

1)Pseudo code – Dynamic programming algorithm.

Function for minimum and maximum grouping and returns optimal group array.

@param:

A - input array.

N – input array length.

M – optimal group array length.

@return:

G - optimal group array.

Max_Min_grouping(A, N, M)

col = N-1;

for (j \leftarrow M-1 to 0)

for (j \leftarrow N-1 to j)

if (j > 0)

for (k \leftarrow j-1 to i)

G \leftarrow **Max_Min_grouping**(A, (N - G[M]), (M-1))

Sum \leftarrow **findSummation**(A, K+1, i)

Min \leftarrow C[j-1][k] < Sum ? C[j-1][k] : Sum

if (Min > C[j][i])

C[j][i] \leftarrow Min

Bmin[j][i] = k

if (j != 0)

G[j] \leftarrow col - Bmin[j][col]

else

G[j] \leftarrow col - Bmin[j][col] + 1

Col \leftarrow Bmin[j][col]

return G

Utility function to find the summation of number.

@param:

A - array.

lIndex - lower bound index of the array.

hIndex - higher bound index of the array.

@return:

sum - summation output.

findSummation(A, lIndex, hIndex)

for (z \leftarrow lIndex to hIndex)

Sum \leftarrow Sum + A[z]

return Sum

2)Running time analysis

N – input array length

M – optimal group array length

Finding the maximum, minimum and summation are residue. The main dominating factors are the input array length(N) and the optimal group array length(M), the space and running time complexity asymptotically is as follows -

Running time = $\Theta(N*M)$

Space time = $\Theta(N*M)$

3)Results

Case 1:

Enter Length of the input array :

12

Enter the input array :

3 9 7 8 2 6 5 10 1 7 6 4

Enter Length of the group array and summation array :

3

C Array :

3 12 19 27 29 35 40 50 51 58 64 68

0 3 7 12 12 16 19 23 24 29 29 33

0 0 3 7 7 8 12 15 16 18 19 19

Bmin Array :

0 0 0 0 0 0 0 0 0 0 0 0

0 0 1 1 1 2 2 3 3 4 4 5

0 0 1 2 2 3 3 5 5 6 6 6

Optimal Grouping Array :

3 4 5

Group Summation Array :
19 21 28

Program ended with exit code: 0

```
190 @param:
191 A - input array.
192 N - Number of columns.
193 M - Number of rows.
194 @return:
195 G - optimal group array.
196 */
197 int* Max_Min_grouping(int *A, int N, int M)
198 {
199     int sum = 0;
200     int min = 0;
201     int col = N-1;
202     int i,j;
203     int gSum = 0;
204
205     for (j = M-1; j >= 0; j--)
206     {
207         for (i = N-1; i >= j; i--)
208         {
209             if (j > 0)
210             {
211                 for (int k = j-1; k < i; k++)
212                 {
213                     G = Max_Min_grouping(A, N-G[M], M-1);
214                     sum = findSummation(A, (k+1), i);
215                     min = C[j-1][k] < sum ? C[j-1][k] : sum;
216                     if (min > C[j][i])
217                     {
```

Enter Length of the group array and summation array :
3

C Array :
3 12 19 27 29 35 40 50 51 58 64 68
0 3 7 12 16 19 23 24 29 29 33
0 0 3 7 7 8 12 15 16 18 19 19

Bmin Array :
0 0 0 0 0 0 0 0 0 0 0
0 0 1 1 1 2 2 3 3 4 4 5
0 0 1 2 2 3 3 5 5 6 6 6

Optimal Grouping Array :
3 4 5

Group Summation Array :
19 21 28

Program ended with exit code: 0

Case 2:

