Application of Matlab in Mathematical Analysis (Multiple Integral)

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As a basic course of mathematics, mathematical analysis is extremely important, although it is based on the name. Especially, the calculus plate in the book is the most important.   For most of the students who have just come to college, especially those who major in mathematics for compulsory mathematical analysis, although high school has contacts, it is in the final analysis the derivation and integration of some simple functions. The real learning of calculus is only started after entering college. Compared with high school mathematics learning content, mathematical analysis of this book is undoubtedly more abstract and in-depth.   For the study of multiple integrals, many times there may be a lot of multiple integrals of the function image can not be stroked out, this time to use some tools, such as Matlab, Matlab is a very powerful mathematical software, one of its functions is to analyze the data, and data visualization, that is, for a multiple integral we can type the corresponding code to get the function image of the integral so that we can get some useful information.   The following examples will show the application of Matlab in multiple integrals.

1. Application of Matlab in Double Integral

Example 1 : Calculation $I = \iint\limits_{D} xy\,d\sigma$ **, where D is a straight line y = 2, x = 5   and the closed region surrounded by y = x.**

(1) Drawing the figure of integral region D.

```
close all;clear all
x=0:0.1:6;
y1=x;                      %Straight line y=x
y2=ones(size(x))*2;        %Straight line y=2
x1=ones(size(x))*5;        %Straight line x=5
plot(x,y1,x,y2,x1,x)       %Draw the 3 boundaries of the Dhold on
x=2:0.1:5;
fill([x,fliplr(x)],[ones(size(x))*2,fliplr(x)],'r') %Draw the fill diagram of the D
xlabel('x');ylabel('y')
text(1.7,1.3,'D');text(1.4,1.6,'y=x')%Add text annotations
```
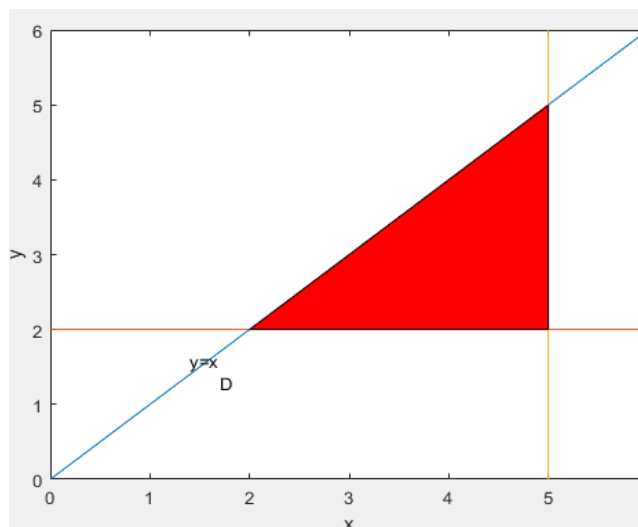

(2) Nested use function int to calculate this integral. The integral region is regarded as an X-type region, namely

D : $2 \le y \le x$, $2 \le x \le 3$

```
syms x y
```

f=x*y;   %Define the product function format long

x1=2;x2=3;y1=2;y2=x; %Determine the integral region

I=int(int(f,y,y1,y2),x,x1,x2) %The symbolic solution of the binary integrals is calculated

I=double(I)   %Convert to numeric

I = 25/8

I = 3.125000000000000

Example 2 : Calculation $\mathbf{I = \iint_D \dfrac{x^2}{y^2} \, d\sigma}$, **where D is a straight line x = 3, y = x   and the closed region surrounded by curve xy = 2.**

(1) Calculate the intersection point of D boundary curve in integral region.

clear all

syms x y

f1=x-3;f2=y-x;f3=2-x*y;

[x1,y1]=solve(f1,f2);

[x2,y2]=solve(f1,f3);;

[x3,y3]=solve(f2,f3);

d1=[x1,y1]

d2=[x2,y2]

d3=[x3,y3]

d1 = [3, 3]

d2 = [3, 2/3]

d3 = [-2^(1/2), -2^(1/2)] [2^(1/2), 2^(1/2)]

