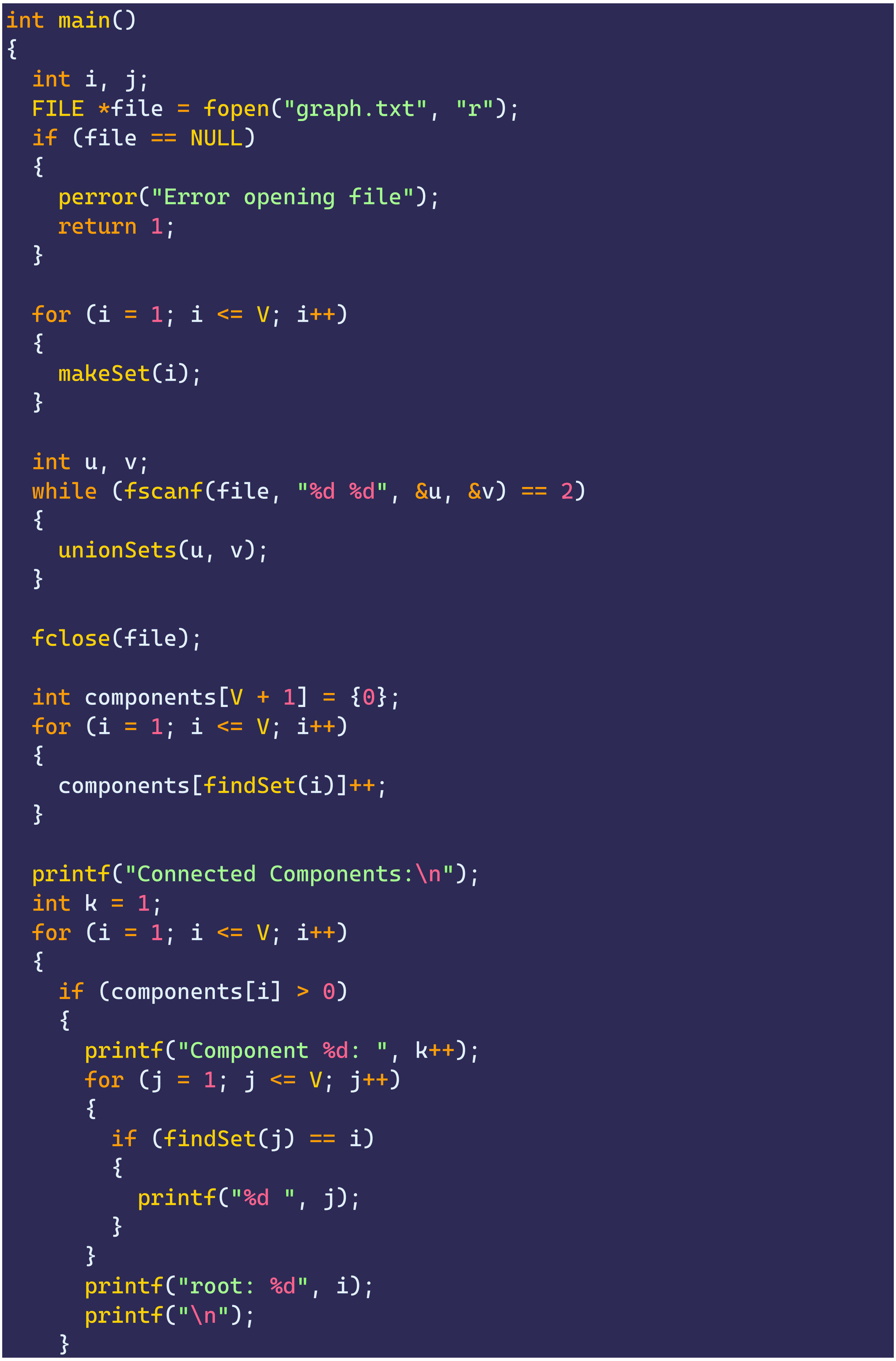
Rooted Tree

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

#define V 13

int p[V + 1];
int rank[V + 1];

void makeSet(int x)
{
  p[x] = x;
  rank[x] = 0;
}

int findSet(int x)
{
  if (x != p[x])
  {
    p[x] = findSet(p[x]);
  }
  return p[x];
}

void link(int x, int y)
{
  if (rank[x] > rank[y])
  {
    p[y] = x;
  }
  else
  {
    p[x] = y;
    if (rank[x] == rank[y])
    {
      rank[y]++;
    }
  }
}