Enter Length of the input array :
7

Enter the input array :
3 9 7 8 2 6 5

Enter Length of the group array and summation array :
2

C Array :
3 12 19 27 29 35 40

0 3 7 12 12 16 19

Bmin Array :
0 0 0 0 0 0 0

0 0 1 1 1 2 2

Optimal Grouping Array :
3 4

Group Summation Array :
19 21

Program ended with exit code: 0

The screenshot shows a C++ IDE with a file named `Max_Min_grouping.cpp`. The code defines a function `findSummation` and a recursive function `Max_Min_grouping`. The `findSummation` function calculates the minimum sum of a grouping array for a given input array `A` of size `N`. The `Max_Min_grouping` function returns the optimal grouping array. The main function reads the input array `A` and its size `N`, and then calls `Max_Min_grouping` to find the optimal grouping array and its summation array.

```
109 //function for minimum and maximum grouping and returns optimal group array.
110 //Params:
111 //191 A - input array.
112 //192 N - Number of columns.
113 //193 M - Number of rows.
114 //194.
115 //195.
116 //196.
117 //197.
118 //198.
119 //199.
120 //200.
121 //201.
122 //202.
123 //203.
124 //204.
125 //205.
126 //206.
127 //207.
128 //208.
129 //209.
130 //210.
131 //211.
132 //212.
133 //213.
134 //214.
135 //215.
136 //216.
137 //217.
138 //218.
139 //219.
140 //220.
141 //221.
142 //222.
143 //223.
144 //224.
145 //225.
146 //226.
147 //227.
148 //228.
149 //229.
150 //230.
151 //231.
152 //232.
153 //233.
154 //234.
155 //235.
156 //236.
157 //237.
158 //238.
159 //239.
160 //240.
161 //241.
162 //242.
163 //243.
164 //244.
165 //245.
166 //246.
167 //247.
168 //248.
169 //249.
170 //250.
171 //251.
172 //252.
173 //253.
174 //254.
175 //255.
176 //256.
177 //257.
178 //258.
179 //259.
180 //260.
181 //261.
182 //262.
183 //263.
184 //264.
185 //265.
186 //266.
187 //267.
188 //268.
189 //269.
190 //270.
191 //271.
192 //272.
193 //273.
194 //274.
195 //275.
196 //276.
197 //277.
198 //278.
199 //279.
200 //280.
201 //281.
202 //282.
203 //283.
204 //284.
205 //285.
206 //286.
207 //287.
208 //288.
209 //289.
210 //290.
211 //291.
212 //292.
213 //293.
214 //294.
215 //295.
216 //296.
217 //297.
218 //298.
219 //299.
220 //300.
221 //301.
222 //302.
223 //303.
224 //304.
225 //305.
226 //306.
227 //307.
228 //308.
229 //309.
230 //310.
231 //311.
232 //312.
233 //313.
234 //314.
235 //315.
236 //316.
237 //317.
238 //318.
239 //319.
240 //320.
241 //321.
242 //322.
243 //323.
244 //324.
245 //325.
246 //326.
247 //327.
248 //328.
249 //329.
250 //330.
251 //331.
252 //332.
253 //333.
254 //334.
255 //335.
256 //336.
257 //337.
258 //338.
259 //339.
260 //340.
261 //341.
262 //342.
263 //343.
264 //344.
265 //345.
266 //346.
267 //347.
268 //348.
269 //349.
270 //350.
271 //351.
272 //352.
273 //353.
274 //354.
275 //355.
276 //356.
277 //357.
278 //358.
279 //359.
280 //360.
281 //361.
282 //362.
283 //363.
284 //364.
285 //365.
286 //366.
287 //367.
288 //368.
289 //369.
290 //370.
291 //371.
292 //372.
293 //373.
294 //374.
295 //375.
296 //376.
297 //377.
298 //378.
299 //379.
300 //380.
301 //381.
