实验七 机翼断面下轮廓线的数值分析

实验目的

1. 加深对各种插值算法的理解
2. 熟悉使用不同类型的插值函数
3. 编程实现对机翼断面下轮廓线的插值仿真和数值分析

实验环境

1. 计算机
2. MATLAB 集成环境

实验内容与代码

已知某机翼断面下轮廓线上的部分数据，如表所示

$$\begin{bmatrix} \begin{bmatrix} x: \\ y: \end{bmatrix} & \begin{bmatrix} 0 & 3 & 5 & 7 & 9 & 11 & 12 & 13 & 14 & 15 \\ 0 & 1.2 & 1.7 & 2.0 & 2.1 & 2.0 & 1.8 & 1.2 & 1.4 & 1.6 \end{bmatrix} \end{bmatrix}$$

1. 试设计出具有一定光滑度的机翼下轮廓线，并画出图形
2. 以表的形式给出 x 每增加 0.5 时的 y 值
3. 分别用拉格朗日插值，牛顿插值，三次样条插值对上述数据点进行拟合

```
clc;clear;
x = [0 3 5 7 9 11 12 13 14 15]
```

```
x = 1×10
     0     3     5     7     9    11    12    13    14    15
```

```
y = [0 1.2 1.7 2.0 2.1 2.0 1.8 1.2 1.4 1.6]
```

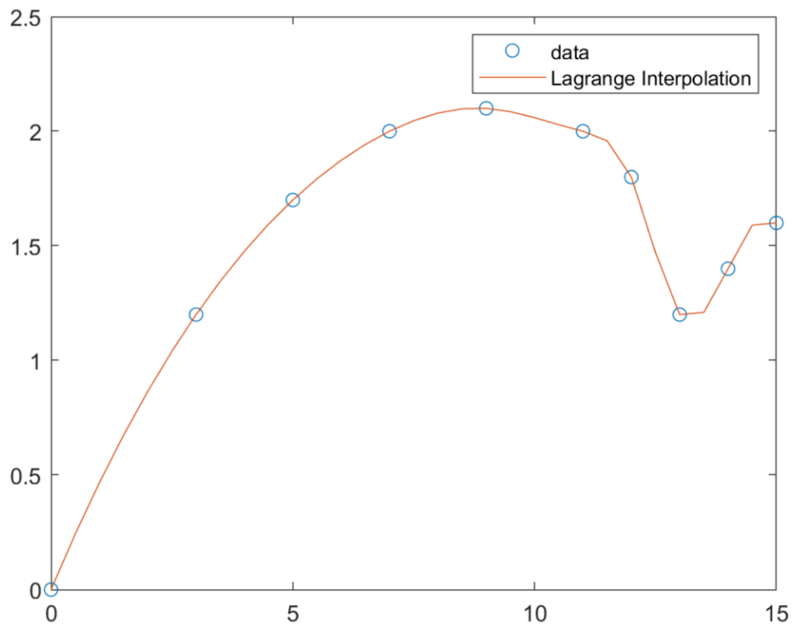
```
y = 1×10
         0    1.2000    1.7000    2.0000    2.1000    2.0000    1.8000 ⋯
```

```
xi = 0:0.5:15
```

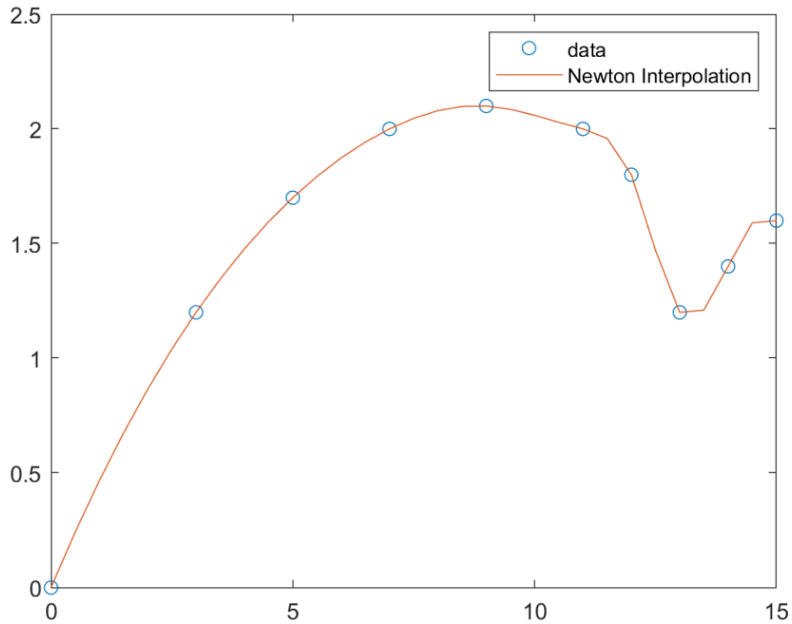
```
xi = 1×31
         0    0.5000    1.0000    1.5000    2.0000    2.5000    3.0000 ⋯
```

```
y1 = zeros(1, 31);
y2 = zeros(1, 31);

for i = 1:31
    y1(i) = lagrangeInterpolation(x, y, xi(i));
```