void unionSets(int x, int y)
{
  link(findSet(x), findSet(y));
}
```

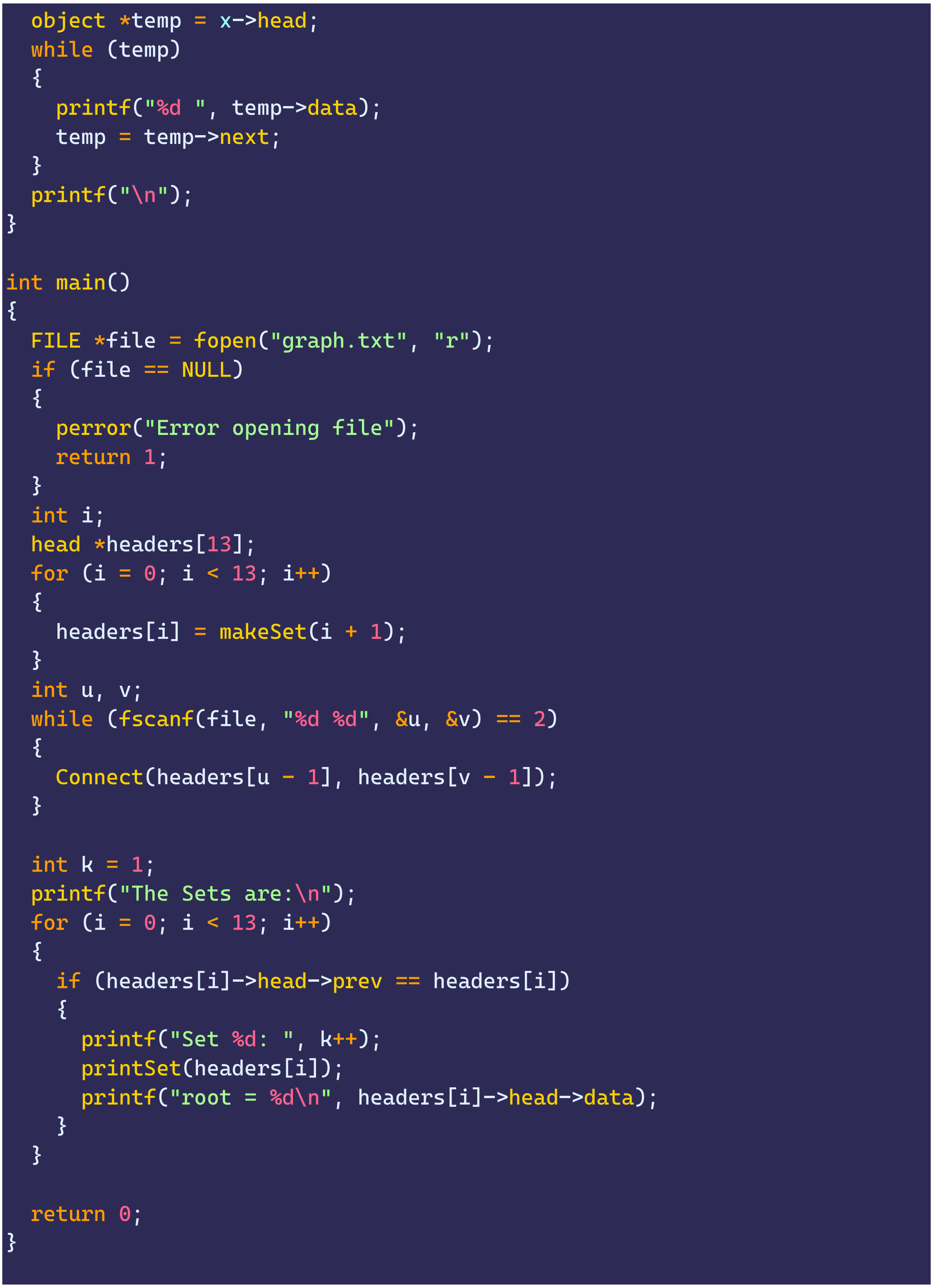


