

Computación 1 - 2025

Gráficos en 2D y 3D

Necesidades

- Visualizar tendencias, patrones, frecuencias, trayectorias o cambios que son difíciles de encontrar en un conjunto de datos.
- ¡Una imagen vale más que mil palabras!
- Los gráficos ayudan a la toma de decisiones.

Ejemplo: Encontrar el máximo de un conjunto

Columns 1 through 10:

2.8175 10.1326 2.2346 16.0404 4.4026 1.9738 1.0462 1.0091 1.1983 3.9982

Columns 11 through 20:

4.0988 1.1173 2.9033 1.8290 3.0760 1.9099 1.7212 4.4390 4.1799 2.8604

Columns 21 through 30:

1.6685 1.6588 23.6487 3.1122 1.3537 2.8040 12.1043 1.1234 7.2549 2.5510

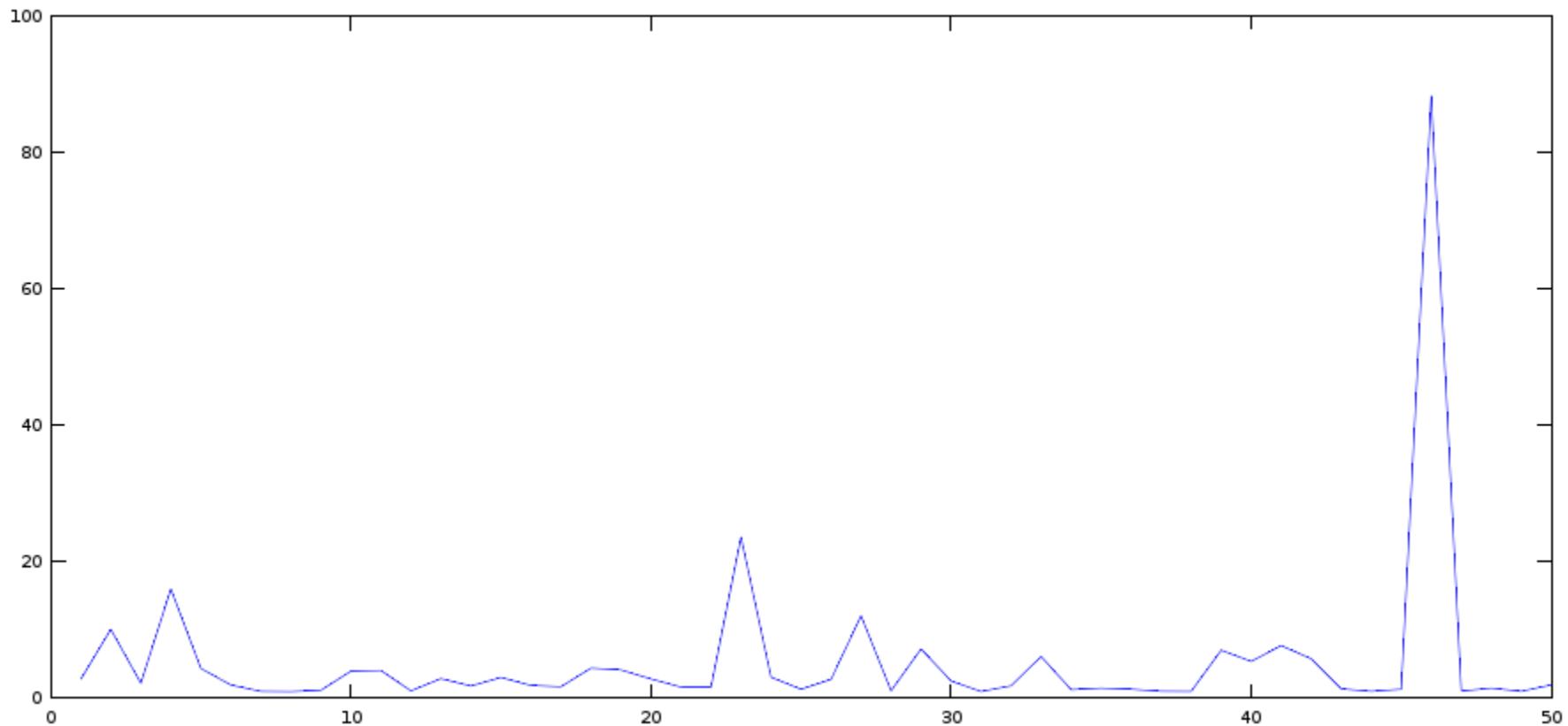
Columns 31 through 40:

1.0208 1.8573 6.1357 1.2936 1.5113 1.3588 1.0568 1.0353 7.0616 5.4359

Columns 41 through 50:

7.7418 5.8158 1.4088 1.0493 1.3506 88.2787 1.0783 1.5144 1.0504 1.9798

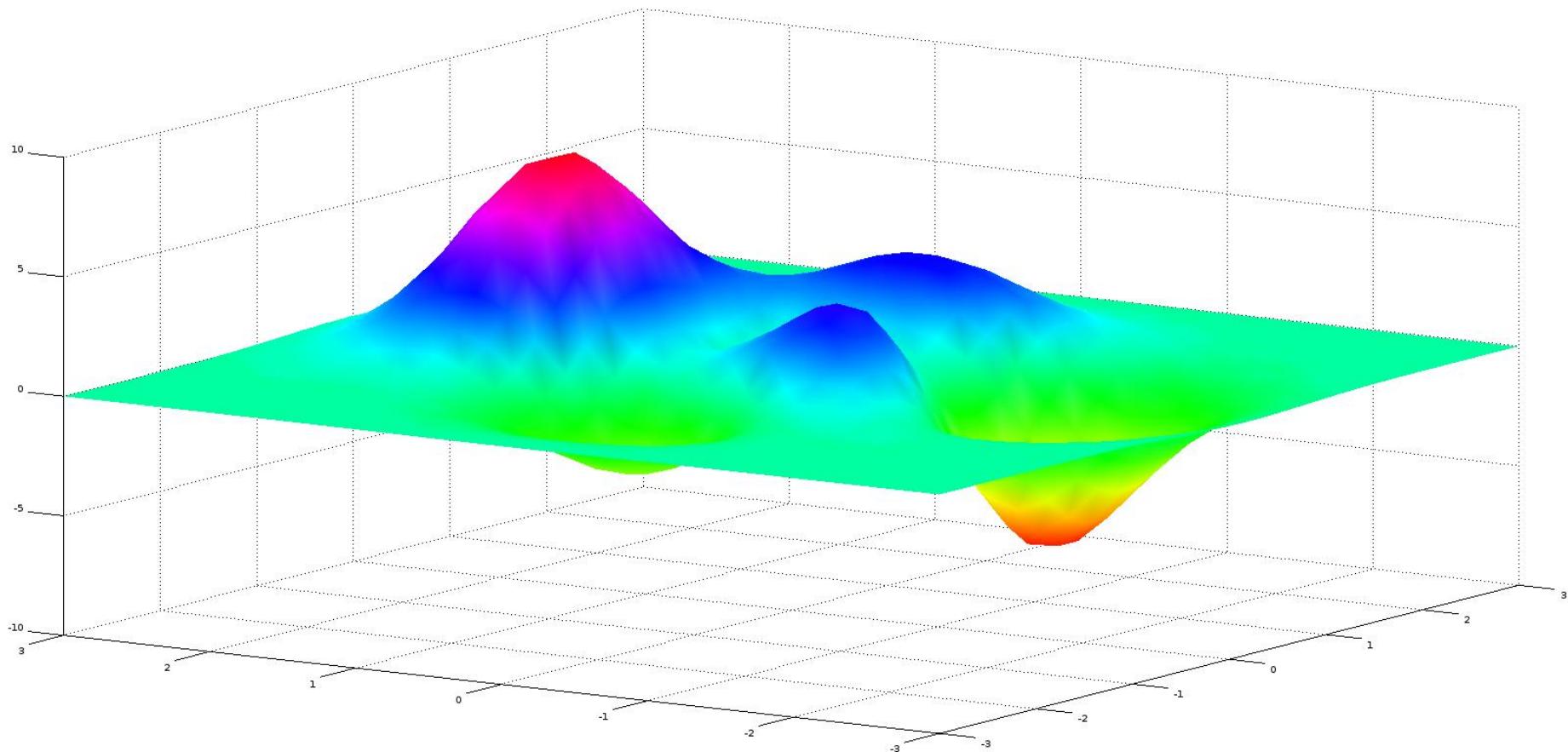
Ejemplo: Encontrar el máximo de un conjunto