302 //382.
303 //383.
304 //384.
305 //385.
306 //386.
307 //387.
308 //388.
309 //389.
310 //390.
311 //391.
312 //392.
313 //393.
314 //394.
315 //395.
316 //396.
317 //397.
318 //398.
319 //399.
320 //400.
321 //401.
322 //402.
323 //403.
324 //404.
325 //405.
326 //406.
327 //407.
328 //408.
329 //409.
330 //410.
331 //411.
332 //412.
333 //413.
334 //414.
335 //415.
336 //416.
337 //417.
338 //418.
339 //419.
340 //420.
341 //421.
342 //422.
343 //423.
344 //424.
345 //425.
346 //426.
347 //427.
348 //428.
349 //429.
350 //430.
351 //431.
352 //432.
353 //433.
354 //434.
355 //435.
356 //436.
357 //437.
358 //438.
359 //439.
360 //440.
361 //441.
362 //442.
363 //443.
364 //444.
365 //445.
366 //446.
367 //447.
368 //448.
369 //449.
370 //450.
371 //451.
372 //452.
373 //453.
374 //454.
375 //455.
376 //456.
377 //457.
378 //458.
379 //459.
380 //460.
381 //461.
382 //462.
383 //463.
384 //464.
385 //465.
386 //466.
387 //467.
388 //468.
389 //469.
390 //470.
391 //471.
392 //472.
393 //473.
394 //474.
395 //475.
396 //476.
397 //477.
398 //478.
399 //479.
400 //480.
401 //481.
402 //482.
403 //483.
404 //484.
405 //485.
406 //486.
407 //487.
408 //488.
409 //489.
410 //490.
411 //491.
412 //492.
413 //493.
414 //494.
415 //495.
416 //496.
417 //497.
418 //498.
419 //499.
420 //500.
421 //501.
422 //502.
423 //503.
424 //504.
425 //505.
426 //506.
427 //507.
428 //508.
429 //509.
430 //510.
431 //511.
432 //512.
433 //513.
434 //514.
435 //515.
436 //516.
437 //517.
438 //518.
439 //519.
440 //520.
441 //521.
442 //522.
443 //523.
444 //524.
445 //525.
446 //526.
447 //527.
448 //528.
449 //529.
450 //530.
451 //531.
452 //532.
453 //533.
454 //534.
455 //535.
456 //536.
457 //537.
458 //538.
459 //539.
460 //540.
461 //541.
462 //542.
463 //543.
464 //544.
465 //545.
466 //546.
467 //547.
468 //548.
469 //549.
470 //550.
471 //551.
472 //552.
473 //553.
474 //554.
475 //555.
476 //556.
477 //557.
478 //558.
479 //559.
480 //560.
481 //561.
482 //562.
483 //563.
484 //564.
485 //565.
486 //566.
487 //567.
488 //568.
489 //569.
490 //570.
491 //571.
492 //572.
493 //573.
494 //574.
495 //575.
496 //576.
497 //577.
498 //578.
499 //579.
500 //580.
501 //581.
502 //582.
503 //583.
504 //584.
505 //585.
506 //586.
507 //587.
508 //588.
509 //589.
510 //590.
511 //591.
512 //592.
513 //593.
514 //594.
515 //595.
516 //596.
517 //597.
518 //598.
519 //599.
520 //600.
521 //601.
522 //602.
523 //603.
524 //604.
525 //605.
526 //606.
527 //607.
528 //608.
529 //609.
530 //610.
531 //611.
532 //612.
533 //613.
534 //614.
535 //615.
536 //616.
537 //617.
538 //618.
539 //619.
540 //620.
541 //621.
542 //622.
543 //623.
544 //624.
545 //625.
546 //626.
547 //627.
548 //628.
549 //629.
550 //630.
551 //631.
552 //632.
553 //633.
554 //634.
555 //635.
556 //636.
557 //637.
558 //638.
559 //639.
560 //640.
561 //641.
562 //642.
563 //643.
564 //644.
565 //645.
566 //646.
567 //647.
568 //648.
569 //649.
570 //650.
571 //651.
572 //652.
573 //653.
574 //654.
575 //655.
576 //656.
577 //657.
578 //658.
579 //659.
580 //660.
581 //661.
582 //662.
