ASSOCIATION RULE MINING

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FREQUENT ITEMSET GENERATION

- Brute-force approach:
  - Each itemset in the lattice is a candidate frequent itemset
  - Count the support of each candidate by scanning the database

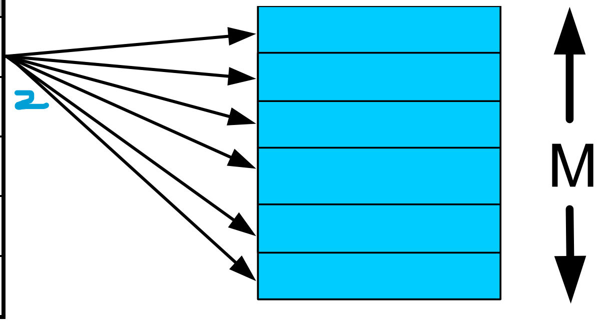
Transactions

TID	*Items*
1	Bread, Milk
2	Bread, Diaper, Beer, Eggs
3	Milk, Diaper, Beer, Coke
4	Bread, Milk, Diaper, Beer
5	Bread, Milk, Diaper, Coke

N

w

msup= **List of Candidates**



  - Match each transaction against every candidate
  - Complexity ~ O(NMw) => Expensive since $M = 2^d$!!!

FREQUENT ITEMSET GENERATION STRATEGIES

- Reduce the number of candidates (M)
  - Complete search: $M=2^d$
  - Use pruning techniques to reduce M

Transactions

N

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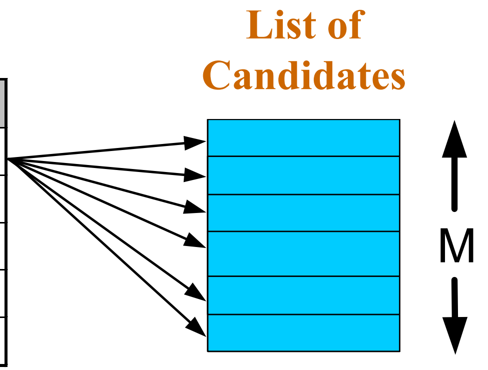

- Reduce the number of transactions (N)
  - Reduce size of N as the size of itemset increases
  - Used by DHP and vertical-based mining algorithms

Given a transaction {B, M, D, C}, find all possible subset with size 3 from this transaction.

- Reduce the number of comparisons (NM)
  - Use efficient data structures to store the candidates or transactions
  - No need to match every candidate against every transaction

REDUCING NUMBER OF CANDIDATES

- Apriori principle:
  - If an itemset is frequent, then all of its subsets must also be frequent
- Apriori principle holds due to the following property of the support measure:

$$\forall X, Y : (X \subseteq Y) \Rightarrow s(X) \geq s(Y)$$

  - Support of an itemset never exceeds the support of its subsets
  - This is known as the anti-monotone property of support

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Support (ratio)
s({Milk, Bread, Diaper}) = 2/5 = # itemsets / total # of transaction $= \frac{2}{5}$

