~~preprocessing~~
Association rules

	frequency
A	7
B	5
C	9
D	8
E	2

مرتب شده →

C	9
D	8
A	7
B	5
E	2

[illegible] You are given the following list of transactions.

Apply the FP-growth algorithm using minsup = 2 (an itemset is frequent if it appears in at least two transactions).

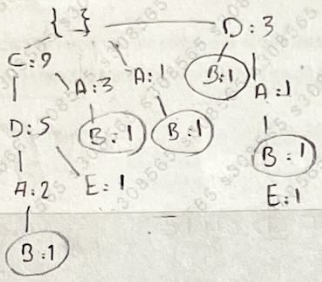
Write the following:

1. B-CPB (B - Conditional Pattern Base)
2. B-CHT (B - Conditional Header Table)
3. BD-CPB (BD - Conditional Pattern Base)

Write *all* and *only* the correct itemsets, along with their support counts.

Use the following syntax:

B-CPB = { element1: support1, element2: support2, ... }
B-CHT = { element1: support1, element2: support2, ... }
BD-CPB = { element1: support1, element2: support2, ... }



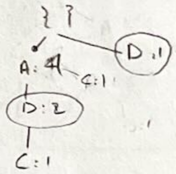
[illegible]
آیتم ها به ترتیب تکرار

ACD	CDA
CD	CD
AC	CA
C	C
BD	DB
ABCD	CDAB
CDE	CDE
ABC	CAB
AC	CA
D	D
CD	CD
AB	AB
ABDE	DABE

For example:

B-CPB = { a: 1, abc: 2 }
B-CHT = { a: 3, b: 2, c: 1 }
BD-CPB = { a: 1, b: 2, c: 3 }

B-CPB = { CDA:1, CA:1, A:1, DA:1, D}
B-CHB = { C:2, D:2, A:4} → A | 4, D | 3, C | 2 → ADC, AC, A, AD, D
BD-CPB = { A:2 }



[illegible]

An itemset is closed if none of its immediate supersets has the same support as the itemset

Given the transactional dataset shown in the figure below, apply the Apriori algorithm to extract all frequent itemsets.

The value of minsup is 2.

An itemset is considered to be frequent if its support count is equal to or higher than the minsup.

Transactions

0	**BE**
1	**BC**
2	**ABDE**
3	**BCDE**
4	**BC**
5	**ABE**
6	**BE**
7	**ACE**
8	**BDE**
9	**AB**

Question 1) List all frequent itemsets having length 2, along with their support count.
Question 2) List all itemsets of length 3 that have been generated by Apriori after the join and prune steps, **before counting their support in the database.**
Question 3) List all frequent itemsets that are **not closed**, along with their support count.

Use the following notation:

```
A1) { ... list of itemsets w/ support count ... }
A2) { ... list of itemsets ... }
A3) { ... list of itemsets w/ support count ... }
```

For example

```
A1) { ab: 2, ac: 3, ad: 2 }
A2) { abc, abd, abe }
A3) { ab: 2, ad: 2, bce: 3 }
```

A 4
B 9
C 4
D 3
E 7

→

AB 3
~~AC 1~~
~~AD 1~~
AE 3
BC 3
BD 3
BE 6
~~CD 1~~
CE 2
DE 3

→

~~ABC~~
~~ABD~~
ABE 2
~~ACD~~
ACE 1
~~ADE~~
BCD 1
CDE 1
BDE 3
BCE 1

[illegible]

You are given the following list of itemsets:

ADE
AB
BCD
BDE
ABC
AE
CD
ABE
ABCDE
ABDE

A 7
B 7
C 4
D 6
E 6

→

AB 5
AC 2
AD 3
AE 5
BC 3
BD 4
BE 4
CD 3
~~CE 1~~
DE 4

→

ABC 2
ABD 2
ABE 3
~~ACD 1~~
~~ACE~~
ADE 3
BCD 2
~~BCE~~
BDE 3
~~CDE~~

Apply the Apriori algorithm to extract all frequent itemsets, considering minsup = 2 (an itemset is frequent if it appears in at least two transactions). Only consider the extraction of itemsets of length up to 3 (included).

