
# 江 蘇 大 學

# JIANGSU UNIVERSITY

# 数据结构与算法课程设计

所属学院：计算机科学与通信工程学院

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# 1. 问题分析与任务定义

## 1.1 问题分析

### 1.1.1 问题分析

•处于开学阶段

1. 新生对校园地理不熟悉，难以快速找到目的地
2. 现有公交线路信息分散，缺乏统一查询平台
3. 当前换乘方案不明确，导致出行效率低下
4. 非公交站点与公交站点间缺乏路径规划

### 1.1.2 核心问题

•需要开发一个校内公交查询系统解决：

- 信息分散问题：整合所有公交线路和站点信息
- 路径规划问题：提供最优路线推荐（时间/距离/换乘）
- 管理维护问题：允许管理员更新线路信息
- **用户区分问题：区分管理员和学生用户权限**

### 1.1.3 技术难点

1. 多目标路径规划算法的实现
2. 公交站点与非公交站点的关联处理
3. 数据持久化存储与加载

## 1.2 任务定义

### 1.2.1 系统功能要求

**管理员端：**

- 初始化: 将所有相关信息**存入文本**, 每次运行系统都要进行**初始化操作，**即从文本中读入各线路相关信息;
- 维护公交线路
  1) 新增公交线路
  2) 修改已有公交线路（修改部分站点信息）
  3) 输入站点名称, 将其从路线中删除 (同时应当修改该站点的公交线路信息)
  4) 增加站点，添加到已有公交线路中

以上信息修改之后均需要输出信息以验证修改结果, 并且将结果写回**存储文件**中。

学生端:

- 公交线路查询
  1) 输入地点名称, 查询出该地点所经过的所有公交线路相关信息, 包括线路编号、经过的站点信息、时间、距离等;
  2) 输出所有校内公交路线;
- 公交路线规划

输入**起点和终点**，输出所有的可达路线及花费的时间（包括从该点步行到公交车站、从公交站步行到终点的时间）

- 最优路线规划
  1) 输入起始站点名和终点名，给出时间最短的路线 （为了体现工作量，请自行设计线路，难易程度不限，量力而行即可）
  2) 输入起始站点名和终点名，给出换乘次数最少的路线;

输出从五棵松出发到达各个地点的距离最短路线

**•管理员功能：**

1. 数据初始化（init_default_data）
   从文件加载线路数据（load_data）
   初始化默认校园地图数据
2. 线路维护：
   新增公交线路（add_bus_route）
   修改已有线路（modify_bus_route）
   删除线路站点（delete_station_from_route）
   添加线路站点（add_station_to_route）
3. 密码管理（manage_password）：
   修改/取消/设置管理员密码

**•学生功能：**

1. 信息查询：
   查询站点线路（query_station_routes）
   显示所有线路（display_all_routes）
2. 路线规划：
   最短时间路线（plan_route(0)）
   最少换乘路线（**plan_route(1)**）
   从五棵松出发的最短距离路线（**plan_route(2)**）

## 2．数据结构的选择和概要设计

## 2.1 初始化草图

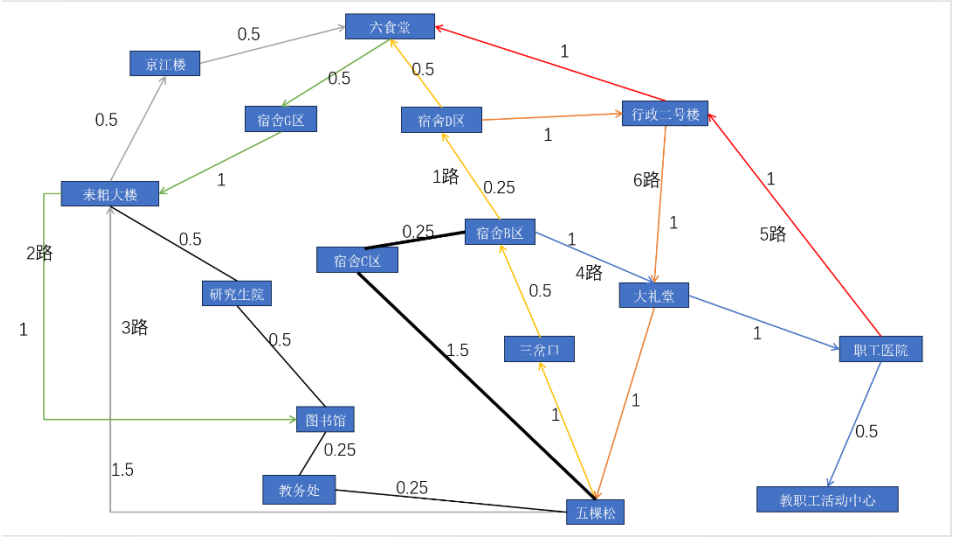


**图 1：江大线路草图**

我根据题目要求，结合我对校园公交和地点的了解，选取了 16 个地点，6 条公交线路，2 个非站点地点，利用 PPT 画出了该线路系统的大致草图。其中公交线路用不同颜色的单向箭头表示，与无向黑线相连的是非公交站点。

## 2.2 数据结构选择

### (1) 站点结构体(Station)

```
typedef struct {
    int id;                     // 站点唯一标识
    char name[MAX_NAME];        // 站点名称(最大 50 字符)
    int is_bus_station;         // 1 表示公交站点，0 表示普通地点
} Station;
```

该数据结构使用结构体封装站点属性，便于统一管理，而 ID 确保唯一性，便于建立站点间关系，同时名称字段方便用户识别，最后标志位区分公交站点和普通地点。

### (2) 线路结构体(Route)

```
typedef struct {
    int id;                     // 线路 ID
    int station_count;          // 站点数量
    int stations[MAX_STATIONS]; // 站点 ID 数组(按顺序存储)
    float distances[MAX_STATIONS]; // 相邻站点间距离(km)
} Route;
```

利用更节省内存的数组存储站点序列，显式存储距离数据便于精确计算，station_count 记录实际站点数，避免遍历整个数组。

### (3) 步行边结构体(WalkEdge)

```
typedef struct {
    int from;                   // 起点 ID
    int to;                     // 终点 ID
    float distance;             // 步行距离(km)
} WalkEdge;
```

用来单独存储非公交路线连接关系，支持双向步行路径（需存储两个方向的边），而距离字段用于计算步行时间。

**(4) 路径结构体(Path)**

```
typedef struct {
    int path[MAX_STATIONS];      // 路径站点序列
    int path_length;             // 路径长度
    float time;                  // 总耗时(分钟)
    float distance;              // 总距离(km)
    int transfers;               // 换乘次数
    char modes[MAX_STATIONS][10]; // 每段交通方式
} Path;
```

该结构体完整记录规划结果的各项指标，modes 数组标注每段是"公交"还是"步行"，便于结果展示和比较。

**(5)辅助数据结构**

全局变量

```
Station stations[MAX_STATIONS]; // 所有站点数组
Route bus_routes[MAX_ROUTES];   // 所有公交线路
WalkEdge walk_edges[MAX_EDGES]; // 所有步行连接
int station_count = 0;          // 当前站点数
int route_count = 0;            // 当前线路数
int walk_edge_count = 0;        // 当前步行边数
```

## 2.3 概要设计

**•数据存储设计（bus_data.txt）**

[站点数]
[ID] [名称] [是否公交站]
...
[线路数]
[线路 ID] [站点数] [站点 ID 序列] [距离序列]
...
[步行边数]
[起点 ID] [终点 ID] [距离]
...
[密码标志] [密码]

**•系统架构设计**

采取模块化设计程序

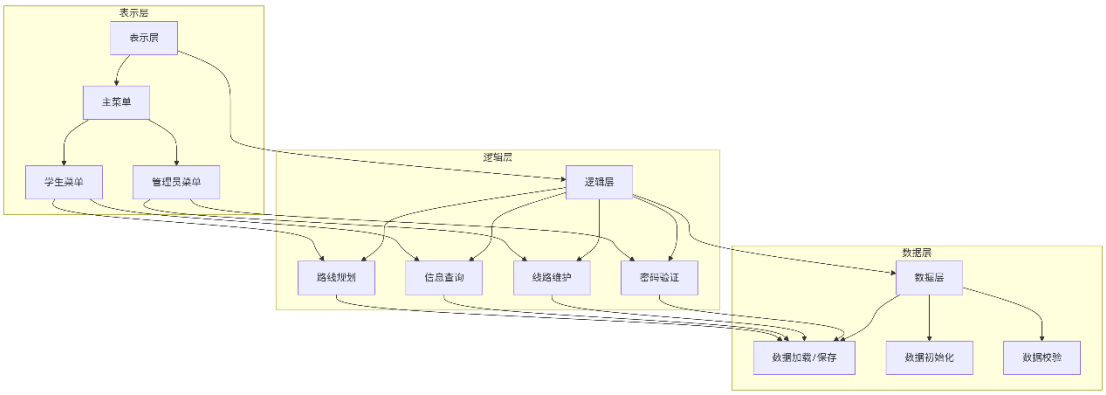


图 2：模块化设计流程图

选择 Dijistra 算法作为核心算法

**•用户界面流程**

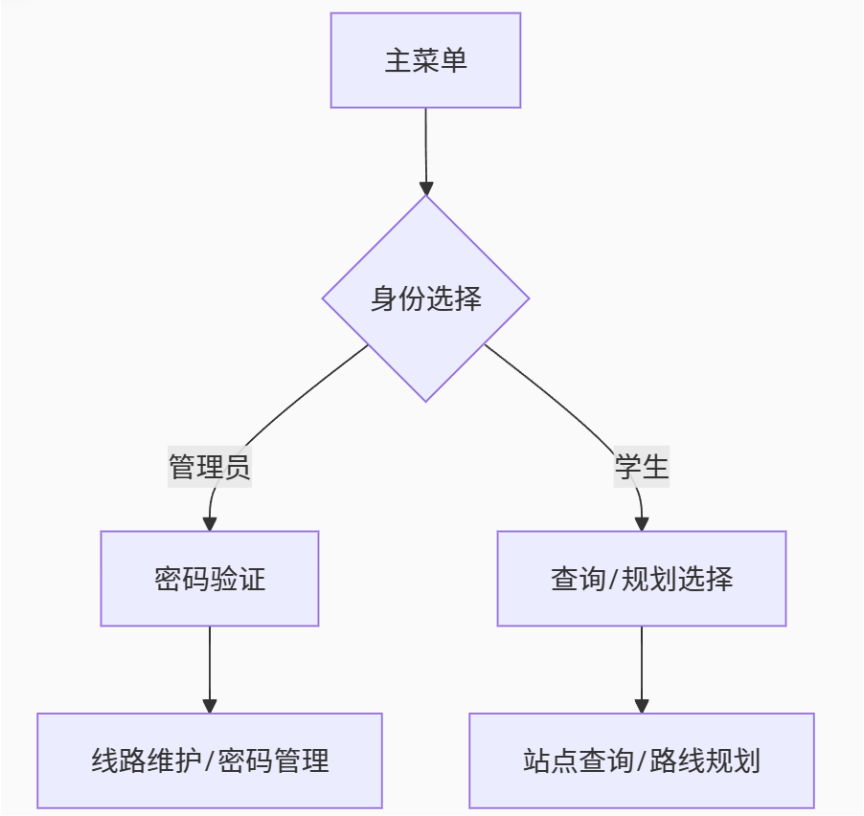


图 3：交互设计流程图

**3．详细设计与编码**

**3.1 初始化系统**

**数据层初始化系统的设计与实现**

**设计实现模块**

1. 模块概述：

数据层初始化系统的主要功能是从文件加载现有数据，或在文件不存在时使

用默认数据初始化系统。

包括站点（Station）、公交线路（Route）、步行边（WalkEdge）等数据结构的初始化。

提供数据保存功能以确保数据持久化。

2. 模块组成：

数据加载模块 (load_data)：从文件 bus_data.txt 读取站点、线路和步行边数据。

默认数据初始化模块 (init_default_data)：当文件加载失败或无数据时，初始化默认站点和线路。

数据保存模块 (save_data)：将当前数据保存到文件。

步行边更新模块 (update_walk_edges)：根据公交线路和默认步行边更新步行边数据。

3. 工作流程：

程序启动时调用 load_data 尝试加载文件数据。

若加载失败或数据为空，则调用 init_default_data 初始化默认数据。

初始化完成后，调用 update_walk_edges 更新步行边。

数据变更后通过 save_data 保存到文件。

**关键问题与解决办法**

问题 1：文件加载失败或格式错误

问题描述：文件可能不存在或格式不匹配，导致数据加载中断。

解决办法：使用文件打开失败时的默认初始化，并通过 fscanf 检查读取结果，防止因格式错误导致崩溃。提供错误提示并继续执行。

问题 2：数据一致性

问题描述：手动修改文件可能导致站点 ID、线路数据不一致。

解决办法：在初始化和更新时，通过 update_bus_station_status 和 update_walk_edges 确保站点是否为公交站点及步行边的动态更新。