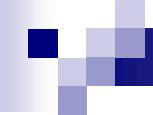


Ejemplo: comprender los valores de una matriz

6.6713e-001	1.8839e+000	4.7741e+000	1.0777e+001	2.1394e+001	3.6471e+001	5.0583e+001
1.3615e+000	3.8340e+000	9.6617e+000	2.1597e+001	4.2155e+001	6.9640e+001	9.0076e+001
2.5254e+000	7.1228e+000	1.7932e+001	3.9905e+001	7.7097e+001	1.2454e+002	1.5203e+002
4.2186e+000	1.2008e+001	3.0443e+001	6.8078e+001	1.3182e+002	2.1240e+002	2.5513e+002
6.2063e+000	1.8068e+001	4.6737e+001	1.0655e+002	2.1060e+002	3.4844e+002	4.3922e+002
7.5942e+000	2.3267e+001	6.2895e+001	1.4951e+002	3.0917e+002	5.4240e+002	7.5890e+002
6.3417e+000	2.2602e+001	6.8123e+001	1.7707e+002	3.9821e+002	7.6741e+002	1.2302e+003
-1.1225e+000	6.8887e+000	4.1208e+001	1.4570e+002	3.9997e+002	9.0680e+002	1.7199e+003
-1.9702e+001	-3.6995e+001	-4.9776e+001	-1.4926e+001	1.7475e+002	7.1218e+002	1.8363e+003
-5.4300e+001	-1.2273e+002	-2.3984e+002	-3.8692e+002	-4.5374e+002	-1.6297e+002	9.5564e+002
-1.0726e+002	-2.5761e+002	-5.4981e+002	-1.0249e+003	-1.6170e+003	-2.0097e+003	-1.5137e+003
-1.7555e+002	-4.3457e+002	-9.6566e+002	-1.9065e+003	-3.2925e+003	-4.8399e+003	-5.7083e+003
-2.4947e+002	-6.2846e+002	-1.4280e+003	-2.9054e+003	-5.2395e+003	-8.2460e+003	-1.1023e+004
-3.1455e+002	-8.0081e+002	-1.8439e+003	-3.8169e+003	-7.0483e+003	-1.1486e+004	-1.6241e+004
-3.5622e+002	-9.1279e+002	-2.1186e+003	-4.4305e+003	-8.2937e+003	-1.3777e+004	-2.0056e+004
-3.6521e+002	-9.3958e+002	-2.1915e+003	-4.6112e+003	-8.7022e+003	-1.4618e+004	-2.1628e+004
-3.4066e+002	-8.7864e+002	-2.0556e+003	-4.3417e+003	-8.2338e+003	-1.3923e+004	-2.0795e+004
-2.8977e+002	-7.4835e+002	-1.7535e+003	-3.7105e+003	-7.0529e+003	-1.1961e+004	-1.7935e+004
-2.2450e+002	-5.7955e+002	-1.3569e+003	-2.8679e+003	-5.4404e+003	-9.1957e+003	-1.3709e+004
-1.5754e+002	-4.0507e+002	-9.4320e+002	-1.9778e+003	-3.7084e+003	-6.1557e+003	-8.9070e+003
-9.8907e+001	-2.5140e+002	-5.7608e+002	-1.1802e+003	-2.1360e+003	-3.3464e+003	-4.3581e+003
-5.4262e+001	-1.3408e+002	-2.9484e+002	-5.6663e+002	-9.1945e+002	-1.1565e+003	-7.7683e+002
-2.4739e+001	-5.6841e+001	-1.1076e+002	-1.6815e+002	-1.3785e+002	2.2964e+002	1.4433e+003
-8.1050e+000	-1.4173e+001	-1.1749e+001	3.8443e+001	2.4657e+002	8.5999e+002	2.3362e+003
-5.1250e-001	4.1789e+000	2.7246e+001	1.0911e+002	3.4831e+002	9.4937e+002	2.2727e+003
1.8783e+000	8.7246e+000	3.2725e+001	1.0544e+002	2.9951e+002	7.6005e+002	1.7364e+003
1.9284e+000	7.3675e+000	2.4829e+001	7.4832e+001	2.0326e+002	4.9992e+002	1.1169e+003
1.2963e+000	4.6465e+000	1.5003e+001	4.3870e+001	1.1657e+002	2.8208e+002	6.2266e+002
7.0011e-001	2.4357e+000	7.6959e+000	2.2143e+001	5.8120e+001	1.3934e+002	3.0541e+002
3.2235e-001	1.1033e+000	3.4431e+000	9.8129e+000	2.5567e+001	6.0947e+001	1.3300e+002

Ejemplo: comprender los valores de una matriz





¿Cómo podemos utilizar la visualización para potenciar la comprensión de los datos?

¿Qué es la visualización?

- “Transformación de lo simbólico en lo geométrico” [McCormick et al. 1987]
- “... encontrar la memoria artificial que mejor soporta nuestras formas naturales de percepción.” [Bertin 1967]
- “El uso de representación visual de los datos, generada por computadora e interactiva para amplificar la comprensión y la adquisición de conocimientos” [Card, Mackinlay, & Shneiderman 1999]

Cuarteto de Anscombe

Set A		Set B		Set C		Set D	
X	Y	X	Y	X	Y	X	Y
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.1	4	5.39	19	12.5
12	10.84	12	9.11	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89

Summary Statistics

$$u_X = 9.0 \quad \sigma_X = 3.32$$

$$u_Y = 7.5 \quad \sigma_Y = 2.03$$

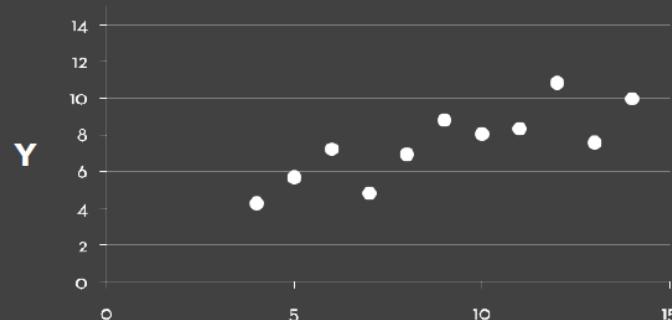
Linear Regression

$$Y = 3 + 0.5 X$$

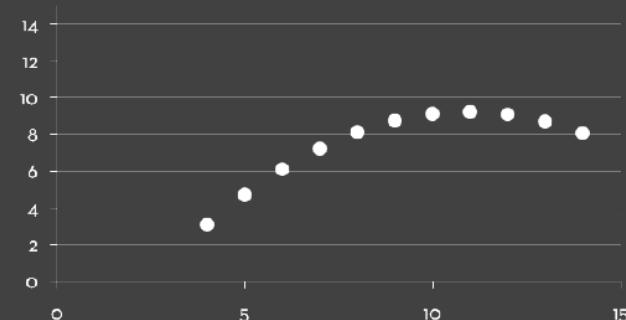
$$R^2 = 0.67$$

[Anscombe 1973]