1. Which are the itemsets that can be pruned during the prune step (ie after the join step)?
2. Which are the itemsets that are pruned after calculating their support count?

Write the answer in the box below, using the following syntax:

1. (itemset1, itemset2, ..., itemsetN)
2. (itemset1, itemset2, ..., itemsetM)

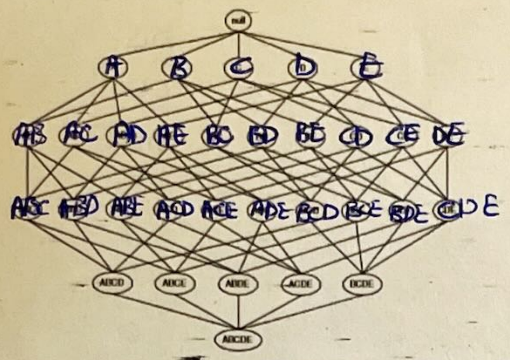
For example:

1. (A, B, AB)
2. (C, D, CD)

$$sup(X) = \frac{\text{تعداد تراکنش های شامل X}}{\text{کل تراکنش ها}} \geq \text{~~Threshold~~ minsup} \rightarrow$$ x is frequent.

حل شده ✓ A maximal frequent itemset is a frequent itemset whose immediate supersets are all infrequent.

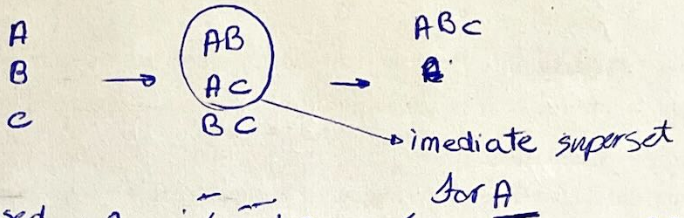
Considering the itemsets generated as in the figure below, it is known that the itemset {ACE} is a **maximal frequent itemset**. Which of the following statements is correct?



* an Item is frequent maximal if none of it's imidiate superset is frequent.

* یعنی اگر ACE، maxi- frequent باشه، هر ترکیبی با همانش قطعاً frequent نیست.

* closed item → an Item is closed if none of it's imidiate subsets has the same support as the item.



- ○ (a) The itemset {ABCD} cannot be a frequent itemset
- ○ (b) The itemset {ACDE} is also a maximal frequent itemset
- ○ (c) None of the other statements are correct
- ○ (d) The itemset {ACD} cannot be a frequent itemset
- ○ (e) The itemset {BC} cannot be a frequent itemset
- ○ (f) The itemset {ACDE} is guaranteed to be a frequent itemset
- ● (g) The itemset {ABCE} cannot be a frequent itemset

• اگر AB و AC ساپورت کمتر از A را داشته باشند، A، closed خواهد بود.

Given the transactional dataset below, apply the Apriori algorithm to extract all frequent itemsets.

جواب ندارد.

Transactions
ABD
AB
CE
ADE
AE
BCE
ACDE
ABC
BCE
AE

27

A 7
B 5
C 5
D 3
E 7
27 ✓

→

AB 3
AC 2
AD 3
AE 4
BC 3
~~BD 1~~
BE 2
~~CD 1~~
CE 4
DE 2

→

~~ABC 1~~
~~ABD~~
ABE 0
~~ACD~~
ACE 1
ADE 2
~~BCD~~
BCE 2
~~BDE~~
~~CDE~~

یعنی اگر یکی از superset هاش ساپورتش برابر با خود آیتم داشته باشند not closed است.

• حالا اگر هیچ immediate superset های آیتم frequent نباشه، اون آیتم maximal frequent خواهد بود.

اگر AB=3 باشه و همه AB هاش ABC باشن یعنی ABC=3 در این صورت AB، not closed است.

در غیر این صورت [یعنی اگر AB در بین superset هایش نباشه] که این یعنی ABE یا ABC، ساپورت کمتر از AB داشته باشند یعنی AB، closed است.

The value of minsup is 2.