问题 3：内存溢出风险

问题描述：站点、线路或步行边数量可能超过预定义最大值。

解决办法：设置 MAX_STATIONS、MAX_ROUTES 和 MAX_EDGES 常量，检查数组边界，并在必要时限制数据添加。

**以下是实现数据层初始化的关键代码：**

```
// 从文件加载数据
void load_data() {
    FILE *fp = fopen("bus_data.txt", "r");
    if (!fp) {
        printf("文件打开失败，将使用默认数据初始化。\n");
        return;
    }

    if (fscanf(fp, "%d", &station_count) != 1) {
        fclose(fp);
        return;
```

```
    }
    for (int i = 0; i < station_count; i++) {
        if (fscanf(fp, "%d %s %d", &stations[i].id, stations[i].name,
&stations[i].is_bus_station) != 3) {
            fclose(fp);
            return;
        }
    }

    if (fscanf(fp, "%d", &route_count) != 1) {
        fclose(fp);
        return;
    }
    for (int i = 0; i < route_count; i++) {
        if      (fscanf(fp,      "%d      %d",      &bus_routes[i].id,
&bus_routes[i].station_count) != 2) {
            fclose(fp);
            return;
        }
        for (int j = 0; j < bus_routes[i].station_count; j++) {
            if (fscanf(fp, "%d", &bus_routes[i].stations[j]) != 1) {
                fclose(fp);
                return;
            }
        }
        for (int j = 0; j < bus_routes[i].station_count 1; j++) {
            if (fscanf(fp, "%f", &bus_routes[i].distances[j]) != 1) {
                fclose(fp);
                return;
            }
        }
    }

    if (fscanf(fp, "%d", &walk_edge_count) != 1) {
        fclose(fp);
        return;
    }
    walk_edge_count = (walk_edge_count > MAX_EDGES) ? MAX_EDGES :
walk_edge_count;
    for (int i = 0; i < walk_edge_count; i++) {
        int from, to;
        float distance;
        if (fscanf(fp, "%d %d %f", &from, &to, &distance) != 3) {
            printf("读取步行边 %d 失败，文件格式可能错误。\n", i);
```

```
            fclose(fp);
            return;
        }
        if (from == 0 && to == 0 && distance == 0.00) {
            break;
        }
        walk_edges[i].from = from;
        walk_edges[i].to = to;
        walk_edges[i].distance = distance;
    }

    if (fscanf(fp, "%d %s", &password_set, admin_password) != 2) {
        fclose(fp);
        return;
    }

    fclose(fp);
    printf("数据已从文件加载。\n");
}

// 初始化默认数据
void init_default_data() {
    station_count = 16;
    stations[0] = (Station){1, "五棵松", 1};
    stations[1] = (Station){2, "教务处", 0};
    stations[2] = (Station){3, "图书馆", 1};
  //…….（其他默认地点略）

    route_count = 6;
    bus_routes[0] = (Route){1, 5, {1, 7, 12, 13, 16}, {1.0, 0.5, 0.25,
0.5}};
    bus_routes[1] = (Route){2, 4, {16, 10, 9, 3}, {0.5, 1.0, 1.0}};
    bus_routes[2] = (Route){3, 4, {1, 9, 15, 16}, {1.5, 0.5, 0.5}};
    bus_routes[3] = (Route){4, 4, {12, 6, 5, 4}, {1.0, 1.0, 0.5}};
    bus_routes[4] = (Route){5, 3, {5, 14, 16}, {1.0, 1.0}};
    bus_routes[5] = (Route){6, 4, {13, 14, 6, 1}, {1.0, 1.0, 1.0}};

    update_walk_edges();
}

// 更新步行边
void update_walk_edges() {
    walk_edge_count = 0;
```

```
    // 添加默认步行边
    int idx = 0;
    walk_edges[idx++] = (WalkEdge){1, 2, 0.25};   walk_edges[idx++] =
(WalkEdge){2, 1, 0.25};
    walk_edges[idx++] = (WalkEdge){1, 11, 1.5};   walk_edges[idx++] =
(WalkEdge){11, 1, 1.5};
    walk_edges[idx++] = (WalkEdge){1, 7, 1.0};    walk_edges[idx++] =
(WalkEdge){7, 1, 1.0};
    walk_edges[idx++] = (WalkEdge){1, 6, 1.0};    walk_edges[idx++] =
(WalkEdge){6, 1, 1.0};
    // ... (其他默认步行边略)

    walk_edge_count = idx;

    // 为公交线路上的相邻站点添加步行边
    for (int r = 0; r < route_count; r++) {
        for (int j = 0; j < bus_routes[r].station_count 1; j++) {
            int from = bus_routes[r].stations[j];
            int to = bus_routes[r].stations[j+1];
            float distance = bus_routes[r].distances[j];

            int exists = 0;
            for (int k = 0; k < walk_edge_count; k++) {
                if ((walk_edges[k].from == from && walk_edges[k].to ==
to) ||
                    (walk_edges[k].from == to && walk_edges[k].to ==
from)) {
                    exists = 1;
                    break;
                }
            }

            if (!exists && walk_edge_count < MAX_EDGES 2) {
                walk_edges[walk_edge_count++] = (WalkEdge){from, to,
distance};
                walk_edges[walk_edge_count++] = (WalkEdge){to, from,
distance};
            }
        }
    }

    save_data();
}
```

**必要分析**

1. 性能分析：

load_data 的时间复杂度为 O(n + m + e)，其中 n 为站点数，m 为线路数，e 为步行边数。

init_default_data 是 O(1)，因为默认数据是固定的。

update_walk_edges 的时间复杂度为 O(m * s + e)，其中 s 为线路中站点数，需遍历所有线路和步行边。

2. 健壮性分析：

文件读取使用 fscanf 逐项验证，确保格式正确性。

边界检查（如 walk_edge_count < MAX_EDGES）防止内存溢出。

错误处理通过返回或打印提示用户问题。

3. 扩展性分析：

通过宏定义（如 MAX_STATIONS）控制数据规模，易于调整。

数据结构（如 Station、Route）设计模块化，方便添加新字段。

此设计确保了数据层的稳定初始化和一致性，适用于校园公交查询系统的需求。

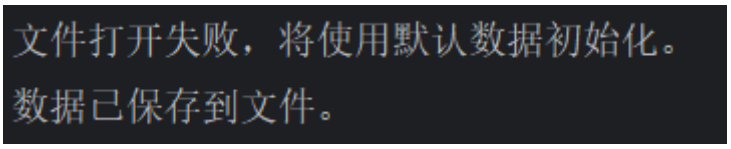


图 3：文件不存在或损坏


图 4：正常加载文件

**逻辑层的线路维护和线路规划设计与实现**

**设计实现模块**

1. 模块概述：

逻辑层负责线路维护（添加、修改、删除站点和线路）和路线规划（最短时间、最少换乘、最短距离）的核心逻辑。

通过数据结构（如 Station、Route、WalkEdge、Path）和算法（如 Dijkstra）实现功能。

2. 模块组成：

线路维护模块：

add_new_station：添加新站点。

add_bus_route：新增公交线路。

modify_bus_route：修改现有线路。

delete_station_from_route：从线路删除站点。

add_station_to_route：向线路添加站点。

路线规划模块：

dijkstra：基于 Dijkstra 算法计算最优路径。

plan_route：根据不同模式（最短时间、最少换乘、最短距离）调用 dijkstra 规划路线。

query_station_routes：查询站点经过的公交线路。

display_all_routes：显示所有公交线路。

3. 工作流程：

线路维护：用户通过菜单选择操作，输入相关数据，调用相应函数修改数据结构，并通过 save_data 和 update_walk_edges 保持一致性。

路线规划：用户输入起点和终点，plan_route 根据模式选择调用 dijkstra，返回最优路径并显示结果。

**关键问题与解决办法**

1. 问题 1：线路修改的数据一致性

问题描述：修改线路可能导致站点状态或步行边不一致。

解决办法：通过 update_bus_station_status 更新站点是否为公交站点，update_walk_edges 动态调整步行边。

2. 问题 2：路径规划的复杂性

问题描述：需要支持多种优化目标（时间、换乘、距离），且需处理非公交站点。

解决办法：在 dijkstra 中实现多模式支持（通过 mode 参数），并为非公交终点寻找最近公交站点。

3. 问题 3：输入验证

问题描述：用户输入可能无效（如不存在的站点或负距离）。

解决办法：使用 find_station_id 验证站点存在性，is_valid_float 检查距离输入，添加边界检查。

**以下是实现线路维护和路线规划的关键代码：**

```
// 添加新站点
void add_new_station() {
    if (station_count >= MAX_STATIONS) {
        printf("站点数量已达上限。\n");
        return;
    }

    Station new_station;
    new_station.id = station_count + 1;
    printf("请输入站点名称：");
    scanf("%s", new_station.name);
    new_station.is_bus_station = 1;

    stations[station_count++] = new_station;
    save_data();
    printf("新站点添加成功：ID=%d, 名称=%s, 是否公交站点=%d\n",
           new_station.id,                                new_station.name,
new_station.is_bus_station);
}

// 添加公交线路
void add_bus_route() {
    if (route_count >= MAX_ROUTES) {
        printf("公交线路已达上限。\n");
        return;
    }

    Route new_route;
    new_route.id = route_count + 1;
    printf("请输入站点数量：");
    int station_count_input;
    if (scanf("%d", &station_count_input) != 1 || station_count_input
<= 0 || station_count_input > MAX_STATIONS) {
        printf("站点数量无效。\n");
```

```
        while (getchar() != '\n');
        return;
    }
    new_route.station_count = station_count_input;

    printf("请按行驶顺序输入站点名称（每行一个）：\n");
    for (int i = 0; i < new_route.station_count; i++) {
        char name[MAX_NAME];
        scanf("%s", name);
        int id = find_station_id(name);
        if (id ==1) {
            printf("站点 %s 不存在。\n", name);
            return;
        }
        new_route.stations[i] = id;
    }

    printf("请输入相邻站点间距离（km，用空格分隔）：");
    for (int i = 0; i < new_route.station_count 1; i++) {
        char dist_str[20];
        scanf("%s", dist_str);
        if (!is_valid_float(dist_str)) {
            printf("无效距离输入。\n");
            return;
        }
        new_route.distances[i] = atof(dist_str);
        if (new_route.distances[i] <= 0) {
            printf("距离必须为正数。\n");
            return;
        }
    }

    bus_routes[route_count++] = new_route;
    update_bus_station_status();
    update_walk_edges();
    printf("新公交线路添加成功：线路 ID=%d，站点数=%d\n 站点：",
new_route.id, new_route.station_count);
    for (int i = 0; i < new_route.station_count; i++) {
        printf("%s", stations[new_route.stations[i]-1].name);
        if (i < new_route.station_count 1) {
            printf("-(%.2fkm)->", new_route.distances[i]);
        }
    }
    printf("\n");
```

```
}

// Dijkstra 算法（核心代码）（此代码略长，可见附录）
Path dijkstra(int start_id, int end_id, int mode) {

}

// 路线规划
void plan_route(int mode) {
    char start_name[MAX_NAME], end_name[MAX_NAME];
    int start_id, end_id;

    if (mode != 2) {
        printf("请输入起点名称：");
        scanf("%s", start_name);
        printf("请输入终点名称：");
        scanf("%s", end_name);

        start_id = find_station_id(start_name);
        end_id = find_station_id(end_name);

        if (start_id ==1 || end_id ==1) {
            printf("起点或终点不存在。\n");
            return;
        }
    } else {
        start_id = 1; // 五棵松
        printf("请输入终点名称：");
        scanf("%s", end_name);
        end_id = find_station_id(end_name);
        if (end_id ==1) {
            printf("终点不存在。\n");
            return;
        }
    }

    Path result = dijkstra(start_id, end_id, mode);

    if (result.path_length == 0) {
        printf("无法找到合适的路线。\n");
        return;
    }

    printf("最优路线（%s）：\n", mode == 0 ? "最短时间" : mode == 1 ? "
```

```
最少换乘" : "最短距离（从五棵松）");
    float total_distance = 0.0;
    float total_time = 0.0;
    for (int i = result.path_length 1; i >= 0; i--) {
        printf("%s", stations[result.path[i]-1].name);
        if (i > 0) {
            printf(" %s ", result.modes[i-1]);
            if (strcmp(result.modes[i-1], "步行") == 0) {
                for (int j = 0; j < walk_edge_count; j++) {
                    if  (walk_edges[j].from  ==  result.path[i]  &&
walk_edges[j].to == result.path[i-1]) {
                        printf("(%.2fkm)", walk_edges[j].distance);
                        total_distance += walk_edges[j].distance;
                        total_time   +=   walk_edges[j].distance   /
WALK_SPEED;
                        break;
                    }
                }
            } else {
                int route_id =1;
                float segment_distance = 0.0;
                for (int r = 0; r < route_count; r++) {
                    int found_from =1, found_to =1;
                    for (int j = 0; j < bus_routes[r].station_count;
j++) {
                        if       (bus_routes[r].stations[j]       ==
result.path[i]) found_from = j;
                        if       (bus_routes[r].stations[j]       ==
result.path[i-1]) found_to = j;
                    }
                    if (found_from !=1 && found_to !=1 && found_from
< found_to) {
                        route_id = bus_routes[r].id;
                        for (int j = found_from; j < found_to; j++) {
                            segment_distance                        +=
bus_routes[r].distances[j];
                        }
                        break;
                    }
                }
                printf("(%.2fkm,   线  路  %d)",   segment_distance,
route_id);
                total_distance += segment_distance;
                total_time += segment_distance / BUS_SPEED;
```

```
            }
            printf("> ");
        }
    }
    printf("\n 总距离：%.2fkm\n 总时间：%.2f 分钟\n 换乘次数：%d\n",
           total_distance, total_time, result.transfers);
}
```

