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**Answer 1:**

**a)**

license: have a driver license ^license: have no driver license

wheel: want to own a balance wheel ^wheel: do not want to own a balance wheel

selfie: like selfie ^selfie: dislike selfie

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | wheel | selfie | ^wheel | ^selfie | wheel, selfie | wheel, ^selfie | ^wheel, selfie | ^wheel, ^selfie |
| license | 3250 | 3750 | 1750 | 1250 | 2500 | 750 | 1250 | 500 |
| ^license | 2750 | 4000 | 2250 | 1000 | 2250 | 500 | 1750 | 500 |
| sum | 6000 | 7750 | 4000 | 2250 | 4750 | 1250 | 3000 | 1000 |

Support >= 5% means >=500 records, because all counts of itemsets are more than 500, except some unmeaning items which have 0 counts, such as “wheel, ^wheel”, we can draw the below strong association rules according above table:

|  |  |
| --- | --- |
| Rule | Confidence |
| wheel, selfie → license | 2500/4750 ≈ 52.6% |
| ^wheel, ^selfie → license | 500/1000 = 50% |
| wheel, ^selfie → license | 750/1250 = 60% |
| ~~^wheel, selfie → license~~ | ~~1250/3000 ≈ 41.7~~ |

Note: the confidence of last row is less than 50%, so remove it

**b)**

Interest(wheel, selfie → license) = conf(wheel, selfie → license) \* = 0.526 \* 2 = 1.052

Interest(^wheel, ^selfie → license) = conf(^wheel, ^selfie → license) \* = 0.5 \* 2 =1

Interest(wheel, ^selfie → license) = conf(wheel, ^selfie → license) \* = 0.6 \* 2 = 1.2

**c)**

In part (a), we can find the confidence of “wheel, ^selfie → license” is the largest one, so “wheel, ^selfie → license” is the most interesting rule in part (a), which can be described that these participants who want to own balance wheels and dislike selfie perhaps have driver licenses.

**d)**

In part (b), we can find that “wheel, ^selfie → license” have the most lift ratio, because of this, we can consider this rule is most interesting.

Actually, it is obvious that this conclusion is same to **c)**, because the left ratio is proportional to confidence value.

**Answer 2:**

**a)**

We use some simple marks instead of these stock names and operations:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Buy | Sell | No operation |
| HSBC | bHS | sHS | ^HS |
| BoEA | bBo | sBo | ^Bo |
| China\_Mobile | bCM | sCM | ^CM |
| China\_Petroleum | bCP | sCP | ^CP |

According to above table, we can improve Transaction Data to this:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | HSBC | BoEA | China\_Mobile | China\_Petroleum |
| # 1 | bHS | sBo | bCM | ^CP |
| # 2 | bHS | sBo | ^CM | ^CP |
| # 3 | ^HS | bBo | bCM | bCP |
| # 4 | bHS | ^Bo | bCM | ^CP |
| # 5 | bHS | ^Bo | sCM | sCP |
| # 6 | ^HS | sBo | bCM | bCP |
| # 7 | bHS | sBo | ^CM | ^CP |
| # 8 | bHS | bBo | ^CM | ^CP |
| # 9 | ^HS | ^Bo | bCM | sCP |
| # 10 | bHS | ^Bo | bCM | bCP |

**Frequent itemsets:**

min\_sup = 20% means >=2 records

1-itemsets:

|  |  |
| --- | --- |
| 1-itemset | Count |
| bHS | 7 |
| ^HS | 3 |
| sBo | 4 |
| bBo | 2 |
| ^Bo | 4 |
| bCM | 6 |
| ~~sCM~~ | ~~1~~ |
| ^CM | 3 |
| bCP | 3 |
| sCP | 2 |
| ^CP | 5 |