An itemset is considered to be frequent if its support count is equal to or higher than the minsup.

Question 1) List all frequent itemsets having length 2, along with their support count.
Question 2) List all itemsets of length 3 that have been generated by Apriori after the join and prune steps, before counting their support in the database.
Question 3) List all frequent itemsets that are not closed, along with their support count.

Use the following notation:

A1) { ... list of itemsets w/ support count ... }
A2) { ... list of itemsets ... }
A3) { ... list of itemsets w/ support count ... }

For example

A1) { ab: 2, ac: 3, ad: 2 }
A2) { abc, abd, abe }
A3) { ab: 2, ad: 2, bce: 3 }

r: A → B

lift or correlation = $\frac{conf(r)}{sup(b)}$ ، $conf(r) = \frac{sup(ab)}{sup(a)}$ ، $sup(a) = \frac{\#a}{\#T}$

$a \to b$ — که ساپورت b

$a \to b$ — ساپورت a

a,b,c تراکنش‌های شامل / #T

#a → تراکنش‌های شامل A

#T → کل تراکنش‌ها

حل شده ✓ Given an **association rule r: A⟶B, lift(r)** is defined as $\frac{conf(r)}{sup(B)}$, where conf(r) is the confidence of r, $\frac{sup(A,B)}{sup(A)}$ and sup(X) is the support of X.

Which of the following statements is correct?

مهم ★

conf , sup ∈ [0, 1]

lift ∈ [0, +∞]

مثلاً در نظر بگیرید که r: bread → butter آنگاه lift(r)>1 باشد یعنی اگر کسی bread بخرد، احتمال زیاد است که butter هم بخرد. برعکس یعنی کسی که bread بخرد ولی احتمال نخریدن butter کمتر است (معمولاً این دو تا رو با هم در سبد خرید می‌بینیم)

○ ~~(a)~~ lift(r) ∈[-1, 1]

● (b) if lift(A ⟶B) > 1, then lift(A ⟶not B) < 1

○ (c) None of the other statements are correct

○ (d) lift(A ⟶B) ≠lift(B ⟶A) ⟹ $\frac{\frac{sup(a,b)}{sup(a)}}{sup(B)} \overset{?}{=} \frac{\frac{sup(a,b)}{sup(b)}}{sup(a)} \Rightarrow lift(A \to B) = lift(B \to A)$

○ (e) lift(r) > 0 implies positive correlation ⟶ positive correlation ⇐ conf(r) > sup(b) یعنی lift>1 باشد e: اگر

○ (f) lift(r) < 0 implies independence ⟶ f: اگر lift(r) = 0 independent هستند.

حل شده The support of an itemset A (sup(A)) is the fraction of transactions that contains A and is represented by P(A).

The confidence of an association rule A ⟶ B is the conditional probability P(B|A).

The following rule ab ⟶ c with confidence(ab ⟶ c) = 1.0 is given. → $conf(ab \to c) = \frac{sup(a,b,c)}{sup(a,b)} = 1$

Which statement is true?

یعنی #(a,b,c) = #(a,b)

○ (a) If a transaction contains ab, it will ~~optionally~~ must contain c.

● (b) If sup(ab) = 1.0, then c must be present in all transactions. → وقتی sup یه آیتمی 1 می‌شود یعنی اون آیتم در تمام تراکنش‌ها حضور دارد

○ (c) None of the other answers is correct.

○ (d) sup(c) can be 0. → d: تنها وضعیتی که می‌تواند این اتفاق بیفتد که sup(a,b)=0 باشد یعنی sup(a,b) در مخرج است نمی‌تواند =0 باشد.

○ (e) If sup(c) = 1.0, then sup(ab) ~~cannot take any value.~~ → e: اگر sup(c)=1 باشد یعنی c در همه Transaction‌ها حضور دارد

○ (f) P(abc) must be 1.0 → نه لزوماً

و از اونجایی که sup(abc) = sup(a,b) هست در این سوال یعنی sup(a,b) هم = 1 خواهد بود. که نمی‌دونیم sup(ab) چند است فقط می‌دونیم sup(abc) = sup

The support of an itemset A (sup(A)) is the fraction of transactions that contains A and is represented by P(A). → P(A) = sup(A)

The confidence of an association rule A ⟶ B is the conditional probability P(B|A) = $conf(A \to B) = \frac{sup(AB)}{sup(A)}$

The following rule ab ⟶ c with confidence(ab ⟶ c) = 1.0 is given. $conf(ab \to c) = \frac{sup(abc)}{sup(ab)} = 1$

Which statement is true?

