

Cálculo 3 - 2024.2

Aula 22: o teste da segunda derivada

Eduardo Ochs - RCN/PURO/UFF

<http://anggtwu.net/2024.2-C3.html>

Links

```
(find-es "maxima" "2024.2-C3-eigenvectors")
```

```
http://anggtwu.net/e/maxima.e.html#2024.2-C3-eigenvectors
```

```

(%i1) [[r1,r2], k, [zneg,zpos]] : [[-2,-1], 10, [-5,10]];
(%o1)
      [[-2,-1],10,[-5,10]]

(%i2) [xmin,ymin,ymax,ymax] : [-5,-5, 5,5];
(%o2)
      [-5,-5,5,5]

(%i3)
f : k * (x - r1) * (x - r2);
(%o3)
      10 (x+1) (x+2)

(%i4) F : k * (x - y+r1) * (x - y+r2);
(%o4)
      10 (y+x) (2y+x)

(%i5) f : expand(f);
(%o5)
      10x^2 + 30x + 20

(%i6) F : expand(F);
(%o6)
      20y^2 + 30xy + 10x^2

(%i7) define(f(x), f);
(%o7)
      f(x) := 10x^2 + 30x + 20

(%i8) define(F(x,y), F);
(%o8)
      F(x,y) := 20y^2 + 30xy + 10x^2

(%i9) solve(f(x)=0, x);
(%o9)
      [x = -2, x = -1]

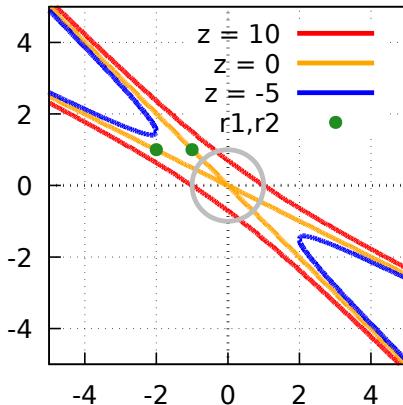
(%i10) [r1,r2];
(%o10)
      [-2,-1]

```

```

(%i11) drawlevels() :=
      [myimpl(F=zpos, lc(red), lk(z=zpos)),
      myimpl(F=0, lc(orange), lk(z=0)),
      myimpl(F=zneg, lc(blue), lk(z=zneg))];
(%i12) drawroots() := pts([[r1,1], [r2,1]], pc(forest_green), pk("r1,r2"), myps(3));
(%i13) drawunitcircle() := mypara([cos(th),sin(th)], th,0,2*%pi, lc(gray));
(%i14) myqdraw(xyrange(), drawlevels(), drawroots(), drawunitcircle());
(%o14)

```



```
(%i15) myexth(fth,[opts]) :=
      myapply_fl('ex1, fth, th,0,2*pi, opts)$
```

```
(%i16) F;
(%o16)
```

$$20y^2 + 30xy + 10x^2$$

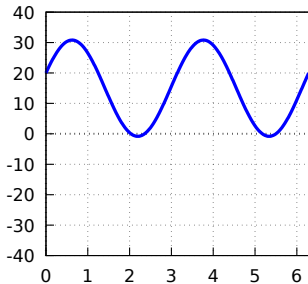
```
(%i17) z1 : subst([y=cos(th), x=sin(th)], F);
```

```
(%o17)
```

$$10(\sin th)^2 + 30 \cos th \sin th + 20(\cos th)^2$$

```
(%i18) block(
      [xmin,xmax,ymin,ymax],
      [xmin,xmax,ymin,ymax] : [0,2*pi, -40,40],
      myqdrawp(xyrange0(), myexth(z1))
    );
```

```
(%o18)
```



```
(%i19) F_x : diff(F,x);
```

```
(%o19)
```

$$30y + 20x$$

```
(%i20) F_y : diff(F,y);
```

```
(%o20)
```

$$40y + 30x$$

```
(%i21) F_xx : diff(F,x,2);
```

```
(%o21)
```

$$20$$

```
(%i22) F_xy : diff(F,x,1,y,1);
```

```
(%o22)
```

$$30$$

```
(%i23) F_yy : diff(F,y,2);
```

```
(%o23)
```

$$40$$

```
(%i24)
```

```
M : matrix([F_xx, F_xy],
           [F_xy, F_yy]);
```

```
(%o24)
```

$$\begin{pmatrix} 20 & 30 \\ 30 & 40 \end{pmatrix}$$

```
(%i25) determinant(M);
```

```
(%o25)
```

$$-100$$

```

(%i26) [vals,vectors] := eigenvectors(M)$
(%i27) [lambda1,lambda2] := vals[1];
(%o27)

$$\begin{bmatrix} 30 - 10^{\frac{1}{2}}, 10^{\frac{1}{2}} + 30 \end{bmatrix}$$

(%i28) [v1,v2] := [vectors[1][1], vectors[2][1]];
(%o28)

$$\left[ \left[ 1, -\left(\frac{\sqrt{10}-1}{3}\right) \right], \left[ 1, \frac{\sqrt{10}+1}{3} \right] \right]$$

(%i29) fpprintprec;
(%o29)
0
(%i30) fpprintprec : 3;
(%o30)
3
(%i31) float([lambda1,v1]);
(%o31)
[-1.62, [1.0, -0.721]]
(%i32) float([lambda2,v2]);
(%o32)
[61.6, [1.0, 1.39]]
(%i33)
lambda1 * lambda2;
(%o33)
 $(30 - 10^{\frac{1}{2}}) (10^{\frac{1}{2}} + 30)$ 
(%i34) expand(lambda1 * lambda2);
(%o34)
-100
(%i35) [M, determinant(M)];
(%o35)

$$\left[ \begin{pmatrix} 20 & 30 \\ 30 & 40 \end{pmatrix}, -100 \right]$$

(%i36) myvector(v,[opts]) := myapply_f1('vector, [0,0], v, hi(0.2), opts)$
(%i37) draweigenvectors() :=
[myvector(v1, lc(gray)),
myvector(v2, lc(gray))}$
(%i38)
myqdrawp(xyrange(), drawlevels(), drawroots(),
drawunitcircle(), draweigenvectors());
(%o38)

```

