COMP4331 Assignment 1 Report HUANG, Zijian 20413784

2.

2.1

(1)   The Environment: MacBook Pro 2018
        Processor: 2.3 GHz Quad-Core Intel Core i5
        Memory: 8 GB 2133 MHz LPDDR3
        Graphics: Intel Iris Plus Graphics 655 1536 MB
        OS: macOS Catalina (version 10.15.3)

(2) Running Time:
① Apriori: 842.7696921825409 s
② Hash Tree: 29.10720992088318 s
③ FP-Growth: 11.285199880599976 s

(3) Explanation:
Hash Tree can decrease the time consumption because it can reduce the number of comparisons, which means that every comparison only needs to be done with a small part of the dataset instead of the whole dataset.

FP-Growth can decrease the time more than the Apriori with hash tree method because:
Disadvantages of Apriori with hash tree:
① It is costly to handle a large number of candidate sets in every k step.
② It is tedious to repeatedly scan the database and check the candidate patterns in every k step.
Advantages of FP-Growth method:
① It can store all information that we need by only scanning the dataset once.
② Large itemsets can be generated by looking through the FP Tree instead of the dataset.

2.2 Closed Frequent Itemsets

(1) Closed frequent itemsets (total number: 699, all frequent itemsets are closed):
[[2], [9], [10], [11], [12], [18], [19], [23], [30], [31], [32], [36], [37], [38], [39], [41], [45], [47], [48], [49], [52], [53], [55], [56], [60], [62], [65], [76], [78], [79], [80], [89], [94], [101], [103], [105], [107], [110], [117], [123], [136], [147], [150], [155], [156], [161], [170], [175], [176], [178], [179], [185], [186], [201], [208], [209], [225], [229], [237], [242], [246], [248], [249], [251], [255], [258], [259], [260], [261], [264], [267], [269], [270], [271], [272], [279], [281], [286], [297], [301], [310], [319], [334], [338], [340], [345], [351], [352], [365], [371], [374], [379], [384], [389], [396], [398], [405], [407], [408], [413], [415], [418], [420], [425], [426], [432], [438], [441], [449], [464], [475], [479], [488], [490], [514], [522], [533], [535], [544], [547], [548], [549], [570], [571], [581], [589], [591], [592], [604], [623], [649], [664], [675], [677], [681], [694], [703], [704], [740], [766], [772], [783], [789], [790], [793], [798], [806], [808], [809], [812], [824], [830], [831], [842], [846], [855], [856], [865], [878], [885], [910], [913], [916], [947], [956], [961], [976], [979], [1000], [1004], [1020], [1043], [1052], [1062], [1066], [1067], [1103], [1113], [1121], [1126], [1135], [1144], [1146], [1158], [1198], [1239], [1277], [1327], [1344], [1355], [1361], [1393], [1404], [1417], [1435], [1479], [1481], [1486], [1513], [1543], [1557], [1578], [1585], [1600], [1659], [1677], [1693], [1704], [1714], [1715],

