Data Mining

ASSOCIATION RULE MINING
FINDING FREQUENT PATTERN
APRIORI ALGORITHM

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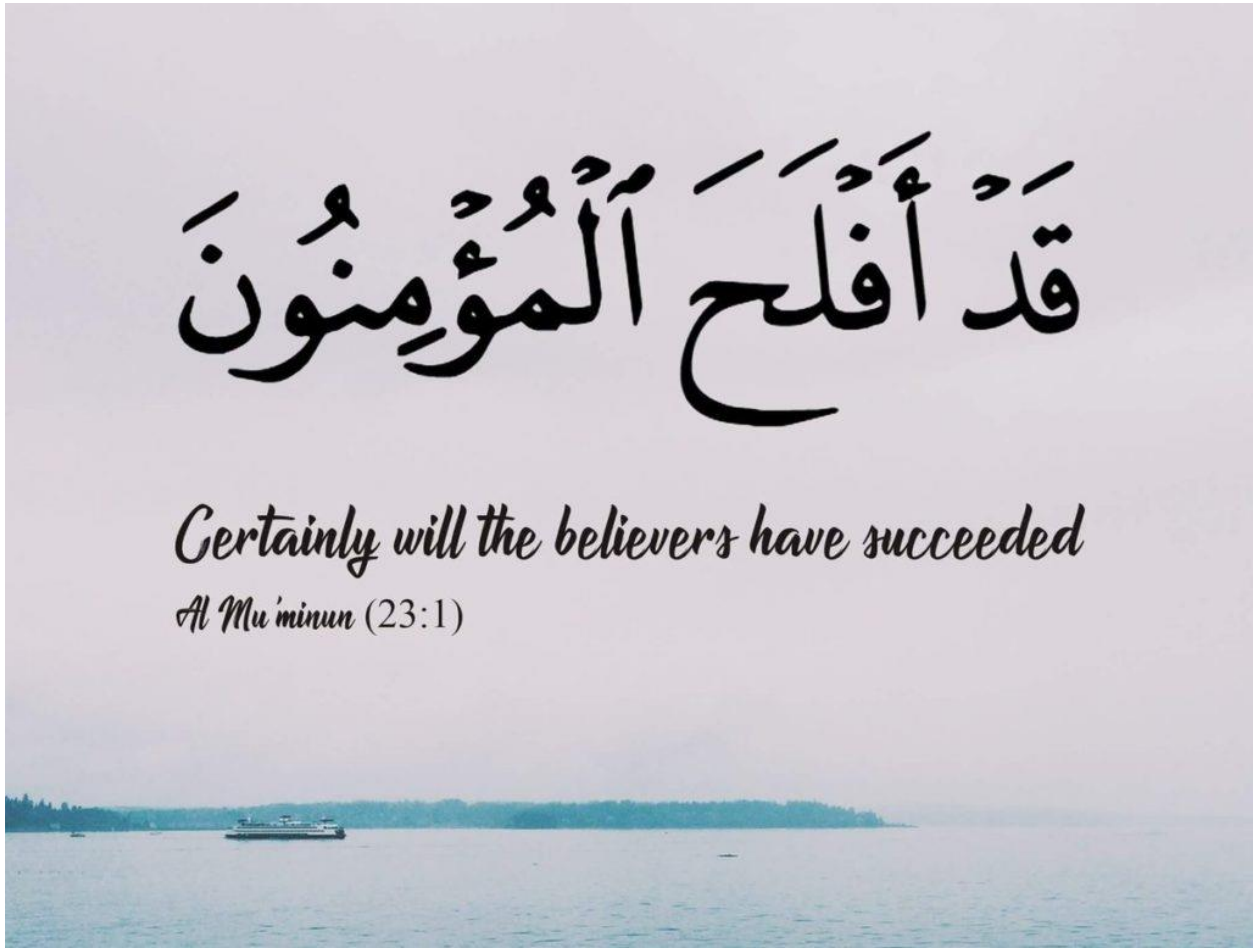
Lesson from Holy Quran



MARKET BASKET ANALYSIS

98% of people who purchased items A and B also purchased item C

Observe the table

1.Check the frequent items?