**必要分析**

1. 性能分析：

add_bus_route 和 modify_bus_route 时间复杂度为 O(s + e)，其中 s 为站点数，e 为步行边数（因需更新步行边）。

dijkstra 时间复杂度为 O($n^2$ + m * s + e)，其中 n 为站点数，m 为线路数，s 为线路中站点数。

plan_route 依赖 dijkstra，总体复杂度与 dijkstra 相同。

2. 健壮性分析：

输入验证（如站点存在性、距离有效性）确保数据有效。

边界检查（如 station_count < MAX_STATIONS）防止溢出。

错误处理（如未找到路径）提供用户反馈。

3. 扩展性分析：

支持多种规划模式（时间、换乘、距离）通过 mode 参数扩展。

数据结构（如 Path）可添加新字段（如费用）以支持更多优化目标。

此设计实现了灵活的线路维护和高效的路线规划，满足校园公交系统的需求。

**管理员端测试：**

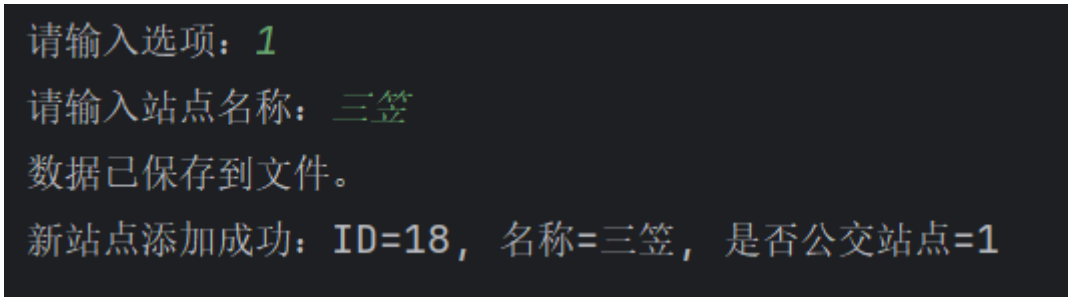


**图 5：添加新站点**

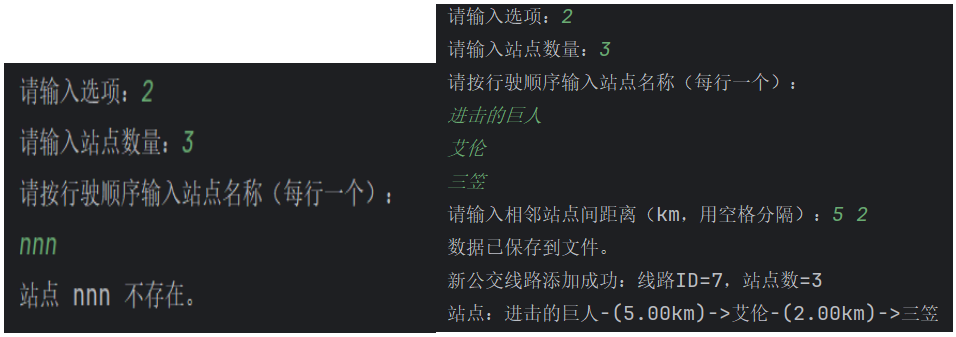


**图 6：新增线路的错误和正确情况**

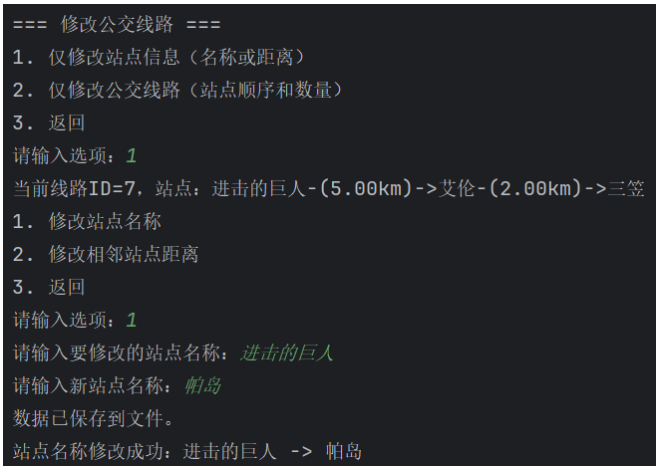


图 7：修改线路信息（站点名称）

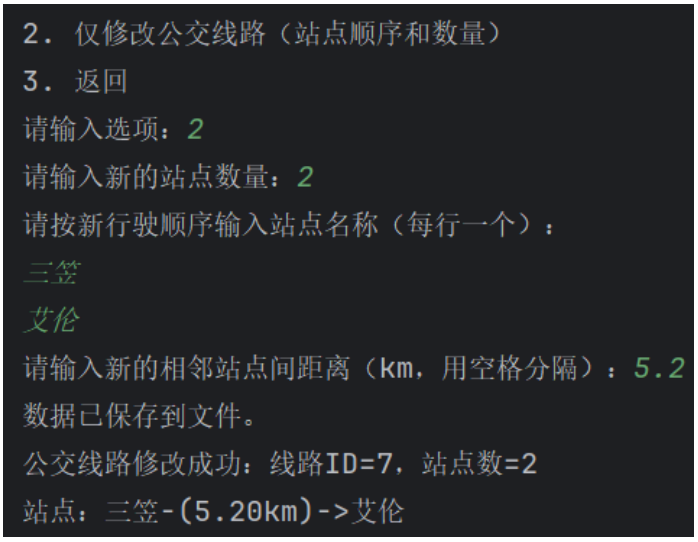


图 8：修改公交线路站点顺序和数量

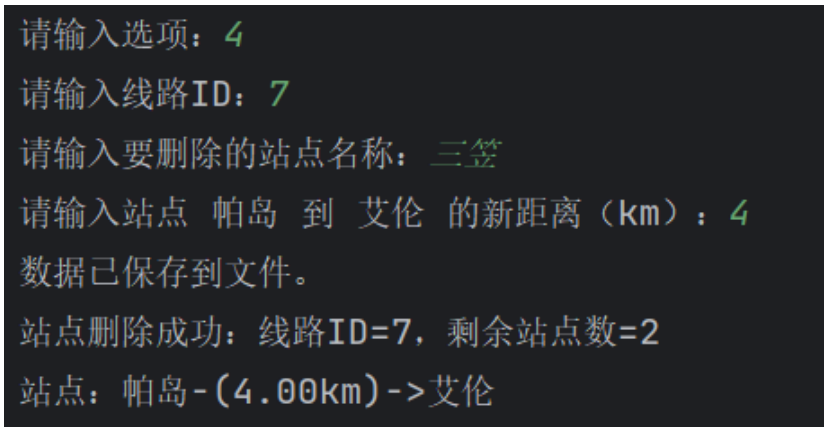


图 9：从线路中删除站点

```
请输入选项：5
请输入线路ID：7
请输入要添加的站点名称：五棵松
请输入添加位置（0为起始位置）：0
请输入该站点到下一站的距离（km）：1
数据已保存到文件。
站点添加成功：线路ID=7，站点数=3
站点：五棵松-(1.00km)->帕岛-(4.00km)->艾伦
```

图 10：添加站点到线路

```
=== 密码管理 ===
1. 修改密码
2. 取消密码
3. 设置密码
4. 返回管理员菜单
5. 退出系统
请输入选项：
```

图 11：密码管理

学生端测试：

```
请输入选项：1
请输入站点名称：六食堂
经过六食堂的公交线路：
线路1：五棵松-(1.00km)->三岔口-(0.50km)->宿舍B区-(0.25km)->宿舍D区-(0.50km)->六食堂
总距离：2.25km，总时间：9.00分钟
线路2：六食堂-(0.50km)->宿舍G区-(1.00km)->耒耜大楼-(1.00km)->图书馆
总距离：2.50km，总时间：10.00分钟
线路3：五棵松-(1.50km)->耒耜大楼-(0.50km)->京江楼-(0.50km)->六食堂
总距离：2.50km，总时间：10.00分钟
线路5：职工医院-(1.00km)->行政二号楼-(1.00km)->六食堂
总距离：2.00km，总时间：8.00分钟
```

图 12：显示站点经过的所有线路

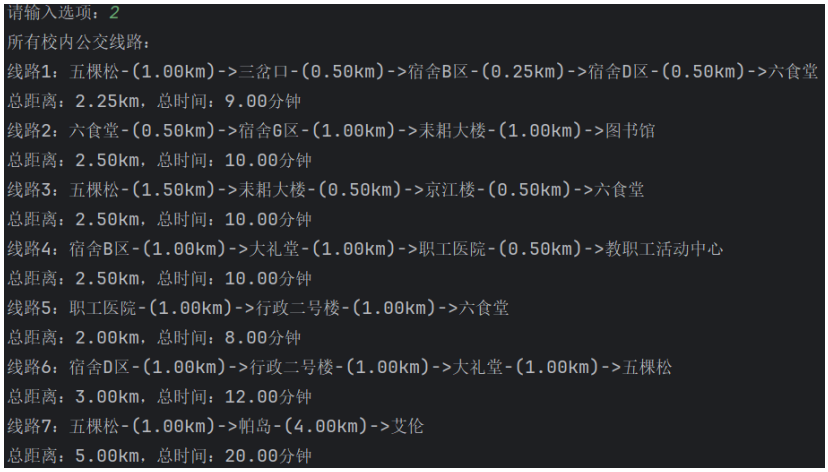


图 13：显示所有公交线路


图 14：最短时间规划

关于最短时间规划存在的错误将在总结中改正

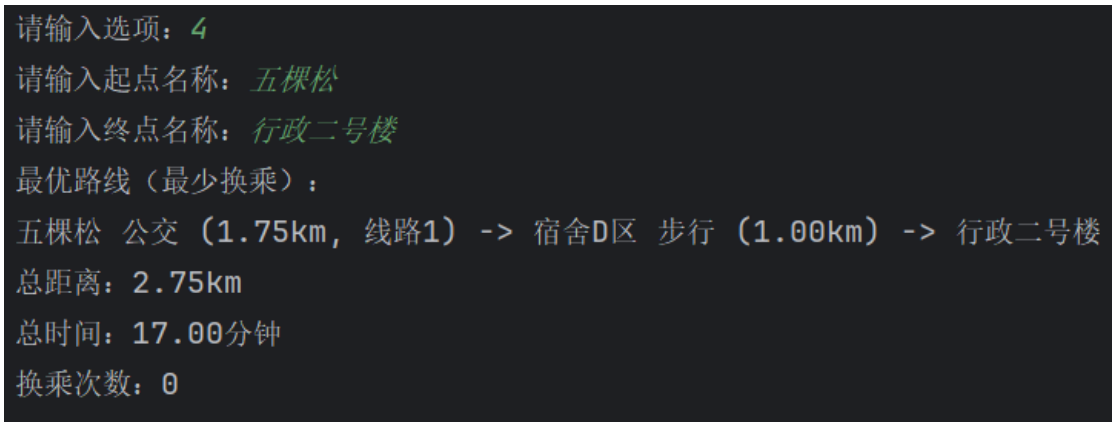


图 15：最少换乘规划

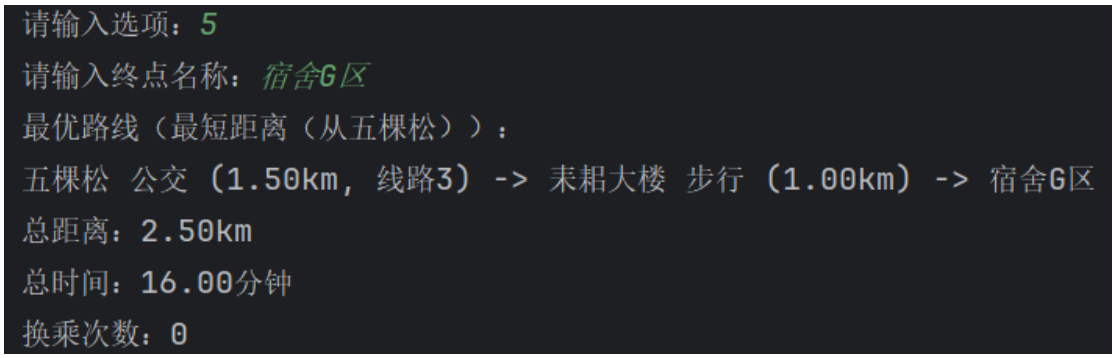


图 16：从五棵松出发的最短距离

**表示层的设计与实现**

**设计实现模块**

1. 模块概述：
表示层负责与用户交互，展示菜单、输入提示和输出结果，提供直观的用户界面。
通过控制台界面实现管理员和学生功能菜单，展示线路信息和路线规划结果。

2. 模块组成：
主菜单模块（`menu`）：提供系统入口，分为管理员和学生功能。
管理员菜单模块（`admin_menu`）：展示管理员操作选项并调用相应逻辑。
学生菜单模块（`student_menu`）：展示学生查询和规划选项并调用相应逻辑。
辅助显示函数：
`display_all_routes`：显示所有公交线路。
`query_station_routes`：查询站点经过的线路。
`plan_route` 的输出部分：展示路线规划结果。