○ (a) None of the other answers is correct.

○ ~~(b)~~ If sup(c) = 1.0, then sup(ab) ~~cannot take any value.~~ → sup(c) = 1 ⇒ sup(a,b) = 1 یعنی c در همه تراکنش‌ها وجود دارد، در نتیجه conf(ab→c)=1 ، a , b هم باید در همه تراکنش‌ها وجود داشته باشند.

○ (c) P(abc) must be 1.0 ← ما فقط می‌دونیم p(abc) = p(ab) اینکه p(abc) چیه نمی‌دونیم هست یا نه

● (d) If sup(ab) = 1.0, then c must be present in all transactions.

○ ~~(e)~~ sup(c) can be 0. → e: نمی‌دونیم! می‌تونه c باشد مگر اینکه sup(ab)=0 باشد.

○ ~~(f)~~ If a transaction contains ab, it will ~~optionally~~ must contain c.

Given an association rule r: A ⟶ B, lift(r) is defined as $\frac{conf(r)}{sup(B)}$, where conf(r) is the confidence of r, $\frac{sup(A,B)}{sup(A)}$ and sup(X) is the support of X.

Which of the following statements is correct?

○ (a) lift(r) > 0 implies positive correlation   lift(r) > 1 ⇒ positive corr.

○ (b) None of the other statements is correct

○ (c) lift(A ⟶ B) ≠ lift(B ⟶ A) $\frac{\frac{sup(ab)}{sup(a)}}{sup(b)} \overset{?}{=} \frac{\frac{sup(ab)}{sup(b)}}{sup(a)}$ → چون این دو کسر مساوی هستند، این گزینه غلط است.

○ (d) lift(r) ∈ [-1, 1]   → $\boxed{lift \in [0, +\infty)}$

○ (e) lift(r) < 0 implies independence   → if lift = 0 ⇒ independence

● (f) if lift(A ⟶ B) > 1, then lift(A ⟶ not B) < 1

f: چون وقتی lift(r) > 1 (r: A → B) ⇐ یعنی وقتی A را می‌خرند احتمال خرید B بیشتره!

به بیان دیگه وقتی A را می‌خرند، احتمال نخریدن B کمتر است ⇐ $lift(A \to \bar{B}) < 1$

The support of a set of items A (sup(A)) is the fraction of transactions that contains A and is represented by P(A).

The confidence of an association rule A ⟶ B is the conditional probability P(B|A).

The following rule ab ⟶ c with confidence(ab ⟶ c) = 1.0 is given. ⇒ $\frac{sup(abc)}{sup(ab)} = 1 \to sup(abc) = sup(ab)$

Which statement is true?

○ (a) If sup(c) = 1.0, then sup(ab) ~~cannot take any value~~.

● (b) If sup(ab) = 1.0, then c must be present in all transactions.

○ (c) If a transaction contains ab, it will ~~optionally~~ must contain c.

○ (d) None of the other answers is correct.

○ (e) P(abc) ~~must~~ be 1.0. → تنها درصورتی که P(ab)=1 باشد.

○ (f) sup(c) can be 0. → $\frac{sup(abc)}{sup(ab)} = 1 \Rightarrow sup(c) \neq 0$ → چون نه صورت نه مخرج نمی‌تونه 0 باشد.

An itemset I is closed if none of its immediate supersets has the same support as I.

An itemset I is represented by a collection of literals (e.g. abc) and a number representing its support count (e.g. abc: 12).