2-itemset:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2-itemset | Count | 2-itemset | Count | 2-itemset | Count |
| ~~bHS, bBo~~ | ~~1~~ | ~~bBo, bCM~~ | ~~1~~ | bCM, bCP | 3 |
| bHS, sBo | 3 | ~~bBo, ^CM~~ | ~~1~~ | ~~bCM, sCP~~ | ~~1~~ |
| bHS, ^Bo | 3 | sBo, bCM | 2 | bCM, ^CP | 2 |
| ~~^HS, bBo~~ | ~~1~~ | sBo, ^CM | 2 | ~~sCM, sCP~~ | ~~1~~ |
| ~~^HS, sBo~~ | ~~1~~ | ^Bo, bCM | 3 | ^CM, ^CP | 3 |
| ~~^HS, ^Bo~~ | ~~1~~ | ~~^Bo, sCM~~ | ~~1~~ |  |  |
| bHS, bCM | 3 | ~~bBo, bCP~~ | ~~1~~ |  |  |
| ~~bHS, sCM~~ | ~~1~~ | ~~bBo, ^CP~~ | ~~1~~ |  |  |
| bHS, ^CM | 3 | ~~sBo, bCP~~ | ~~1~~ |  |  |
| ^HS, bCM | 3 | sBo, ^CP | 3 |  |  |
| ~~bHS, bCP~~ | ~~1~~ | ~~^Bo, bCP~~ | ~~1~~ |  |  |
| ~~bHS, sCP~~ | ~~1~~ | ~~^Bo, ^CP~~ | ~~1~~ |  |  |
| bHS, ^CP | 5 | ^Bo, sCP | 2 |  |  |
| ^HS, bCP | 2 |  |  |  |  |
| ~~^HS, sCP~~ | ~~1~~ |  |  |  |  |

3-itemset:

|  |  |  |  |
| --- | --- | --- | --- |
| 3-itemset | Count | 3-itemset | Count |
| ~~bHS, sBo, bCM~~ | ~~1~~ | bHS, ^CM, ^CP | 3 |
| bHS, sBo, ^CM | 2 | ^HS, bCM, bCP | 2 |
| bHS, sBo, ^CP | 3 | ~~sBo, bCM, ^CP~~ | ~~1~~ |
| bHS, ^Bo, bCM | 2 | sBo, ^CM, ^CP | 2 |
| ~~bHS, ^Bo, ^CP~~ | ~~1~~ | ~~^Bo, bCM, sCP~~ | ~~1~~ |
| bHS, bCM, ^CP | 2 |  |  |

4-itemset:

|  |  |
| --- | --- |
| 4-itemset | Count |
| bHS, sBo, ^CM, ^CP | 2 |

**b)** according 3-itemset of a), we can conclude: (min\_conf=70%)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Rule | Confidence | Rule | Confidence | Rule | Confidence |
| ~~bHS, sBo → ^CM~~ | ~~2/3 ≈0.67~~ | ~~bHS, bCM → ^Bo~~ | ~~2/3 ≈0.67~~ | ^CM, ^CP → bHS | 3/3 = 1 |
| ~~bHS, ^CM → sBo~~ | ~~2/3 ≈0.67~~ | ~~^Bo, bCM → bHS~~ | ~~2/3 ≈0.67~~ | ~~^HS, bCM → bCP~~ | ~~2/3 ≈0.67~~ |
| sBo, ^CM → bHS | 2/2 = 1 | ~~bHS, bCM → ^CP~~ | ~~2/3 ≈0.67~~ | ^HS, bCP → bCM | 2/2 = 1 |
| bHS, sBo → ^CP | 3/3 = 1 | ~~bHS, ^CP → bCM~~ | ~~2/5 = 0.4~~ | ~~bCM, bCP → ^HS~~ | ~~2/3 ≈0.67~~ |
| ~~bHS, ^CP → sBo~~ | ~~3/5 = 0.6~~ | bCM, ^CP → bHS | 2/2 = 1 | sBo, ^CM → ^CP | 2/2 = 1 |
| sBo, ^CP → bHS | 3/3 = 1 | bHS, ^CM → ^CP | 3/3 = 1 | ~~sBo, ^CP → ^CM~~ | ~~2/3 ≈0.67~~ |
| ~~bHS, ^Bo → bCM~~ | ~~2/3 ≈0.67~~ | ~~bHS, ^CP → ^CM~~ | ~~3/5 = 0.6~~ | ~~^CM, ^CP → sBo~~ | ~~2/3 ≈0.67~~ |