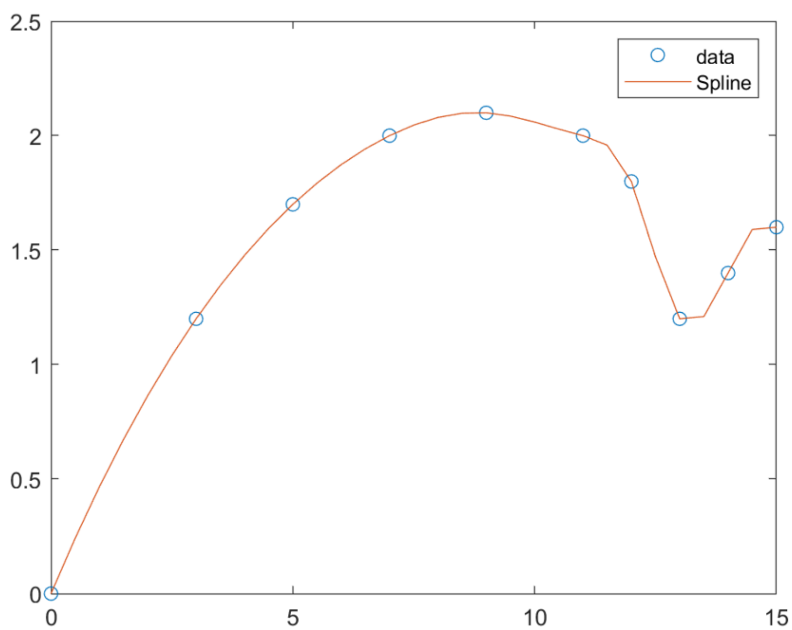
```
end

for i = 1:31
    y2(i) = newtonInterpolation(x, y, xi(i));
end

y3 = mySpline(x, y, xi);
plot(x, y, 'o', xi, y1, '-')
legend({'data', 'Lagrange Interpolation'})
```




```
plot(x, y, 'o', xi, y2, '-')
legend({'data', 'Newton Interpolation'})
```




```
plot(x, y, 'o', xi, y3, '-')
legend({'data', 'Spline'})
```



