

Limpa a memória e libera para que o texto dos warnings apareçam completos

```
close all; clc;
warning( 'off', 'all' );
```

### Transfer function instances

Declara instâncias da função triangular, trapezoidal, gaussiana e seus devidos intervalos.

```
interval          = [-1, 10];
triangleFunctions = {@(x) triangle(x,0,2,4),      @(x) triangle(x,3,5,7), ...
                    @(x) triangle(x,6,8,10)};
trapezoidalFuctions = {@(x) trapezoidal(x,-1,0,2,3), @(x) trapezoidal(x,2,4,5,7), ...
                      @(x) trapezoidal(x,7,8,9,10)};
gaussianFunctions  = {@(x)gaussian(x, 4, 1),      @(x)gaussian(x, 4, 2), ...
                      @(x)gaussian(x, 4, 3),      @(x)gaussian(x, 4, 4)};
```

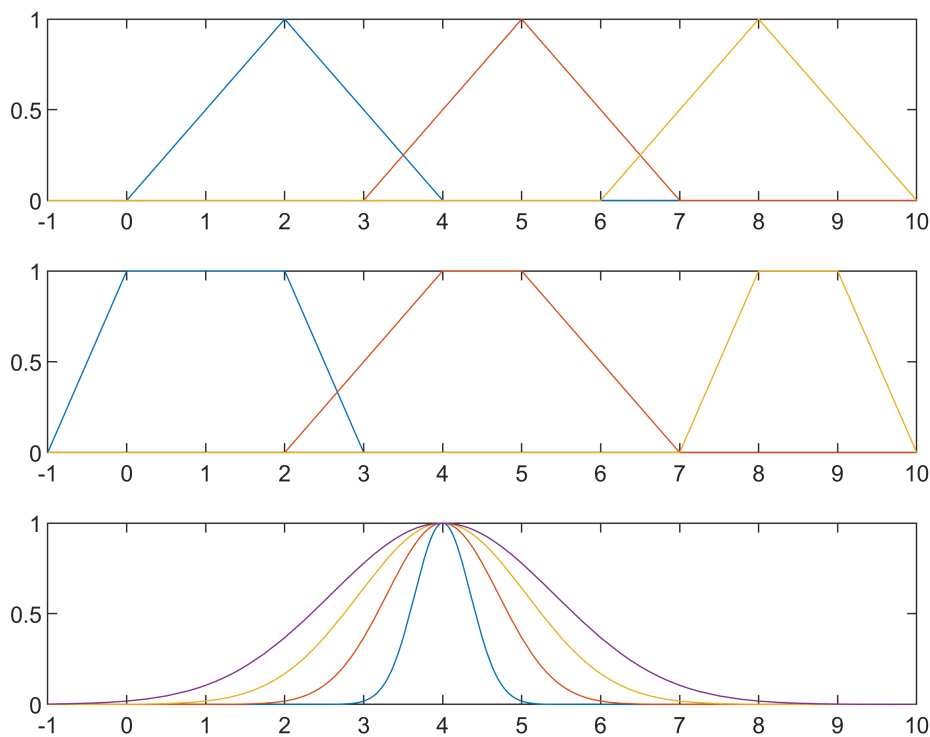
### Plot transfer functions

Realiza o plot das funções de transferência definidas anteriormente

```
figure(1);
subplot(3,1,1);
fplot(triangleFunctions{1}, interval); hold on;
fplot(triangleFunctions{2}, interval);
fplot(triangleFunctions{3}, interval); hold off;

subplot(3,1,2);
fplot(trapezoidalFuctions{1}, interval); hold on;
fplot(trapezoidalFuctions{2}, interval);
fplot(trapezoidalFuctions{3}, interval); hold off;

subplot(3,1,3);
fplot(gaussianFunctions{1}, interval); hold on;
fplot(gaussianFunctions{2}, interval);
fplot(gaussianFunctions{3}, interval);
fplot(gaussianFunctions{4}, interval); hold off;
```



