

The background of the slide is a complex, abstract composition. It features a dark, muted purple or brownish background. Overlaid on this are several geometric and data-like elements: a network of thin, light-colored lines forming a web-like structure; numerous small, green and blue dots scattered across the field; and a series of faint, light-colored plus signs arranged in a grid-like pattern. In the upper left, there's a horizontal band with some faint, illegible text or symbols. In the lower left, there's a small, rectangular inset showing a cluster of orange and red dots. The overall aesthetic is technical and data-driven.

Session 4: Mining Negative Correlations

Rare Patterns vs. Negative Patterns

❑ Rare patterns

- ❑ Very low support but interesting (e.g., buying Rolex watches)
- ❑ How to mine them? Setting individualized, group-based min-support thresholds for different groups of items

❑ Negative patterns

- ❑ Negatively correlated: Unlikely to happen together
- ❑ Ex.: Since it is unlikely that the same customer buys both a **Ford Expedition** (an SUV car) and a **Ford Fusion** (a hybrid car), buying a **Ford Expedition** and buying a **Ford Fusion** are likely negatively correlated patterns
- ❑ How to define negative patterns?

Defining Negative Correlated Patterns

- A support-based definition
 - If itemsets A and B are both frequent but rarely occur together, i.e.,
 $\text{sup}(A \cup B) \ll \text{sup}(A) \times \text{sup}(B)$
 - Then A and B are negatively correlated
- Is this a good definition for large transaction datasets?
- Ex.: Suppose a store sold two needle packages A and B 100 times each, but only one transaction contained both A and B
 - When there are in total 200 transactions, we have
 - $s(A \cup B) = 0.005, s(A) \times s(B) = 0.25, s(A \cup B) \ll s(A) \times s(B)$
 - But when there are 10^5 transactions, we have
 - $s(A \cup B) = 1/10^5, s(A) \times s(B) = 1/10^3 \times 1/10^3, s(A \cup B) > s(A) \times s(B)$
 - What is the problem?—Null transactions: The support-based definition is not null-invariant!

Does this remind you the definition of *lift*?

Defining Negative Correlation: Need Null-Invariance in Definition

- ❑ A good definition on negative correlation should take care of the null-invariance problem
 - ❑ Whether two itemsets A and B are negatively correlated should not be influenced by the number of null-transactions
- ❑ A Kulczynski measure-based definition
 - ❑ If itemsets A and B are frequent but $(P(A|B) + P(B|A))/2 < \epsilon$, where ϵ is a negative pattern threshold, then A and B are negatively correlated
- ❑ For the same needle package problem:
 - ❑ No matter there are in total 200 or 10^5 transactions
 - ❑ If $\epsilon = 0.01$, we have $(P(A|B) + P(B|A))/2 = (0.01 + 0.01)/2 < \epsilon$