中山大学本科生课程作业

课程名称: 人工智能编程语言　　　　　**学院**: 智能工程学院

任课老师: 王帅　　　　　　　　　　　**年级专业**: **22** 智科

姓名: 张芮熙　　　　　　　　　　　　**学号**: **22354188**

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3. 代码运行结果展示

4. 算法分析

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一． 设计思路

题目要求：

　　对于f(x)=2*x1*x1+4*x2*x2-6x1-2x1x2, 利用最速下降法迭代求得f(x)的最小值。

　　要解这道题，首先要明白其原理，就是给出一个起始点，求出目前点的梯度，这里有两种终止条件，第一种是梯度绝对值已经小于设定的一个很小的值，相当于变化率很低，导数趋近于0；第二种就是迭代次数达到一个较大的次数，经过很多次迭代，最小值也不会改变，这就是我们要求解的优化问题。

二． 源代码及截图

f = @(x) 2*x(1)^2 + 4*x(2)^2 - 6*x(1) - 2*x(1)*x(2);   % 定义目标函数

gradf = @(x) [4*x(1)-6-2*x(2); 8*x(2)-2*x(1)]; % 定义目标函数的梯度

x0 = [1; 1];   % 设置初始点

alpha = 0.01;   % 设置迭代步长

max_iter = 1e-6;   % 设置迭代次数

% 迭代求解

x = x0;

count=0;

d=1;

while abs(d)>max_iter

g = gradf(x);   % 计算梯度

d = -g;   % 最速下降方向

x = x + alpha*d;   % 更新x

count=count+1;   %迭代次数记录

% 输出迭代信息

disp(['Iter ', num2str(count), ': x = [', num2str(x(1)), ', ', num2str(x(2)), '], f(x) = ', num2str(f(x))]);

end

```matlab
% 定义目标函数
f = @(x) 2*x(1)^2 + 4*x(2)^2 - 6*x(1) - 2*x(1)*x(2);
% 定义目标函数的梯度
gradf = @(x) [4*x(1)-6-2*x(2); 8*x(2)-2*x(1)];
% 设置初始点
x0 = [1; 1];
% 设置迭代步长
alpha = 0.01;
% 设置迭代次数
max_iter = 1e-6;
% 迭代求解
x = x0;
count=0;
d=1;
while abs(d)>max_iter
    % 计算梯度
    g = gradf(x);
    % 最速下降方向
    d = -g;
    % 更新x
    x = x + alpha*d;
    count=count+1;
    % 输出迭代信息
    disp(['Iter ', num2str(count), ': x = [', num2str(x(1)), ', ', num2str(x(2)), '], f(x) = ', num2str(f(x))]);
end
```