After the analysis of a transactional dataset, the list of frequent itemsets found (with support counts) is the following:

not closed → immediate هاش، sup شون باید از I بزرگتر باشند.

length=1 a:150 b:160 c:180 d:150 e:150
length=2 ab:140 ac:120 ad:130 ae:140
length=3 abc:120 acd:110 abe:130
length=4 abce:120

immediate هاش، ساپورت برابر یا بزرگتر دارند! how come? ← not closed

Which of the following statements is true?

○ (a) The only non-closed itemsets are **ac**, **ad**

● (b) The only non-closed itemsets are **ac**, **abc**

○ (c) The only non-closed itemsets are **ac**, **ad**, **abc**, **abce**

○ (d) The only non-closed itemsets are **ac**, **ad**

○ (e) The only closed itemsets are **ac**, **abc**

○ (f) None of the other answers is correct

The confidence of a rule is defined as:

$$confidence(A \rightarrow B) = \frac{sup(A,B)}{sup(A)}$$

where sup(x) indicates the fraction of transactions where x occurs (i.e. the support).

Let R: a,b -> c,d be an association rule. $r: ab \rightarrow cd$

In the transactional database you find the following records:

$$conf(ab \rightarrow cd) = \frac{sup(abcd)}{sup(ab)} = \frac{1}{2}$$

a b c d
a e f
a c d
a b
b c d f
b c d e
a e
b f

○ (a) confidence(R) = 8/6
○ (b) confidence(R) = 24/25
○ (c) confidence(R) = 2/3
○ (d) confidence(R) = 1/3
○ (e) None of the answers is correct
● (f) confidence(R) = 1/2

Which of the following statements is true?

An itemset is defined to be frequent maximal if none of its immediate supersets (i.e. including one more item) is frequent.

جواب درست رادادم ولی منطق سوال "د" رو نفهمیدم

After the analysis of a transactional dataset, the complete set of maximal frequent itemsets with minsup=900 are:

abc: 930 $\rightarrow c \in (930, +\infty)$

def: 980 $\rightarrow d \in [980, +\infty)$

Which of the following statements is true?

○ (a) sup(ab) can be in range [900, 929], sup(abcd) cannot be in range [0, 930]
○ (b) sup(ab) can be a value in range [900, 929], sup(cd) cannot be in range [900, 930]
○ (c) sup(ab) can be a value in range [930, 1000], sup(abcd) can be a value in range [900, 930] → X
○ (d) None of the other answers is correct
→ ○ (e) sup(ab) can be a value in range [930, 1000], sup(cd) cannot be in range [900, 930]
○ (f) sup(ab) can be a value in range [900, 929], sup(abcd) can be a value in range [900, 930]

• گزینه f, e رد می‌شوند چون وقتی ترکیب ab با c در 930 تا تراکنش ظاهر شده یعنی sup(ab) هم باید بیشتر از
930 تا باشد نه فقط 930 تا ab با c تا 930 ترکیب شده!

$abcd < 900 \rightarrow cd < 960$?

cd frequent

$cd \in [930, +\infty)$

a: 6
b: 4
c: 6
D: 5
E: 5

26 ✓

→ Close ~~AB: 3~~
~~AC: 4~~
✓AD: 2
✓AE: 2

~~BC: 2~~
~~BD: 0~~
~~BE: 1~~
~~CD: 3~~
~~CE: 3~~
~~DE: 4~~

→ ~~ABC: 1~~
~~ABD:~~
~~ABE:~~
ACD: 2
~~ACE: 2~~
~~ADE: 1~~

~~BCD~~
~~BCE~~
~~BDE~~
CDE: 2

Given the transactional dataset shown in the figure below, apply the Apriori algorithm to extract all frequent itemsets.

[illegible]

✓The value of minsup is 2.

An itemset is considered to be frequent if its support count is equal to or higher than the minsup.