(2) Drawing the integral area figure.

close all

y0=-1:0.01:4;x0=3*ones(size(y));

plot(x0,y0);

hold on

ezplot('x');ezplot('2/x')

x=2^(1/2):0.001:3;

fill([x,3],[2./x,3],'g')

text(1.2,1.4,'y=x');text(1.5,0.5,'xy=2');text(2.02,1.3,'x=3')

text(2.05,2,'(3,3)');text(0.8,1,'(2^(1/2), 2^(1/2))');text(2.05,0.6,'(3,2/3)')

axis([0,3,0,3])
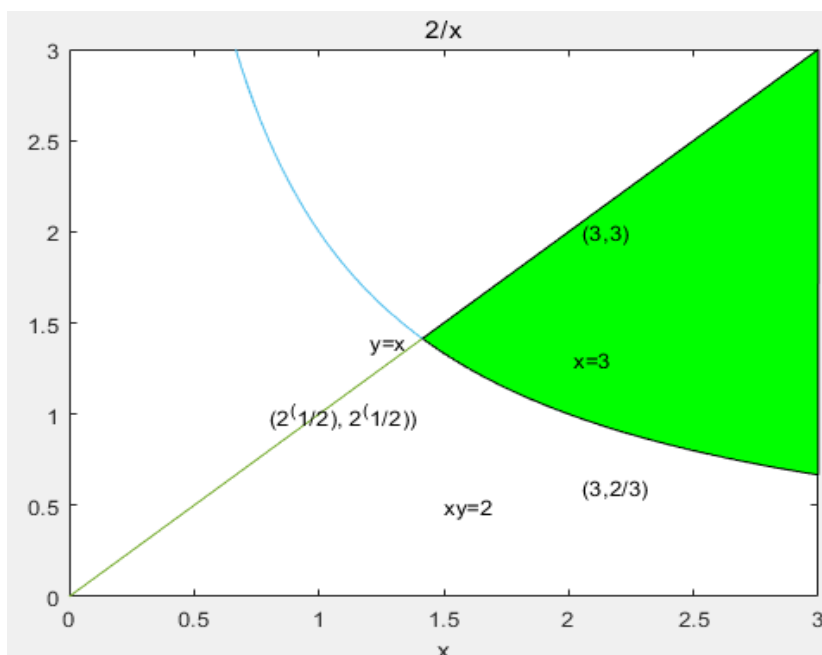
(3) Transform the double integral into the double integral.

If D is X type, then D : $1/x \leq y \leq x$, $1 \leq x \leq 2$.

If D is Y-type, then D = D1 ∪ D2, where

D1 : $2/y \leq x \leq 3, 1 \leq y \leq 2$,

D2 : $y \leq x \leq 3, 2 \leq y \leq 3$.

```
syms x y
f=x^2/y^2;
c=1/x;d=x;a=1;b=2;          %D is the type x region
Iyx=int(int(f,y,c,d),x,a,b)  %quadratic integration of y after x
a1=2/y;b1=3;c1=1;d1=2;  %D is the type y region
a2=y;b2=3;c2=2;d2=3;
Ixy=int(int(f,x,a1,b1),y,c1,d1)+int(int(f,x,a2,b2),y,c2,d2) %quadratic integration of x after y
Iyx = 9/4
Ixy = 109/24
```

Example 3: Calculation $I = \iint\limits_{|x|+|y|\leq 2} (|x| + |y|)dxdy$.

