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19BCE245
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Design and Analysis of Algorithms

Practical 9

- **Code :**

```
*
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DAA Practical 9   | Knapsack using Dynamic Programming
*/

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <limits.h>
#include <stdbool.h>

/* used by printm routine */
#define INDEX(a,i,j,lda)  a[ (i)*lda + (j) ]
#define INDENT(n)         for(int _ = 0; _ < n ; _++)
printf(" ")

/* used by knapsack01 routine */
#define M(i, j)           M[ (i)*(w+1) + (j) ]
#define max(a, b)         (((a) > (b)) ? (a) : (b))

void printm(const char *name,
            const int *a,
            const int lda,
            const int m,
            const int n)
{
    const int len = strlen(name) + 1;
    const int mid = m / 2;
    INDENT(len);
    printf("/ ");

    for( int i=0 ; i<n ; i++ ) printf("      ");
    printf(" \\\n");
    for (int i=0 ; i<m ; i++) {
        if ( i == mid ) printf("%s ", name);
        else INDENT(len);
        printf("| ");
        for (int j=0 ; j<n ; j++) {
            printf("%5d ", INDEX(a,i,j,lda));
        }
        printf(" |\n");
    }
    INDENT(len);
    printf("\\ ");
    for( int i=0 ; i<n ; i++ ) printf("      ");
    printf(" /\n");
}

int knapsack01(const int w,
               const int *weights,
               const int *value,
               const int n)
{
    int *M = ( int * ) malloc( (n+1)*(w+1) *
sizeof(int) );

    for(int i = 0 ; i < w+1 ; i++) M(0, i) = 0;
    for(int j = 0 ; j < n+1 ; j++) M(j, 0) = 0;

    // DP
    for ( int n_items = 1 ; n_items < n+1 ; n_items++ ) {
        for (int weight = 1 ; weight < w+1 ; weight++ ) {
            if ( weights[ n_items-1 ] <= weight ) {
                M( n_items , weight ) = max(
                    value[ n_items-1 ] + M( n_items-1 ,
weight - weights[ n_items-1 ] ) ,
                    M( n_items-1 , weight )
                );
            }
            else {
                M( n_items , weight ) = M( n_items-1 ,
weight );
            }
        }
    }

    int max_loot = M( n, w );

    printm("Memoization Table Entries ==> ", M, w+1, n+1,
w+1);

    int res = max_loot;
    int w_remaining = w;
    bool flag = false;

    printf("\n\t> Selected Weights : ");
    for ( int n_items = n; n_items > 0 && res > 0;
n_items--) {
        if (res == M(n_items-1,w_remaining)){