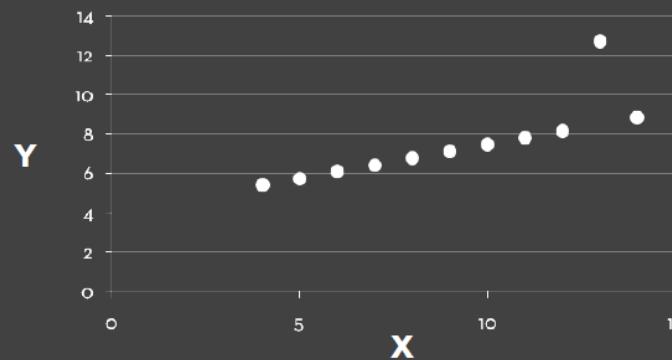
Set A



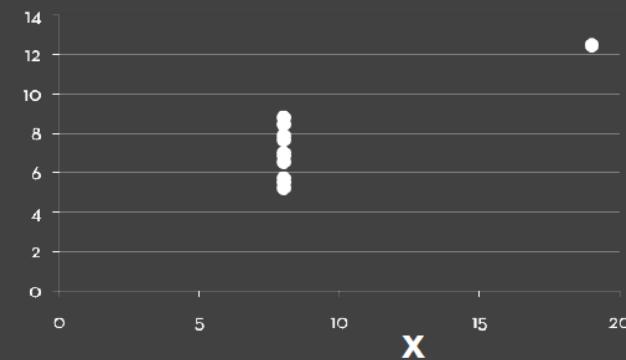
Set B



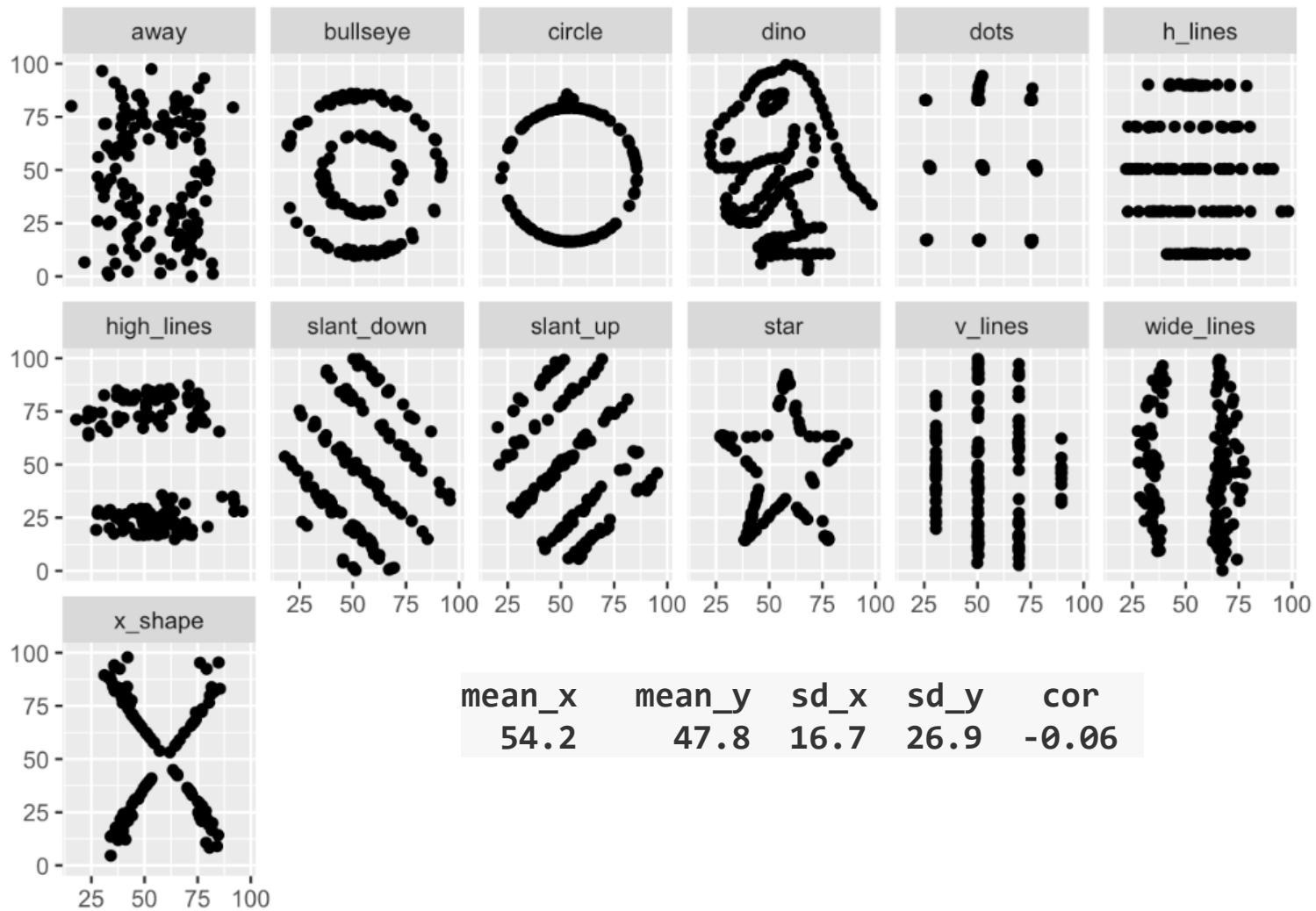
Set C



Set D

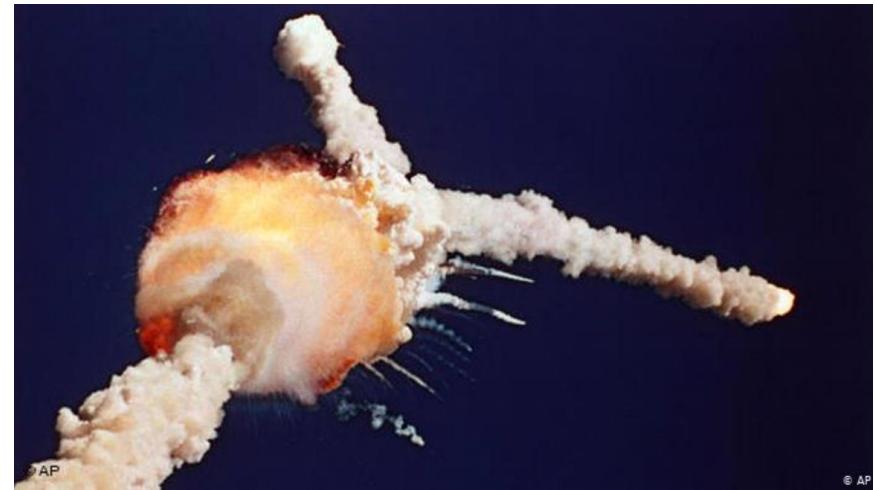
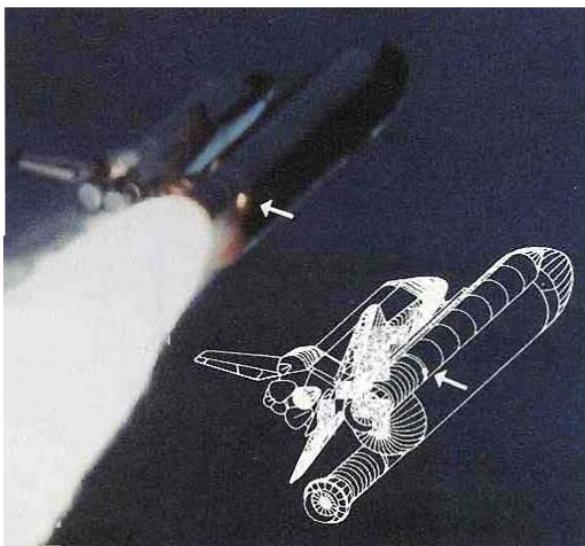


[Anscombe 1973]



Apoyar al razonamiento

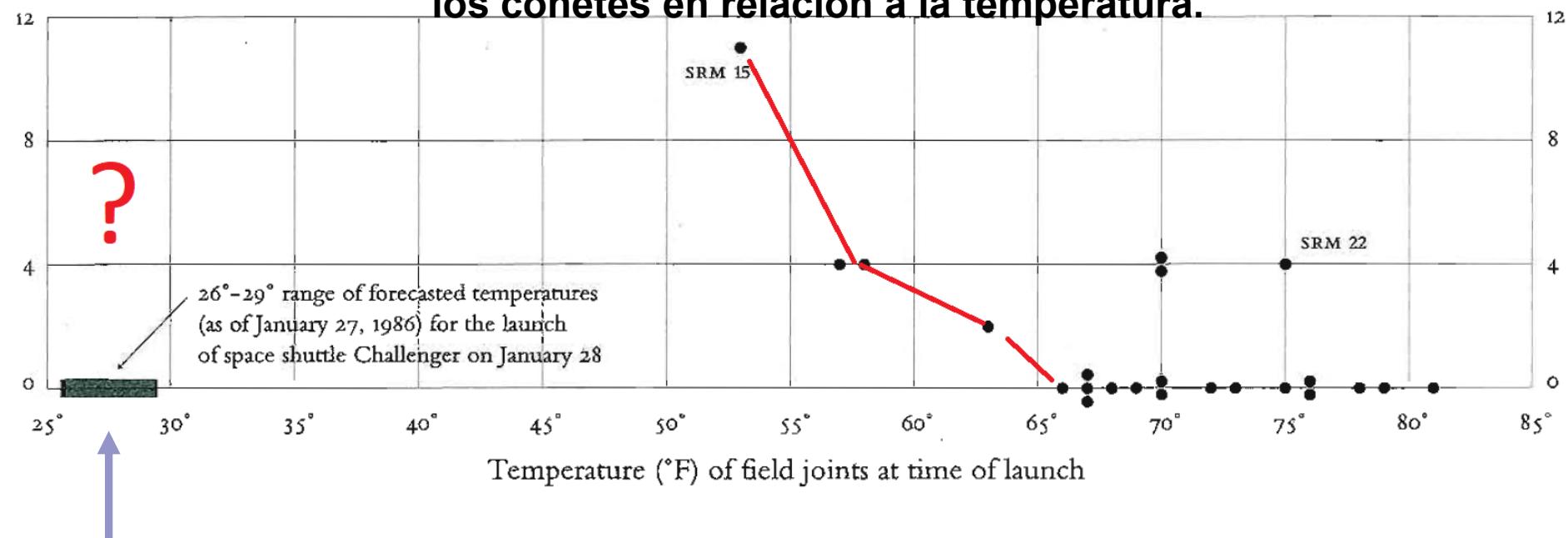
Explosión del Challenger, en enero de 1986.



Apoyar al razonamiento

O-ring damage
index, each launch

Registro histórico (antes del accidente) de fallas de los cohetes en relación a la temperatura.



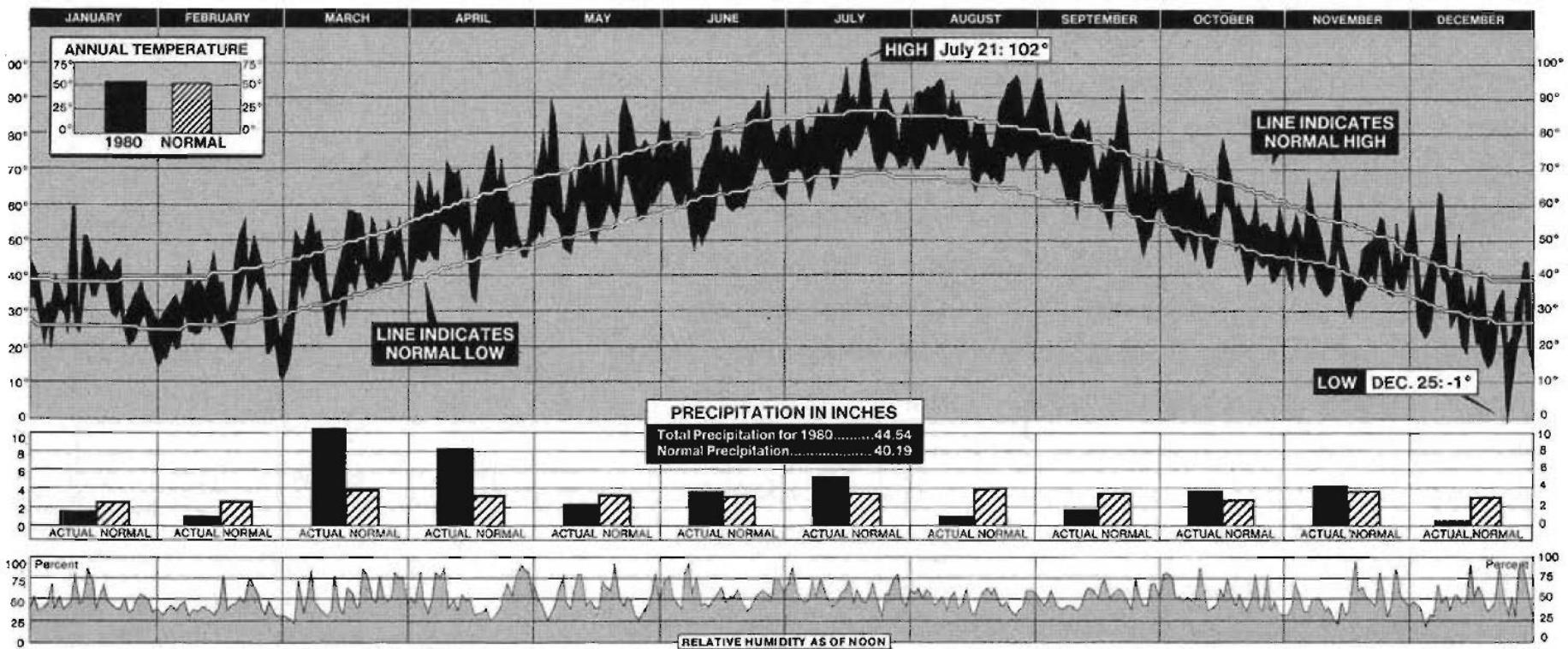
Temperatura pronosticada para el día del lanzamiento del Challenger

- En 1854, el brote de cólera mata a más de 700 personas en una semana. Dr. John Snow hace el mapa e hipotetiza que la causa debe ser la bomba de agua (pump) de Broad Street.