Question 1) List all frequent itemsets having length 2 along with their support count. {AB:3, AC:4, AD:2, AE:2, BC:2, CD:3, CE:3, DE:4}

Question 2) List all itemsets of length 3 that have been generated by Apriori after the join and prune steps, before counting their support on the database. {ABC:1, ACD:2, ACE:2, ADE:1, CDE:2}

Question 3) List all frequent itemsets that are NOT closed, along with their support count. {AD:2, AE:2}

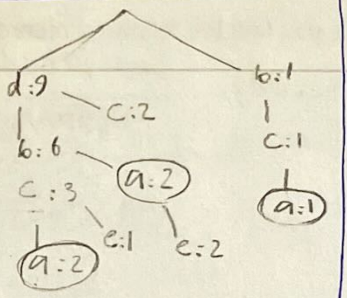
You are given the following list of transactions.

dc	cd
dbae	abde
dbce	bcde
dbca	abcd
bca	abc
d	d
dbca	abcd
dc	cd
dbae	abde
db	bd

a | 5
b | 7
c | 6
d | 9
e | 3
30

→

d | 9
b | 7
c | 6
a | 5
e | 3



Write the following:

1. **A-CPB (A - Conditional Pattern Base)**
2. **A-CHT (A - Conditional Header Table)**
3. **AC-CPB (AC - Conditional Pattern Base)**

Write all and only the correct itemsets, along with their support counts.

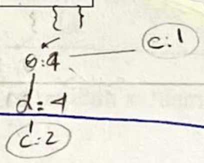
A-CPB = {dbc:2, db:2, bc:1} → b | 5, d | 4, c | 3

A-CHT = {d:4, b:5, c:3}

AC-CPB = {bd:2, b:1}

list of transaction
bdc
bdc
bd
bd
bc

→



Transactions
ab
cde
bc
ab
acd
abce
de
acde
ac
de

Apply the FP-growth algorithm using minsup = 2 (an itemset is frequent if it appears in at least two transactions).

~~a,b باید (= فقط موقعیم که جا درست بین ۲ آیتم~~
~~باید frequent باشد.~~ ~~r: A → B~~

چرا آیتم B باید frequent باشد؟ ~~چون اصلا هم~~

در این رابطه نمیدانم. ~~Corr مثبت (یعنی بزرگتر از ۱) داشته باشد و میدانیم آیتم a~~

~~frequent هست و این یعنی در fulfill شدن ۲ میباشد~~

b هم frequent باشد.

چرا sup(a,b) باید حداقل 0.1 باشد؟

چون a، frequent هست و در fulfill کردن ۲

هر دو آیتم باید frequent باشد.

~~sup~~ [illegible]

و اینکه sup(a,b) حداکثر میتواند sup

○ (a) sup(B) < 1/2

~~○ (b) Not enough information is provided to address the question~~

~~○ (c) None of the other answers is correct~~

○ (d) sup(B) > 1/2

○ (e) sup(B) > 1/10

○ (f) sup(B) > 1/5

● (g) sup(B) < 1/5

~~○ (h) sup(B) < 1/10~~

For a rule $A \rightarrow B$, the following can be computed:

$$confidence(A \rightarrow B) = \frac{sup(A,B)}{sup(A)}$$

$$lift(A \rightarrow B) = correlation(A \rightarrow B) = \frac{confidence(A \rightarrow B)}{sup(B)}$$

Where sup(X) is the support of an itemset X, i.e. the fraction of transactions that contain X.

A frequent itemset is maximal if none of its supersets is frequent.

You are given a transactional dataset. You extract all frequent itemsets using a minimum support of 0.1 (an itemset is considered frequent if it appears in at least 10% of the transactions).

minsup =

You find that the itemset A = {a1, a2, … } has support sup(A) = 0.5 and it is maximal.

Which of the following constraints on the support of B = {b1, b2, …} guarantees that the rule A → B has positive correlation? $\rightarrow \frac{sup(a,b)}{sup(a) \cdot sup(b)} > 1 \rightarrow 2\,sup(a,b) > sup(b)$

$sup(B) = \frac{\#B}{\#T}$

$0.1 < sup(B) < sup(a)$

If applicable (i.e. a solution can be found and is among the provided answers), choose the most permissive constraint, which is the constraint that produces the largest possible range of permissible values. For example, if both sup(B) > x and sup(B) > y satisfy the request, you must choose sup(B) > min(x, y). Likewise if the options are in the form sup(B) < x and sup(B) < y, choose sup(B) < max(x, y).