[1783], [1814], [1867], [1872], [1986], [1987], [2046], [2051], [2056], [2080], [2118], [2135], [2168], [2184], [2199], [2238], [2241], [2284], [2329], [2343], [2383], [2399], [2437], [2505], [2523], [2673], [2775], [2879], [2958], [2987], [3270], [3361], [3616], [3799], [4336], [4698], [4883], [8978], [8985], [9501], [9555], [10444], [10446], [10491], [10515], [10653], [10656], [12925], [12929], [12943], [12946], [12951], [12959], [13041], [13189], [14098], [14099], [14933], [15618], [15832], [16010], [16011], [16217], [16430], [32, 39], [32, 89], [32, 110], [32, 170], [32, 270], [32, 310], [32, 41], [32, 101], [32, 271], [32, 38], [32, 48], [32, 36], [32, 237], [32, 65], [32, 225], [32, 475], [39, 60], [39, 110], [39, 170], [39, 260], [39, 270], [39, 310], [39, 570], [39, 740], [39, 1600], [39, 3270], [39, 16010], [39, 41], [39, 101], [39, 161], [39, 201], [39, 271], [39, 301], [39, 371], [39, 681], [39, 13041], [39, 16011], [39, 242], [39, 272], [39, 522], [39, 592], [39, 772], [39, 812], [39, 15832], [9, 48], [19, 48], [39, 48], [39, 78], [39, 258], [39, 338], [39, 438], [39, 548], [39, 1198], [39, 1578], [39, 2238], [39, 2958], [39, 8978], [39, 14098], [9, 39], [19, 39], [39, 49], [39, 79], [39, 89], [39, 179], [39, 229], [39, 249], [39, 269], [39, 279], [39, 379], [39, 389], [39, 479], [39, 549], [39, 589], [39, 649], [39, 789], [39, 809], [39, 12929], [39, 103], [39, 123], [39, 413], [39, 533], [39, 703], [39, 783], [39, 1393], [39, 76], [39, 156], [39, 186], [39, 286], [39, 396], [39, 766], [39, 806], [39, 956], [39, 976], [39, 1146], [39, 1986], [39, 3616], [39, 107], [39, 117], [39, 147], [39, 237], [39, 267], [39, 407], [39, 677], [39, 1327], [39, 16217], [39, 45], [39, 55], [39, 65], [39, 105], [39, 175], [39, 185], [39, 225], [39, 255], [39, 405], [39, 475], [39, 535], [39, 675], [39, 1135], [39, 1435], [39, 10515], [39, 12925], [39, 264], [39, 334], [39, 464], [39, 544], [39, 604], [39, 664], [39, 824], [39, 1004], [39, 1344], [39, 1814], [270, 271], [16010, 16011], [10, 48], [10, 39], [41, 15832], [11, 48], [31, 48], [41, 48], [41, 438], [41, 2238], [11, 39], [31, 39], [41, 79], [41, 89], [41, 413], [41, 110], [41, 170], [41, 270], [41, 310], [41, 16010], [41, 101], [41, 271], [41, 1146], [41, 147], [41, 237], [41, 1327], [41, 16217], [41, 65], [41, 225], [41, 475], [18, 39], [38, 39], [38, 89], [48, 49], [48, 79], [48, 89], [48, 179], [48, 229], [48, 249], [48, 269], [48, 389], [48, 479], [48, 549], [48, 589], [48, 649], [48, 789], [48, 12929], [48, 103], [48, 123], [48, 413], [48, 533], [48, 703], [48, 783], [48, 1393], [38, 110], [38, 170], [38, 310], [38, 790], [48, 60], [48, 110], [48, 170], [48, 270], [48, 310], [48, 340], [48, 570], [48, 740], [48, 1600], [48, 3270], [48, 16010], [38, 41], [38, 281], [38, 371], [48, 101], [48, 161], [48, 201], [48, 271], [48, 301], [48, 13041], [48, 522], [48, 592], [48, 772], [48, 812], [48, 15832], [38, 56], [38, 286], [48, 76], [48, 156], [48, 186], [48, 286], [48, 766], [48, 956], [48, 976], [48, 1146], [38, 47], [38, 237], [48, 107], [48, 117], [48, 147], [48, 237], [48, 407], [48, 677], [48, 1327], [48, 16217], [18, 48], [38, 48], [38, 2238], [48, 78], [48, 258], [48, 338], [48, 438], [48, 488], [48, 548], [48, 1578], [48, 2238], [48, 2958], [48, 14098], [38, 55], [38, 65], [38, 105], [38, 225], [48, 65], [48, 175], [48, 185], [48, 225], [48, 255], [48, 405], [48, 425], [48, 475], [48, 535], [48, 1135], [48, 1435], [48, 10515], [48, 12925], [48, 264], [48, 334], [48, 464], [48, 544], [48, 604], [48, 824], [48, 1004], [48, 1344], [48, 1814], [23, 48], [23, 39], [36, 38], [36, 48], [36, 39], [36, 41], [37, 38], [37, 48], [37, 39], [45, 48], [225, 2238], [32, 39, 89], [32, 39, 41], [32, 39, 48], [32, 39, 65], [32, 39, 225], [32, 38, 39], [32, 48, 89], [32, 38, 110], [32, 38, 170], [32, 38, 41], [32, 38, 48], [32, 48, 65], [32, 36, 38], [32, 41, 48], [39, 270, 271], [39, 16010, 16011], [39, 41, 110], [39, 41, 170], [39, 41, 310], [39, 41, 271], [39, 41, 48], [39, 41, 2238], [39, 41, 89], [39, 41, 237], [39, 41, 65], [39, 41, 225], [39, 41, 475], [39, 48, 60], [39, 48, 110], [39, 48, 170], [39, 48, 270], [39, 48, 310], [39, 48, 570], [39, 48, 3270], [39, 48, 16010], [39, 48, 101], [39, 48, 201], [39, 48, 271], [39, 48, 301], [39, 48, 13041], [39, 48, 522], [39, 48, 592], [39, 48, 15832], [39, 48, 78], [39, 48, 258], [39, 48, 338], [39, 48, 438], [39, 48, 548], [39, 48, 2238], [39, 48, 2958], [39, 48, 14098], [39, 48, 49], [39, 48, 79], [39, 48, 89], [39, 48, 179], [39, 48, 249], [39, 48, 589], [39, 48, 123], [39, 48, 413], [39, 48, 533], [39, 48, 783], [39, 48, 1393], [39, 48, 286],