Encontrar patrones: Clima de NYC

NEW YORK CITY'S WEATHER FOR 1980



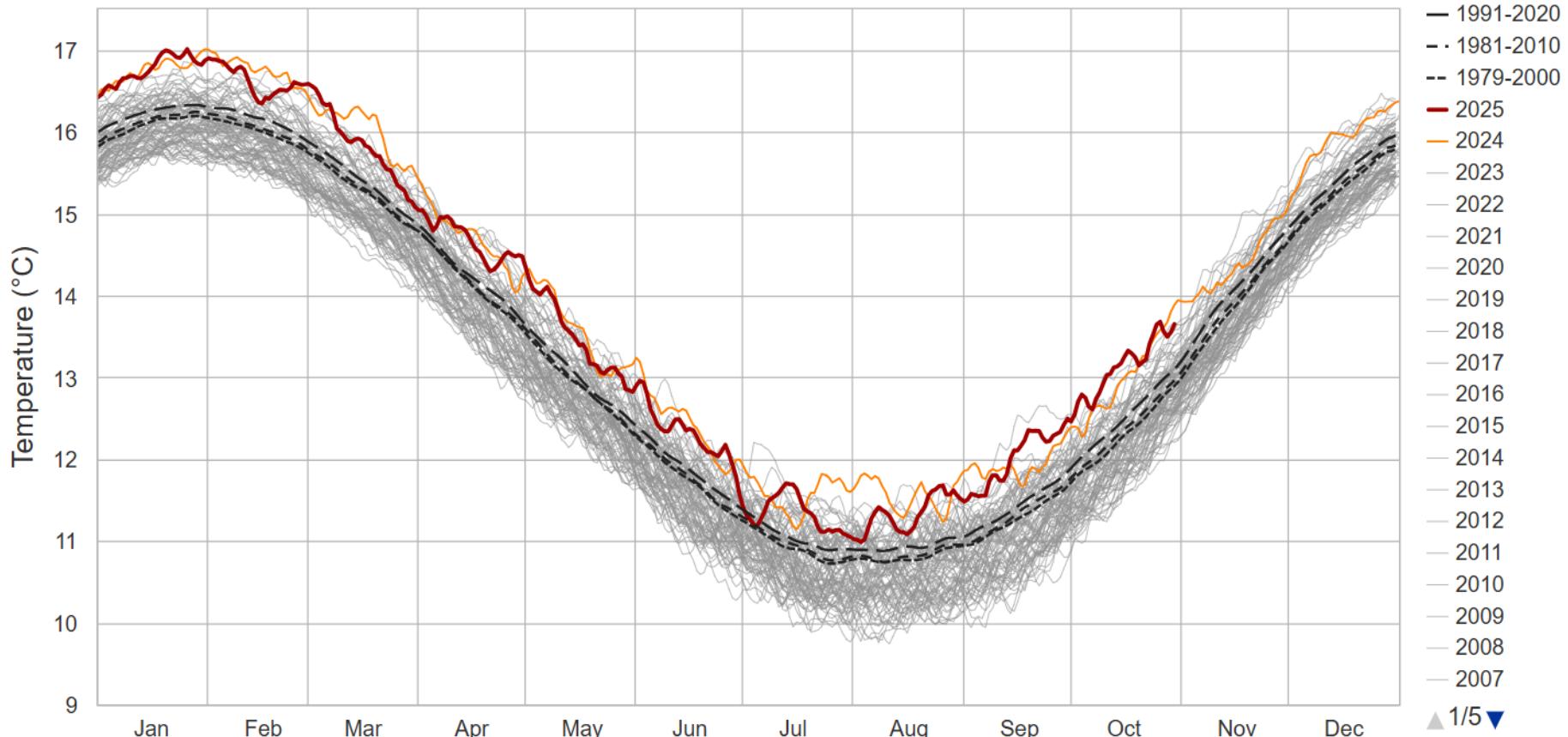
New York Times, January 11, 1981, p. 32.

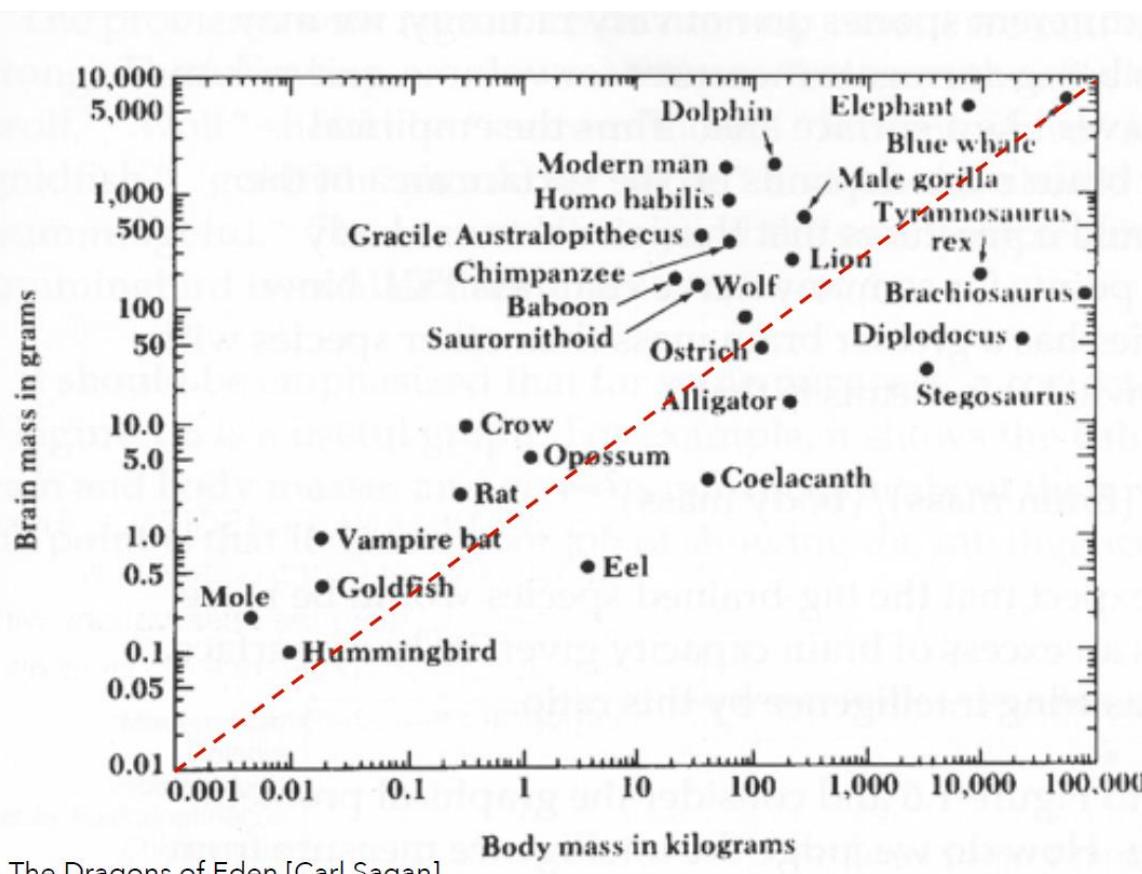
Comunicar: Clima del Mundo

Daily Surface Air Temp, Southern Hemisphere (0–90°S, 0–360°E)

≡ Export Chart

Dataset: ECMWF Reanalysis v5 (ERA5) downloaded from C3S | Image Credit: ClimateReanalyzer.org, Climate Change Institute, University of Maine



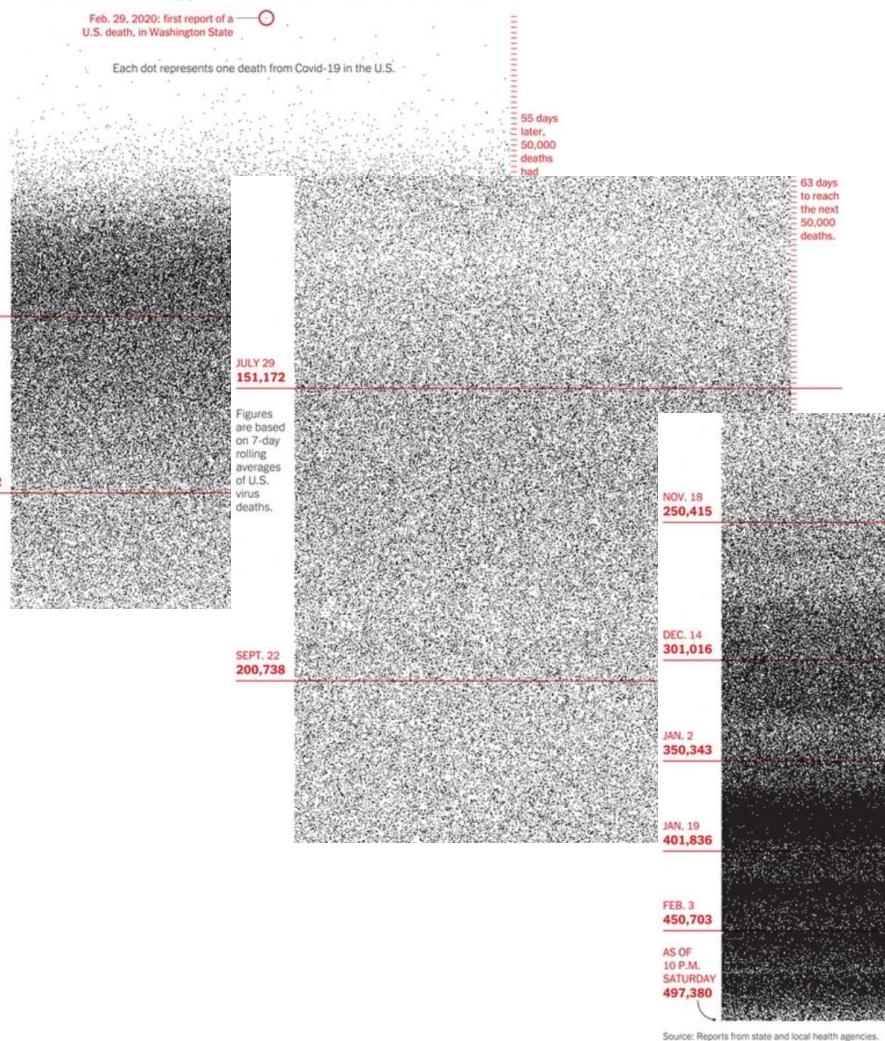


Responder preguntas:
¿Quién tiene el cerebro más potente?