2. Which items are frequent wrt other items?

3. This makes Pattern.

Transaction-id	Items bought
10	A, B, D
20	A, C, D
30	A, D, E
40	B, E, F
50	B, C, D, E, F

What Is Frequent Pattern Analysis?

- Frequent Occurances: a pattern
- **What is a Pattern?**
- (a set of items, subsequences, substructures, etc.) that occurs frequently in a data set
- **History**
- First proposed by Agrawal, Imielinski, and Swami [AIS93] in the context of two concepts, we study here
  - Finding Frequent Itemsets
  - Finding Association Rule.

What Is Frequent Pattern Analysis?

- **Motivation: Finding inherent regularities in data**
  - What products were often purchased together?—
    - E.g., Milk and Bread
  - What are the subsequent purchases after buying a PC?
    - Peripheral devices
  - What kinds of DNA are sensitive to this new drug?
  - Can you add more examples???

Applications

- Basket data analysis,
  - cross-marketing/sale campaign analysis,
- Document Analysis
- Web Analysis
  - Usage Analysis (Log (click stream) analysis)
  - Content Analysis (C0-Occurance of)
  - Structure Analysis (
- Expert Group Finding
- Social Network Analysis
  - Similar Interest Finding
  - Terrorist Network

Document analysis

- **A text document data set. Each document is treated as a "bag" of keywords**

doc1: Student, Teach, School

doc2: Student, School

doc3: Teach, School, City, Game

doc4: Baseball, Basketball

doc5: Basketball, Player, Spectator

doc6: Baseball, Coach, Game, Team

doc7: Basketball, Team, City, Game

Support & Confidence

- Itemset X = $\{x_1, \ldots, x_k\}$
- Find all the rules *X* → *Y* with minimum support and confidence
  - support, *s*, probability that a transaction contains X ∪ Y
  - confidence, *c*, conditional probability that a transaction having X also contains *Y*

Transaction-id	Items bought
10	A, B, D
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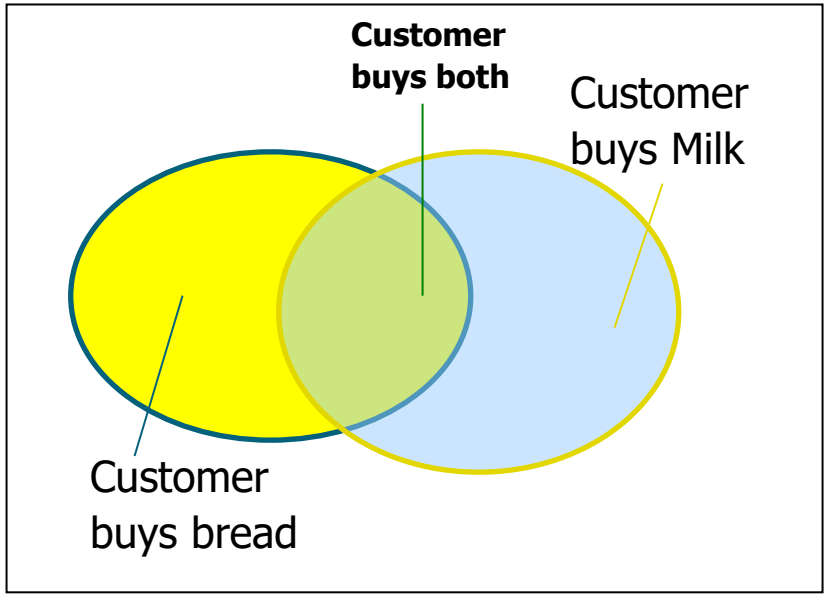
Let sup_{min} *= 50%,* $conf_{min}$ *= 50%*
Freq. Pat.: {A:3, B:3, D:4, E:3, AD:3}
Association rules:

A → *D* (60%, 100%)
D → *A* (60%, 75%)