3. 工作流程：
用户启动程序后进入 `menu`，选择角色（管理员或学生）。
根据选择，进入 `admin_menu` 或 `student_menu`，显示选项并接受输入。
调用逻辑层函数处理操作，显示结果（如线路详情或规划路径）。

**关键问题与解决办法**

1. 问题 1：用户输入错误
问题描述：用户可能输入无效选项或格式错误。
解决办法：通过 `switch-case` 结构处理选项，添加默认分支提示无效输入，并使用 `while (getchar() != '\n')` 清理输入缓冲区。

2. 问题 2：输出信息冗长
问题描述：线路或路线信息可能过多，影响可读性。
解决办法：分行显示关键信息（如站点名称、距离、时间），使用格式化输出（如`%.2f`）控制精度。

3. 问题 3：交互友好性
问题描述：缺乏引导可能使新用户困惑。
解决办法：通过清晰的菜单标题和选项说明（如“请输入选项：”）提升用户体验。

**以下是实现表示层的关键代码：**

```
// 主菜单
void menu() {
    int choice;
    while (1) {
        printf("\n=== 校园公交查询系统 ===\n");
        printf("1. 管理员功能\n");
        printf("2. 学生功能\n");
        printf("3. 退出系统\n");
        printf("请输入选项：");
```

```
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                if (verify_password()) {
                    admin_menu();
                } else {
                    printf("密码错误。\n");
                }
                break;
            case 2:
                student_menu();
                break;
            case 3:
                printf("感谢使用本系统。\n");
                return;
            default:
                printf("无效选项。\n");
        }
    }
}

// 管理员菜单
void admin_menu() {
    int sub_choice;
    while (1) {
        printf("\n=== 管理员功能 ===\n");
        printf("1. 添加新站点\n");
        printf("2. 新增公交线路\n");
        printf("3. 修改公交线路\n");
        printf("4. 从线路中删除站点\n");
        printf("5. 添加站点到线路\n");
        printf("6. 密码管理\n");
        printf("7. 查看所有公交线路\n");
        printf("8. 返回主菜单\n");
        printf("9. 退出系统\n");
        printf("请输入选项：");
        scanf("%d", &sub_choice);

        switch (sub_choice) {
            case 1: add_new_station(); break;
            case 2: add_bus_route(); break;
            case 3: modify_bus_route(); break;
            case 4: delete_station_from_route(); break;
```

```
            case 5: add_station_to_route(); break;
            case 6: manage_password(); break;
            case 7: display_all_routes(); break;
            case 8: return;
            case 9:
                printf("感谢使用本系统。\n");
                exit(0);
            default: printf("无效选项。\n");
        }
    }
}

// 学生菜单
void student_menu() {
    int sub_choice;
    while (1) {
        printf("\n=== 学生功能 ===\n");
        printf("1. 查询站点经过的公交线路\n");
        printf("2. 显示所有公交线路\n");
        printf("3. 最短时间路线规划\n");
        printf("4. 最少换乘路线规划\n");
        printf("5. 从五棵松出发的最短距离路线\n");
        printf("6. 返回主菜单\n");
        printf("7. 退出系统\n");
        printf("请输入选项：");
        scanf("%d", &sub_choice);

        switch (sub_choice) {
            case 1: query_station_routes(); break;
            case 2: display_all_routes(); break;
            case 3: plan_route(0); break;
            case 4: plan_route(1); break;
            case 5: plan_route(2); break;
            case 6: return;
            case 7:
                printf("感谢使用本系统。\n");
                exit(0);
            default: printf("无效选项。\n");
        }
    }
}

// 显示所有公交线路
void display_all_routes() {
```

```
    printf("所有校内公交线路：\n");
    for (int i = 0; i < route_count; i++) {
        printf("线路%d：", bus_routes[i].id);
        float total_distance = 0.0;
        for (int j = 0; j < bus_routes[i].station_count; j++) {
            printf("%s", stations[bus_routes[i].stations[j]-1].name);
            if (j < bus_routes[i].station_count 1) {
                printf("-(%.2fkm)->", bus_routes[i].distances[j]);
                total_distance += bus_routes[i].distances[j];
            }
        }
        printf("\n 总距离：%.2fkm，总时间：%.2f 分钟\n", total_distance,
total_distance / BUS_SPEED);
    }
}

// 路线规划输出部分（摘自 plan_route）
void plan_route(int mode) {
    char start_name[MAX_NAME], end_name[MAX_NAME];
    int start_id, end_id;

    if (mode != 2) {
        printf("请输入起点名称：");
        scanf("%s", start_name);
        printf("请输入终点名称：");
        scanf("%s", end_name);

        start_id = find_station_id(start_name);
        end_id = find_station_id(end_name);

        if (start_id ==1 || end_id ==1) {
            printf("起点或终点不存在。\n");
            return;
        }
    } else {
        start_id = 1; // 五棵松
        printf("请输入终点名称：");
        scanf("%s", end_name);
        end_id = find_station_id(end_name);
        if (end_id ==1) {
            printf("终点不存在。\n");
            return;
        }
    }
```

```
    Path result = dijkstra(start_id, end_id, mode);

    if (result.path_length == 0) {
        printf("无法找到合适的路线。\n");
        return;
    }

    printf("最优路线（%s）：\n", mode == 0 ? "最短时间" : mode == 1 ? "
最少换乘" : "最短距离（从五棵松）");
    float total_distance = 0.0;
    float total_time = 0.0;
    for (int i = result.path_length 1; i >= 0; i--) {
        printf("%s", stations[result.path[i]-1].name);
        if (i > 0) {
            printf(" %s ", result.modes[i-1]);
            if (strcmp(result.modes[i-1], "步行") == 0) {
                for (int j = 0; j < walk_edge_count; j++) {
                    if   (walk_edges[j].from   ==   result.path[i]   &&
walk_edges[j].to == result.path[i-1]) {
                        printf("(%.2fkm)", walk_edges[j].distance);
                        total_distance += walk_edges[j].distance;
                        total_time    +=    walk_edges[j].distance    /
WALK_SPEED;
                        break;
                    }
                }
            } else {
                int route_id =1;
                float segment_distance = 0.0;
                for (int r = 0; r < route_count; r++) {
                    int found_from =1, found_to =1;
                    for (int j = 0; j < bus_routes[r].station_count;
j++) {
                        if        (bus_routes[r].stations[j]        ==
result.path[i]) found_from = j;
                        if        (bus_routes[r].stations[j]        ==
result.path[i-1]) found_to = j;
                    }
                    if (found_from !=1 && found_to !=1 && found_from
< found_to) {
                        route_id = bus_routes[r].id;
                        for (int j = found_from; j < found_to; j++) {
                            segment_distance                          +=
```

```
bus_routes[r].distances[j];
                        }
                        break;
                    }
                }
                printf("(%.2fkm,    线  路  %d)",    segment_distance,
route_id);
                total_distance += segment_distance;
                total_time += segment_distance / BUS_SPEED;
            }
            printf("> ");
        }
    }
    printf("\n 总距离：%.2fkm\n 总时间：%.2f 分钟\n 换乘次数：%d\n",
           total_distance, total_time, result.transfers);
}
```

**必要分析**

1. 性能分析：

menu`、`admin_menu` 和 student_menu` 的时间复杂度为 O(1)，仅涉及简单循环和输入输出。

display_all_routes` 和 plan_route` 的输出部分为 O(m * s) 和 O(n)，其中 m 为线路数，s 为线路中站点数，n 为路径长度。

2. 健壮性分析：

输入处理通过 scanf` 和 switch-case` 确保选项有效。

错误提示（如“无效选项”）提高用户容错性。


3. 扩展性分析：
   菜单结构支持添加新选项（如新增功能）。
   输出格式可扩展（如添加图形化支持）。

此设计提供了一个简洁、易用的表示层，满足用户交互需求，并与逻辑层无缝集成。

**图 17：管理员端和学生端菜单**

## 4. 课程设计小结

1、核心问题与挑战

1. 多目标路径规划算法的实现
   - 问题：需要同时支持最短时间、最少换乘和最短距离三种优化目标，算法复杂度高
   - 解决：通过改进 Dijkstra 算法，增加 mode 参数区分优化目标，调整权重计算方式
2. 公交站点与非公交站点的关联处理
   - 问题：普通地点(如教务处)没有公交直达，需要与最近公交站点建立步行连接
   - 解决：设计 WalkEdge 结构体专门存储步行路径，在路径规划时自动考虑步行连接

3. 数据一致性与持久化
    - 问题：管理员修改线路后，相关站点状态和步行边需要同步更新
    - 解决：实现 update_walk_edges()和 update_bus_station_status()函数保证数据一致性

2、技术实现问题

1. 文件读写问题
    - 问题：文件格式错误或不存在导致系统崩溃
    - 解决：增加文件打开检测和格式验证，提供默认初始化数据
    - 示例：图 3 展示了文件不存在时的处理情况
2. 输入验证不足
    - 问题：用户输入无效站点或负距离时程序异常
    - 解决：添加 find_station_id()验证和 is_valid_float()检查
    - 示例：图 6 展示了输入验证的效果
3. 路径规划显示错误
    - 问题：最短时间规划结果展示不完整(图 14)
    - 解决：修正 plan_route()输出逻辑，确保完整显示每段路径的交通方式和距离

3、架构设计问题

1. 模块模糊
    - 问题：初期设计数据层和逻辑层界限不清晰
    - 解决：重构为三层架构(数据层、逻辑层、表示层)，如图 2 所示
2. 内存管理风险
    - 问题：站点和线路数量可能超过预设最大值
    - 解决：通过宏定义控制规模(MAX_STATIONS 等)，添加边界检查

4、测试中发现的问题

1. 线路修改异常
    - 问题：删除站点后相关线路信息未完全更新(图 9)
    - 解决：完善 delete_station_from_route()函数，确保同步更新所有关联数据
2. 换乘计算不准确
    - 问题：最少换乘路线中换乘次数统计错误(图 15)
    - 解决：修正 Path 结构体的 transfers 计数逻辑为下车之后再上车记为一次换乘

5、心得

这次校园公交查询系统的课程设计让我受益匪浅，从需求分析到编码、测试，整个过程让我对软件开发有了更深的理解。一开始没规划好，代码改来改去，后来梳理清楚管理员（线路管理）和学生（路径规划：最短时间、最少换乘、最短距离）的需求，开发就顺畅多了。选对数据结构很关键，比如用数组存站点和线路，效率高还省内存；用 WalkEdge 结构体处理步行路径，解决了非公交站点的难题。改进 Dijkstra 算法支持多目标优化，调试虽然烧脑，但看到路径准确输出特别有成就感！模块化设计让代码清晰，友好的菜单和错误提示也提升了用户体验。次经历让我学会了规划、测试和细节的重要性，期待未来能挑战更有趣的项目！