The Toll: America Approaches Half a Million Covid Deaths

Feb. 29, 2020: first report of a U.S. death, in Washington State

Each dot represents one death from Covid-19 in the U.S.



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Comunicar, Informar, Inspirar

U.S. VIRUS DEATHS NEARING 500,000 IN JUST ONE YEAR

MORE THAN IN 3 WARS

Empty Spaces in Cities, Towns, Restaurants, Homes and Hearts

By JULIE ROSEN

CHICAGO — A nation marked by a year of death and despair, a year that has had the power to shatter the soul, has reached a milestone that few know about: more than 500,000 Americans have died of Covid-19.

More Americans have perished from the virus than died in the first and second battles of World War I, World War II and the Korean War combined.

The milestone comes as a hopeful sign that the virus is finally slowing down: daily deaths are showing signs of a downward trend.

But there is concern about what the future holds: when and if it may be months before the virus is gone for good.

Each death has left untold numbers of survivors — spouses, parents, children, friends, co-workers — who have never known the world without that loved one.

Empty spaces in communities are a reminder of the loss of a regular need to sit, one side of a table, a sofa, a bed, a chair, a sofa.

The living find themselves surrounded by the void. They are alone with their spouses, parents, relatives and friends, in a world of empty chairs.

“It’s like the world has been torn in half,” said Eric Jost, 52, of Elgin, Ill., who stands at his piano on Sundays, playing for an empty room. That spot belonged to Moses, his 87-year-old father, who died in December. “It’s like the world has been torn in half,” said Eric Jost, 52, of Elgin, Ill., who stands at his piano on Sundays, playing for an empty room. That spot belonged to Moses, his 87-year-old father, who died in December.

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26 days to reach the next 50,000 deaths.

Russia Fears But Can't Quite Open Internet

By ANTON TRISHANOV

MOSCOW — Margarita Sotnikova, a 30-year-old mother of two, has been trying to get her government to block access to the web.

“Foreign platforms in our country are a source of social instability,” she said. “We can’t afford to have them.”

Russia’s open internet shaped by American culture of discontent, was born in 1991, but it was not until the return of the opposition to power in 2011 that it has been manifested by the country’s free press, which has been fighting to expose the numerous scandals, but also the numerous awards, but also the numerous accolades, that have come with the investigation into President Vladimir Putin’s son, his son-in-law, his wife and his supporters’ calls for a return to the Soviet Union.

As a result, Mr. Putin faced the biggest pressure in years last year, and he responded unwilling — and, to some degree, reluctantly — to the pressure, with other drastic measures to limit the web. The web is still there, but the challenge Mr. Putin faces is how to keep it from being a platform for the exchange of high-speed internet with the world.

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SPOTS 33-37

Osaka Wines Australian Open

Sit. Roll Over. Wait Your Turn.

Day 1: The first day of the Grand Slam ends after a straight set win for Novak Djokovic over Daniil Medvedev.

By JULIA HARRIS

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SUNDAY STYLES

Boredom Is Making Us Buy

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Garland Faces Resurgent Peril Of Extremism

Oklahoma City Attack Shaped His View

CLIMATE CHANGE WRATH

Unprepared for Throats

Facing Power Grids

Water and Roads

This article is by Christopher Flavelle, Real Estate and Home editor.

Even as Texas struggled to respond to the extreme cold weather, the state’s most powerful utility regulators were looking for ways to improve the system.

“It really looked like we were not doing enough to prevent calling the demand and to prevent the kind of outages that we saw,” said Mark F. Fruge, director of the Texas Public Utility Commission.

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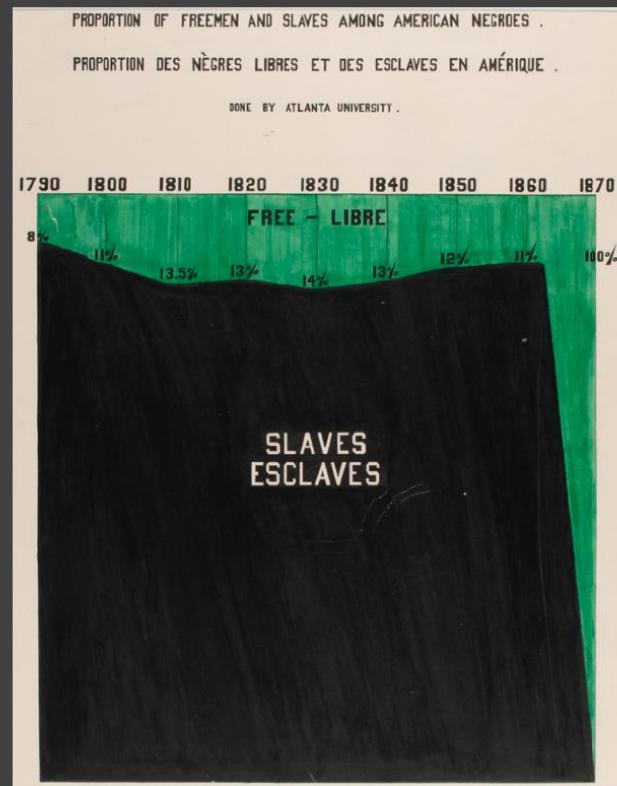
SUNDAY REVIEW

SPOTLIGHT

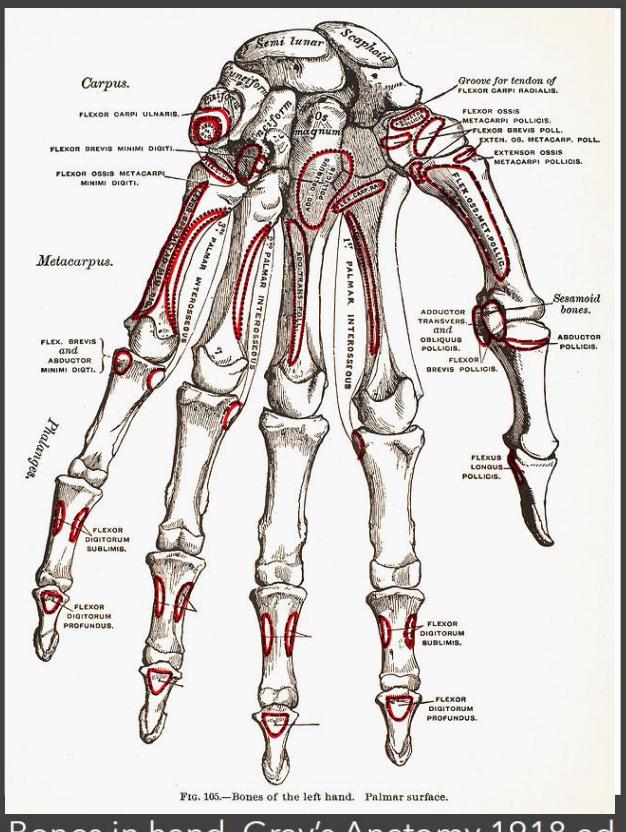
SUNDAY BUSINESS

SUNDAY OPINION

Comunicar, Informar, Inspirar



Visualizing Black America, Du Bois et al. 1900



Bones in hand, Gray's Anatomy 1918 ed.

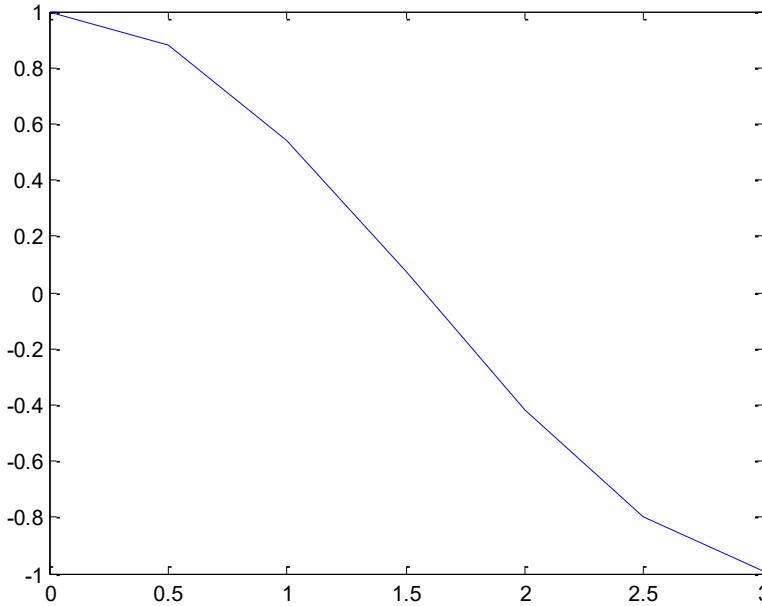
Primeras ideas sobre realización de gráficos

- Los gráficos representados en una computadora son discretos.
- A partir de una curva (matemática, materialmente inexistente), se toman puntos representantes y un programa se encarga de realizar una **interpolación**.
- El resultado de la **interpolación** se asemeja en mayor o en menor medida a la curva original.
- Existen varias formas de realizar **interpolaciones**.
- Para representar curvas, en Octave/Matlab utilizamos una interpolación lineal para aproximar el gráfico a la curva original.