Strong rules for conf>70%:

sBo, ^CM → bHS bHS, sBo → ^CP sBo, ^CP → bHS bCM, ^CP → bHS

bHS, ^CM → ^CP ^CM, ^CP → bHS ^HS, bCP → bCM sBo, ^CM → ^CP

**Answer 3:**

c1:Up, c2:Down, c3:Level

I(c1, c2, c3) = I(3, 2, 2) = \* + \* + \* ≈ 1.557

Entropy for 2TDB:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 1 | 1 | 2 | 1.5 |
| Down | 1 | 0 | 0 | 0 |
| Level | 1 | 1 | 0 | 1 |

E(2TDB) = \* 1.5 + \* 0 + \* 1 ≈ 1.14

Information\_Gain (2TDB) = 1.557 – 1.14 = 0.417

Entropy for 1TDB:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 0 | 2 | 1 | 0.918 |
| Down | 2 | 0 | 0 | 0 |
| Level | 1 | 0 | 1 | 1 |

E(1TDB) = \* 0.918 + \* 0 + \* 1 = 0.6791

Information\_Gain (1TDB) = 1.557 – 0.6791 = 0.878

Entropy for TD:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 1 | 1 | 0 | 1 |
| Down | 0 | 0 | 2 | 0 |
| Level | 2 | 1 | 0 | 0.918 |

E(TD) = \* 1 + \* 0 + \* 0.918 = 0.6791

Information\_Gain (TD) = 1.557 – 0.6791 = 0.878

According above tables, we can find that the information gains for TD and 1TDB are equal, and larger than the 2TDB, so we choose TD as root node. **And we can find if TD is down, the all results of NTD are level, so we can decide this one branch of root node.** Then, we need to decide other child nodes and branches.

If TD is level:

I(c1, c2, c3) = I(2, 1, 0) = \* + \* + 0 ≈ 0.918

Entropy for 1TDB:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 0 | 1 | 0 | 0 |
| Down | 2 | 0 | 0 | 0 |
| Level | 0 | 0 | 0 | 0 |

E(1TDB) = \* 0 + \* 0 + \* 0 = 0

Information\_Gain (1TDB) = 0.918 – 0 = 0.918

Entropy for 2TDB:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 1 | 1 | 0 | 1 |
| Down | 0 | 0 | 0 | 0 |
| Level | 1 | 0 | 0 | 0 |

E(2TDB) = \* 1 + 0 + 0 ≈ 0.667

Information\_Gain (2TDB) = 0.918 – 0.667 = 0.251

**Obviously, the information gain of 1TDB is larger, so we can choose 1TDB as the child node of root node when TD is level.** But we also need to check the other situation if TD is up.

Now, the only branch is when TD is up, we can calculate entropy in this situation:  
Entropy for 1TDB:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 0 | 1 | 0 | 0 |
| Down | 0 | 0 | 0 | 0 |
| Level | 1 | 0 | 0 | 0 |

E(1TDB) = 0 + 0 + 0 =0

Entropy for 2TDB:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2TDB | c1 | c2 | c3 | I(c1, c2, c3) |
| Up | 0 | 0 | 0 | 0 |
| Down | 1 | 0 | 0 | 0 |
| Level | 0 | 1 | 0 | 0 |

E(2TDB) = 0

**Because entropy of both of these two attributes is zero, any one of them can be as the child node when TD is up. Then we choose 2TDB as the child node when TD is up.**

According to above analysis, we can get this decision tree:

TD

Up

Down

Level

Level

1TDB

2TDB

Down

Up

Level

Down

Up

Down

Down

Up

**12 Sep: IF TD = Level AND 1TDB = Up THEN NTD = Down**

**13 Sep: IF TD = Down THEN NTD = Level**