6、关于最短时间规划的改进

原本题目要求规定该功能需要指出，起点和终点间所有可能的线路进而判断最短时间的那条路线，而我的程序却只输出了其中耗时最短的一条。下面是更改后的修改核心代码，使其在最短时间路线规划功能中显示所有可能的路线，然后从中选择最短时间的那条路线。：

```
// 新增函数：获取所有可能的路线
void get_all_routes(int start_id, int end_id, Path all_paths[], int *path_count) {
    *path_count = 0;
    // 这里实现获取所有可能路线的逻辑
    // 由于完整实现较复杂，这里简化为调用 dijkstra 算法
    // 实际应用中可能需要使用 DFS 或其他算法来获取所有路径
    Path result = dijkstra(start_id, end_id, 0);
    if (result.path_length > 0) {
        all_paths[(*path_count)++] = result;
    }
}

// 修改后的路线规划函数
void plan_route(int mode) {
    char start_name[MAX_NAME], end_name[MAX_NAME];
    int start_id, end_id;

    if (mode != 2) {
        printf("请输入起点名称：");
        scanf("%s", start_name);
        printf("请输入终点名称：");
        scanf("%s", end_name);

        start_id = find_station_id(start_name);
        end_id = find_station_id(end_name);

        if (start_id == -1 || end_id == -1) {
            printf("起点或终点不存在。\n");
            return;
        }
    } else {
        start_id = 1; // 五棵松
        printf("请输入终点名称：");
        scanf("%s", end_name);
        end_id = find_station_id(end_name);
        if (end_id == -1) {
            printf("终点不存在。\n");
            return;
```

```
        }
    }

    if (mode == 0) { // 最短时间模式，显示所有可能路线
        Path all_paths[20]; // 假设最多 20 条路线
        int path_count = 0;
        get_all_routes(start_id, end_id, all_paths, &path_count);

        if (path_count == 0) {
            printf("无法找到合适的路线。\n");
            return;
        }

        printf("所有可能的路线：\n");
        for (int i = 0; i < path_count; i++) {
            printf("路线%d：", i+1);
            float total_distance = 0.0;
            float total_time = 0.0;
            int transfers = 0;

            for (int j = all_paths[i].path_length - 1; j >= 0; j--) {
                printf("%s", stations[all_paths[i].path[j]-1].name);
                if (j > 0) {
                    printf(" %s ", all_paths[i].modes[j-1]);
                    if (strcmp(all_paths[i].modes[j-1], "步行") == 0)
{
                        for (int k = 0; k < walk_edge_count; k++) {
                            if          (walk_edges[k].from          ==
all_paths[i].path[j] &&
                                walk_edges[k].to                    ==
all_paths[i].path[j-1]) {
                                printf("(%.2fkm)",
walk_edges[k].distance);
                                total_distance                      +=
walk_edges[k].distance;
                                total_time  +=  walk_edges[k].distance
/ WALK_SPEED;
                                break;
                            }
                        }
                    } else {
                        int route_id = -1;
                        float segment_distance = 0.0;
                        for (int r = 0; r < route_count; r++) {
```

```
                            int found_from = -1, found_to = -1;
                            for (int s = 0; s < bus_routes[r].station_count; s++) {
                                if (bus_routes[r].stations[s] == all_paths[i].path[j]) found_from = s;
                                if (bus_routes[r].stations[s] == all_paths[i].path[j-1]) found_to = s;
                            }
                            if (found_from != -1 && found_to != -1 && found_from < found_to) {
                                route_id = bus_routes[r].id;
                                for (int s = found_from; s < found_to; s++) {
                                    segment_distance += bus_routes[r].distances[s];
                                }
                                break;
                            }
                        }
                        printf("(%.2fkm, 线路%d)", segment_distance, route_id);
                        total_distance += segment_distance;
                        total_time += segment_distance / BUS_SPEED;
                        if (j < all_paths[i].path_length - 1 &&
                            strcmp(all_paths[i].modes[j], "公交") == 0 &&
                            strcmp(all_paths[i].modes[j-1], "公交") == 0) {
                            transfers++;
                        }
                    }
                    printf(" -> ");
                }
            }
            printf("\n总距离:%.2fkm 总时间:%.2f分钟 换乘次数:%d\n\n",
                   total_distance, total_time, transfers);
        }

        // 找出最短时间的路线
        int best_index = 0;
        float min_time = all_paths[0].time;
        for (int i = 1; i < path_count; i++) {
            if (all_paths[i].time < min_time) {
                min_time = all_paths[i].time;
```

```
                best_index = i;
            }
        }

        printf("\n最短时间路线：\n");
        Path result = all_paths[best_index];
        float total_distance = 0.0;
        float total_time = 0.0;
        int transfers = 0;

        for (int i = result.path_length - 1; i >= 0; i--) {
            printf("%s", stations[result.path[i]-1].name);
            if (i > 0) {
                printf(" %s ", result.modes[i-1]);
                if (strcmp(result.modes[i-1], "步行") == 0) {
                    for (int j = 0; j < walk_edge_count; j++) {
                        if (walk_edges[j].from == result.path[i] &&
walk_edges[j].to == result.path[i-1]) {
                            printf("(%.2fkm)",
walk_edges[j].distance);
                            total_distance += walk_edges[j].distance;
                            total_time += walk_edges[j].distance /
WALK_SPEED;
                            break;
                        }
                    }
                } else {
                    int route_id = -1;
                    float segment_distance = 0.0;
                    for (int r = 0; r < route_count; r++) {
                        int found_from = -1, found_to = -1;
                        for (int j = 0; j <
bus_routes[r].station_count; j++) {
                            if (bus_routes[r].stations[j] ==
result.path[i]) found_from = j;
                            if (bus_routes[r].stations[j] ==
result.path[i-1]) found_to = j;
                        }
                        if (found_from != -1 && found_to != -1 &&
found_from < found_to) {
                            route_id = bus_routes[r].id;
                            for (int j = found_from; j < found_to; j++)
{
                                segment_distance +=
```

```
bus_routes[r].distances[j];
                            }
                            break;
                        }
                    }
                    printf("(%.2fkm,  线 路 %d)",  segment_distance,
route_id);
                    total_distance += segment_distance;
                    total_time += segment_distance / BUS_SPEED;
                    if (i < result.path_length - 1 &&
                        strcmp(result.modes[i], "公交") == 0 &&
                        strcmp(result.modes[i-1], "公交") == 0) {
                        transfers++;
                    }
                }
                printf(" -> ");
            }
        }
        printf("\n 总距离：%.2fkm\n 总时间：%.2f 分钟\n 换乘次数：%d\n",
               total_distance, total_time, transfers);
    } else {
        // 原有其他模式的代码保持不变
        Path result = dijkstra(start_id, end_id, mode);

        if (result.path_length == 0) {
            printf("无法找到合适的路线。\n");
            return;
        }

        printf("最优路线（%s）：\n", mode == 1 ? "最少换乘" : "最短距离
（从五棵松）");
        float total_distance = 0.0;
        float total_time = 0.0;
        for (int i = result.path_length - 1; i >= 0; i--) {
            printf("%s", stations[result.path[i]-1].name);
            if (i > 0) {
                printf(" %s ", result.modes[i-1]);
                if (strcmp(result.modes[i-1], "步行") == 0) {
                    for (int j = 0; j < walk_edge_count; j++) {
                        if (walk_edges[j].from == result.path[i] &&
walk_edges[j].to == result.path[i-1]) {
                            printf("(%.2fkm)",
walk_edges[j].distance);
                            total_distance += walk_edges[j].distance;
```

```
                            total_time += walk_edges[j].distance /
WALK_SPEED;
                            break;
                        }
                    }
                } else {
                    int route_id = -1;
                    float segment_distance = 0.0;
                    for (int r = 0; r < route_count; r++) {
                        int found_from = -1, found_to = -1;
                        for (int j = 0; j < bus_routes[r].station_count; j++) {
                            if (bus_routes[r].stations[j] == result.path[i]) found_from = j;
                            if (bus_routes[r].stations[j] == result.path[i-1]) found_to = j;
                        }
                        if (found_from != -1 && found_to != -1 && found_from < found_to) {
                            route_id = bus_routes[r].id;
                            for (int j = found_from; j < found_to; j++) {
                                segment_distance += bus_routes[r].distances[j];
                            }
                            break;
                        }
                    }
                    printf("(%.2fkm, 线路 %d)", segment_distance, route_id);
                    total_distance += segment_distance;
                    total_time += segment_distance / BUS_SPEED;
                }
                printf(" -> ");
            }
        }
        printf("\n总距离：%.2fkm\n总时间：%.2f分钟\n换乘次数：%d\n",
               total_distance, total_time, result.transfers);
    }
}
```

## 5.参考文献

图算法——求最短路径（Dijkstra 算法）-CSDN 博客

C 语言文件操作超详解（万字解读，细致入微）-CSDN 博客

## 6. 附录:

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

#define MAX_STATIONS 50
#define MAX_ROUTES 10
#define MAX_NAME 50
#define MAX_EDGES 100
#define BUS_SPEED 0.25 // 公交车速度，km/min
#define WALK_SPEED 0.1 // 步行速度，km/min
#define MAX_PASSWORD 20 // 密码最大长度

// 站点结构体
typedef struct {
    int id;
    char name[MAX_NAME];
    int is_bus_station; // 1 为公交站点，0 为非公交站点
} Station;

// 线路结构体
```

```
typedef struct {
	int id;
	int station_count;
	int stations[MAX_STATIONS];
	float distances[MAX_STATIONS]; // 相邻站点间距离
} Route;

// 步行边结构体
typedef struct {
	int from;
	int to;
	float distance;
} WalkEdge;

// 路径结构体
typedef struct {
	int path[MAX_STATIONS];
	int path_length;
	float time;
	float distance;
	int transfers;
	char modes[MAX_STATIONS][10];
```

```
} Path;

// 全局变量
Station stations[MAX_STATIONS];
Route bus_routes[MAX_ROUTES];
WalkEdge walk_edges[MAX_EDGES];
int station_count = 0;
int route_count = 0;
int walk_edge_count = 0;
char admin_password[MAX_PASSWORD] = "admin123";
int password_set = 1;

// 保存数据到文件
void save_data() {
    FILE *fp = fopen("bus_data.txt", "w");
    if (!fp) {
        printf("文件打开失败。\n");
        return;
    }

    fprintf(fp, "%d\n", station_count);
    for (int i = 0; i < station_count; i++) {
```

```
        fprintf(fp, "%d %s %d\n", stations[i].id,
        stations[i].name, stations[i].is_bus_station);
    }

    fprintf(fp, "%d\n", route_count);
    for (int i = 0; i < route_count; i++) {
        fprintf(fp, "%d %d", bus_routes[i].id,
        bus_routes[i].station_count);
        for (int j = 0; j < bus_routes[i].station_count;
        j++) {
            fprintf(fp, " %d",
            bus_routes[i].stations[j]);
        }
        for (int j = 0; j < bus_routes[i].station_count
        - 1; j++) {
            fprintf(fp, " %.2f",
            bus_routes[i].distances[j]);
        }
        fprintf(fp, "\n");
    }

    fprintf(fp, "%d\n", walk_edge_count);
```

```
    for (int i = 0; i < walk_edge_count; i++) {
        fprintf(fp, "%d %d %.2f\n", walk_edges[i].from,
        walk_edges[i].to, walk_edges[i].distance);
    }

    fprintf(fp, "%d %s\n", password_set,
    admin_password);

    fclose(fp);
    printf("数据已保存到文件。\n");
}

// 从文件加载数据
void load_data() {
    FILE *fp = fopen("bus_data.txt", "r");
    if (!fp) {
        printf("文件打开失败，将使用默认数据初始化。\n");
        return;
    }

    if (fscanf(fp, "%d", &station_count) != 1) {
        fclose(fp);
```

```
        return;
    }
    for (int i = 0; i < station_count; i++) {
        if (fscanf(fp, "%d %s %d", &stations[i].id,
        stations[i].name,
        &stations[i].is_bus_station) != 3) {
            fclose(fp);
            return;
        }
    }

    if (fscanf(fp, "%d", &route_count) != 1) {
        fclose(fp);
        return;
    }
    for (int i = 0; i < route_count; i++) {
        if (fscanf(fp, "%d %d", &bus_routes[i].id,
        &bus_routes[i].station_count) != 2) {
            fclose(fp);
            return;
        }
        for (int j = 0; j < bus_routes[i].station_count;
```

```
        j++) {
            if (fscanf(fp, "%d",
            &bus_routes[i].stations[j]) != 1) {
                fclose(fp);
                return;
            }
        }
        for (int j = 0; j < bus_routes[i].station_count
        - 1; j++) {
            if (fscanf(fp, "%f",
            &bus_routes[i].distances[j]) != 1) {
                fclose(fp);
                return;
            }
        }
    }

    if (fscanf(fp, "%d", &walk_edge_count) != 1) {
        fclose(fp);
        return;
    }
    walk_edge_count = (walk_edge_count > MAX_EDGES) ?
```

```
MAX_EDGES : walk_edge_count;
for (int i = 0; i < walk_edge_count; i++) {
    int from, to;
    float distance;
    if (fscanf(fp, "%d %d %f", &from, &to,
    &distance) != 3) {
        printf("读取步行边 %d 失败，文件格式可能错误。
        \n", i);
        fclose(fp);
        return;
    }
    if (from == 0 && to == 0 && distance == 0.00) {
        break;
    }
    walk_edges[i].from = from;
    walk_edges[i].to = to;
    walk_edges[i].distance = distance;
}

if (fscanf(fp, "%d %s", &password_set,
admin_password) != 2) {
    fclose(fp);
```

```
            return;
        }

        fclose(fp);
        printf("数据已从文件加载。\n");
}

// 更新步行边
void update_walk_edges() {
        walk_edge_count = 0;

        // 添加默认步行边
        int idx = 0;
        walk_edges[idx++]   =   (WalkEdge){1,   2,   0.25};
        walk_edges[idx++] = (WalkEdge){2, 1, 0.25};
        walk_edges[idx++]   =   (WalkEdge){1,   11,   1.5};
        walk_edges[idx++] = (WalkEdge){11, 1, 1.5};
        walk_edges[idx++]   =   (WalkEdge){1,   7,   1.0};
        walk_edges[idx++] = (WalkEdge){7, 1, 1.0};
        walk_edges[idx++]   =   (WalkEdge){1,   6,   1.0};
        walk_edges[idx++] = (WalkEdge){6, 1, 1.0};
        walk_edges[idx++]   =   (WalkEdge){2,   3,   0.25};
```