(1) Drawing the figure of integral region D.

```
clear all.   close all
clear all;close all
x1=linspace(0,2);x2=linspace(-2,0);
y1=2-x1;y4=x1-2;y2=2+x2;y3=-2-x2;
plot(x1,y1,x1,y4,x2,y2,x2,y3)       %Draw the various boundary lines of the D
hold on
fill([2,0,0,2],[0,2,0,0],'r')          %Draw a fill plot within the first quadrant
text(0.3,0.3,'D_1')
axis equal
grid on
```
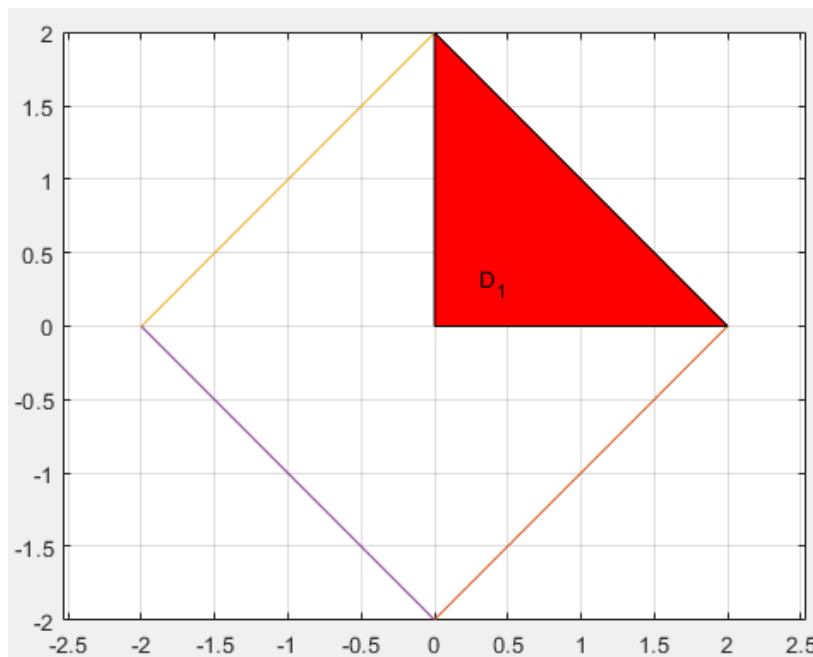

(2) Using parity to calculate the double integral.

Since the integral region D is axisymmetric with respect to x axis and y axis, and the integrand function is even with respect to variables x and y, so

$$I = \iint\limits_{|x|+|y|\leq 2} (|x| + |y|)dxdy = 4\iint\limits_{D1} (x + y)\ dxdy$$

```
syms x y
f=x+y;
I=4*int(int(f,y,0,2-x),x,0,2)
I = 32/3
```

2. Application of Matlab in triple integral

Example 4 : Draw triple integra $I = \iiint\limits_{\Omega} x\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$ **, where Ω is a closed region figure enclosed by three coordinate**