## Plot Complement Functions

Realize the plot of last complement defined functions

```
figure(2);
subplot(4,3,1);
fplot(triangleFunctions{1}, interval); hold on;
fplot(triangleFunctions{2}, interval);
fplot(triangleFunctions{3}, interval); hold off;
title("Triangle Function")
subplot(4,3,2);
fplot(trapezoidalFuctions{1}, interval); hold on;
fplot(trapezoidalFuctions{2}, interval);
fplot(trapezoidalFuctions{3}, interval); hold off;
title("Trapezoidal Function")
subplot(4,3,3);
fplot(gaussianFunctions{1}, interval); hold on;
fplot(gaussianFunctions{2}, interval);
fplot(gaussianFunctions{3}, interval);
fplot(gaussianFunctions{4}, interval); hold off;
title("Gaussian Function")

subplot(4,3,4);
fplot(@(x) zedehComplement(x,triangleFunctions{1}), interval); hold on;
fplot(@(x) zedehComplement(x,triangleFunctions{2}), interval);
fplot(@(x) zedehComplement(x,triangleFunctions{3}), interval); hold off;
title("Triangle Zadeh");
```

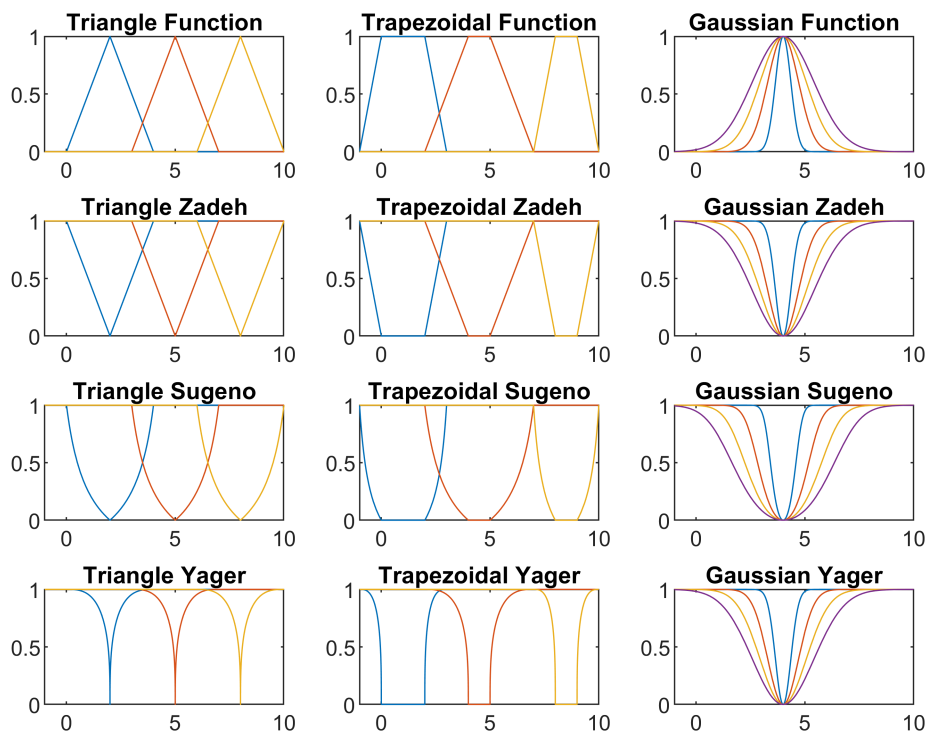
```

subplot(4,3,5);
fplot(@(x) zedehComplement(x, trapezoidalFuctions{1}), interval); hold on;
fplot(@(x) zedehComplement(x, trapezoidalFuctions{2}), interval);
fplot(@(x) zedehComplement(x, trapezoidalFuctions{3}), interval); hold off;
title("Trapezoidal Zedeh");
subplot(4,3,6);
fplot(@(x) zedehComplement(x, gaussianFunctions{1}), interval); hold on;
fplot(@(x) zedehComplement(x, gaussianFunctions{2}), interval);
fplot(@(x) zedehComplement(x, gaussianFunctions{3}), interval);
fplot(@(x) zedehComplement(x, gaussianFunctions{4}), interval); hold off;
title("Gaussian Zedeh");

subplot(4,3,7); s = 2;
fplot(@(x) sugenoComplement(x, s, triangleFunctions{1}), interval); hold on;
fplot(@(x) sugenoComplement(x, s, triangleFunctions{2}), interval);
fplot(@(x) sugenoComplement(x, s, triangleFunctions{3}), interval); hold off;
title("Triangle Sugeno");
subplot(4,3,8);
fplot(@(x) sugenoComplement(x, s, trapezoidalFuctions{1}), interval); hold on;
fplot(@(x) sugenoComplement(x, s, trapezoidalFuctions{2}), interval);
fplot(@(x) sugenoComplement(x, s, trapezoidalFuctions{3}), interval); hold off;
title("Trapezoidal Sugeno");
subplot(4,3,9);
fplot(@(x) sugenoComplement(x, s, gaussianFunctions{1}), interval); hold on;
fplot(@(x) sugenoComplement(x, s, gaussianFunctions{2}), interval);
fplot(@(x) sugenoComplement(x, s, gaussianFunctions{3}), interval);
fplot(@(x) sugenoComplement(x, s, gaussianFunctions{4}), interval); hold off;
title("Gaussian Sugeno");

subplot(4,3,10); w = 3;
fplot(@(x) yagerComplement(x, w, triangleFunctions{1}), interval); hold on;
fplot(@(x) yagerComplement(x, w, triangleFunctions{2}), interval);
fplot(@(x) yagerComplement(x, w, triangleFunctions{3}), interval); hold off;
title("Triangle Yager");
subplot(4,3,11); w = 3;
fplot(@(x) yagerComplement(x, w, trapezoidalFuctions{1}), interval); hold on;
fplot(@(x) yagerComplement(x, w, trapezoidalFuctions{2}), interval);
fplot(@(x) yagerComplement(x, w, trapezoidalFuctions{3}), interval); hold off;
title("Trapezoidal Yager");
subplot(4,3,12); w = 1;
fplot(@(x) yagerComplement(x, w, gaussianFunctions{1}), interval); hold on;
fplot(@(x) yagerComplement(x, w, gaussianFunctions{2}), interval);
fplot(@(x) yagerComplement(x, w, gaussianFunctions{3}), interval);
fplot(@(x) yagerComplement(x, w, gaussianFunctions{4}), interval); hold off;
title("Gaussian Yager");

