designed for a two-week period, during which the tasks can be completed flexibly (Exercise 1 is planned for the first exercise session, and Exercises 2 and 3 for the second session).

The sample solution will be published after the two weeks have elapsed.

Preparation

Before participating in the exercise, you must prepare the following:

1. **Install Python and pip on your computer**
   - Detailed instructions can be found in `1-Introduction-Python-Pandas.pdf`.
2. **Download provided additional files**
   - Download `Additional-Files-Student.zip` from StudOn
   - Extract it to a folder of your choice.
3. **Install required Python packages**
   - Open a terminal and navigate to the folder where you extracted the files.
   - Run the command `pip install -r requirements.txt` within the extracted additional files folder to install the required Python packages.

Exercise 1: Mining Frequent Patterns

This exercise comprises practical data science tasks and thus utilizes a Jupyter Notebook:

1. Open `Mining-Frequent-Patterns.ipynb`.
2. Take a look at the tasks (blue boxes) in the notebook and try to solve them.

If you are unfamiliar with how to open a Jupyter Notebook, please refer to Exercise 1 of `1-Introduction-Python-Pandas.pdf`.

The solution to the exercise can be found in `Additional-Files-Solution.zip`.

Exercise 2: Apriori

Given is a **transactional dataset**:

ID	Transaction
1	Apple, Banana, Cherry
2	Banana, Cherry
3	Cherry, Apple
4	Dragonfruit, Apple, Banana
5	Apple, Dragonfruit

Use **Apriori** to find all frequent itemsets for a **minimum support count** of **2**.

Write down **all** intermediate steps.

1. **Count the occurrences of each 1-itemset**:

   Each item that occurs in the dataset is a 1-itemset:

   - Apple: 4
   - Banana: 3
   - Cherry: 3
   - Dragonfruit: 2

2. **Prune non-frequent 1-itemsets**:

   All 1-itemsets have a support count of at least 2. Therefore, all 1-itemsets are frequent.

3. **Generate length-2 candidate itemsets**:

   The candidate itemsets are generated by combining all the frequent 1-itemsets:

   - Apple, Banana
   - Apple, Cherry
   - Apple, Dragonfruit
   - Banana, Cherry
   - Banana, Dragonfruit
   - Cherry, Dragonfruit

4. **Count the occurrences of each length-2 candidate itemset**:
    - Apple, Banana: 2
    - Apple, Cherry: 2
    - Apple, Dragonfruit: 2
    - Banana, Cherry: 2
    - Banana, Dragonfruit: 1
    - Cherry, Dragonfruit: 0
5. **Prune non-frequent length-2 candidate itemsets**:

    The length-2 candidate itemsets that have a support count of at least 2 are:
    - Apple, Banana
    - Apple, Cherry
    - Apple, Dragonfruit
    - Banana, Cherry
6. **Generate length-3 candidate itemsets**:

    The candidate itemsets are generated by combining all the frequent length-2 itemsets:
    - Apple, Banana, Cherry

    This length-3 itemset contains the frequent length-2 itemsets „Apple, Banana“ and „Banana, Cherry“, and „Apple, Cherry“ and is the only valid length-3 candidate.

    Common Mistake: *A common mistake is that „Apple, Banana, Dragonfruit“, „Apple, Cherry, Dragonfruit“, and „Banana, Cherry, Dragonfruit“ are generated as length-3 candidates. These 3-itemsets each contain at least one non-frequent 2-itemset (e.g „Apple, Banana, Dragonfruit“ contains „Banana, Dragonfruit“) and are therefore not valid length-3 candidates.*
7. **Count the occurrences of the length-3 candidate itemset**:
    - Apple, Banana, Cherry: 1
8. **Prune non-frequent length-3 candidate itemsets**:

    „Apple, Banana, Cherry“ has a support count of 1, which is below the minimum support count of 2. Therefore, there are no frequent length-3 itemsets.
9. **Generate length-4 candidate itemsets**:

    There are no frequent length-3 itemsets, so there are no valid length-4 candidates.
10. **Termination**:

    The algorithm terminates because there are no length-4 candidates.

Result:
The frequent itemsets for a minimum support count of 2 are:

1. Apple
2. Banana
3. Cherry
4. Dragonf.
5. Apple, Banana
6. Apple, Cherry
7. Apple, Dragonf.
8. Banana, Cherry

Exercise 3: FP-growth

Given is a **transactional dataset**:

ID	Transaction
1	Apple, Banana
2	Banana, Cherry
3	Cherry, Apple
4	Apple, Banana
5	Apple, Dragonfruit

Use **FP-growth** to find all frequent itemsets for a **minimum support count** of **2**.

Write down **all** intermediate steps. This **includes** the header table for each FP-tree.