583 //663.
584 //664.
585 //665.
586 //666.
587 //667.
588 //668.
589 //669.
590 //670.
591 //671.
592 //672.
593 //673.
594 //674.
595 //675.
596 //676.
597 //677.
598 //678.
599 //679.
600 //680.
601 //681.
602 //682.
603 //683.
604 //684.
605 //685.
606 //686.
607 //687.
608 //688.
609 //689.
610 //690.
611 //691.
612 //692.
613 //693.
614 //694.
615 //695.
616 //696.
617 //697.
618 //698.
619 //699.
620 //700.
621 //701.
622 //702.
623 //703.
624 //704.
625 //705.
626 //706.
627 //707.
628 //708.
629 //709.
630 //710.
631 //711.
632 //712.
633 //713.
634 //714.
635 //715.
636 //716.
637 //717.
638 //718.
639 //719.
640 //720.
641 //721.
642 //722.
643 //723.
644 //724.
645 //725.
646 //726.
647 //727.
648 //728.
649 //729.
650 //730.
651 //731.
652 //732.
653 //733.
654 //734.
655 //735.
656 //736.
657 //737.
658 //738.
659 //739.
660 //740.
661 //741.
662 //742.
663 //743.
664 //744.
665 //745.
666 //746.
667 //747.
668 //748.
669 //749.
670 //750.
671 //751.
672 //752.
673 //753.
674 //754.
675 //755.
676 //756.
677 //757.
678 //758.
679 //759.
680 //760.
681 //761.
682 //762.
683 //763.
684 //764.
685 //765.
686 //766.
687 //767.
688 //768.
689 //769.
690 //770.
691 //771.
692 //772.
693 //773.
694 //774.
695 //775.
696 //776.
697 //777.
698 //778.
699 //779.
700 //780.
701 //781.
702 //782.
703 //783.
704 //784.
705 //785.
706 //786.
707 //787.
708 //788.
709 //789.
710 //790.
711 //791.
712 //792.
713 //793.
714 //794.
715 //795.
716 //796.
717 //797.
718 //798.
719 //799.
720 //800.
721 //801.
722 //802.
723 //803.
724 //804.
725 //805.
726 //806.
727 //807.
728 //808.
729 //809.
730 //810.
731 //811.
732 //812.
733 //813.
734 //814.
735 //815.
736 //816.
737 //817.
738 //818.
739 //819.
740 //820.
741 //821.
742 //822.
743 //823.
744 //824.
745 //825.
746 //826.
747 //827.
748 //828.
749 //829.
750 //830.
751 //831.
752 //832.
753 //833.
754 //834.
755 //835.
756 //836.
757 //837.
758 //838.
759 //839.
760 //840.
761 //841.
762 //842.
763 //843.
764 //844.
765 //845.
766 //846.
767 //847.
768 //848.
769 //849.
770 //850.
771 //851.
772 //852.
773 //853.
774 //854.
775 //855.
776 //856.
777 //857.
778 //858.
779 //859.
780 //860.
781 //861.
782 //862.
783 //863.
784 //864.
785 //865.
786 //866.
787 //867.
788 //868.
789 //869.
790 //870.
791 //871.
792 //872.
793 //873.
794 //874.
795 //875.
796 //876.
797 //877.
798 //878.
799 //879.
800 //880.
801 //881.
802 //882.
803 //883.
804 //884.
805 //885.
806 //886.
807 //887.
808 //888.
809 //889.
810 //890.
811 //891.
812 //892.
813 //893.
814 //894.
815 //895.
816 //896.
817 //897.
818 //898.
819 //899.
820 //900.
821 //901.
822 //902.
823 //903.
824 //904.
825 //905.
826 //906.
827 //907.
828 //908.
829 //909.
830 //910.
831 //911.
832 //912.
833 //913.
834 //914.
835 //915.
836 //916.
837 //917.
838 //918.
839 //919.
840 //920.
841 //921.
842 //922.
843 //923.
844 //924.
845 //925.
846 //926.
847 //927.
848 //928.
849 //929.
850 //930.
851 //931.
852 //932.
853 //933.
854 //934.
855 //935.
856 //936.
857 //937.
858 //938.
859 //939.
860 //940.
861 //941.
862 //942.
