

## Implicit Functions

OR := ORIGIN

$$f(x, y) := x^4 + y^4 + 0.4 \cdot \sin(7 \cdot x) + 0.3 \cdot \sin(4 \cdot \pi \cdot y) - 1$$

$$x_{min} := -1.2 \quad x_{max} := 1.2 \quad y_{min} := -1.2 \quad y_{max} := 1.2$$

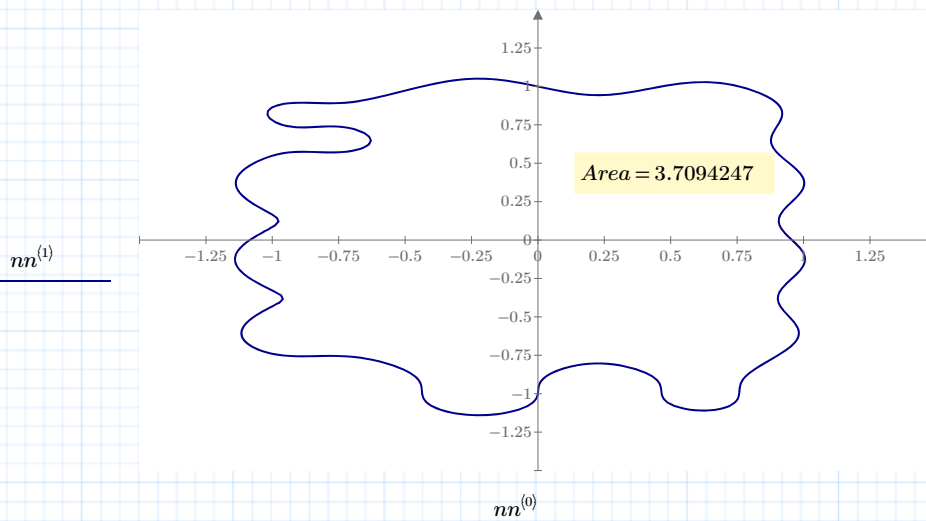
$$coords := \begin{bmatrix} x_{max} & y_{max} \\ x_{min} & y_{min} \end{bmatrix} \quad [nx \quad ny] := [100 \quad 100] \quad grids := [nx \quad ny]^T$$

$$H := \text{implicitplot2d}(f, coords, grids)$$

```
H2 := "Get unique points"
k ← OR
for i ∈ OR..last(H(0))
  if mod(i, 3) = 0
    R3k ← Hi
    k ← k + 1
return R3
```

```
nn := "Nearest neighbor sorting"
xyd ← H2
xyd(OR+2) ← 0
for i ∈ OR+1..last(H2(OR))
  final ← submatrix(xyd, OR, i-1, OR, OR+2)
  H ← submatrix(xyd, i, last(H2(OR)), OR, OR+2)
  for j ∈ OR..last(H2(OR)) - i
    Hj, OR+2 ← √((Hj, OR} - finali-1, OR})2 + (Hj, OR+1} - finali-1, OR+1})2)
  H ← csort(H, OR+2)
  xyd ← stack(final, H)
xyd ← stack(xyd, xyd(OR))
return xyd
```

```
Area := "Trapezoidal rule"
x ← nn(OR)
y ← nn(OR+1)
A ← 0
for i ∈ OR..last(x) - 1
  A ← A + (yi+1} + yi}) / 2 * (xi+1} - xi})
return A
```



## Add a B-Spline

$$x := nn^{(OR)} \quad y := nn^{(OR+1)}$$

$$t := 0 .. \text{last}(x) = \begin{bmatrix} 0 \\ 1 \\ \vdots \end{bmatrix}$$

$$n := 3$$

$$N_{div} := 500$$

$$\text{range} := \min(t), \min(t) + \frac{\max(t) - \min(t)}{N_{div}} .. \max(t) = \begin{bmatrix} 0 \\ \vdots \end{bmatrix}$$

Fit x vs t

$$bx := \text{Spline2}(t, x, n)$$

$$\text{spline1} := \text{Binterp}(\text{range}, bx)^T$$

$$f_{cubicx}(a) := \text{interp}(\text{cspline}(\text{range}, \text{spline1}^{(OR)}), \text{range}, \text{spline1}^{(OR)}, a)$$

Fit y vs t

$$by := \text{Spline2}(t, y, n)$$

$$\text{spline2} := \text{Binterp}(\text{range}, by)^T$$

$$f_{cubicy}(a) := \text{interp}(\text{cspline}(\text{range}, \text{spline2}^{(OR)}), \text{range}, \text{spline2}^{(OR)}, a)$$

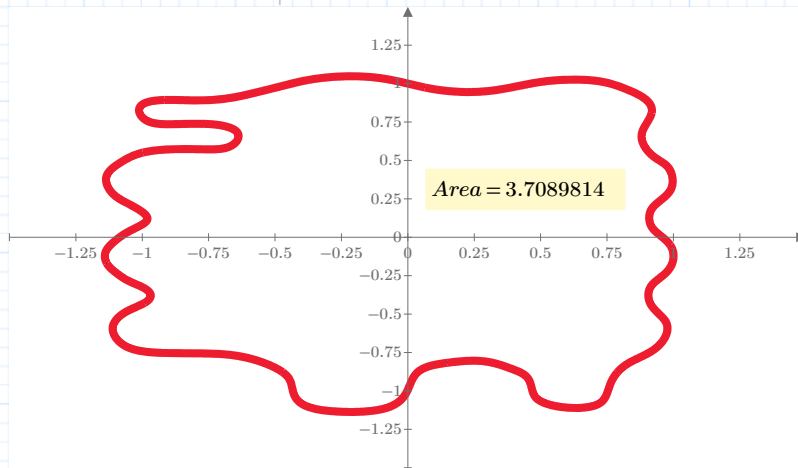
$$tt := 0, 0.1 .. 468 = \begin{bmatrix} 0 \\ \vdots \end{bmatrix}$$

$$x2 := f_{cubicx}(tt) \quad y2 := f_{cubicy}(tt) \quad \text{last}(tt) = 4.68 \cdot 10^3$$

```
Area := | "Trapezoidal rule"
        | x ← x2
        | y ← y2
        | A ← 0
        | for i ∈ OR .. last(x) - 1
        | | A ← A +  $\frac{y_{i+1} + y_i}{2} \cdot (x_{i+1} - x_i)$ 
        | | return A
```

$nn^{(1)}$

$y2$



$nn^{(0)}$

$x2$