σ

Support count: # of the itemsets that show in the transaction $= 2$

Confidence $= \frac{\# X \cup Y}{\# X} = \frac{2}{3}$

$s = \frac{\sigma}{\underline{totalT}}$

$X = \{M, B\}$

$Y = \{D\}$

$X \rightarrow Y$

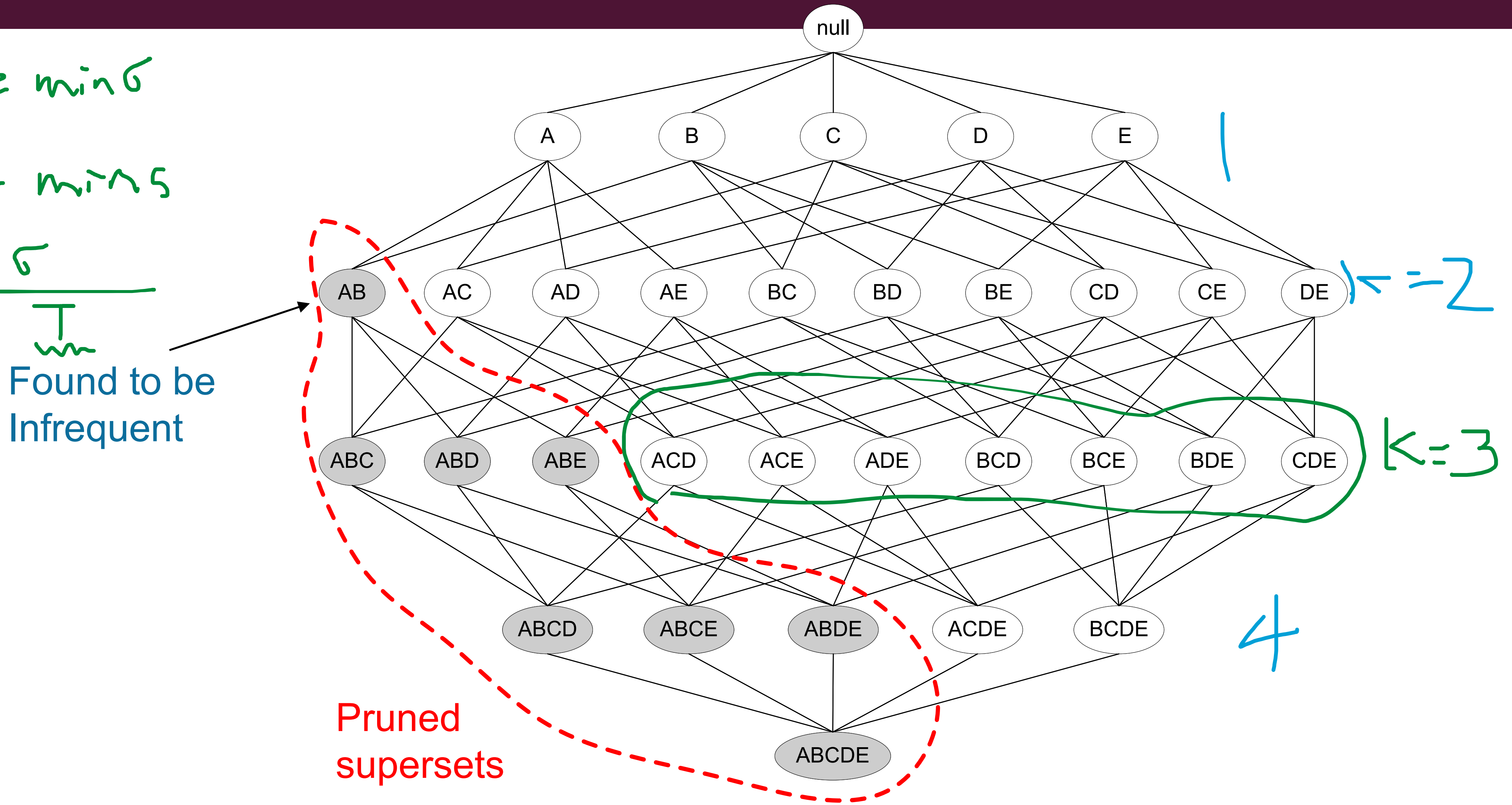
$X \cup Y = \{M, B, D\}$

ILLUSTRATING APRIORI PRINCIPLE

$\sigma \geq min\sigma$

$s \geq mins$

$s = \dfrac{\sigma}{T}$



SUPPORT COUNTING OF CANDIDATE ITEMSETS

- To reduce number of comparisons, store the candidate itemsets in a hash structure / hash function
  - Instead of matching each transaction against every candidate, match it against candidates contained in the hashed buckets

Transactions

N

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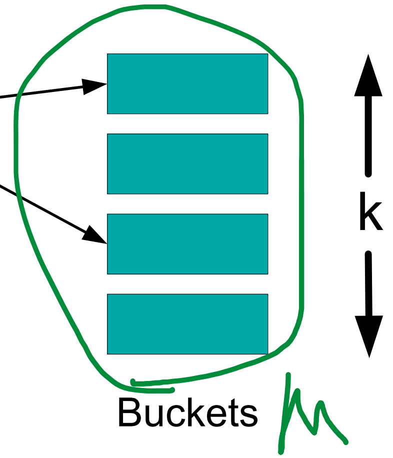
Hash Structure



N.M

SUPPORT COUNTING: AN EXAMPLE

Suppose you have 15 candidate itemsets of length 3: → Reduce M from Apriori Alg

{1 4 5}, {1 2 4}, {4 5 7}, {1 2 5}, {4 5 8}, {1 5 9}, {1 3 6}, {2 3 4}, {5 6 7}, {3 4 5}, {3 5 6}, {3 5 7}, {6 8 9}, {3 6 7}, {3 6 8}