An example

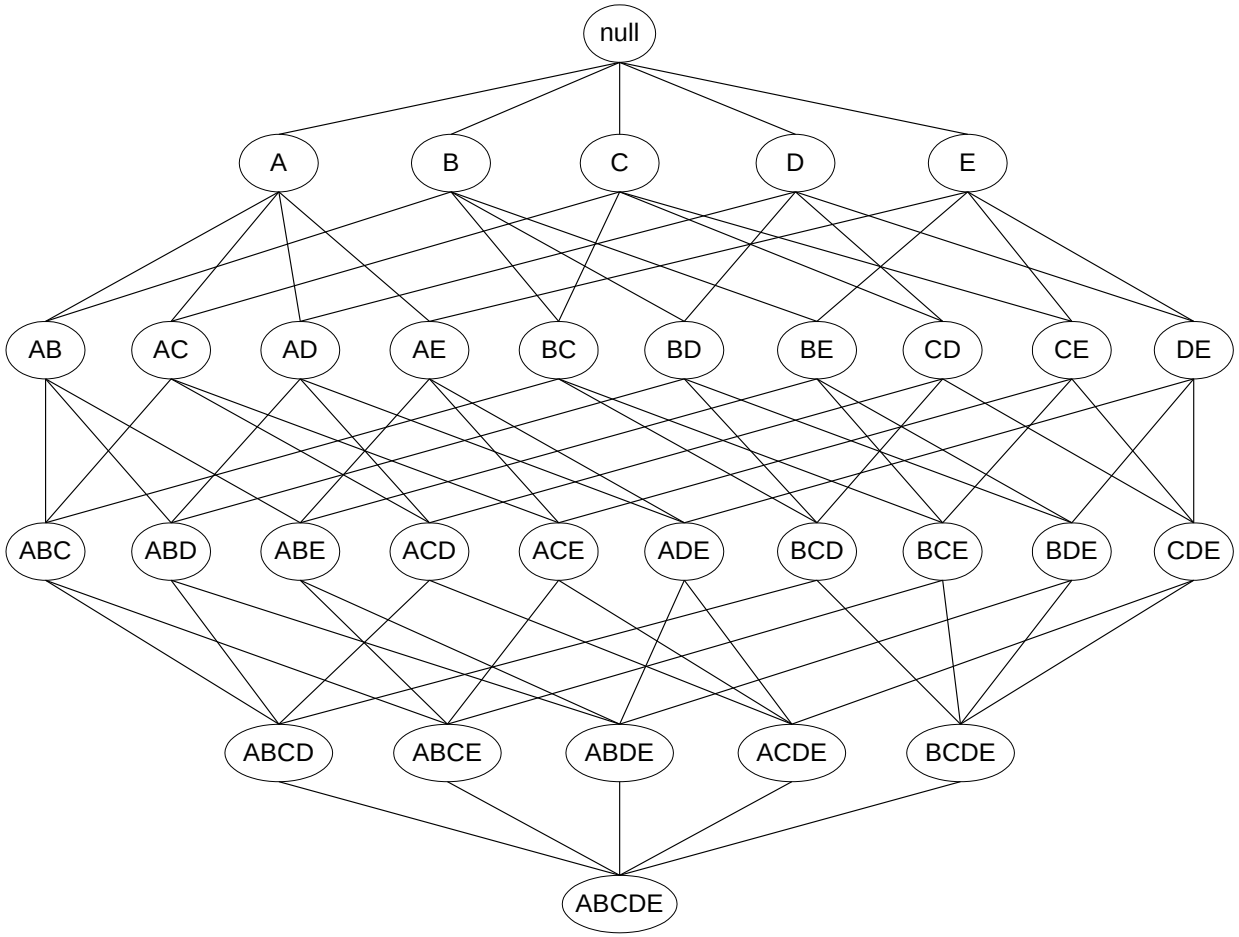
- Take Transaction data
- An example frequent *itemset*: {Chicken, Clothes, Milk}

Find the support of this frequent itemset

Assume any rule and find its Confidence

t1: Beef, Chicken, Milk
t2: Beef, Cheese
t3: Cheese, Boots
t4: Beef, Chicken, Cheese
t5: Beef, Chicken, Clothes, Cheese, Milk
t6: Chicken, Clothes, Milk
t7: Chicken, Milk, Clothes

How many itemsets are there?