```c
int main()
{
  int i, j;
  FILE *file = fopen("graph.txt", "r");
  if (file == NULL)
  {
    perror("Error opening file");
    return 1;
  }

  for (i = 1; i <= V; i++)
  {
    makeSet(i);
  }

  int u, v;
  while (fscanf(file, "%d %d", &u, &v) == 2)
  {
    unionSets(u, v);
  }

  fclose(file);

  int components[V + 1] = {0};
  for (i = 1; i <= V; i++)
  {
    components[findSet(i)]++;
  }

  printf("Connected Components:\n");
  int k = 1;
  for (i = 1; i <= V; i++)
  {
    if (components[i] > 0)
    {
      printf("Component %d: ", k++);
      for (j = 1; j <= V; j++)
      {
        if (findSet(j) == i)
        {
          printf("%d ", j);
        }
      }
      printf("root: %d", i);
      printf("\n");
    }
  }

  return 0;
}
```

Linked List

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

typedef struct head
{
  struct object *head;
  struct object *tail;
  int size;
} head;

typedef struct object
{
  int data;
  struct object *next;
  head *prev;
} object;

head *makeSet(int data)
{
  head *Header = (head *)malloc(sizeof(head));
  Header->head = (object *)malloc(sizeof(object));
  Header->tail = (object *)malloc(sizeof(object));
  Header->size = 1;

  Header->head->data = data;
  Header->head->next = NULL;
  Header->head->prev = Header;

  Header->tail = Header->head;
  return Header;
}

head *findSet(head *x)
{
  return x->head->prev;
}

int SameSet(head *x, head *y)
{
  return (x->head->prev == y->head->prev);
}
```

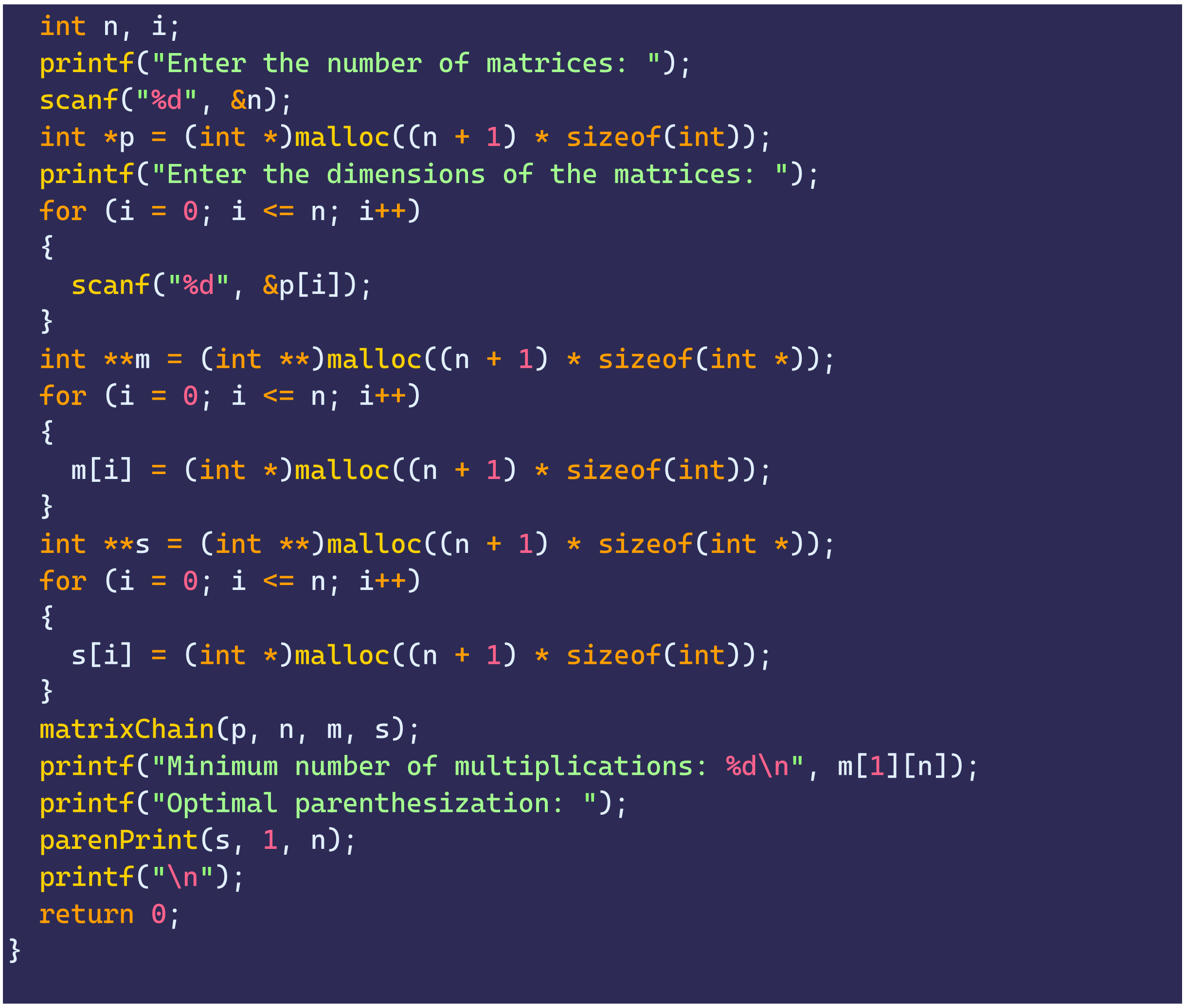
```
void Union(head *x, head *y)
{
  if (x->head->prev == y->head->prev)
  {
    return;
  }
  head *X = x->head->prev;
  head *Y = y->head->prev;
  if (X->size > Y->size)
  {
    object *temp = Y->head, *prev;
    while (temp)
    {
      prev = temp;
      temp->prev = X;
      temp = temp->next;
    }

    X->tail->next = Y->head;
    X->tail = prev;
    X->size += Y->size;
    return;
  }
  object *temp = X->head, *prev;
  while (temp)
  {
    prev = temp;
    temp->prev = Y;
    temp = temp->next;
  }

  Y->tail->next = X->head;
  Y->tail = prev;
  Y->size += X->size;
}

void Connect(head *x, head *y)
{
  if(!SameSet(x, y))
  {
    Union(x, y);
  }
}

void printSet(head *x)
{
  printf("Size of the set = %d\n", x->size);
```



```
  object *temp = x->head;
  while (temp)
  {
    printf("%d ", temp->data);
    temp = temp->next;
  }
  printf("\n");
}

int main()
{
  FILE *file = fopen("graph.txt", "r");
  if (file == NULL)
  {
    perror("Error opening file");
    return 1;
  }
  int i;
  head *headers[13];
  for (i = 0; i < 13; i++)
  {
    headers[i] = makeSet(i + 1);
  }
  int u, v;
  while (fscanf(file, "%d %d", &u, &v) == 2)
  {
    Connect(headers[u - 1], headers[v - 1]);
  }

  int k = 1;
  printf("The Sets are:\n");
  for (i = 0; i < 13; i++)
  {
    if (headers[i]->head->prev == headers[i])
    {
      printf("Set %d: ", k++);
      printSet(headers[i]);
      printf("root = %d\n", headers[i]->head->data);
    }
  }

  return 0;
}
```