How many of these itemsets are supported by transaction (1,2,3,5,6)?

itemsets pruned

N

1

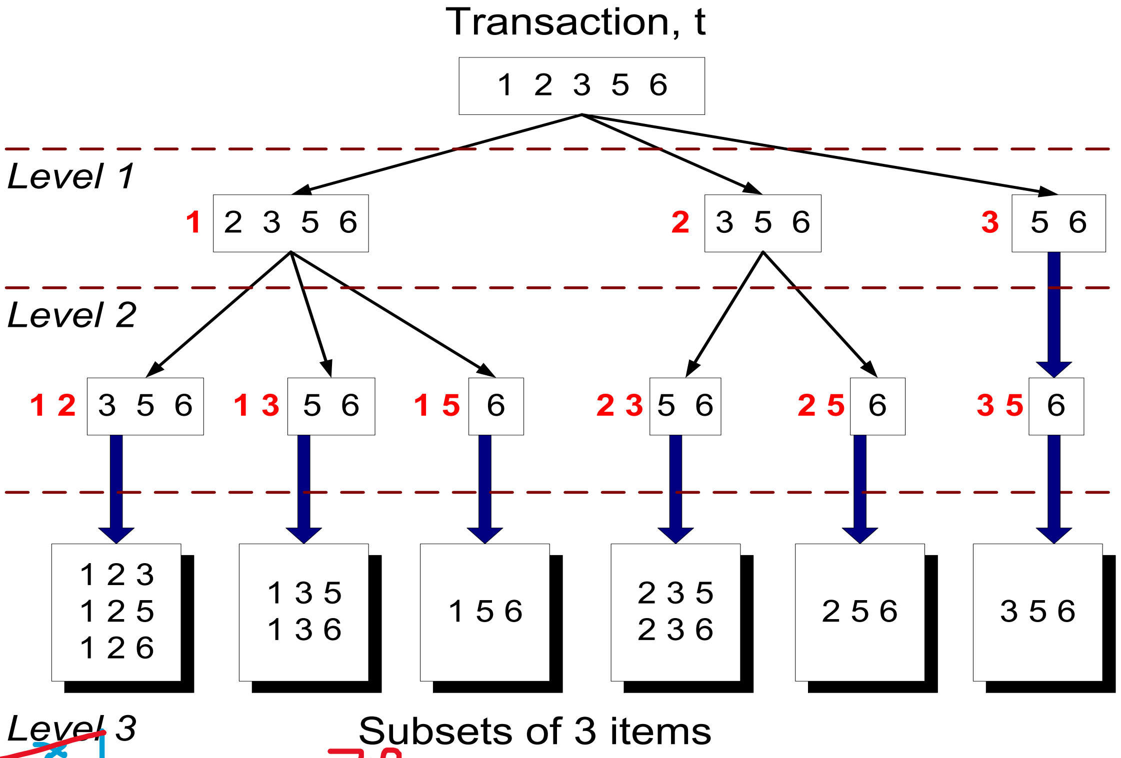
5 | 1 2 3 5 6

M

1 4 5

1 2 4

k = 3



$$C^n_r = C^5_3 = \frac{n!}{r!\,(n-r)!} = \frac{5!}{3!\,2!} = \frac{5\times4\times\cancel{3\times2\times1}}{\cancel{3\times2\times1}\cdot 2\times1} = \frac{20}{2} = 10$$