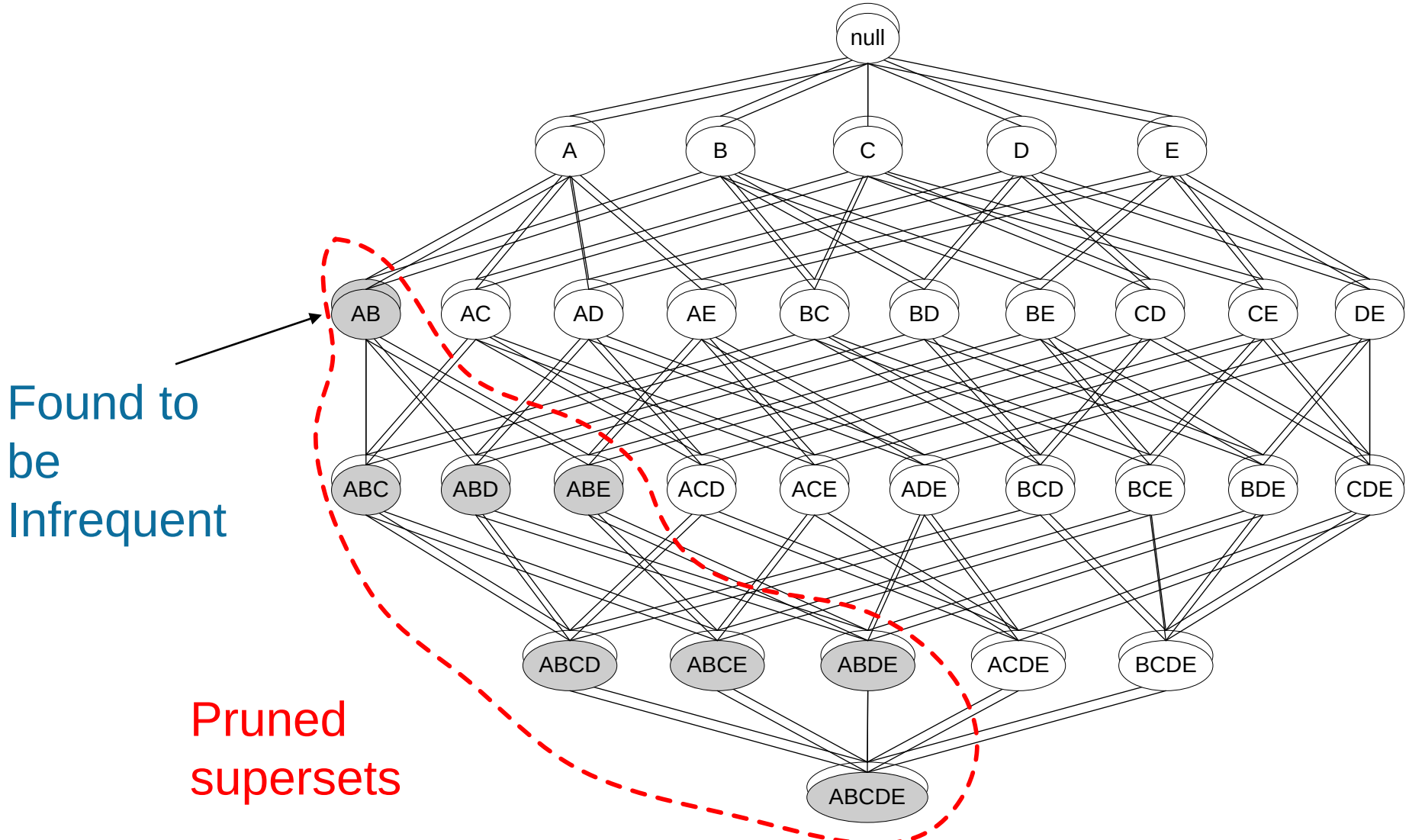
Given d items, there are 2^d possible itemsets