此实时脚本中使用的函数:

```
%{
    Solve f(point) using the methods of Lagrange Interpolation

    @Title: lagrangeInterpolation
    @param x double 1d array, corresponding to the x-lable of knowing points
    in the function's plots
    @param y double 1d array, corresponding to the y-lable o knowing points
    in the function's plots
    @param point double the x-lable of the point you want to solve
    @return double
%}
function res = lagrangeInterpolation(x, y, point)
    res = 0;
    n = length(x);

    for i=1:n
      xp = x([1:i-1 i+1:n]);
      res = res + y(i)*prod((point-xp)/(x(i)-xp));
    end
end

%{
    Solve f(point) using the methods of Newton Interpolation

    @Title: newtonInterpolation
    @param x double 1d array, corresponding to the x-lable of knowing points
    in the function's plots
    @param y double 1d array, corresponding to the y-lable o knowing points
    in the function's plots
    @param point double the x-lable of the point you want to solve
    @return double
%}
function res = newtonInterpolation(x, y, point)
    n = length(x);
    f = zeros(n,n);

    % Assign values to the first column of the difference quotient table
    for k = 1:n
        f(k) = y(k);
    end
    % Solve the difference quotient table
    for i = 2:n       % The difference quotient table starts from order 0; but
the matrix is stored from dimension 1
        for k = i:n
```

```
            f(k,i) = (f(k,i-1)-f(k-1,i-1))/(x(k)-x(k+1-i));
        end
    end

    % Solve the Newton Interpolation Formular
    p=0;

    for k=2:n
        t=1;
        for j=1:k-1
            t=t*(point-x(j));
        end
        p=f(k,k)*t+p;
    end
    p = f(1,1) + p;

    res = p;
end

function output = mySpline(x,y,xq)
    %SPLINE Cubic spline data interpolation.
    %   YQ = MYSPLINE(X,Y,XQ) performs cubic spline interpolation using the
    %   values Y at sample points X to find interpolated values YQ at the query
    %   points XQ.
    %       - X must be a vector.
    %       - If Y is a vector, Y(j) is the value at X(j).
    %       - If Y is a matrix or n-D array, Y(:,...,:,j) is the value at X(j).
    %
    %   SPLINE chooses slopes at X(j) such that YQ has a continuous second
    %   derivative. Thus, SPLINE produces smooth results.
    %
    %   Ordinarily, SPLINE uses not-a-knot conditions for the end slopes at
    %   X(1) and X(end). However, if Y contains two more values than X has
    %   entries, then the first and last value in Y are used as the end slopes.
    %
    %   PP = SPLINE(X,Y) returns the piecewise polynomial form PP of the
    %   interpolant. You can use PP as an input to PPVAL or UNMKPP.
    %
    %   Example: Interpolate a sine-like curve over a finer mesh
    %
    %       x = 0:10;
    %       y = sin(x);
    %       xq = 0:.25:10;
    %       yq = mySpline(x,y,xq);
    %       figure
    %       plot(x,y,'o',xq,yq)
```

```
    %
    %   Example: Perform spline interpolation with prescribed end slopes.
    %            Set the slopes to zero at the end points of the interpolant.
    %
    %       x = -4:4;
    %       y = [0 .15 1.12 2.36 2.36 1.46 .49 .06 0];
    %       cs = mySpline(x,[0 y 0]);
    %       xq = linspace(-4,4,101);
    %       figure
    %       plot(x,y,'o',xq,ppval(cs,xq));

    % Check and adjust input data
    [x,y,sizey,endslopes] = chckxywp(x,y);
    n = length(x);
    yd = prod(sizey);

    % Generate the cubic spline interpolant in ppform
    dd = ones(yd,1);
    dx = diff(x);
    divdif = diff(y,[],2)./dx(dd,:);
    if n == 2
        if isempty(endslopes)
            % the interpolant is a straight line
            pp = mkpp(x,[divdif y(:,1)],sizey);
        else
            % the interpolant is the cubic Hermite polynomial
            pp = pwch(x,y,endslopes,dx,divdif);
            pp.dim = sizey;
        end
    elseif n == 3 && isempty(endslopes)
        % the interpolant is a parabola
        y(:,2:3) = divdif;
        y(:,3) = diff(divdif')'/(x(3)-x(1));
        y(:,2) = y(:,2)-y(:,3)*dx(1);
        pp = mkpp(x([1,3]),y(:,[3 2 1]),sizey);
    else
        % set up the sparse, tridiagonal, linear system b = ?*c for the slopes
        b = zeros(yd,n);
        b(:,2:n-1) = 3*(dx(dd,2:n-1).*divdif(:,1:n-2)+dx(dd,1:n-
2).*divdif(:,2:n-1));
        if isempty(endslopes)
            x31 = x(3)-x(1);
            xn = x(n)-x(n-2);
            b(:,1) = ((dx(1)+2*x31)*dx(2)*divdif(:,1)+dx(1)^2*divdif(:,2))/x31;
            b(:,n) = (dx(n-1)^2*divdif(:,n-2)+(2*xn+dx(n-1))*dx(n-
2)*divdif(:,n-1))/xn;
```

```
        else
            x31 = 0;
            xn = 0;
            b(:,[1 n]) = dx(dd,[2 n-2]).*endslopes;
        end
        dxt = dx(:);
        c = spdiags([ [x31;dxt(1:n-2);0] ...
            [dxt(2);2*(dxt(2:n-1)+dxt(1:n-2));dxt(n-2)] ...
            [0;dxt(2:n-1);xn] ],[-1 0 1],n,n);

        % sparse linear equation solution for the slopes
        mmdflag = spparms('autommd');
        spparms('autommd',0);
        s = b/c;
        spparms('autommd',mmdflag);

        % construct piecewise cubic Hermite interpolant
        % to values and computed slopes
        pp = pwch(x,y,s,dx,divdif);
        pp.dim = sizey;
    end

    if nargin == 2
        output = pp;
    else
        output = ppval(pp,xq);
    end
end
```

实验小结

通过此次实验，加深了对各种插值算法的理解，熟悉使用了不同类型的插值函数，并编程实现对机翼断面下轮廓线的插值仿真和数值分析