```



## Plot Functions Intersect

```
figure(3);
subplot(4,3,1);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,2);    fplot(gaussianFunctions{4}, interval);
title("Gaussian Function 4")
subplot(4,3,3);    fplot(@(x) minIntersection(x, triangleFunctions{1}, gaussianFunctions{4}),
title("min Intersection")

subplot(4,3,4);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,5);    fplot(gaussianFunctions{4}, interval);
title("Gaussian Function 4")
subplot(4,3,6);    fplot(@(x) productIntersection(x, triangleFunctions{1}, gaussianFunctions{4}),
title("product Intersection")

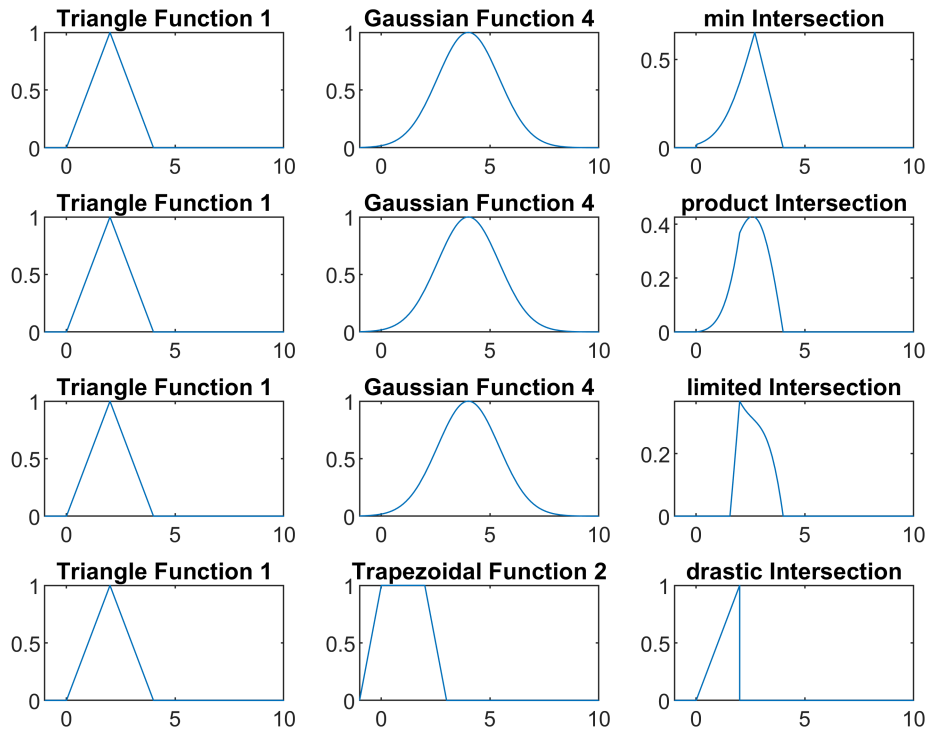
subplot(4,3,7);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,8);    fplot(gaussianFunctions{4}, interval);
title("Gaussian Function 4")
subplot(4,3,9);    fplot(@(x) limitedIntersection(x, triangleFunctions{1}, gaussianFunctions{4}),
title("limited Intersection")

subplot(4,3,10);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,11);    fplot(trapezoidalFuctions{1}, interval);
```

```

title("Trapezoidal Function 2")
subplot(4,3,12);    fplot(@(x) drasticIntersection(x, triangleFunctions{1}, trapezoidalFuction
title("drastic Intersection")

```



## Plot Union

```

figure(4);