Apriori Principle

- How to avoid to many computations?
- Solution:
  - Apriori Pruning principle

- Apriori pruning principle: If there is any itemset which is infrequent, its superset should not be generated/tested! Method:

Illustrating the Apriori principle



The Apriori Algorithm—An Example

Database TDB

Tid	Items
10	A, C, D
20	B, C, E
30	A, B, C, E
40	B, E

1^{st} scan →

$Sup_{min} = 2$

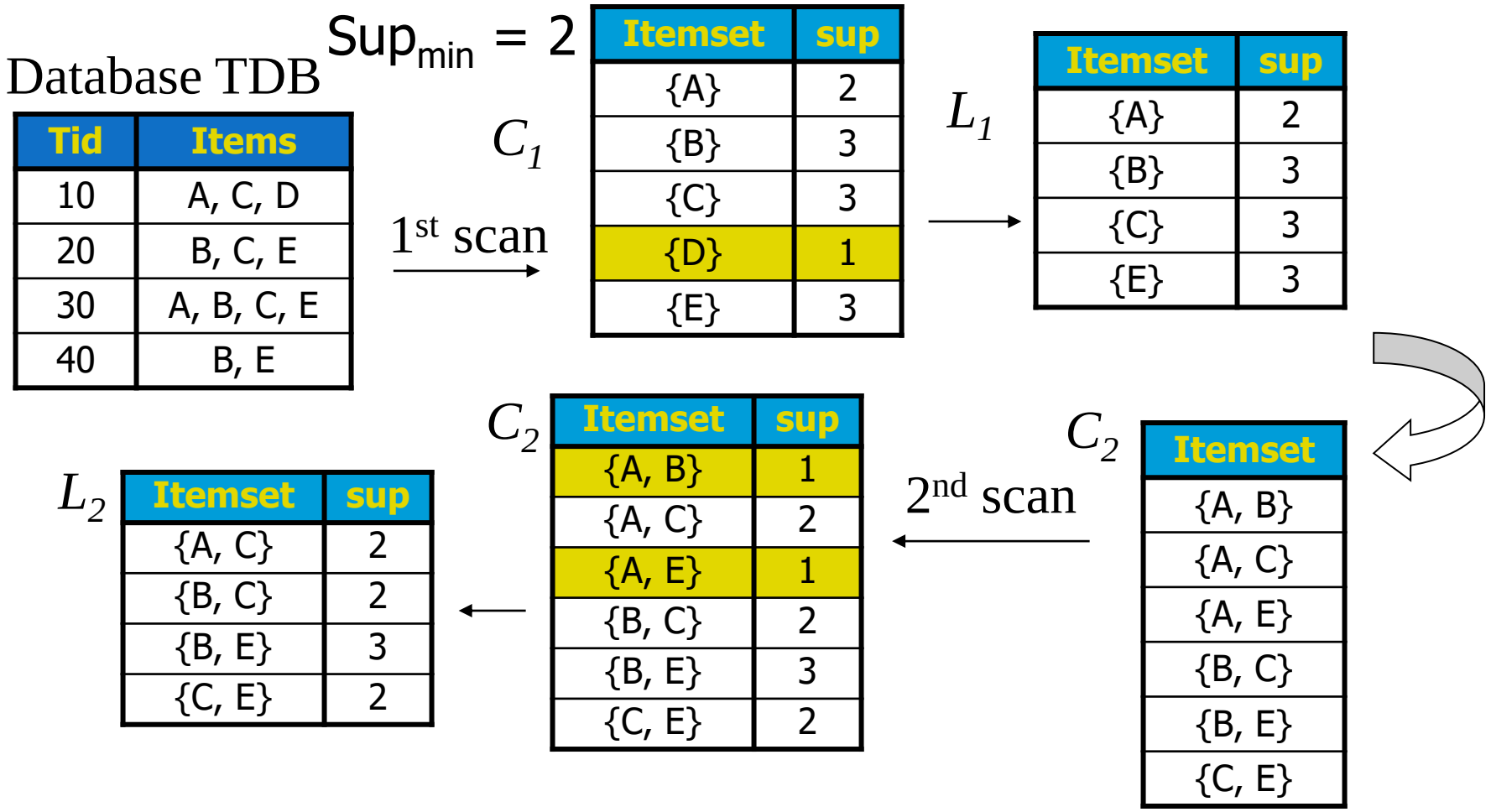
C_1

Itemset	sup
{A}	2
{B}	3
{C}	3
{D}	1
{E}	3

L_1 →

Itemset	sup
{A}	2
{B}	3
{C}	3
{E}	3

The Apriori Algorithm—An Example