三．代码运行结果展示

```
>> Assignment3
Iter 1: x = [1.04, 0.94], f(x) = -2.4976
Iter 2: x = [1.0772, 0.8856], f(x) = -2.9133
Iter 3: x = [1.1118, 0.8363], f(x) = -3.2607
Iter 4: x = [1.1441, 0.79163], f(x) = -3.5513
Iter 5: x = [1.1741, 0.75118], f(x) = -3.7945
Iter 6: x = [1.2022, 0.71457], f(x) = -3.9983
Iter 7: x = [1.2284, 0.68145], f(x) = -4.1692
Iter 8: x = [1.2529, 0.6515], f(x) = -4.3126
Iter 9: x = [1.2758, 0.62444], f(x) = -4.4331
Iter 10: x = [1.2973, 0.6], f(x) = -4.5345
Iter 11: x = [1.3174, 0.57794], f(x) = -4.62
Iter 12: x = [1.3362, 0.55806], f(x) = -4.6921
Iter 13: x = [1.354, 0.54014], f(x) = -4.753
Iter 14: x = [1.3706, 0.524], f(x) = -4.8046
Iter 15: x = [1.3863, 0.5095], f(x) = -4.8484
Iter 16: x = [1.401, 0.49646], f(x) = -4.8856
Iter 17: x = [1.4149, 0.48476], f(x) = -4.9173
Iter 18: x = [1.428, 0.47428], f(x) = -4.9444
Iter 19: x = [1.4404, 0.4649], f(x) = -4.9676
Iter 20: x = [1.452, 0.45651], f(x) = -4.9875
Iter 21: x = [1.4631, 0.44903], f(x) = -5.0047
Iter 22: x = [1.4735, 0.44237], f(x) = -5.0195
Iter 23: x = [1.4834, 0.43645], f(x) = -5.0324
Iter 24: x = [1.4928, 0.43121], f(x) = -5.0436
Iter 25: x = [1.5017, 0.42657], f(x) = -5.0533
Iter 26: x = [1.5102, 0.42248], f(x) = -5.0619
Iter 27: x = [1.5183, 0.41888], f(x) = -5.0694
Iter 28: x = [1.5259, 0.41574], f(x) = -5.0761
Iter 29: x = [1.5332, 0.413], f(x) = -5.0819
Iter 30: x = [1.5401, 0.41062], f(x) = -5.0871
Iter 31: x = [1.5467, 0.40857], f(x) = -5.0918
Iter 32: x = [1.553, 0.40682], f(x) = -5.096
Iter 33: x = [1.559, 0.40534], f(x) = -5.0997
Iter 34: x = [1.5648, 0.40409], f(x) = -5.1031
Iter 35: x = [1.5703, 0.40306], f(x) = -5.1061
Iter 36: x = [1.5755, 0.40222], f(x) = -5.1089
Iter 37: x = [1.5805, 0.40155], f(x) = -5.1114
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Iter 88: x = [1.6903, 0.41889], f(x) = -5.1418
Iter 89: x = [1.6911, 0.41918], f(x) = -5.1419
Iter 90: x = [1.6918, 0.41947], f(x) = -5.1419
Iter 91: x = [1.6925, 0.41975], f(x) = -5.142
Iter 92: x = [1.6932, 0.42002], f(x) = -5.142
Iter 93: x = [1.6939, 0.42028], f(x) = -5.1421
Iter 94: x = [1.6945, 0.42053], f(x) = -5.1421
Iter 95: x = [1.6952, 0.42078], f(x) = -5.1422
Iter 96: x = [1.6958, 0.42102], f(x) = -5.1422
Iter 97: x = [1.6964, 0.42126], f(x) = -5.1423
Iter 98: x = [1.6969, 0.42148], f(x) = -5.1423
Iter 99: x = [1.6975, 0.4217], f(x) = -5.1423
Iter 100: x = [1.698, 0.42192], f(x) = -5.1424
Iter 101: x = [1.6985, 0.42212], f(x) = -5.1424
Iter 102: x = [1.699, 0.42232], f(x) = -5.1424
Iter 103: x = [1.6995, 0.42252], f(x) = -5.1425
Iter 104: x = [1.7, 0.42271], f(x) = -5.1425
Iter 105: x = [1.7004, 0.42289], f(x) = -5.1425
Iter 106: x = [1.7009, 0.42307], f(x) = -5.1425
Iter 107: x = [1.7013, 0.42324], f(x) = -5.1425
Iter 108: x = [1.7017, 0.42341], f(x) = -5.1426
Iter 109: x = [1.7021, 0.42357], f(x) = -5.1426
Iter 110: x = [1.7025, 0.42373], f(x) = -5.1426
Iter 111: x = [1.7029, 0.42388], f(x) = -5.1426
Iter 112: x = [1.7032, 0.42403], f(x) = -5.1426
Iter 113: x = [1.7036, 0.42417], f(x) = -5.1426
Iter 114: x = [1.7039, 0.42431], f(x) = -5.1427
Iter 115: x = [1.7043, 0.42444], f(x) = -5.1427
Iter 116: x = [1.7046, 0.42457], f(x) = -5.1427
Iter 117: x = [1.7049, 0.4247], f(x) = -5.1427
Iter 118: x = [1.7052, 0.42482], f(x) = -5.1427
Iter 119: x = [1.7055, 0.42494], f(x) = -5.1427
Iter 120: x = [1.7058, 0.42505], f(x) = -5.1427
Iter 121: x = [1.706, 0.42516], f(x) = -5.1427
Iter 122: x = [1.7063, 0.42527], f(x) = -5.1427
Iter 123: x = [1.7065, 0.42537], f(x) = -5.1427
Iter 124: x = [1.7068, 0.42548], f(x) = -5.1428
Iter 125: x = [1.707, 0.42557], f(x) = -5.1428
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Iter 216: x = [1.7139, 0.42841], f(x) = -5.1429
Iter 217: x = [1.7139, 0.42842], f(x) = -5.1429
Iter 218: x = [1.7139, 0.42842], f(x) = -5.1429
Iter 219: x = [1.7139, 0.42843], f(x) = -5.1429
Iter 220: x = [1.7139, 0.42843], f(x) = -5.1429
Iter 221: x = [1.714, 0.42844], f(x) = -5.1429
Iter 222: x = [1.714, 0.42844], f(x) = -5.1429
Iter 223: x = [1.714, 0.42844], f(x) = -5.1429