```
walk_edges[idx++] = (WalkEdge){3, 2, 0.25};
walk_edges[idx++] = (WalkEdge){4, 5, 0.5};
walk_edges[idx++] = (WalkEdge){5, 4, 0.5};
walk_edges[idx++] = (WalkEdge){7, 12, 0.5};
walk_edges[idx++] = (WalkEdge){12, 7, 0.5};
walk_edges[idx++] = (WalkEdge){11, 12, 0.25};
walk_edges[idx++] = (WalkEdge){12, 11, 0.25};
walk_edges[idx++] = (WalkEdge){12, 6, 1.0};
walk_edges[idx++] = (WalkEdge){6, 12, 1.0};
walk_edges[idx++] = (WalkEdge){12, 13, 0.25};
walk_edges[idx++] = (WalkEdge){13, 12, 0.25};
walk_edges[idx++] = (WalkEdge){6, 5, 1.0};
walk_edges[idx++] = (WalkEdge){5, 6, 1.0};
walk_edges[idx++] = (WalkEdge){5, 14, 1.0};
walk_edges[idx++] = (WalkEdge){14, 5, 1.0};
walk_edges[idx++] = (WalkEdge){6, 14, 1.0};
walk_edges[idx++] = (WalkEdge){14, 6, 1.0};
walk_edges[idx++] = (WalkEdge){13, 14, 1.0};
walk_edges[idx++] = (WalkEdge){14, 13, 1.0};
walk_edges[idx++] = (WalkEdge){14, 16, 1.0};
walk_edges[idx++] = (WalkEdge){16, 14, 1.0};
walk_edges[idx++] = (WalkEdge){13, 16, 0.5};
```

```
walk_edges[idx++] = (WalkEdge){16, 13, 0.5};
walk_edges[idx++]  =  (WalkEdge){16,  15,  0.5};
walk_edges[idx++] = (WalkEdge){15, 16, 0.5};
walk_edges[idx++]  =  (WalkEdge){16,  10,  0.5};
walk_edges[idx++] = (WalkEdge){10, 16, 0.5};
walk_edges[idx++]  =  (WalkEdge){10,  9,  1.0};
walk_edges[idx++] = (WalkEdge){9, 10, 1.0};
walk_edges[idx++]  =  (WalkEdge){9,  15,  0.5};
walk_edges[idx++] = (WalkEdge){15, 9, 0.5};
walk_edges[idx++]  =  (WalkEdge){9,  8,  0.5};
walk_edges[idx++] = (WalkEdge){8, 9, 0.5};
walk_edges[idx++]  =  (WalkEdge){8,  3,  0.5};
walk_edges[idx++] = (WalkEdge){3, 8, 0.5};
walk_edges[idx++]  =  (WalkEdge){9,  1,  1.5};
walk_edges[idx++] = (WalkEdge){1, 9, 1.5};
walk_edges[idx++]  =  (WalkEdge){9,  3,  1.0};
walk_edges[idx++] = (WalkEdge){3, 9, 1.0};

walk_edge_count = idx;

// 为公交线路上的相邻站点添加步行边
for (int r = 0; r < route_count; r++) {
```

```
for (int j = 0; j < bus_routes[r].station_count
- 1; j++) {
    int from = bus_routes[r].stations[j];
    int to = bus_routes[r].stations[j+1];
    float distance = bus_routes[r].distances[j];

    int exists = 0;
    for (int k = 0; k < walk_edge_count; k++) {
        if ((walk_edges[k].from == from &&
        walk_edges[k].to == to) ||
            (walk_edges[k].from == to &&
            walk_edges[k].to == from)) {
            exists = 1;
            break;
        }
    }

    if (!exists && walk_edge_count < MAX_EDGES -
    2) {
        walk_edges[walk_edge_count++] =
        (WalkEdge){from, to, distance};
        walk_edges[walk_edge_count++] =
```

```
                    (WalkEdge){to, from, distance};
                }
            }
        }

        save_data();
}

// 初始化默认数据
void init_default_data() {
        station_count = 16;
        stations[0] = (Station){1, "五棵松", 1};
        stations[1] = (Station){2, "教务处", 0};
        stations[2] = (Station){3, "图书馆", 1};
        stations[3] = (Station){4, "教职工活动中心", 1};
        stations[4] = (Station){5, "职工医院", 1};
        stations[5] = (Station){6, "大礼堂", 1};
        stations[6] = (Station){7, "三岔口", 1};
        stations[7] = (Station){8, "研究生院", 0};
        stations[8] = (Station){9, "耒耜大楼", 1};
        stations[9] = (Station){10, "宿舍G区", 1};
        stations[10] = (Station){11, "宿舍C区", 0};
```

```
    stations[11] = (Station){12, "宿舍B区", 1};
    stations[12] = (Station){13, "宿舍D区", 1};
    stations[13] = (Station){14, "行政二号楼", 1};
    stations[14] = (Station){15, "京江楼", 1};
    stations[15] = (Station){16, "六食堂", 1};

    route_count = 6;
    bus_routes[0] = (Route){1, 5, {1, 7, 12, 13, 16},
    {1.0, 0.5, 0.25, 0.5}};
    bus_routes[1] = (Route){2, 4, {16, 10, 9, 3}, {0.5,
    1.0, 1.0}};
    bus_routes[2] = (Route){3, 4, {1, 9, 15, 16}, {1.5,
    0.5, 0.5}};
    bus_routes[3] = (Route){4, 4, {12, 6, 5, 4}, {1.0,
    1.0, 0.5}};
    bus_routes[4] = (Route){5, 3, {5, 14, 16}, {1.0,
    1.0}};
    bus_routes[5] = (Route){6, 4, {13, 14, 6, 1}, {1.0,
    1.0, 1.0}};

    update_walk_edges();
}
```

```
// 根据站点名称查找 ID
int find_station_id(char *name) {
    for (int i = 0; i < station_count; i++) {
        if (strcmp(stations[i].name, name) == 0) {
            return stations[i].id;
        }
    }
    return -1;
}

// 验证输入是否为有效浮点数
int is_valid_float(char *str) {
    int has_dot = 0, has_digit = 0;
    for (int i = 0; str[i]; i++) {
        if (isdigit(str[i])) has_digit = 1;
        else if (str[i] == '.' && !has_dot) has_dot = 1;
        else return 0;
    }
    return has_digit;
}
```

```
// 更新站点是否为公交站点
void update_bus_station_status() {
    for (int i = 0; i < station_count; i++) {
        stations[i].is_bus_station = 0;
        for (int r = 0; r < route_count; r++) {
            for (int j = 0; j < bus_routes[r].station_count; j++) {
                if (bus_routes[r].stations[j] == stations[i].id) {
                    stations[i].is_bus_station = 1;
                    break;
                }
            }
            if (stations[i].is_bus_station) break;
        }
    }
}

// 验证密码
int verify_password() {
    if (!password_set) return 1;
    char input_password[MAX_PASSWORD];
```

```
        printf("请输入管理员密码：");
        scanf("%s", input_password);
        return strcmp(input_password, admin_password) == 0;
}

// 管理密码
void manage_password() {
        int sub_choice;
        while (1) {
            printf("\n=== 密码管理 ===\n");
            printf("1. 修改密码\n");
            printf("2. 取消密码\n");
            printf("3. 设置密码\n");
            printf("4. 返回管理员菜单\n");
            printf("5. 退出系统\n");
            printf("请输入选项：");
            scanf("%d", &sub_choice);

            switch (sub_choice) {
                case 1:
                        if (verify_password()) {
                            printf("请输入新密码：");
```

```
            scanf("%s", admin_password);
            password_set = 1;
            save_data();
            printf("密码修改成功。\n");
        } else {
            printf("密码错误。\n");
        }
        break;
    case 2:
        if (verify_password()) {
            password_set = 0;
            strcpy(admin_password, "");
            save_data();
            printf("密码已取消。\n");
        } else {
            printf("密码错误。\n");
        }
        break;
    case 3:
        printf("请输入新密码：");
        scanf("%s", admin_password);
        password_set = 1;
```

```
                save_data();
                printf("密码设置成功。\n");
                break;
            case 4:
                return;
            case 5:
                printf("感谢使用本系统。\n");
                exit(0);
            default:
                printf("无效选项。\n");
        }
    }
}

// 添加新站点
void add_new_station() {
    if (station_count >= MAX_STATIONS) {
        printf("站点数量已达上限。\n");
        return;
    }

    Station new_station;
```

```
    new_station.id = station_count + 1;
    printf("请输入站点名称：");
    scanf("%s", new_station.name);
    new_station.is_bus_station = 1;

    stations[station_count++] = new_station;
    save_data();

    printf("新站点添加成功：ID=%d, 名称=%s, 是否公交站
    点=%d\n",
           new_station.id,          new_station.name,
           new_station.is_bus_station);
}

// 添加公交线路
void add_bus_route() {
    if (route_count >= MAX_ROUTES) {
       printf("公交线路已达上限。\n");
       return;
    }

    Route new_route;
```

```
new_route.id = route_count + 1;
printf("请输入站点数量：");
int station_count_input;
if (scanf("%d", &station_count_input) != 1 ||
station_count_input <= 0 || station_count_input >
MAX_STATIONS) {
    printf("站点数量无效。\n");
    while (getchar() != '\n');
    return;
}
new_route.station_count = station_count_input;

printf("请按行驶顺序输入站点名称（每行一个）：\n");
for (int i = 0; i < new_route.station_count; i++)
{
    char name[MAX_NAME];
    scanf("%s", name);
    int id = find_station_id(name);
    if (id == -1) {
        printf("站点 %s 不存在。\n", name);
        return;
    }
```

```
        new_route.stations[i] = id;
    }

    printf("请输入相邻站点间距离（km，用空格分隔）：");
    for (int i = 0; i < new_route.station_count - 1;
    i++) {
        char dist_str[20];
        scanf("%s", dist_str);
        if (!is_valid_float(dist_str)) {
            printf("无效距离输入。\n");
            return;
        }
        new_route.distances[i] = atof(dist_str);
        if (new_route.distances[i] <= 0) {
            printf("距离必须为正数。\n");
            return;
        }
    }

    bus_routes[route_count++] = new_route;
    update_bus_station_status();
    update_walk_edges();
```

```
        printf("新公交线路添加成功：线路 ID=%d，站点数=%d\n
        站点：", new_route.id, new_route.station_count);
        for (int i = 0; i < new_route.station_count; i++)
        {
            printf("%s",    stations[new_route.stations[i]-
            1].name);
            if (i < new_route.station_count - 1) {
                printf("-(%.2fkm)->",
                new_route.distances[i]);
            }
        }
        printf("\n");
}

// 修改站点信息
void modify_station_info(int route_idx) {
        printf(" 当 前 线 路  ID=%d ， 站 点 ： ",
        bus_routes[route_idx].id);
        for      (int      j      =      0;      j      <
        bus_routes[route_idx].station_count; j++) {
            printf("%s",
```

```
            stations[bus_routes[route_idx].stations[j]-
            1].name);
            if (j < bus_routes[route_idx].station_count - 1)
            {
                printf("-(%.2fkm)->",
                bus_routes[route_idx].distances[j]);
            }
        }
        printf("\n");

        int sub_choice;
        printf("1. 修改站点名称\n");
        printf("2. 修改相邻站点距离\n");
        printf("3. 返回\n");
        printf("请输入选项：");
        scanf("%d", &sub_choice);

        switch (sub_choice) {
            case 1: {
                char old_name[MAX_NAME], new_name[MAX_NAME];
                printf("请输入要修改的站点名称：");
                scanf("%s", old_name);
```

```
int station_idx = -1;
for (int j = 0; j < bus_routes[route_idx].station_count; j++) {
    if (strcmp(stations[bus_routes[route_idx].stations[j]-1].name, old_name) == 0) {
        station_idx = bus_routes[route_idx].stations[j] - 1;
        break;
    }
}
if (station_idx == -1) {
    printf("线路中未找到站点 %s。\n", old_name);
    return;
}
printf("请输入新站点名称：");
scanf("%s", new_name);
if (find_station_id(new_name) != -1) {
    printf("站点名称 %s 已存在。\n",
```

```
                new_name);
                return;
            }
            strcpy(stations[station_idx].name,
            new_name);
            save_data();
            printf("站点名称修改成功：%s -> %s\n",
            old_name, new_name);
            break;
        }
        case 2: {
            printf("请输入要修改的相邻站点对（格式：站点
            1 站点 2）：");
            char name1[MAX_NAME], name2[MAX_NAME];
            scanf("%s %s", name1, name2);
            int idx1 = -1, idx2 = -1;
            for (int j = 0; j <
            bus_routes[route_idx].station_count; j++) {
                if
                (strcmp(stations[bus_routes[route_idx
                ].stations[j]-1].name, name1) == 0)
                idx1 = j;
```