[39, 48, 956], [39, 48, 1146], [39, 48, 147], [39, 48, 237], [39, 48, 677], [39, 48, 1327], [39, 48, 16217], [39, 48, 65], [39, 48, 185], [39, 48, 225], [39, 48, 255], [39, 48, 475], [39, 48, 12925], [39, 48, 264], [39, 48, 604], [39, 48, 824], [9, 39, 48], [19, 39, 48], [41, 48, 89], [41, 48, 110], [41, 48, 170], [41, 48, 310], [41, 48, 65], [41, 48, 225], [41, 48, 475], [38, 39, 48], [38, 39, 89], [38, 39, 110], [38, 39, 170], [38, 39, 41], [38, 39, 371], [38, 39, 286], [38, 39, 237], [38, 39, 55], [38, 39, 65], [38, 39, 105], [38, 39, 225], [38, 41, 110], [38, 41, 170], [38, 41, 48], [38, 48, 89], [38, 48, 110], [38, 48, 170], [38, 48, 286], [38, 48, 237], [38, 48, 65], [36, 38, 48], [36, 38, 39], [36, 38, 41], [36, 39, 48], [36, 39, 41], [37, 38, 48], [37, 38, 39], [37, 39, 48], [32, 39, 41, 48], [32, 39, 48, 89], [32, 38, 39, 41], [32, 38, 39, 48], [32, 38, 41, 48], [39, 41, 48, 170], [39, 41, 48, 310], [39, 41, 48, 89], [39, 41, 48, 65], [39, 41, 48, 225], [38, 39, 48, 89], [38, 39, 48, 110], [38, 39, 48, 170], [38, 39, 48, 286], [38, 39, 41, 48], [38, 39, 41, 110], [38, 39, 41, 170], [38, 41, 48, 110], [38, 41, 48, 170], [36, 38, 39, 48], [36, 38, 39, 41], [37, 38, 39, 48], [32, 38, 39, 41, 48], [38, 39, 41, 48, 170]]