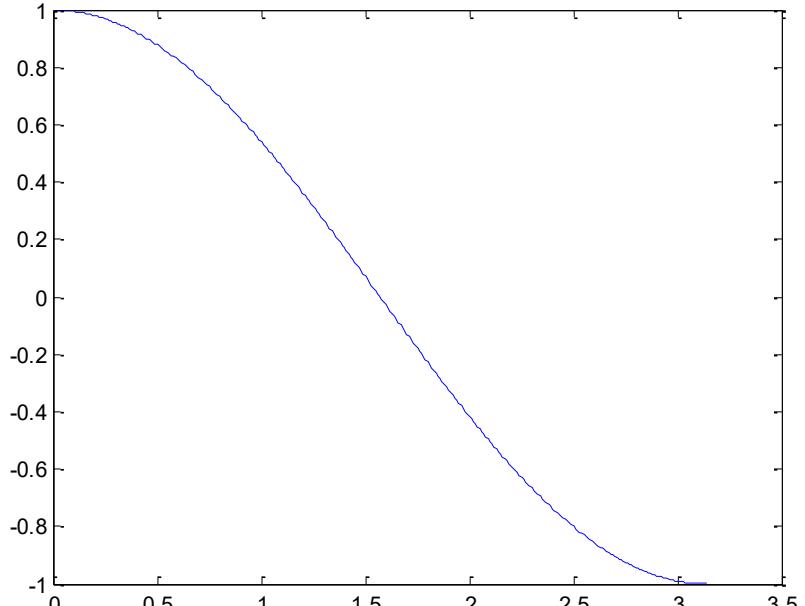
Primeras ideas sobre realización de gráficos

- Cuantos más puntos, mejor será la aproximación
- Ejemplos:

$f(x) = \cos(x)$ para el conjunto $x = [0:0.5:\pi]$



$f(x) = \cos(x)$ para el conjunto $x = [0:0.01:\pi]$



Herramientas

■ Operaciones para dibujar gráficos bidimensionales:

`plot`

Traza líneas.

`semilogx, semilogy.`

Traza líneas, donde un eje tiene escala logarítmica

`loglog`

Traza líneas, donde ambos ejes tienen escala logarítmica

`contour`

Traza isolíneas, curvas de nivel.

`quiver`

Despliega vectores de velocidad como flechas.

Herramientas

■ Operaciones para controlar la ventana de dibujo:

`title`

Agrega un título.

`legend`

Agrega una leyenda.

`xlabel`

Etiqueta el eje x.

`ylabel`

Etiqueta el eje y.

`grid`

Activar o desactivar la grilla.

`hold`

Permite determinar si el gráfico se descartará ante un nuevo trazo.

`subplot`

Divide la ventana de dibujo en celdas.

Herramientas

■ Operaciones para cambiar la escala de los ejes:

axis

Cambia la escala de los ejes.

`axis([xmin xmax ymin ymax])`

`axis('square')`

get

Permite obtener el valor de una propiedad gráfica.

set

Permite definir el valor de una propiedad gráfica.

Traza de líneas usando `plot`

- Sintaxis:

```
plot(Y)
```

```
plot(x1, y1, ...)
```

```
plot(x1, y2, tipo_de_trazo)
```

Traza de líneas usando `plot`

- `plot(Y)`

Traza las columnas de Y contra sus índices.

- `plot(X1, Y1, ...)`

Traza las columnas de Yi contra las columnas de Xi.

- `plot(X1, Y2, tipo_de_trazo)`

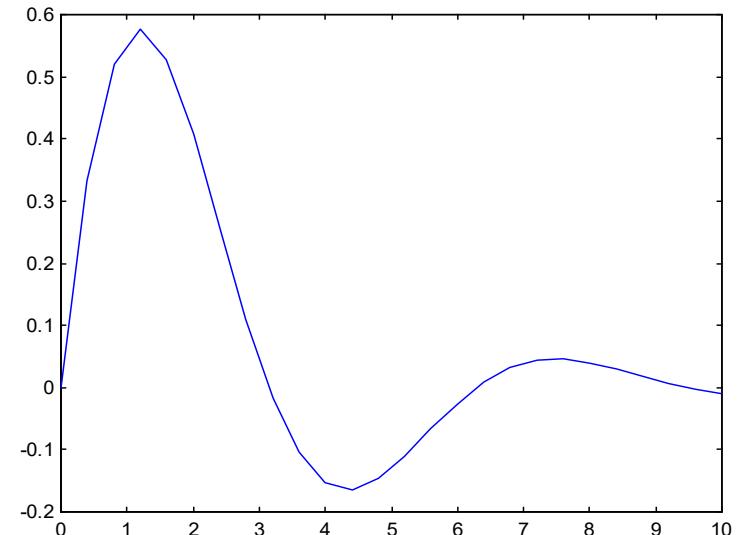
Ítem anterior, pero permite definir el tipo de línea, la forma de los puntos y el color del trazo.

Traza de líneas usando `plot`

■ Ejemplo:

$$f(x) = \sin(x) e^{-0.4x}$$

```
x = ( 0:0.4:10 ) ;  
y = sin(x) .* exp(-0.4 .* x) ;  
  
plot(x, y)
```

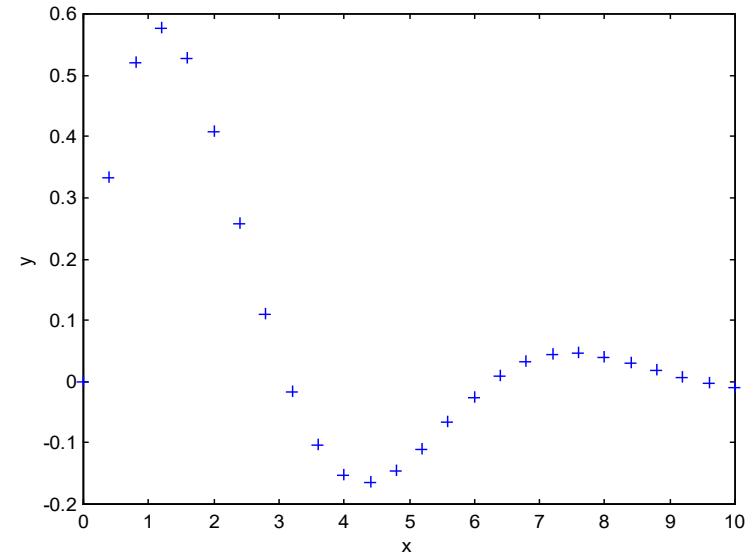


Traza de líneas usando `plot`

■ Ejemplo:

$$f(x) = \sin(x) e^{-0.4x}$$

```
x = ( 0:0.4:10 ) ;  
y = sin(x) .* exp(-0.4 .* x) ;  
  
plot(x, y, '+')
```



Traza de líneas usando `plot`

■ Tipos de trazo: forma del punto

Especificador	Forma de punto
+	Signo de más
o	Círculo
*	Asterisco
.	Punto
x	Cruz
'square' o s	Cuadrado
'diamond' o d	Diamante
^	Triángulo apuntando hacia arriba
v	Triángulo apuntando hacia abajo
>	Triángulo apuntando hacia la derecha
<	Triángulo apuntando hacia la izquierda
'pentagram' o p	Estrella de cinco puntos
'hexagram' o h	Estrella de seis puntos

Traza de líneas usando `plot`

■ Tipos de trazo: tipo de línea

Especificador	Tipo de línea
-	Continua
--	Guionada
:	Punteada
-.	Guionada y punteada

Traza de líneas usando `plot`

■ Tipos de trazo: color

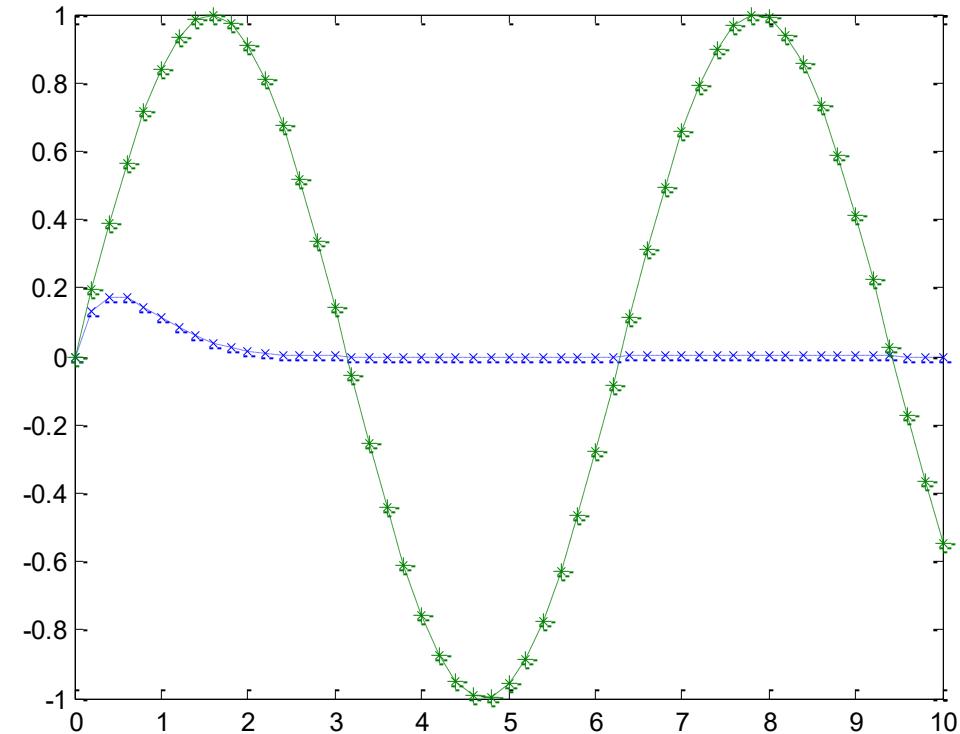
Especificador	Color
r	Rojo
g	Verde
b	Azul
c	Cian
m	Magenta
y	Amarillo
k	Negro
w	Blanco

Traza de líneas usando `plot`

- Ejemplo: $f(x) = \sin(x) e^{-4x}$
 $g(x) = \sin(x)$

```
x = ( 0:0.4:10 );
f = sin(x) .* exp(-4 .* x);
g = sin(x);

plot(x,f,':x',x,g,'--*')
```

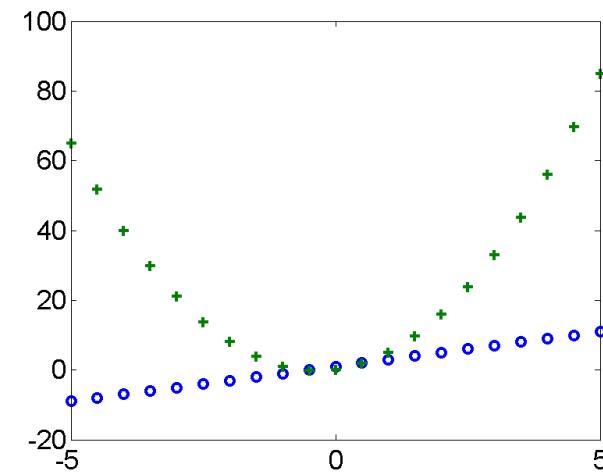
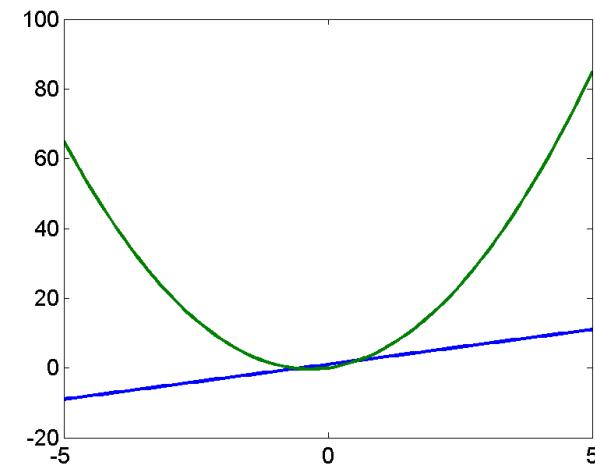


Traza de líneas usando `plot`

- Podemos mezclar marcas de puntos y tipos de línea en cualquier combinación.
- Esto es importante cuando el medio de visualización no permite colores.