1. **Count the occurrences of each 1-itemset**:

   Each item that occurs in the dataset is a 1-itemset:

   - Apple: 4
   - Banana: 3
   - Cherry: 2
   - Dragonfruit: 1

2. **Prune non-frequent 1-itemsets**:

   The 1-itemsets that have a support count of at least 2 are:

   - Apple: 4
   - Banana: 3
   - Cherry: 2

3. **Create the f-list for our dataset**:

   The f-list is created by sorting the 1-itemsets in descending order of their support count:

   - Apple → Banana → Cherry

4. **Order the items in the transactions according to the f-list**:

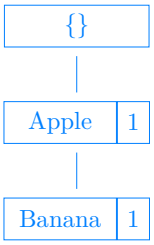
   Additionally, non frequent items are removed from the transactions:

ID	Transaction
1	Apple, Banana
2	Banana, Cherry
3	Apple, Cherry
4	Apple, Banana
5	Apple

5. **Create the initial FP-tree**:

The initial FP-tree is created by inserting the items of each transaction into the tree:

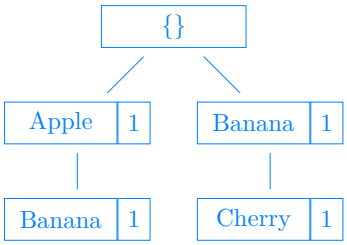
a) **Insert the first transaction (Apple, Banana)**:



Header table:

Item	Freq.	Nodes
Apple	1	1
Banana	1	1
Cherry	0	0

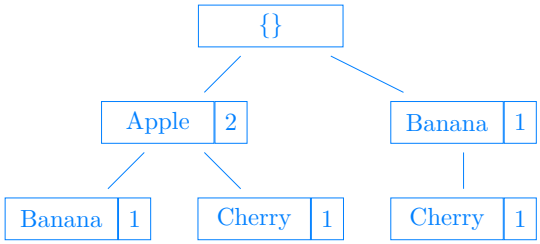
b) **Insert the second transaction (Banana, Cherry)**:



Header table:

Item	Freq.	Nodes
Apple	1	1
Banana	2	2
Cherry	1	1

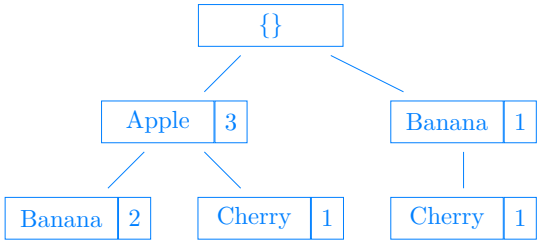
c) **Insert the third transaction (Apple, Cherry)**:



Header table:

Item	Freq.	Nodes
Apple	2	1
Banana	2	2
Cherry	2	2

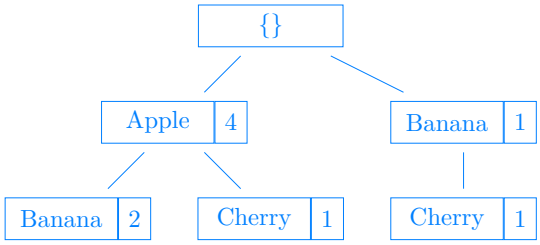
d) **Insert the fourth transaction (Apple, Banana)**:



Header table:

Item	Freq.	Nodes
Apple	3	1
Banana	3	2
Cherry	3	3

e) **Insert the fifth transaction (Apple)**:



Header table:

Item	Freq.	Nodes
Apple	4	1
Banana	3	2
Cherry	2	2

6. **Determine the conditional pattern base for each frequent item in the header tables of the FP-tree**:

   a) **Conditional pattern base for Apple**:

   Apple is the direct child of the root node, so the conditional pattern base for Apple is empty.

   b) **Conditional pattern base for Banana**:

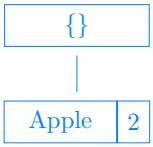
   - Apple: 2

   c) **Conditional pattern base for Cherry**:

   - Apple: 1
   - Banana: 1

7. **Create the conditional FP-trees**:

   a) **Conditional FP-tree for Banana**:

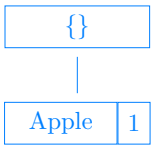


Header table:

Item	Freq.	Nodes
(Banana,) Apple	2	1

   b) **Conditional FP-tree for Cherry**:

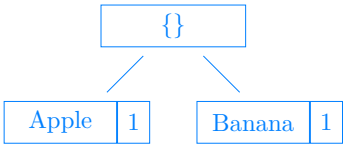
   i. **Insert „Apple: 1“**:



Header table:

Item	Freq.	Nodes
(Cherry,) Apple	1	1
(Cherry,) Banana	0	0

   ii. **Insert „Banana: 1“**:



Header table:

Item	Freq.	Nodes
(Cherry,) Apple	1	1
(Cherry,) Banana	1	1

8. **Determine the conditional pattern base for each frequent itemset in the header tables of the conditional FP-trees**:

   a) **Conditional pattern base for „Banana, Apple“**:

   Apple is the direct child of the root node, so the conditional pattern base is empty.

9. **Termination**:

   The algorithm terminates because there are no more conditional FP-trees to create.

Result:
The frequent itemsets for a minimum support count of 2 are:

1. Apple
2. Banana
3. Cherry
4. Banana, Apple