863 //943.
864 //944.
865 //945.
866 //946.
867 //947.
868 //948.
869 //949.
870 //950.
871 //951.
872 //952.
873 //953.
874 //954.
875 //955.
876 //956.
877 //957.
878 //958.
879 //959.
880 //960.
881 //961.
882 //962.
883 //963.
884 //964.
885 //965.
886 //966.
887 //967.
888 //968.
889 //969.
890 //970.
891 //971.
892 //972.
893 //973.
894 //974.
895 //975.
896 //976.
897 //977.
898 //978.
899 //979.
900 //980.
901 //981.
902 //982.
903 //983.
904 //984.
905 //985.
906 //986.
907 //987.
908 //988.
909 //989.
910 //990.
911 //991.
912 //992.
913 //993.
914 //994.
915 //995.
916 //996.
917 //997.
918 //998.
919 //999.
920 //1000.
921 //1001.
922 //1002.
923 //1003.
924 //1004.
925 //1005.
926 //1006.
927 //1007.
928 //1008.
929 //1009.
930 //1010.
931 //1011.
932 //1012.
933 //1013.
934 //1014.
935 //1015.
936 //1016.
937 //1017.
938 //1018.
939 //1019.
940 //1020.
941 //1021.
942 //1022.
943 //1023.
944 //1024.
945 //1025.
946 //1026.
947 //1027.
948 //1028.
949 //1029.
950 //1030.
951 //1031.
952 //1032.
953 //1033.
954 //1034.
955 //1035.
956 //1036.
957 //1037.
958 //1038.
959 //1039.
960 //1040.
961 //1041.
962 //1042.
963 //1043.
964 //1044.
965 //1045.
966 //1046.
967 //1047.
968 //1048.
969 //1049.
970 //1050.
971 //1051.
972 //1052.
973 //1053.
974 //1054.
975 //1055.
976 //1056.
977 //1057.
978 //1058.
979 //1059.
980 //1060.
981 //1061.
982 //1062.
983 //1063.
984 //1064.
985 //1065.
986 //1066.
987 //1067.
988 //1068.
989 //1069.
990 //1070.
991 //1071.
992 //1072.
993 //1073.
994 //1074.
995 //1075.
996 //1076.
997 //1077.
998 //1078.
999 //1079.
1000 //1080.
1001 //1081.
1002 //1082.
1003 //1083.
1004 //1084.
1005 //1085.
1006 //1086.
1007 //1087.
1008 //1088.
1009 //1089.
1010 //1090.
1011 //1091.
1012 //1092.
1013 //1093.
1014 //1094.
1015 //1095.
1016 //1096.
1017 //1097.
1018 //1098.
1019 //1099.
1020 //1100.
1021 //1101.
1022 //1102.
1023 //1103.
1024 //1104.
1025 //1105.
1026 //1106.
1027 //1107.
1028 //1108.
1029 //1109.
1030 //1110.
1031 //1111.
1032 //1112.
1033 //1113.
1034 //1114.
1035 //1115.
1036 //1116.
1037 //1117.
1038 //1118.
1039 //1119.
1040 //1120.
1041 //1121.
1042 //1122.
1043 //1123.
1044 //1124.
1045 //1125.
1046 //1126.
1047 //1127.
1048 //1128.
1049 //1129.
1050 //1130.
1051 //1131.
1052 //1132.
1053 //1133.
1054 //1134.
1055 //1135.
1056 //1136.
1057 //1137.
1058 //1138.
1059 //1139.
1060 //1140.
1061 //1141.
1062 //1142.
1063 //1143.
1064 //1144.
1065 //1145.
1066 //1146.
1067 //1147.
1068 //1148.
1069 //1149.
1070 //1150.
1071 //1151.
1072 //1152.
1073 //1153.
1074 //1154.
1075 //1155.
1076 //1156.
1077 //1157.
1078 //1158.
1079 //1159.
1080 //1160.
1081 //1161.
1082 //1162.
1083 //1163.
1084 //1164.
1085 //1165.
1086 //1166.
1087 //1167.
1088 //1168.
1089 //1169.
1090 //1170.
1091 //1171.
1092 //1172.
1093 //1173.
1094 //1174.
1095 //1175.
1096 //1176.
1097 //1177.
1098 //1178.
1099 //1179.
1100 //1180.
1101 //1181.
1102 //1182.
1103 //1183.
1104 //1184.
1105 //1185.
1106 //1186.
1107 //1187.
1108 //1188.
1109 //1189.
1110 //1190.
1111 //1191.
1112 //1192.
1113 //1193.
1114 //1194.