planes and plane 3x + 2y + z = 1.

```
clear all;close all
fill3([1/3 0 0],[0 1/2 0],[0 0 1],'g')
hold on
fill3([1/3 0 0],[0 1/2 0],[0 0 0],'k')
fill3([0 0 0],[0 1/2 0],[0 0 1],'r')
fill3([1/33 0 0],[0 0 0],[0 0 1],'b')
grid on
alpha(0.5)
view(-152,14)
xlabel('x axis');ylabel('y axis');zlabel('z axis')
```
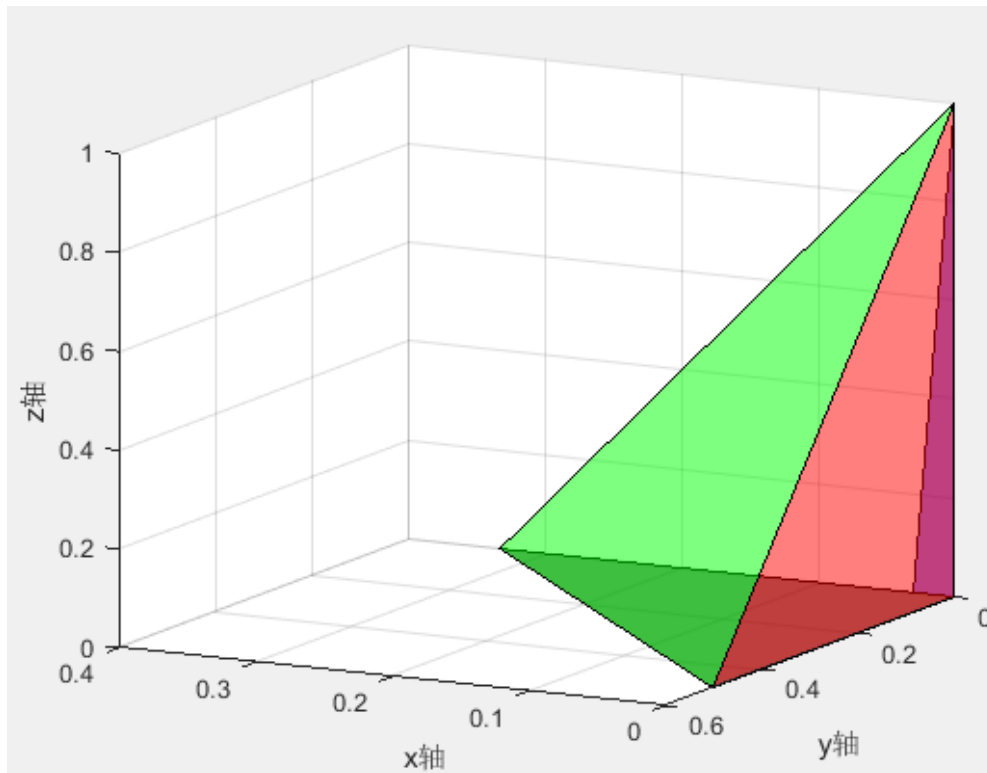

Example 5 : Draw $I = \iiint\limits_{\Omega} xyz\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$ **, where Ω is a closed region enclosed by spherical** $x^2 + y^2 + z^2 = 4$ **and**

three coordinate surfaces in the first quadrant.

```
clear all;close all
[x,y,z]=sphere(40);           %Painting unit ball face
z(x<0|y<0|z<0)=NaN;                %Shield the parts of x<0, y<0, and z<0
surf(2*x,2*y,2*z)
title(' integral domain；domain of integration ')
xlabel('x');ylabel('y')
axis equal
view(-25,-32)          %Set the perspective
```

pause   %   stop；halt；pause；be at a standstill；break down

view(0,90)   %Projection of the integral region on the xoy plane

title('Projection of the integral region on the xoy plane')

From the above images, it is not difficult to see the powerful function of Matlab, especially its powerful mathematical operation, data processing and image processing ability. In the study of mathematical analysis, Matlab can not only help us to learn in terms of integral, but also strengthen our understanding of the corresponding problems and improve our learning efficiency with its powerful function on many issues such as series, function limit, derivation, linear and non-linear equations, and differential equation solution. It has to be said that Matlab is absolutely a powerful tool for mathematics learning.   At the same time, the programming language of Matlab in solving problems is not complicated. Instead, it is more in line with the general idea of our daily proof of solving problems, so it is also friendly for beginners.   In summary, Matlab is a simple and powerful software. For mathematical analysis, Matlab can absolutely become a powerful help for us to learn mathematical analysis with its powerful functions.

References

[1] 《Study on the Solution of a Mathematical Analysis Exercise after Class》 ' Wang Chengqiang Chengdu Normal University School of Mathematics album : basic science. Social Science II : Mathematics.   Higher education classification number: O172.2-4. G642

[2] 《Analysis on Calculation Method of Triple Integral》'Zhao Xiaoyan Li Jicheng Xi' an Jiaotong University School of Mathematics and Statistics album : Basic Science. Social Science II: Mathematics. Higher education classification number : G642. O172.1-4

[3] 《Application of Matlab in Higher Mathematics Teaching》 'Wang Zhuyuan Wang Juan Anhui Sanlian College Foundation album: Social Science II. Basic science topic : mathematics. Higher education classification number: G642. O13 - 4