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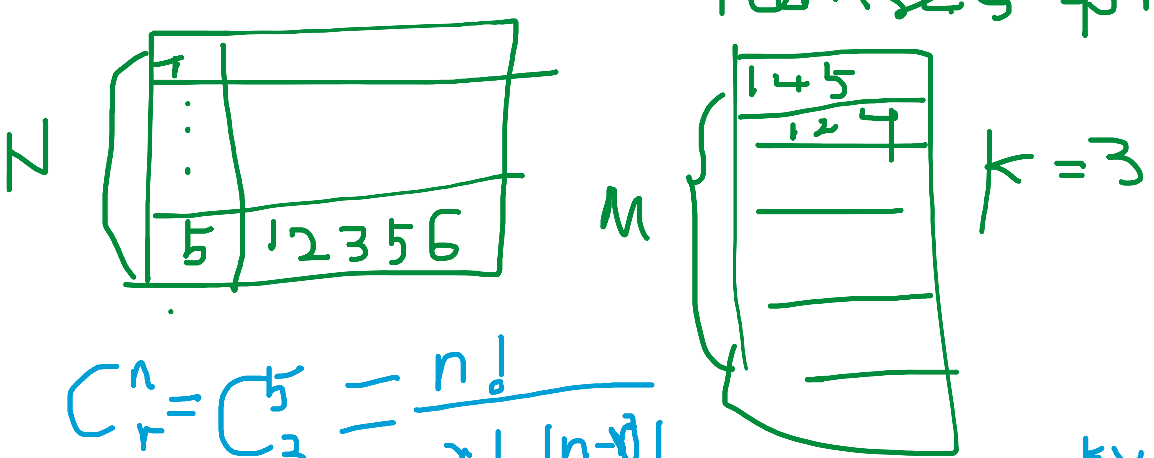
{1 4 5}, {1 2 4}, {4 5 7}, {1 2 5}, {4 5 8}, {1 5 9}, {1 3 6}, {2 3 4}, {5 6 7}, {3 4 5}, {3 5 6}, {3 5 7}, {6 8 9}, {3 6 7}, {3 6 8}

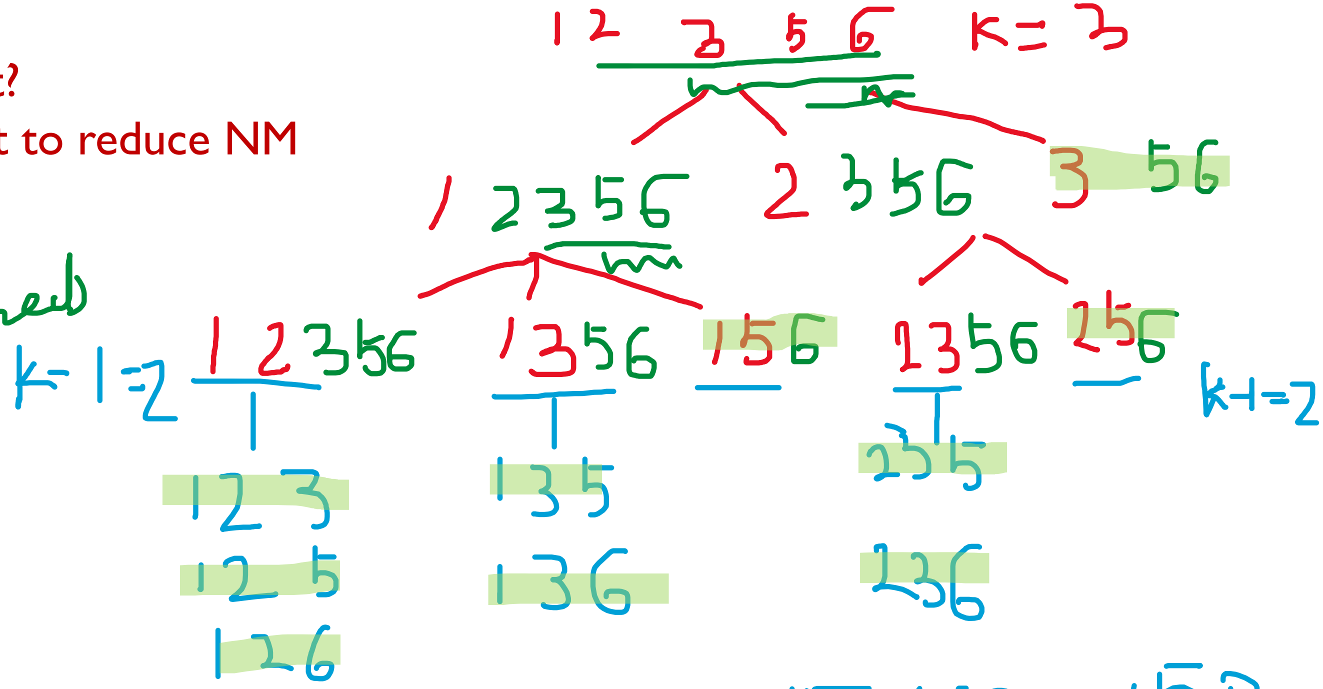
How to find all the subsets with k items from an itemset?

Given an itemset {1,2,3,5,6} ⇔ one transaction, we want to reduce NM

How many of these itemsets are supported by transaction (1,2,3,5,6)?

itemsets pruned





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$$15\times10=150$$