Iter 224: x = [1.714, 0.42845], f(x) = -5.1429
Iter 225: x = [1.714, 0.42845], f(x) = -5.1429
Iter 226: x = [1.714, 0.42846], f(x) = -5.1429
Iter 227: x = [1.714, 0.42846], f(x) = -5.1429
Iter 228: x = [1.714, 0.42846], f(x) = -5.1429
Iter 229: x = [1.714, 0.42847], f(x) = -5.1429
Iter 230: x = [1.714, 0.42847], f(x) = -5.1429
Iter 231: x = [1.714, 0.42847], f(x) = -5.1429
Iter 232: x = [1.7141, 0.42848], f(x) = -5.1429
Iter 233: x = [1.7141, 0.42848], f(x) = -5.1429
Iter 234: x = [1.7141, 0.42848], f(x) = -5.1429
Iter 235: x = [1.7141, 0.42848], f(x) = -5.1429
Iter 236: x = [1.7141, 0.42849], f(x) = -5.1429
Iter 237: x = [1.7141, 0.42849], f(x) = -5.1429
Iter 238: x = [1.7141, 0.42849], f(x) = -5.1429
Iter 239: x = [1.7141, 0.4285], f(x) = -5.1429
Iter 240: x = [1.7141, 0.4285], f(x) = -5.1429
Iter 241: x = [1.7141, 0.4285], f(x) = -5.1429
Iter 242: x = [1.7141, 0.4285], f(x) = -5.1429
Iter 243: x = [1.7141, 0.4285], f(x) = -5.1429
Iter 244: x = [1.7141, 0.42851], f(x) = -5.1429
Iter 245: x = [1.7141, 0.42851], f(x) = -5.1429
Iter 246: x = [1.7141, 0.42851], f(x) = -5.1429
Iter 247: x = [1.7141, 0.42851], f(x) = -5.1429
Iter 248: x = [1.7141, 0.42851], f(x) = -5.1429
Iter 249: x = [1.7142, 0.42852], f(x) = -5.1429
Iter 250: x = [1.7142, 0.42852], f(x) = -5.1429
Iter 251: x = [1.7142, 0.42852], f(x) = -5.1429
Iter 252: x = [1.7142, 0.42852], f(x) = -5.1429
Iter 253: x = [1.7142, 0.42852], f(x) = -5.1429
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Iter 375: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 376: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 377: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 378: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 379: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 380: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 381: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 382: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 383: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 384: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 385: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 386: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 387: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 388: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 389: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 390: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 391: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 392: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 393: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 394: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 395: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 396: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 397: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 398: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 399: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 400: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 401: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 402: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 403: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 404: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 405: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 406: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 407: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 408: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 409: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 410: x = [1.7143, 0.42857], f(x) = -5.1429
Iter 411: x = [1.7143, 0.42857], f(x) = -5.1429
```

当迭代了大约400次之后，我们发现梯度小于设定值1e-6，达到了我们的预期要求，输出f(x),这个值就是我们要求的优化值。

四．算法分析

最速下降法，顾名思义，就是给出一个起始点，求出目前点的梯度，通过不断迭代取得最优解，这里有两种终止条件，第一种是梯度绝对值已经小于设定的一个很小的值，相当于变化率很低，导数趋近于0；第二种就是迭代次数达到一个较大的次数，经过很多次迭代，最小值也不会改变，这就是我们要求解的优化问题。

五．心得体会

这道题和机器学习中的SGD很相似，有点类似于SGD的手动实现，其中步长不宜设置的过大，否则可能会导致偏离最优解，同时也不能设置过小，否则要迭代很多次才能达到目的，增加了问题的计算难度，跳出迭代有两种方式，一种是通过迭代次数，一种是通过梯度的比较（绝对值小于一个很小的数字），利用while循环进行实现。迭代时需要引入Matlab当中的库函数进行求解。