subplot(4,3,1);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,2);    fplot(gaussianFunctions{4}, interval);
title("Gaussian Function 4")
subplot(4,3,3);    fplot(@(x) maxUnion(x, triangleFunctions{1}, ...
    gaussianFunctions{4}), interval);
title("max union")

subplot(4,3,4);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,5);    fplot(gaussianFunctions{4}, interval);
title("Gaussian Function 4")
subplot(4,3,6);    fplot(@(x) probUnion(x, triangleFunctions{1}, ...
    gaussianFunctions{4}), interval);
title("prob Union")

subplot(4,3,7);    fplot(triangleFunctions{1}, interval);
title("Triangle Function 1")
subplot(4,3,8);    fplot(gaussianFunctions{4}, interval);
title("Gaussian Function 4")
subplot(4,3,9);    fplot(@(x) limitedUnion(x, triangleFunctions{1}, ...

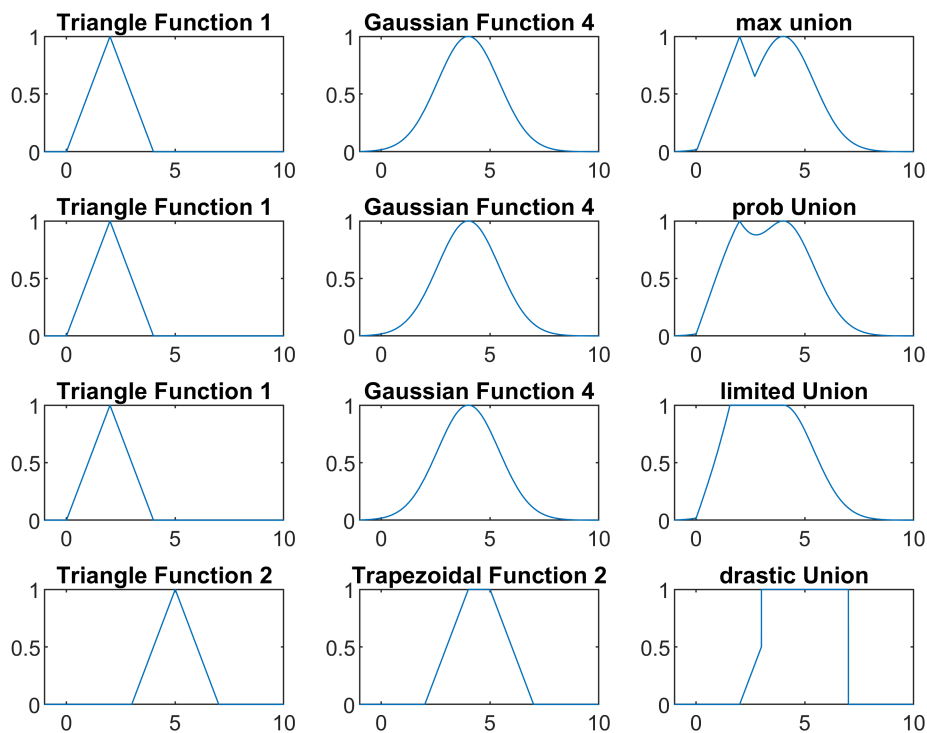
```

```

    gaussianFunctions{4}), interval);
title("limited Union")

subplot(4,3,10);    fplot(triangleFunctions{2}, interval);
title("Triangle Function 2")
subplot(4,3,11);    fplot(trapezoidalFuctions{2}, interval);
title("Trapezoidal Function 2")
subplot(4,3,12);    fplot(@(x) drasticUnion(x, triangleFunctions{2}, ...
    trapezoidalFuctions{2}), interval);
title("drastic Union")

