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## Exercise 1

a) The single attribute cannot uniquely identify all rows.

The combinations of (A, B), (B, C) and (A, C, D) can uniquely identify all rows as a minimal set of attributes.

Then we can choose (A, B) or (B, C) or (A, C, D) as a key.

b) The key (A, B) can be a reasonable choice for a production database.

Since the attribute user_order_id can be assumed to be unique among orders by the same user.

And the combination can uniquely identify a tuple.

## Exercise 2:

a) $\pi_{city}(Store)$

b) $\sigma_{city = 'Bonn' \vee 'Berlin'}(Store)$

c) $\pi_{name}((\rho_{store\_id \leftarrow id}(\sigma_{city = 'Bochum'}(store)) \bowtie Sold\_in \bowtie (\rho_{product\_id \leftarrow id}(product))))$

d) $\pi_{customer\_id}(\sigma_{name = 'pizza'}(order \bowtie (\rho_{product\_id \leftarrow id}(product)) \bowtie (\rho_{customer\_id}(customer))))$

e) $\pi_{customer\_id}((\pi_{customer\_id, product\_id}(order)) \div (\rho_{product\_id \leftarrow id}(\pi_{id}(product)))) \bowtie (\rho_{customer\_id \leftarrow id}(customer))$