```
            if
            (strcmp(stations[bus_routes[route_idx
            ].stations[j]-1].name,  name2)  ==  0)
            idx2 = j;
        }
        if (idx1 == -1 || idx2 == -1 || abs(idx1 -
        idx2) != 1) {
            printf("站点对无效或非相邻站点。\n");
            return;
        }
        int dist_idx = idx1 < idx2 ? idx1 : idx2;
        printf("请输入 %s 到 %s 的新距离（km）：",
        name1, name2);
        char dist_str[20];
        scanf("%s", dist_str);
        if (!is_valid_float(dist_str)) {
            printf("无效距离输入。\n");
            return;
        }
        float new_dist = atof(dist_str);
        if (new_dist <= 0) {
            printf("距离必须为正数。\n");
```

```
                return;
            }
            bus_routes[route_idx].distances[dist_idx] =
            new_dist;
            save_data();
            printf("距离修改成功：%s 到 %s 的距离更新
            为 %.2fkm\n", name1, name2, new_dist);
            break;
        }
        case 3:
            return;
        default:
            printf("无效选项。\n");
    }
}

// 修改公交线路
void modify_bus_route() {
    int route_id;
    printf("请输入要修改的线路 ID：");
    if (scanf("%d", &route_id) != 1 || route_id <= 0)
    {
```

```
        printf("无效线路 ID。\n");
        while (getchar() != '\n');
        return;
    }

    int route_idx = -1;
    for (int i = 0; i < route_count; i++) {
        if (bus_routes[i].id == route_id) {
            route_idx = i;
            break;
        }
    }
    if (route_idx == -1) {
        printf("未找到该线路。\n");
        return;
    }

    int sub_choice;
    printf("\n=== 修改公交线路 ===\n");
    printf("1. 仅修改站点信息（名称或距离）\n");
    printf("2. 仅修改公交线路（站点顺序和数量）\n");
    printf("3. 返回\n");
```

```
printf("请输入选项：");
scanf("%d", &sub_choice);

switch (sub_choice) {
    case 1:
        modify_station_info(route_idx);
        break;
    case 2: {
        printf("请输入新的站点数量：");
        int new_count;
        if (scanf("%d", &new_count) != 1 || new_count
        <= 0 || new_count > MAX_STATIONS) {
            printf("站点数量无效。\n");
            while (getchar() != '\n');
            return;
        }
        bus_routes[route_idx].station_count =
        new_count;

        printf("请按新行驶顺序输入站点名称（每行一
        个）：\n");
        for (int j = 0; j <
```

```
bus_routes[route_idx].station_count; j++) {
        char name[MAX_NAME];
        scanf("%s", name);
        int id = find_station_id(name);
        if (id == -1) {
            printf("站点 %s 不存在。\n", name);
            return;
        }
        bus_routes[route_idx].stations[j]   =
        id;
}

printf("请输入新的相邻站点间距离（km，用空格
分隔）：");
for     (int     j     =     0;     j     <
bus_routes[route_idx].station_count - 1; j++)
{
        char dist_str[20];
        scanf("%s", dist_str);
        if (!is_valid_float(dist_str)) {
            printf("无效距离输入。\n");
            return;
```

```
            }
            bus_routes[route_idx].distances[j]  =
            atof(dist_str);
            if (bus_routes[route_idx].distances[j]
            <= 0) {
                printf("距离必须为正数。\n");
                return;
            }
        }

        update_bus_station_status();
        update_walk_edges();
        printf("公交线路修改成功：线路 ID=%d，站点数
        =%d\n 站点：", bus_routes[route_idx].id,
        bus_routes[route_idx].station_count);
        for (int j = 0; j <
        bus_routes[route_idx].station_count; j++) {
            printf("%s",
            stations[bus_routes[route_idx].statio
            ns[j]-1].name);
            if (j <
            bus_routes[route_idx].station_count -
```

```
                    1) {
                        printf("-(%.2fkm)->",
                        bus_routes[route_idx].distances[j]
                        );
                    }
                }
                printf("\n");
                break;
            }
            case 3:
                return;
            default:
                printf("无效选项。\n");
        }
    }

    // 从线路中删除站点
    void delete_station_from_route() {
        int route_id;
        char station_name[MAX_NAME];
        printf("请输入线路 ID: ");
        if (scanf("%d", &route_id) != 1 || route_id <= 0)
```

```
{
    printf("无效线路 ID。\n");
    while (getchar() != '\n');
    return;
}
printf("请输入要删除的站点名称：");
scanf("%s", station_name);

int station_id = find_station_id(station_name);
if (station_id == -1) {
    printf("站点 %s 不存在。\n", station_name);
    return;
}

int route_idx = -1;
for (int i = 0; i < route_count; i++) {
    if (bus_routes[i].id == route_id) {
        route_idx = i;
        break;
    }
}
if (route_idx == -1) {
```

```
        printf("未找到该线路。\n");
        return;
    }

    int delete_idx = -1;
    for (int j = 0; j < bus_routes[route_idx].station_count; j++) {
        if (bus_routes[route_idx].stations[j] == station_id) {
            delete_idx = j;
            break;
        }
    }
    if (delete_idx == -1) {
        printf("线路中未找到该站点。\n");
        return;
    }

    int new_count = bus_routes[route_idx].station_count - 1;
    int new_stations[MAX_STATIONS];
    float new_distances[MAX_STATIONS];
```

```
        for (int j = 0, k = 0; j < bus_routes[route_idx].station_count; j++) {
            if (j != delete_idx) {
                new_stations[k] = bus_routes[route_idx].stations[j];
                if (j < bus_routes[route_idx].station_count - 1 && k < new_count - 1) {
                    new_distances[k] = bus_routes[route_idx].distances[j];
                }
                k++;
            }
        }

        if (delete_idx > 0 && delete_idx < bus_routes[route_idx].station_count - 1) {
            printf("请输入站点 %s 到 %s 的新距离（km）：", stations[new_stations[delete_idx-1]-1].name, stations[new_stations[delete_idx]-1].name);
            char dist_str[20];
            scanf("%s", dist_str);
```

```
            if (!is_valid_float(dist_str)) {
                printf("无效距离输入。\n");
                return;
            }
            new_distances[delete_idx-1] = atof(dist_str);
            if (new_distances[delete_idx-1] <= 0) {
                printf("距离必须为正数。\n");
                return;
            }
        }

        bus_routes[route_idx].station_count = new_count;
        for (int j = 0; j < new_count; j++) {
            bus_routes[route_idx].stations[j]            =
            new_stations[j];
            if (j < new_count - 1) {
                bus_routes[route_idx].distances[j]       =
                new_distances[j];
            }
        }

        update_bus_station_status();
```

```
        update_walk_edges();
        printf("站点删除成功：线路 ID=%d，剩余站点数=%d\n 站
        点 : ", bus_routes[route_idx].id,
        bus_routes[route_idx].station_count);
        for (int j = 0; j <
        bus_routes[route_idx].station_count; j++) {
            printf("%s",
            stations[bus_routes[route_idx].stations[j]-
            1].name);
            if (j < bus_routes[route_idx].station_count - 1)
            {
                printf("-(%.2fkm)->",
                bus_routes[route_idx].distances[j]);
            }
        }
        printf("\n");
    }

    // 添加站点到线路
    void add_station_to_route() {
        int route_id;
        char station_name[MAX_NAME];
```

```
int position;
printf("请输入线路 ID：");
if (scanf("%d", &route_id) != 1 || route_id <= 0)
{
    printf("无效线路 ID。\n");
    while (getchar() != '\n');
    return;
}
printf("请输入要添加的站点名称：");
scanf("%s", station_name);
printf("请输入添加位置（0 为起始位置）：");
if (scanf("%d", &position) != 1) {
    printf("无效位置输入。\n");
    while (getchar() != '\n');
    return;
}

int station_id = find_station_id(station_name);
if (station_id == -1) {
    printf("站点 %s 不存在。\n", station_name);
    return;
}
```

```
int route_idx = -1;
for (int i = 0; i < route_count; i++) {
    if (bus_routes[i].id == route_id) {
        route_idx = i;
        break;
    }
}
if (route_idx == -1) {
    printf("未找到该线路。\n");
    return;
}

if (position < 0 || position > bus_routes[route_idx].station_count) {
    printf("位置无效。\n");
    return;
}

for (int j = bus_routes[route_idx].station_count; j > position; j--) {
    bus_routes[route_idx].stations[j] =
```

```
            bus_routes[route_idx].stations[j-1];
            if (j < bus_routes[route_idx].station_count) {
                bus_routes[route_idx].distances[j]         =
                bus_routes[route_idx].distances[j-1];
            }
        }

        bus_routes[route_idx].stations[position]         =
        station_id;
        bus_routes[route_idx].station_count++;
        stations[station_id-1].is_bus_station = 1;

        if (position < bus_routes[route_idx].station_count
        - 1) {
            printf("请输入该站点到下一站的距离（km）：");
            char dist_str[20];
            scanf("%s", dist_str);
            if (!is_valid_float(dist_str) || atof(dist_str)
            <= 0) {
                printf("无效距离输入。\n");
                return;
            }
```

```
        bus_routes[route_idx].distances[position]     =
        atof(dist_str);
    }
    if (position > 0) {
        printf("请输入上一站到该站点的距离（km）：");
        char dist_str[20];
        scanf("%s", dist_str);
        if (!is_valid_float(dist_str) || atof(dist_str)
        <= 0) {
            printf("无效距离输入。\n");
            return;
        }
        bus_routes[route_idx].distances[position-1]   =
        atof(dist_str);
    }

    update_bus_station_status();
    update_walk_edges();
    printf("站点添加成功：线路 ID=%d，站点数=%d\n 站点：
    ",                          bus_routes[route_idx].id,
    bus_routes[route_idx].station_count);
    for       (int       j       =       0;       j       <
```

```
        bus_routes[route_idx].station_count; j++) {
            printf("%s",
            stations[bus_routes[route_idx].stations[j]-
            1].name);
            if (j < bus_routes[route_idx].station_count - 1)
            {
                printf("-(%.2fkm)->",
                bus_routes[route_idx].distances[j]);
            }
        }
        printf("\n");
}

// 查询站点经过的公交线路
void query_station_routes() {
        char station_name[MAX_NAME];
        printf("请输入站点名称：");
        scanf("%s", station_name);

        int station_id = find_station_id(station_name);
        if (station_id == -1) {
            printf("未找到该站点。\n");
```

```
    return;
}

printf("经过%s 的公交线路：\n", station_name);
int found = 0;
for (int i = 0; i < route_count; i++) {
    for (int j = 0; j < bus_routes[i].station_count;
    j++) {
        if (bus_routes[i].stations[j] == station_id)
        {
                found = 1;
                printf("线路%d：", bus_routes[i].id);
                float total_distance = 0.0;
                for    (int    k    =    0;    k    <
                bus_routes[i].station_count; k++) {
                    printf("%s",
                    stations[bus_routes[i].stations[k]
                    -1].name);
                    if                (k                <
                    bus_routes[i].station_count - 1) {
                    printf("-(%.2fkm)->",
                    bus_routes[i].distances[k]);
```

```
                    total_distance                    +=
                    bus_routes[i].distances[k];
                    }
                }
                printf("\n 总距离：%.2fkm，总时间：%.2f
                分    钟    \n",    total_distance,
                total_distance / BUS_SPEED);
            }
        }
    }
    if (!found) {
        printf("该站点没有公交线路经过。\n");
    }
}

// 显示所有公交线路
void display_all_routes() {
    printf("所有校内公交线路：\n");
    for (int i = 0; i < route_count; i++) {
        printf("线路%d：", bus_routes[i].id);
        float total_distance = 0.0;
        for (int j = 0; j < bus_routes[i].station_count;
```

```
            j++) {
                printf("%s",
                stations[bus_routes[i].stations[j]-1].name);
                if (j < bus_routes[i].station_count - 1) {
                    printf("-(%.2fkm)->",
                    bus_routes[i].distances[j]);
                    total_distance                    +=
                    bus_routes[i].distances[j];
                }
            }
            printf("\n 总距离：%.2fkm，总时间：%.2f 分钟\n",
            total_distance, total_distance / BUS_SPEED);
        }
}

// Dijkstra 算法
Path dijkstra(int start_id, int end_id, int mode) {
        float dist[MAX_STATIONS]; // 主要度量（时间/换乘次
        数/距离）
        float total_time[MAX_STATIONS]; // 总用时（用于最
        少换乘模式比较）
        float total_dist[MAX_STATIONS]; // 总距离
```

```
int prev[MAX_STATIONS];
int visited[MAX_STATIONS];
char modes[MAX_STATIONS][10];
int transfers[MAX_STATIONS];
int prev_route[MAX_STATIONS]; // 记录上一个使用的
线路 ID

Path result = {{0}, 0, 99999.0, 99999.0, 999, {""}};

for (int i = 0; i < station_count; i++) {
    dist[i] = 99999.0;
    total_time[i] = 99999.0;
    total_dist[i] = 99999.0;
    prev[i] = -1;
    visited[i] = 0;
    transfers[i] = 999;
    prev_route[i] = -1;
    strcpy(modes[i], "");
}

dist[start_id-1] = 0;
total_time[start_id-1] = 0;
```

```
total_dist[start_id-1] = 0;
transfers[start_id-1] = 0;