            continue;
        }
        else {
            // This item is included.
            if(flag){
                printf(", %d", weights[n_items - 1]);
            }
            else{
                printf("%d", weights[n_items - 1]);
                flag = true;
            }

            // Since this weight is included its value is
deducted
            res = res - value[n_items - 1];
            w_remaining = w_remaining - weights[n_items -
1];
        }
    }

    free(M);

    return max_loot;
}
```
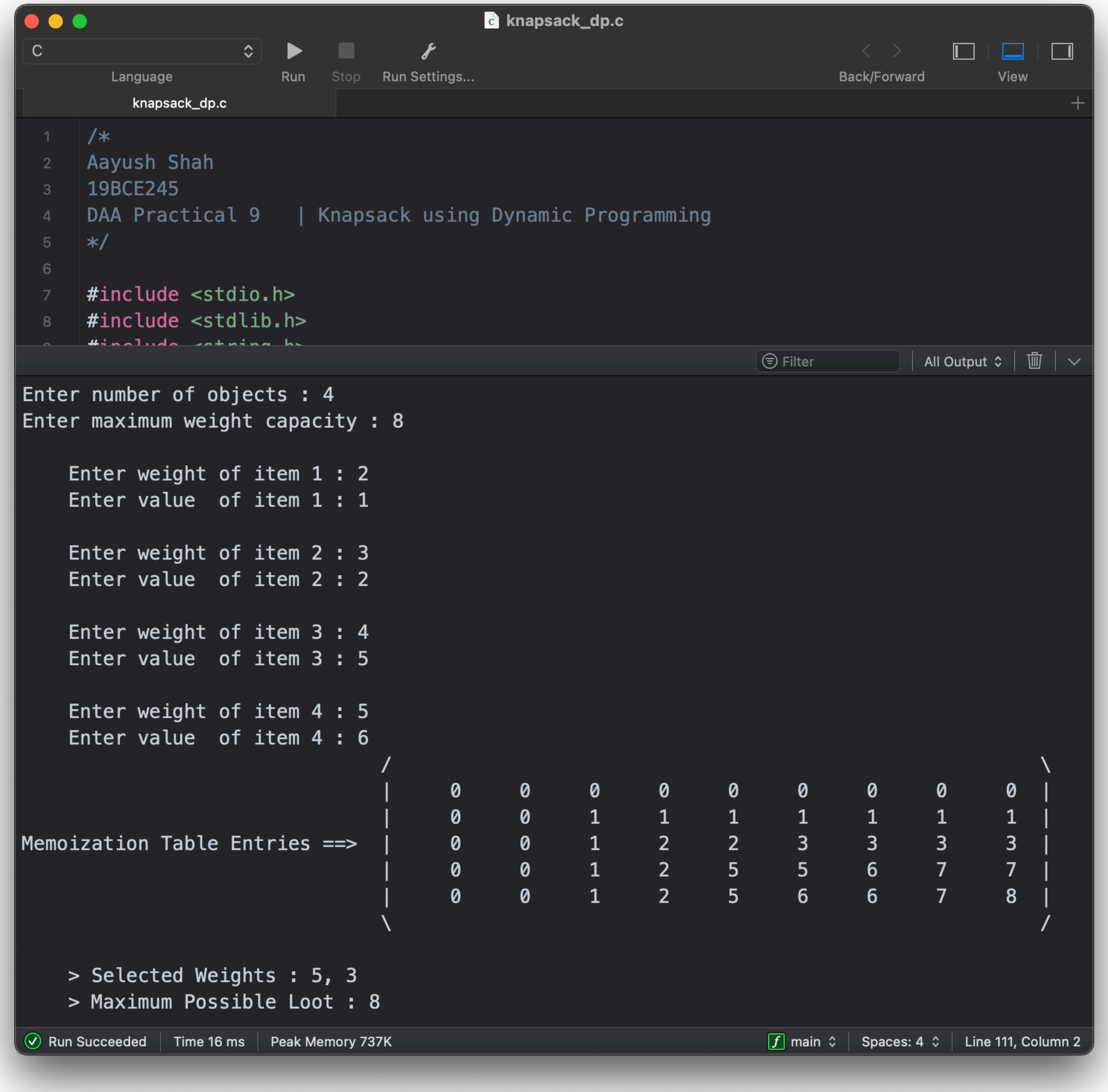

```
int main()
{
//  int n = 4;          // n : number of objects
//  int w = 8;          // w : maximum weight capacity
//  int weights[] = {2, 3, 4, 5};
//  int value[]   = {1, 2, 5, 6};

    int n,w;
    printf("Enter number of objects : ");
    scanf("%d",&n);
    int weights[n],value[n];
    printf("Enter maximum weight capacity : ");
    scanf("%d",&w);
    for(int i=0;i<n;i++){
        printf("\n\tEnter weight of item %d : ", i+1);
        scanf("%d",&weights[i]);
        printf("\tEnter value  of item %d : ", i+1);
        scanf("%d",&value[i]);
    }
    printf("\n\t> Maximum Possible Loot : %d\n\n",
knapsack01(w, weights, value, n));
    return 0;
}
```

- **Output :**



```c
/*
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*/

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
```

```
Enter number of objects : 4
Enter maximum weight capacity : 8

    Enter weight of item 1 : 2
    Enter value  of item 1 : 1

    Enter weight of item 2 : 3
    Enter value  of item 2 : 2

    Enter weight of item 3 : 4
    Enter value  of item 3 : 5

    Enter weight of item 4 : 5
    Enter value  of item 4 : 6
                                /                                                        \
                                |     0     0     0     0     0     0     0     0     0   |
                                |     0     0     1     1     1     1     1     1     1   |
Memoization Table Entries ==>   |     0     0     1     2     2     3     3     3     3   |
                                |     0     0     1     2     5     5     6     7     7   |
                                |     0     0     1     2     5     6     6     7     8   |
                                \                                                        /

    > Selected Weights : 5, 3
    > Maximum Possible Loot : 8
```