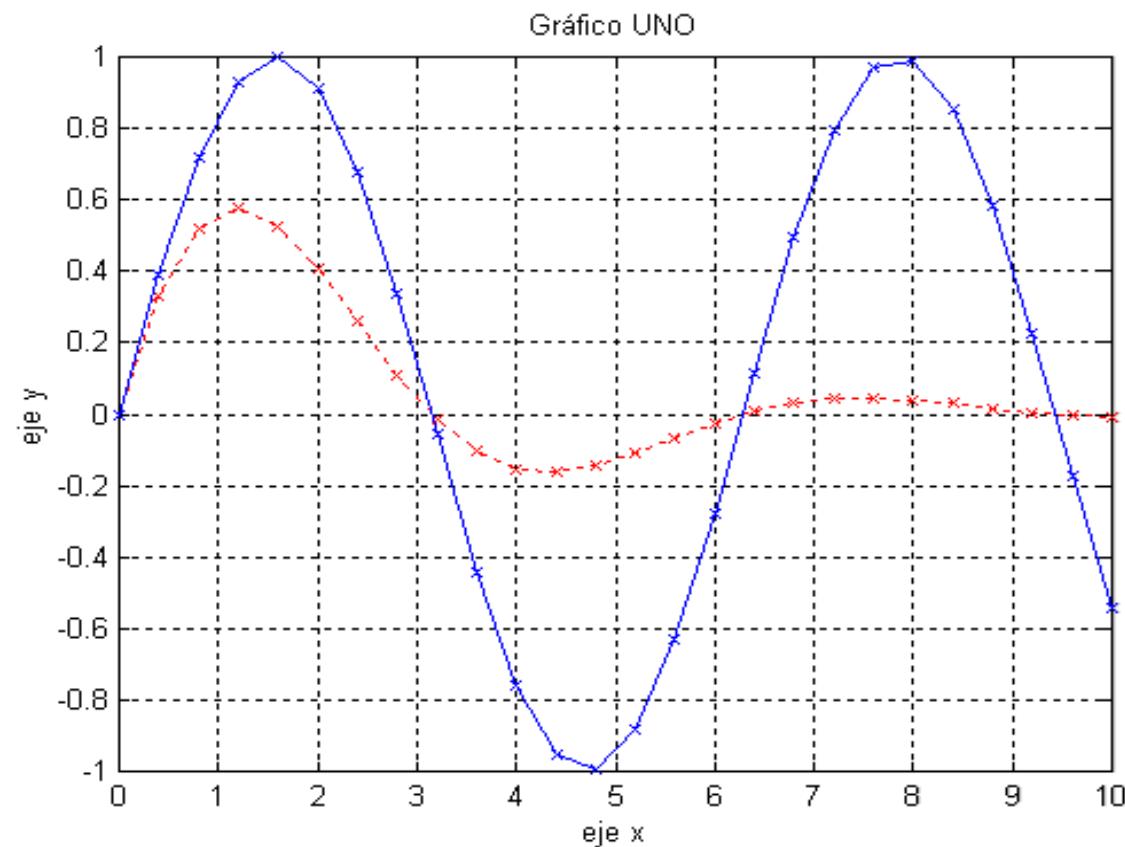
Traza de líneas usando `plot`

- Gráficas simultáneas.
 - Utilizando el formato por defecto:
 - `plot(x1, y1, x2, y2)`
 - Aplicando un formato propio:
 - `plot(x1, y1, 'o', x2, y2, '+')`
 - Usando hold on:
 - `plot(x1, y1, 'o')`
 - `hold on`
 - `plot(x2, y2, '+')`



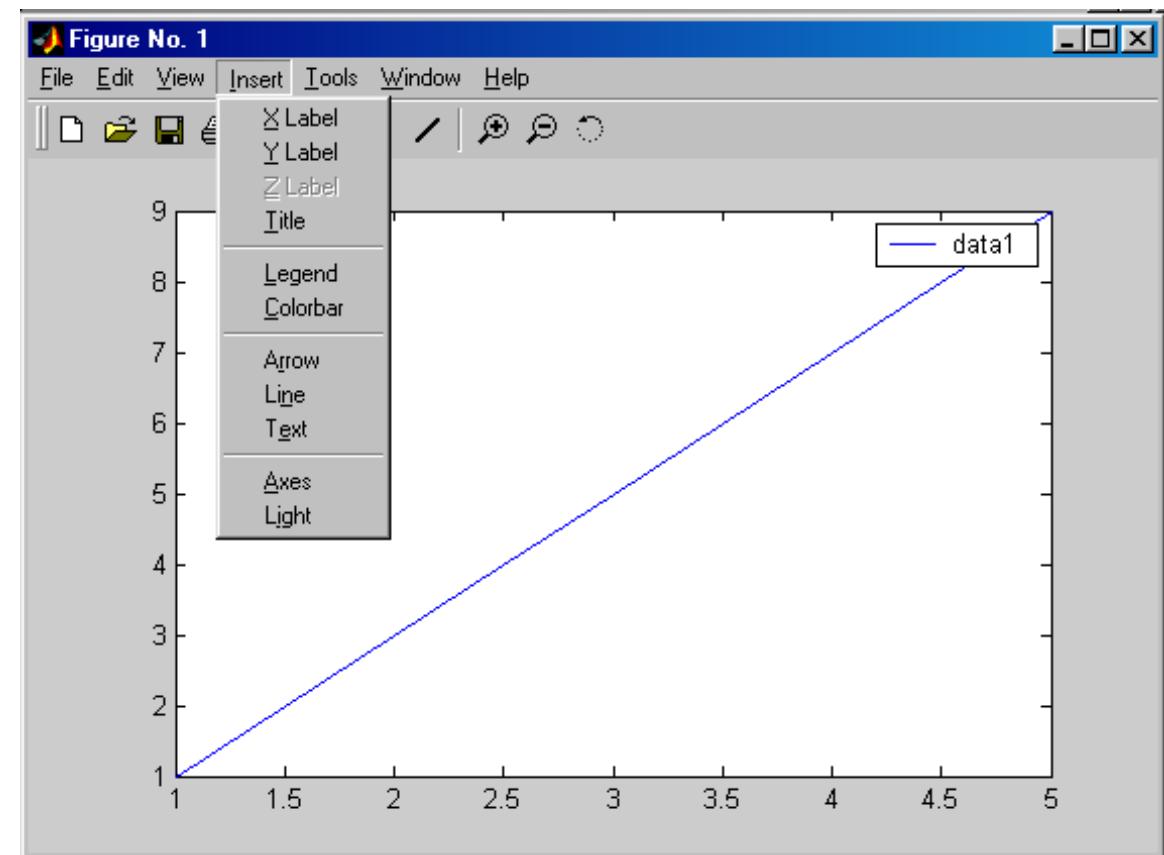
Grilla, etiqueta, título

```
plot ( x, y, ':xr')
grid on
xlabel('eje x');
ylabel('eje y');
hold on
plot ( x, y1, '-xb')
title('Gráfico UNO')
```



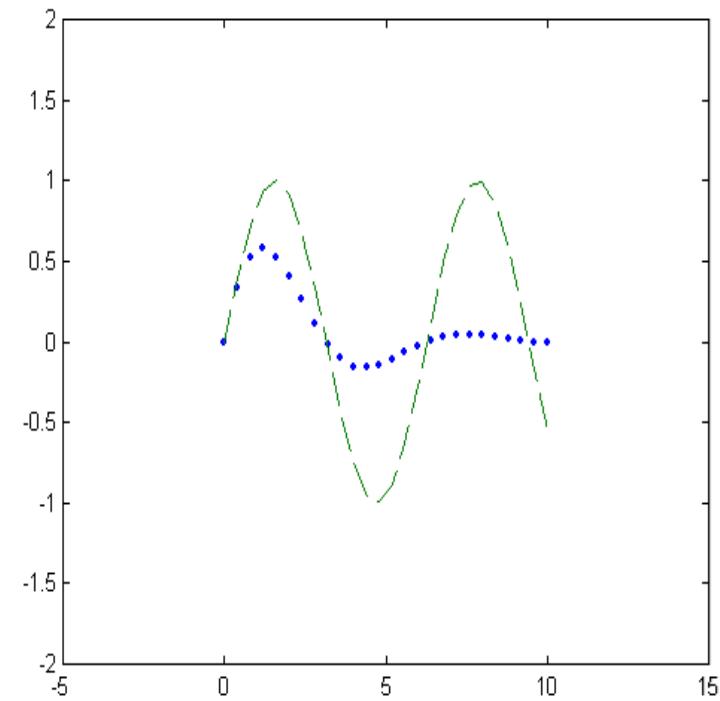
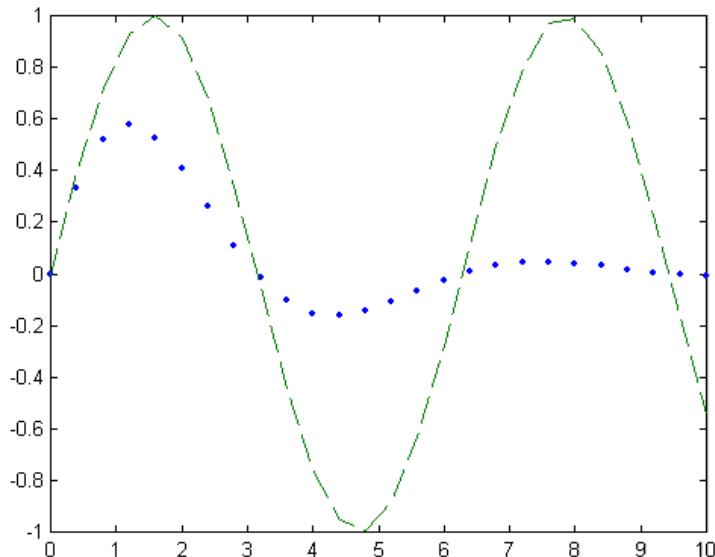
Grilla, etiqueta, título

```
plot ( x, y, '-b' )
```