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{D}	1
{E}	3

L_1

Itemset	sup
{A}	2
{B}	3
{C}	3
{E}	3

C_2

Itemset
{A, B}
{A, C}
{A, E}
{B, C}
{B, E}
{C, E}

2nd scan

C_2

Itemset	sup
{A, B}	1
{A, C}	2
{A, E}	1
{B, C}	2
{B, E}	3
{C, E}	2

L_2

Itemset	sup
{A, C}	2
{B, C}	2
{B, E}	3
{C, E}	2

C_3

Itemset
{B, C, E}

3rd scan

L_3

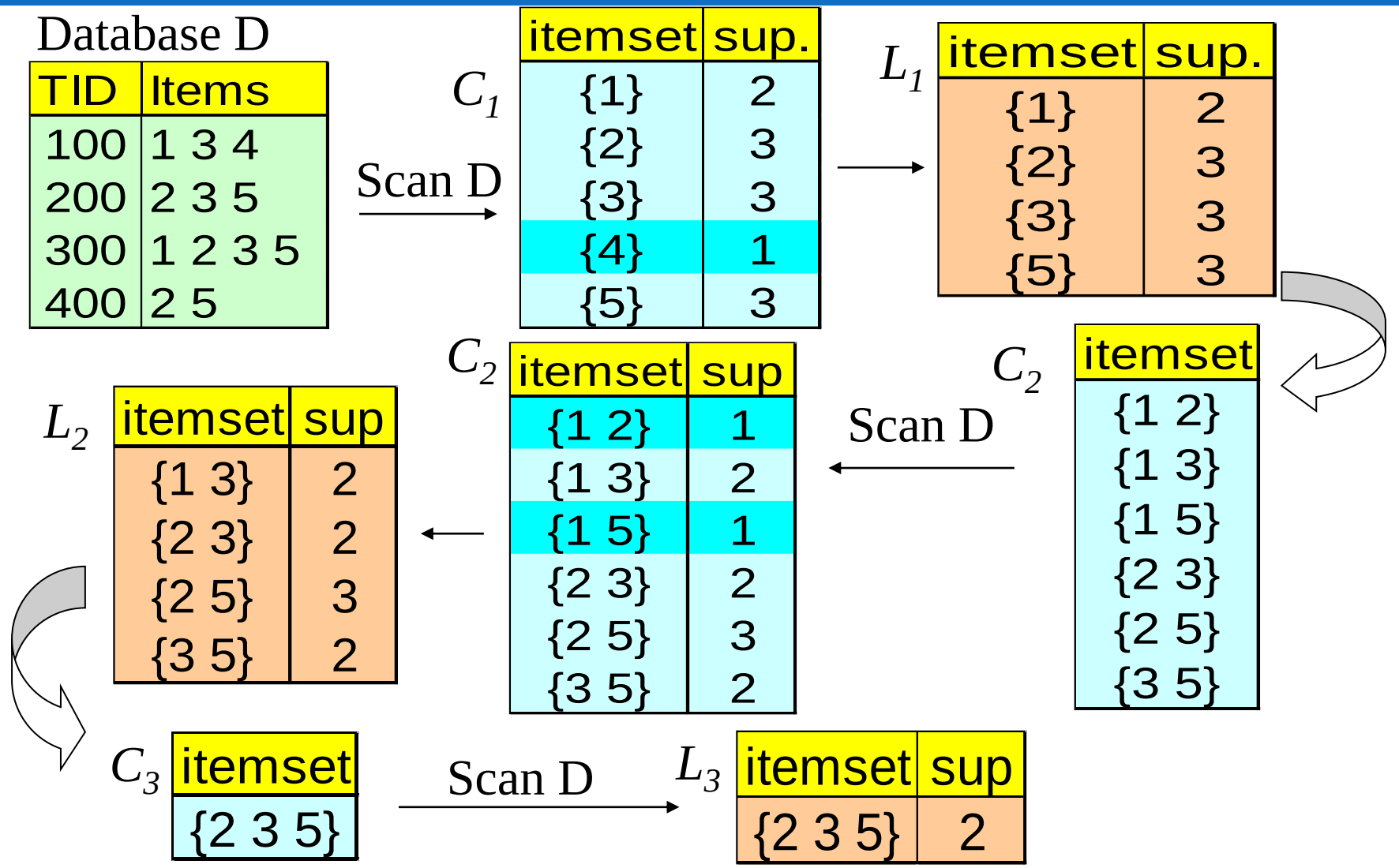
Itemset	sup
{B, C, E}	2

The Apriori Algorithm — Exercise

Database D

TID	Items
100	1 3 4
200	2 3 5
300	1 2 3 5
400	2 5

The Apriori Algorithm — Exercise Solved



The Apriori Algorithm (Pseudo-Code)

C_k: Candidate itemset of size k