Matrix Multiplication

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

void matrixChain(int *p, int n, int **m, int **s)
{
  int i, l, j, k, q;
  for (i = 1; i <= n; i++)
  {
    m[i][i] = 0;
  }
  for (l = 2; l <= n; l++)
  {
    for (i = 1; i <= n - l + 1; i++)
    {
      j = i + l - 1;
      m[i][j] = INT_MAX;
      for (k = i; k <= j - 1; k++)
      {
        q = m[i][k] + m[k + 1][j] + p[i - 1] * p[k] * p[j];
        if (q < m[i][j])
        {
          m[i][j] = q;
          s[i][j] = k;
        }
      }
    }
  }
}

void parenPrint(int **s, int i, int j)
{
  if (i == j)
  {
    printf("A%d", i);
  }
  else
  {
    printf("(");
    parenPrint(s, i, s[i][j]);
    parenPrint(s, s[i][j] + 1, j);
    printf(")");
  }
}

int main()
{
```



```c
  int n, i;
  printf("Enter the number of matrices: ");
  scanf("%d", &n);
  int *p = (int *)malloc((n + 1) * sizeof(int));
  printf("Enter the dimensions of the matrices: ");
  for (i = 0; i <= n; i++)
  {
    scanf("%d", &p[i]);
  }
  int **m = (int **)malloc((n + 1) * sizeof(int *));
  for (i = 0; i <= n; i++)
  {
    m[i] = (int *)malloc((n + 1) * sizeof(int));
  }
  int **s = (int **)malloc((n + 1) * sizeof(int *));
  for (i = 0; i <= n; i++)
  {
    s[i] = (int *)malloc((n + 1) * sizeof(int));
  }
  matrixChain(p, n, m, s);
  printf("Minimum number of multiplications: %d\n", m[1][n]);
  printf("Optimal parenthesization: ");
  parenPrint(s, 1, n);
  printf("\n");
  return 0;
}
```