(2) maximal frequent itemsets (total number: 354):
[[2], [12], [30], [52], [53], [62], [80], [94], [136], [150], [155], [176], [178], [208], [209], [246], [248], [251], [259], [261], [297], [319], [345], [351], [352], [365], [374], [384], [398], [408], [415], [418], [420], [426], [432], [441], [449], [490], [514], [547], [571], [581], [591], [623], [694], [704], [793], [798], [808], [830], [831], [842], [846], [855], [856], [865], [878], [885], [910], [913], [916], [947], [961], [979], [1000], [1020], [1043], [1052], [1062], [1066], [1067], [1103], [1113], [1121], [1126], [1144], [1158], [1239], [1277], [1355], [1361], [1404], [1417], [1479], [1481], [1486], [1513], [1543], [1557], [1585], [1659], [1677], [1693], [1704], [1714], [1715], [1783], [1867], [1872], [1987], [2046], [2051], [2056], [2080], [2118], [2135], [2168], [2184], [2199], [2241], [2284], [2329], [2343], [2383], [2399], [2437], [2505], [2523], [2673], [2775], [2879], [2987], [3361], [3799], [4336], [4698], [4883], [8985], [9501], [9555], [10444], [10446], [10491], [10653], [10656], [12943], [12946], [12951], [12959], [13189], [14099], [14933], [15618], [16430], [32, 270], [32, 310], [32, 101], [32, 271], [32, 237], [32, 475], [39, 260], [39, 740], [39, 1600], [39, 161], [39, 681], [39, 242], [39, 272], [39, 772], [39, 812], [39, 1198], [39, 1578], [39, 8978], [39, 229], [39, 269], [39, 279], [39, 379], [39, 389], [39, 479], [39, 549], [39, 649], [39, 789], [39, 809], [39, 12929], [39, 103], [39, 703], [39, 76], [39, 156], [39, 186], [39, 396], [39, 766], [39, 806], [39, 976], [39, 1986], [39, 3616], [39, 107], [39, 117], [39, 267], [39, 407], [39, 45], [39, 175], [39, 405], [39, 535], [39, 675], [39, 1135], [39, 1435], [39, 10515], [39, 334], [39, 464], [39, 544], [39, 664], [39, 1004], [39, 1344], [39, 1814], [10, 48], [10, 39], [41, 15832], [11, 48], [31, 48], [41, 438], [11, 39], [31, 39], [41, 79], [41, 413], [41, 270], [41, 16010], [41, 101], [41, 1146], [41, 147], [41, 1327], [41, 16217], [18, 39], [48, 229], [48, 269], [48, 389], [48, 479], [48, 549], [48, 649], [48, 789], [48, 12929], [48, 103], [48, 703], [38, 310], [38, 790], [48, 340], [48, 740], [48, 1600], [38, 281], [48, 161], [48, 772], [48, 812], [38, 56], [48, 76], [48, 156], [48, 186], [48, 766], [48, 976], [38, 47], [48, 107], [48, 117], [48, 407], [18, 48], [38, 2238], [48, 488], [48, 1578], [48, 175], [48, 405], [48, 425], [48, 535], [48, 1135], [48, 1435], [48, 10515], [48, 334], [48, 464], [48, 544], [48, 1004], [48, 1344], [48, 1814], [23, 48], [23, 39], [45, 48], [225, 2238], [32, 39, 65], [32, 39, 225], [32, 38, 110], [32, 38, 170], [32, 48, 65], [32, 36, 38], [39, 270, 271], [39, 16010, 16011], [39, 41, 271], [39, 41, 2238], [39, 41, 237], [39, 41, 475], [39, 48, 60], [39, 48, 270], [39, 48, 570], [39, 48, 3270], [39, 48, 16010], [39, 48, 101], [39, 48, 201], [39, 48, 271], [39, 48, 301], [39, 48, 13041], [39, 48, 522], [39, 48, 592], [39, 48, 15832], [39, 48, 78], [39, 48, 258], [39, 48, 338], [39, 48, 438], [39, 48, 548], [39, 48, 2238], [39, 48, 2958], [39, 48, 14098], [39, 48, 49], [39, 48, 79], [39, 48, 179], [39, 48, 249], [39, 48, 589], [39, 48, 123], [39, 48, 413], [39, 48, 533], [39, 48, 783], [39,

48, 1393], [39, 48, 956], [39, 48, 1146], [39, 48, 147], [39, 48, 237], [39, 48, 677], [39, 48, 1327], [39, 48, 16217], [39, 48, 185], [39, 48, 255], [39, 48, 475], [39, 48, 12925], [39, 48, 264], [39, 48, 604], [39, 48, 824], [9, 39, 48], [19, 39, 48], [41, 48, 475], [38, 39, 371], [38, 39, 237], [38, 39, 55], [38, 39, 65], [38, 39, 105], [38, 39, 225], [38, 48, 237], [38, 48, 65], [32, 39, 48, 89], [39, 41, 48, 310], [39, 41, 48, 89], [39, 41, 48, 65], [39, 41, 48, 225], [38, 39, 48, 89], [38, 39, 48, 110], [38, 39, 48, 286], [38, 39, 41, 110], [38, 41, 48, 110], [36, 38, 39, 48], [36, 38, 39, 41], [37, 38, 39, 48], [32, 38, 39, 41, 48], [38, 39, 41, 48, 170]]