L_k : frequent itemset of size k

L_1 = {frequent items};

for (k = 1; L_k !=∅; k++) **do begin**

  C_{k+1} = candidates generated from L_k;

  for each transaction t in database do

    increment the count of all candidates in C_{k+1} that are contained in t

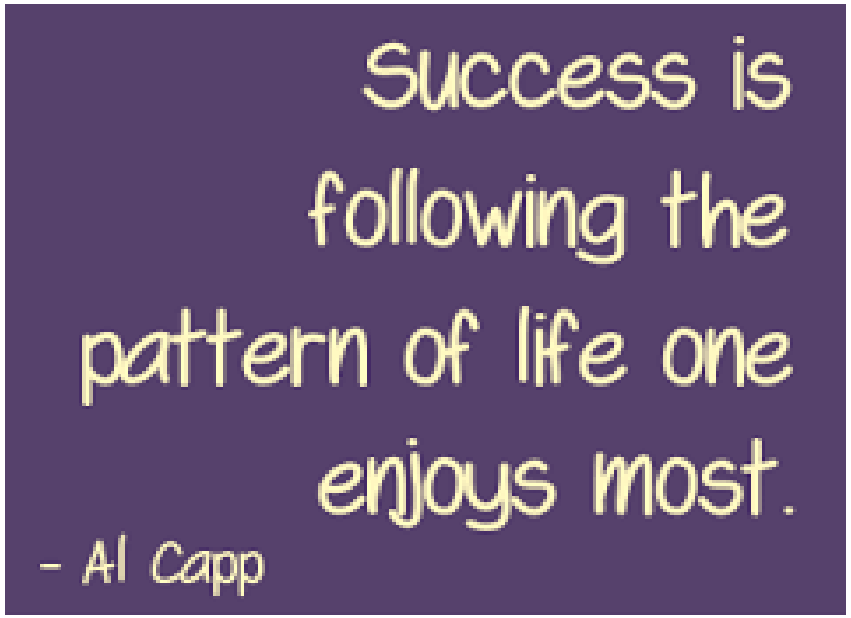
  L_{k+1} = candidates in C_{k+1} with min_support

  end

return $\cup_k L_k$;

Implementation of Apriori: Optional but recommended

- Options
- Languages
  - Python/R
- API/Libraries
- Python/R


Success is following the pattern of life one enjoys most.
- Al Capp