$sup(b) < 0.2 \Leftarrow \begin{cases} sup(b) < \boxed{2\,\underbrace{sup(a,b)}_{0.1 \le \quad < 0.5}} \\ 0.2 < \quad < 1 \end{cases}$

تفاوت closed, frequent maximal, maximal

maximal ها frequent هستند .

An itemset is maximal if it is frequent and none of its supersets is frequent

After extracting the frequent itemsets from a transactional dataset, you find that -- among others -- the itemsets ABC and BD are maximal.

Which of the following statements is correct? maximal

اگر ABC ۲ تایی خودش frequent است، superset های آن frequent نیست

اگر BD maximal است

● (a) AC is frequent ✓

○ (b) ABCD is frequent

○ (c) ABD is maximal

○ (d) AC is maximal

○ (e) ABCD is frequent only if BCD is frequent

○ (f) None of the other statements is correct

○ (g) ABD is frequent

○ (h) ABCD is maximal

Given the transactional dataset shown in the figure below, apply the Apriori algorithm to extract all frequent itemsets.

The value of minsup is 2 (an itemset is frequent if it appears in at least 2 transactions).

An itemset is considered to be frequent if its support count is equal to or higher than the minsup.

{AB:2, AC:6, AD:4, AE:3, BC:2, CD:4, CE:4, DE:3}

1. List all frequent itemsets having length 2, **along with their support count.**
2. List all candidate itemsets of length 3 that have been generated by Apriori **after the join and prune steps,** before counting their support in the database.
3. List all frequent itemsets that are **not closed,** along with their support count. ?

?× 2. { ABC, ACD, ACE, ADE, CDE}

3. } ABC:2, ACD:4,

DE
ACDE
ABCE
ABC
CE
ACD
CD
ACD
ACDE
BD

A:6
B:3
C:8
D:7
E:5

29 ✓

AB: 2
AC: 6
AD: 4
AE: 3
BC: 2
~~BD: 1~~
~~BE: 1~~
CD: 4
CE: 4
DE: 3

ABC: 2
~~ABD~~
~~ABE~~
ACD: 4
ACE: 3
ADE: 2
~~BCD~~
~~BCE~~
~~BDE~~
CDE: 2

3 points (no penalty for a wrong answer)

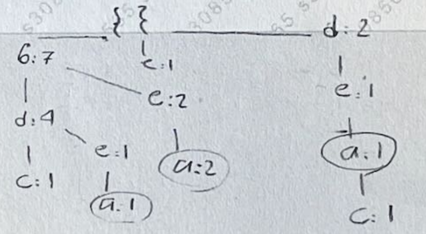
You are given the following list of transactions.

bcd — bdc
acde — deac
bd — bd
b — b
abe — bea
e — e
abe — bea
bd — bd
d — d
abde — bdea

Item	frequency
A	4
B	7
C	2
D	6
E	5

مرتب

item	frequency
B	7
D	6
E	5
A	4
C	2
	24



A-CPB = { ebd:1, eb:2, ed:1}
A-CHT = { b:3, d:2, e:4}
AD-CPB = {eb:1, e:1}

e	4
b	3
d	2

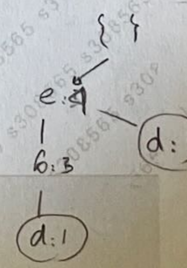
→ ebd
eb
eb
ed

Apply the FP-growth algorithm using minsup = 2 (an itemset is frequent if it appears in at least two transactions).

Write the following:

1. A-CPB (A - Conditional Pattern Base)
2. A-CHT (A - Conditional Header Table)
3. AD-CPB (AD - Conditional Pattern Base)

Write *all* and *only* the correct itemsets, along with their support counts.



Use the following syntax:

A-CPB = { element1: support1, element2: support2, ... }
A-CHT = { element1: support1, element2: support2, ... }
AD-CPB = { element1: support1, element2: support2, ... }

For example:

A-CPB = { a: 1, abc: 2 }
A-CHT = { a: 3, b: 2, c: 1 }
AD-CPB = { a: 1, b: 2, c: 3 }