```



## Funções de Pertinência

Definição da função triangular

```

function res = triangle(x,a,m,b)
res = max(min((x-a)/(m-a), (b-x)/(b-m)), 0);
end

```

Definição da função Trapezoidal

```

function res = trapezoidal(x,a,m,n,b)
a = min((x-a)./(m-a), (b-x)./(b-n));
res = max(min(a, 1), 0);
end

```

Definição da função Gaussiana

```
function res = gaussian(x, m, k)
k = k/2;
res = exp(-(x-m).^2)/(k^2));
end
```

### Funções de União (S - normas)

Zadeh - max

```
function res = maxUnion(x, func1, func2)
res = max(func1(x), func2(x));
end
```

Soma Probabilística

```
function res = probUnion(x, func1, func2)
res = func1(x) + func2(x) - func1(x).*func2(x);
end
```

Soma Limitada

```
function res = limitedUnion(x, func1, func2)
res = min(1, func1(x) + func2(x));
end
```

Soma Drástica

```
function res = drasticUnion(x, func1, func2)
if (func1(x) == 0)
res = func2(x);
elseif (func2(x) == 0)
res = func1(x);
else
res = 1;
end
end
```

### Funções de Intercessão (T - normas )

Zadeh - min

```
function res = minIntersection(x, func1, func2)
res = min(func1(x), func2(x));
end
```

Algebraic product

```
function res = productIntersection(x, func1, func2)
res = func1(x).*func2(x);
end
```

Limited difference

```
function res = limitedIntersection(x, func1, func2)
```

```

    res = max(0, func1(x) + func2(x) - 1);
end

```

Drastic product

```

function res = drasticIntersection(x, func1, func2)
    if (func1(x) == 1)
        res = func2(x);
    elseif (func2(x) == 1)
        res = func1(x);
    else
        res = 0;
    end
end

```

## Funções de Complemento

Zadeh - probabilistic complement

```

function res = zedehComplement(x, func)
    res = 1 - func(x);
end

```

Sugeno | s pertence (-1, infinito)

```

function res = sugenoComplement(x, s, func)
    if s >= -1; s = s; else; s = -1; end
    res = (1-func(x)) ./ (1+s*func(x));
end

```

Yager

```

function res = yagerComplement(x, w, func)
    res = (1-func(x).^w).^(1./w);
end

```