1115 //1195.
1116 //1196.
1117 //1197.
1118 //1198.
1119 //1199.
1120 //1200.
1121 //1201.
1122 //1202.
1123 //1203.
1124 //1204.
1125 //1205.
1126 //1206.
1127 //1207.
1128 //1208.
1129 //1209.
1130 //1210.
1131 //1211.
1132 //1212.
1133 //1213.
1134 //1214.
1135 //1215.
1136 //1216.
1137 //1217.
1138 //1218.
1139 //1219.
1140 //1220.
1141 //1221.
1142 //1222.
1143 //1223.
1144 //1224.
1145 //1225.
1146 //1226.
1147 //1227.
1148 //1228.
1149 //1229.
1150 //1230.
1151 //1231.
1152 //1232.
1153 //1233.
1154 //1234.
1155 //1235.
1156 //1236.
1157 //1237.
1158 //1238.
1159 //1239.
1160 //1240.
1161 //1241.
1162 //1242.
1163 //1243.
1164 //1244.
1165 //1245.
1166 //1246.
1167 //1247.
1168 //1248.
1169 //1249.
1170 //1250.
1171 //1251.
1172 //1252.
1173 //1253.
1174 //1254.
1175 //1255.
1176 //1256.
1177 //1257.
1178 //1258.
1179 //1259.
1180 //1260.
1181 //1261.
1182 //1262.
1183 //1263.
1184 //1264.
1185 //1265.
1186 //1266.
1187 //1267.
1188 //1268.
1189 //1269.
1190 //1270.
1191 //1271.
1192 //1272.
1193 //1273.
1194 //1274.
1195 //1275.
1196 //1276.
1197 //1277.
1198 //1278.
1199 //1279.
1200 //1280.
1201 //1281.
1202 //1282.
1203 //1283.
1204 //1284.
1205 //1285.
1206 //1286.
1207 //1287.
1208 //1288.
1209 //1289.
1210 //1290.
1211 //1291.
1212 //1292.
1213 //1293.
1214 //1294.
1215 //1295.
1216 //1296.
1217 //1297.
1218 //1298.
1219 //1299.
1220 //1300.
1221 //1301.
1222 //1302.
1223 //1303.
1224 //1304.
1225 //1305.
1226 //1306.
1227 //1307.
1228 //1308.
1229 //1309.
1230 //1310.
1231 //1311.
1232 //1312.
1233 //1313.
1234 //1314.
1235 //1315.
1236 //1316.
1237 //1317.
1238 //1318.
1239 //1319.
1240 //1320.
1241 //1321.
1242 //1322.
1243 //1323.
1244 //1324.
1245 //1325.
1246 //1326.
1247 //1327.
1248 //1328.
1249 //1329.
1250 //1330.
1251 //1331.
1252 //1332.
1253 //1333.
1254 //1334.
1255 //1335.
1256 //1336.
1257 //1337.
1258 //1338.
1259 //1339.
1260 //1340.
1261 //1341.
1262 //1342.
1263 //1343.
1264 //1344.
1265 //1345.
1266 //1346.
1267 //1347.
1268 //1348.
1269 //1349.
1270 //1350.
1271 //1351.
1272 //1352.
1273 //1353.
1274 //1354.
1275 //1355.
1276 //1356.
1277 //1357.
1278 //1358.
1279 //1359.
1280 //1360.
1281 //1361.
1282 //1362.
1283 //1363.
1284 //1364.
1285 //1365.
1286 //1366.
1287 //1367.
1288 //1368.
1289 //1369.
1290 //1370.
1291 //1371.
1292 //1372.
1293 //1373.
1294 //1374.
1295 //1375.
1296 //1376.
1297 //1377.
1298 //1378.
1299 //1379.
1300 //1380.
1301 //1381.
1302 //1382.
1303 //1383.
1304 //1384.
1305 //1385.
1306 //1386.
1307 //1387.
1308 //1388.
1309 //1389.
1310 //1390.
1311 //1391.
1312 //1392.
1313 //1393.
1314 //1394.
1315 //1395.
1316 //1396.
1317 //1397.
1318 //1398.
1319 //1399.
1320 //1400.
1321 //1401.
1322 //1402.
1323 //1403.
1324 //1404.
1325 //1405.
1326 //1406.
1327 //1407.
1328 //1408.
1329 //1409.
1330 //1410.
1331 //1411.
1332 //1412.
1333 //1413.
1334 //1414.
1335 //1415.
1336 //1416.
1337 //1417.
1338 //1418.
1339 //1419.
1340 //1420.
1341 //1421.
1342 //1422.
1343 //1423.
1344 //1424.
1345 //1425.
1346 //1426.
1347 //1427.
1348 //1428.
1349 //1429.
1350 //1430.
1351 //1431.
135
```