// 处理非公交站点终点（最少换乘）
int target_id = end_id;
if (stations[end_id-1].is_bus_station == 0 && mode
== 1) {
    float min_dist = 99999.0;
    for (int i = 0; i < walk_edge_count; i++) {
        if (walk_edges[i].from == end_id &&
        stations[walk_edges[i].to-1].is_bus_station)
        {
            if (walk_edges[i].distance < min_dist)
            {
                min_dist = walk_edges[i].distance;
                target_id = walk_edges[i].to;
            }
        }
        if (walk_edges[i].to == end_id &&
        stations[walk_edges[i].from-
        1].is_bus_station) {
            if (walk_edges[i].distance < min_dist)
```

```
                {
                    min_dist = walk_edges[i].distance;
                    target_id = walk_edges[i].from;
                }
            }
        }
    }

    for (int i = 0; i < station_count; i++) {
        int min_idx = -1;
        float min_dist = 99999.0;

        for (int j = 0; j < station_count; j++) {
            if (!visited[j]) {
                if (mode == 1) {
                    if (min_idx == -1 || transfers[j]
                    < transfers[min_idx] ||
                    (transfers[j] == transfers[min_idx]
                    &&          total_time[j]          <
                    total_time[min_idx])) {
                    min_dist = dist[j];
                    min_idx = j;
```

```
            }
        } else if (dist[j] < min_dist) {
            min_dist = dist[j];
            min_idx = j;
        }
    }
}

if (min_idx == -1 || min_idx == target_id-1)
break;
visited[min_idx] = 1;

// 公交线路
for (int r = 0; r < route_count; r++) {
    int found = 0;
    int route_start_idx = -1;
    for (int j = 0; j < 
    bus_routes[r].station_count; j++) {
        if (bus_routes[r].stations[j] == 
        min_idx + 1) {
            found = 1;
            route_start_idx = j;
```

```
                break;
            }
        }
        if (found) {
            for (int j = route_start_idx + 1; j <
            bus_routes[r].station_count; j++) {
                float segment_dist = 0.0;
                int transfer = 0;

                if (prev[min_idx] != -1 &&
                strcmp(modes[min_idx], "公交") ==
                0 && prev_route[min_idx] !=
                bus_routes[r].id) {
                transfer = 1;
                }

                for (int k = route_start_idx; k <
                j; k++) {
                segment_dist                    +=
                bus_routes[r].distances[k];
                }
                float time = segment_dist /
```

```
BUS_SPEED;
int next_station =
bus_routes[r].stations[j] - 1;

if (!visited[next_station]) {
float new_dist = (mode == 0) ?
dist[min_idx] + time :
(mode == 1) ? dist[min_idx] +
(transfer ? 1 : 0) :
dist[min_idx] + segment_dist;
float new_total_time =
total_time[min_idx] + time;
float new_total_dist =
total_dist[min_idx] + segment_dist;
int new_transfers =
transfers[min_idx] + transfer;

if (mode == 1) {
if (new_transfers <
transfers[next_station] ||
(new_transfers ==
transfers[next_station] &&
```

```
                        new_total_time                    <
                        total_time[next_station])) {
                        dist[next_station] = new_dist;
                        total_time[next_station]          =
                        new_total_time;
                        total_dist[next_station]          =
                        new_total_dist;
                        prev[next_station] = min_idx;
                        transfers[next_station]           =
                        new_transfers;
strcpy(modes[next_station], "公交");
                        prev_route[next_station]          =
                        bus_routes[r].id;
                        }
                        }    else    if    (new_dist    <
                        dist[next_station]) {
                        dist[next_station] = new_dist;
                        total_time[next_station]          =
                        new_total_time;
                        total_dist[next_station]          =
                        new_total_dist;
                        prev[next_station] = min_idx;
```

```
                transfers[next_station]          =
                new_transfers;
                strcpy(modes[next_station], "公交
                ");
                prev_route[next_station]         =
                bus_routes[r].id;
                }
                }
            }
        }
    }

    // 步行边
    for (int j = 0; j < walk_edge_count; j++) {
        if (walk_edges[j].from == min_idx + 1
        && !visited[walk_edges[j].to-1]) {
            float time = walk_edges[j].distance /
            WALK_SPEED;
            float new_dist = (mode == 0) ?
            dist[min_idx] + time :
                (mode == 1) ? dist[min_idx] :
                dist[min_idx]                    +
```

```
            walk_edges[j].distance;
        float         new_total_time         =
        total_time[min_idx] + time;
        float         new_total_dist         =
        total_dist[min_idx]                  +
        walk_edges[j].distance;

        if (mode == 1) {
            if      (transfers[min_idx]      <
            transfers[walk_edges[j].to-1] ||
            (transfers[min_idx]              ==
            transfers[walk_edges[j].to-1]    &&
            new_total_time                   <
            total_time[walk_edges[j].to-1])) {
            dist[walk_edges[j].to-1]         =
            new_dist;
            total_time[walk_edges[j].to-1]   =
            new_total_time;
            total_dist[walk_edges[j].to-1]   =
            new_total_dist;
            prev[walk_edges[j].to-1] = min_idx;
            transfers[walk_edges[j].to-1]    =
```

```
                transfers[min_idx];
                strcpy(modes[walk_edges[j].to-1],
                "步行");
                prev_route[walk_edges[j].to-1] = -
                1;
                }
            }     else     if     (new_dist     <
            dist[walk_edges[j].to-1]) {
                dist[walk_edges[j].to-1]          =
                new_dist;
                total_time[walk_edges[j].to-1]    =
                new_total_time;
                total_dist[walk_edges[j].to-1]    =
                new_total_dist;
                prev[walk_edges[j].to-1] = min_idx;
                transfers[walk_edges[j].to-1]     =
                transfers[min_idx];
                strcpy(modes[walk_edges[j].to-1],
                "步行");
                prev_route[walk_edges[j].to-1] = -
                1;
            }
```

```
            }
        }
    }

    // 处理非公交站点终点
    if (target_id != end_id) {
        for (int j = 0; j < walk_edge_count; j++) {
            if ((walk_edges[j].from == target_id &&
            walk_edges[j].to == end_id) ||
                    (walk_edges[j].to == target_id &&
                    walk_edges[j].from == end_id)) {
                    float time = walk_edges[j].distance /
                    WALK_SPEED;
                    dist[end_id-1] = (mode == 0) ?
                    dist[target_id-1] + time :
                        (mode == 1) ? dist[target_id-1] :
                        dist[target_id-1] +
                        walk_edges[j].distance;
                    total_time[end_id-1] =
                    total_time[target_id-1] + time;
                    total_dist[end_id-1] =
                    total_dist[target_id-1] +
```

```
                walk_edges[j].distance;
                prev[end_id-1] = target_id-1;
                transfers[end_id-1]                    =
                transfers[target_id-1];
                strcpy(modes[end_id-1], "步行");
                prev_route[end_id-1] = -1;
                break;
            }
        }
    }

    if (dist[end_id-1] != 99999.0) {
        result.time = total_time[end_id-1];
        result.distance = total_dist[end_id-1];
        result.path_length = 0;
        int current = end_id - 1;
        while (current != -1) {
            result.path[result.path_length] = current +
            1;
            strcpy(result.modes[result.path_length],
            modes[current]);
            result.path_length++;
```

```
            current = prev[current];
        }
        result.transfers = transfers[end_id-1];
    }

    return result;
}

// 路线规划
void plan_route(int mode) {
    char start_name[MAX_NAME], end_name[MAX_NAME];
    int start_id, end_id;

    if (mode != 2) {
        printf("请输入起点名称：");
        scanf("%s", start_name);
        printf("请输入终点名称：");
        scanf("%s", end_name);

        start_id = find_station_id(start_name);
        end_id = find_station_id(end_name);
```

```
        if (start_id == -1 || end_id == -1) {
            printf("起点或终点不存在。\n");
            return;
        }
    } else {
        start_id = 1; // 五棵松
        printf("请输入终点名称：");
        scanf("%s", end_name);
        end_id = find_station_id(end_name);
        if (end_id == -1) {
            printf("终点不存在。\n");
            return;
        }
    }

    Path result = dijkstra(start_id, end_id, mode);

    if (result.path_length == 0) {
        printf("无法找到合适的路线。\n");
        return;
    }
```

```
printf("最优路线（%s）：\n", mode == 0 ? "最短时间
" : mode == 1 ? "最少换乘" : "最短距离（从五棵松）
");
float total_distance = 0.0;
float total_time = 0.0;
for (int i = result.path_length - 1; i >= 0; i--)
{
   printf("%s", stations[result.path[i]-1].name);
   if (i > 0) {
      printf(" %s ", result.modes[i-1]);
      if (strcmp(result.modes[i-1], "步行") == 0)
      {
            for (int j = 0; j < walk_edge_count;
            j++) {
               if      (walk_edges[j].from      ==
               result.path[i] && walk_edges[j].to
               == result.path[i-1]) {
               printf("(%.2fkm)",
               walk_edges[j].distance);
               total_distance                  +=
               walk_edges[j].distance;
               total_time                      +=
```

```
                walk_edges[j].distance /
                WALK_SPEED;
                break;
                }
            }
        } else {
            int route_id = -1;
            float segment_distance = 0.0;
            for (int r = 0; r < route_count; r++)
            {
                int found_from = -1, found_to = -1;
                for (int j = 0; j <
                bus_routes[r].station_count; j++)
                {
                if (bus_routes[r].stations[j] ==
                result.path[i]) found_from = j;
                if (bus_routes[r].stations[j] ==
                result.path[i-1]) found_to = j;
                }
                if (found_from != -1 && found_to !=
                -1 && found_from < found_to) {
                route_id = bus_routes[r].id;
```

```
                    for (int j = found_from; j <
                    found_to; j++) {
                    segment_distance                +=
                    bus_routes[r].distances[j];
                    }
                    break;
                    }
                }
                printf("(%.2fkm,     线    路    %d)",
                segment_distance, route_id);
                total_distance += segment_distance;
                total_time   +=   segment_distance   /
                BUS_SPEED;
            }
            printf(" -> ");
        }
    }
    printf("\n 总距离：%.2fkm\n 总时间：%.2f 分钟\n 换乘
    次数：%d\n",
            total_distance,                total_time,
            result.transfers);
}
```

```
// 管理员菜单
void admin_menu() {
    int sub_choice;
    while (1) {
        printf("\n=== 管理员功能 ===\n");
        printf("1. 添加新站点\n");
        printf("2. 新增公交线路\n");
        printf("3. 修改公交线路\n");
        printf("4. 从线路中删除站点\n");
        printf("5. 添加站点到线路\n");
        printf("6. 密码管理\n");
        printf("7. 查看所有公交线路\n");
        printf("8. 返回主菜单\n");
        printf("9. 退出系统\n");
        printf("请输入选项：");
        scanf("%d", &sub_choice);

        switch (sub_choice) {
            case 1: add_new_station(); break;
            case 2: add_bus_route(); break;
            case 3: modify_bus_route(); break;
```

```
            case 4: delete_station_from_route(); break;
            case 5: add_station_to_route(); break;
            case 6: manage_password(); break;
            case 7: display_all_routes(); break;
            case 8: return;
            case 9:
                printf("感谢使用本系统。\n");
                exit(0);
            default: printf("无效选项。\n");
        }
    }
}

// 学生菜单
void student_menu() {
    int sub_choice;
    while (1) {
        printf("\n=== 学生功能 ===\n");
        printf("1. 查询站点经过的公交线路\n");
        printf("2. 显示所有公交线路\n");
        printf("3. 最短时间路线规划\n");
        printf("4. 最少换乘路线规划\n");
```

```
            printf("5. 从五棵松出发的最短距离路线\n");
            printf("6. 返回主菜单\n");
            printf("7. 退出系统\n");
            printf("请输入选项：");
            scanf("%d", &sub_choice);

            switch (sub_choice) {
                case 1: query_station_routes(); break;
                case 2: display_all_routes(); break;
                case 3: plan_route(0); break;
                case 4: plan_route(1); break;
                case 5: plan_route(2); break;
                case 6: return;
                case 7:
                    printf("感谢使用本系统。\n");
                    exit(0);
                default: printf("无效选项。\n");
            }
        }
    }

    // 主菜单
```

```
void menu() {
        int choice;
        while (1) {
            printf("\n=== 校园公交查询系统 ===\n");
            printf("1. 管理员功能\n");
            printf("2. 学生功能\n");
            printf("3. 退出系统\n");
            printf("请输入选项：");
            scanf("%d", &choice);

            switch (choice) {
                case 1:
                        if (verify_password()) {
                            admin_menu();
                        } else {
                            printf("密码错误。\n");
                        }
                        break;
                case 2:
                        student_menu();
                        break;
                case 3:
```

```
                printf("感谢使用本系统。\n");
                return;
            default:
                printf("无效选项。\n");
        }
    }
}

int main() {
    load_data();
    if (station_count == 0) {
        init_default_data();
    }
    menu();
    return 0;
}
```