Escala de los ejes

- Escala seleccionada por Octave/Matlab
- Escala con `axis([-5 15 -2 2])`



Escala de los ejes

- Se puede hacer un forzar que la escala en alguno de los ejes (o ambos) sea logarítmica.
- Para ello, se utilizan los comandos `loglog`, `semilogx` o `semilogy`.
- Su funcionamiento es similar a `plot`, con la diferencia de que utilizan una escala logarítmica para realizar el trazo.

División de la ventana con `subplot`

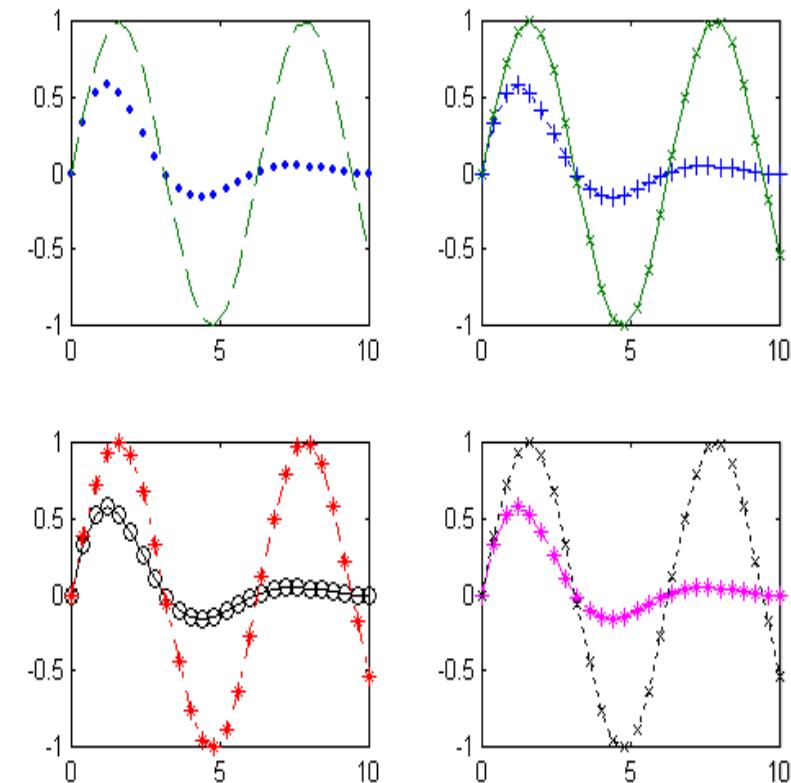
- El comando subplot permite dividir la ventana de dibujo en $m*n$ celdas.
- A cada celda se le asigna un número: de izquierda a derecha y de arriba hacia abajo.
- El número permite definir sobre qué celda se trabajará.
- Sintaxis:

`subplot(m, n, número)`

Divide la ventana en m filas por n columnas, especificando qué número de celda se utilizará para dibujar el gráfico.

División de la ventana con `subplot`

```
subplot( 2, 2, 1)
plot ( x, y, '.' , x, y1, '---' )
subplot( 2, 2, 2)
plot ( x, y, '+:', x, y1, 'x-' )
subplot( 2, 2, 3)
plot ( x, y, 'o-k' , x, y1, '*-.r' )
subplot( 2, 2, 4)
plot ( x, y, '*--m' , x, y1, 'x:k' )
```

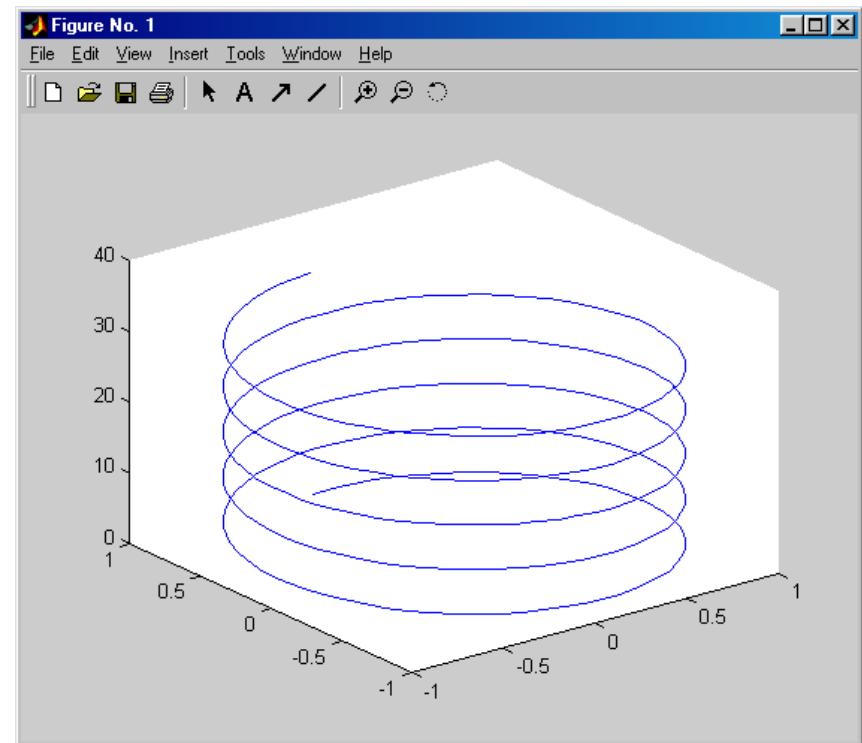


Otras opciones de gráficos

- Gráficas 3D
- Mallas (mesh)
- Superficies con texturas
- Efectos de iluminación, etc.

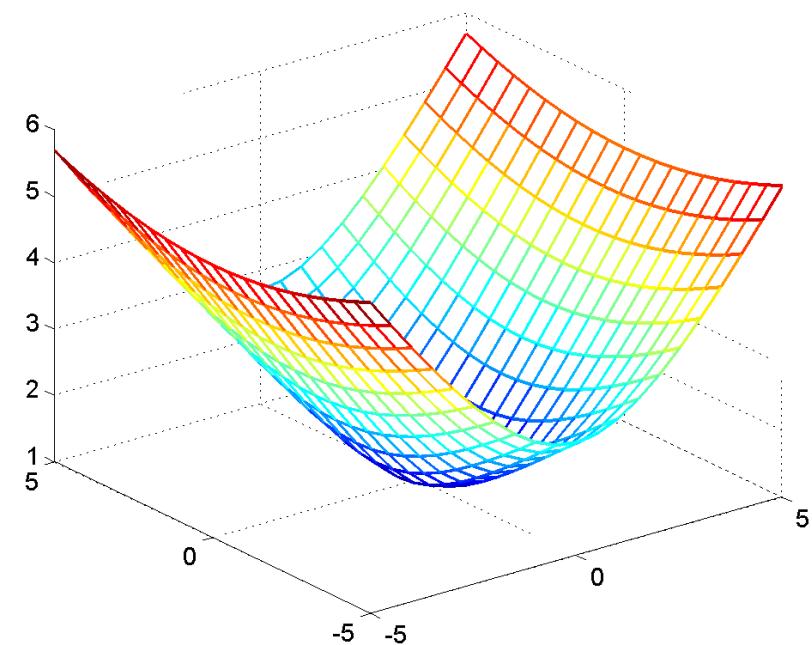
Ejemplo de plot 3D

```
t = 0:.1:10*pi;  
plot3 (sin(t), cos(t), t)
```



Ejemplo de mesh

```
x = [-5:.5:5];  
y = x;  
[X,Y] = meshgrid(x,y);  
Z = sqrt(1+0.25*Y.^2+X.^2);  
mesh(X,Y,Z)
```



Funcionamiento de meshgrid

- Transforma el dominio especificado por los vectores x e y en matrices X e Y.
- X e Y pueden ser utilizadas para evaluar funciones de dos variables y gráficas tridimensionales (usando mesh o surface).
- Las filas de la matriz X son copias del vector x.
- Las columnas de la matriz Y son copias del vector y.
- Ejemplo:

```
[X, Y] = meshgrid(1:3, 10:14)      X =           Y =  
  
           1   2   3       10   10   10  
           1   2   3       11   11   11  
           1   2   3       12   12   12  
           1   2   3       13   13   13  
           1   2   3       14   14   14
```

Funcionamiento de meshgrid

■ Ejemplo:

```
[X, Y] = meshgrid(-3:3, -3:3)
```

X =

```
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
-3 -2 -1 0 1 2 3
```

Y =

```
-3 -3 -3 -3 -3 -3 -3
-2 -2 -2 -2 -2 -2 -2
-1 -1 -1 -1 -1 -1 -1
 0 0 0 0 0 0 0
 1 1 1 1 1 1 1
 2 2 2 2 2 2 2
 3 3 3 3 3 3 3
```

Funcionamiento de meshgrid

■ Plano Z = 10:

```
>> Z = ones(7,7)*10
```

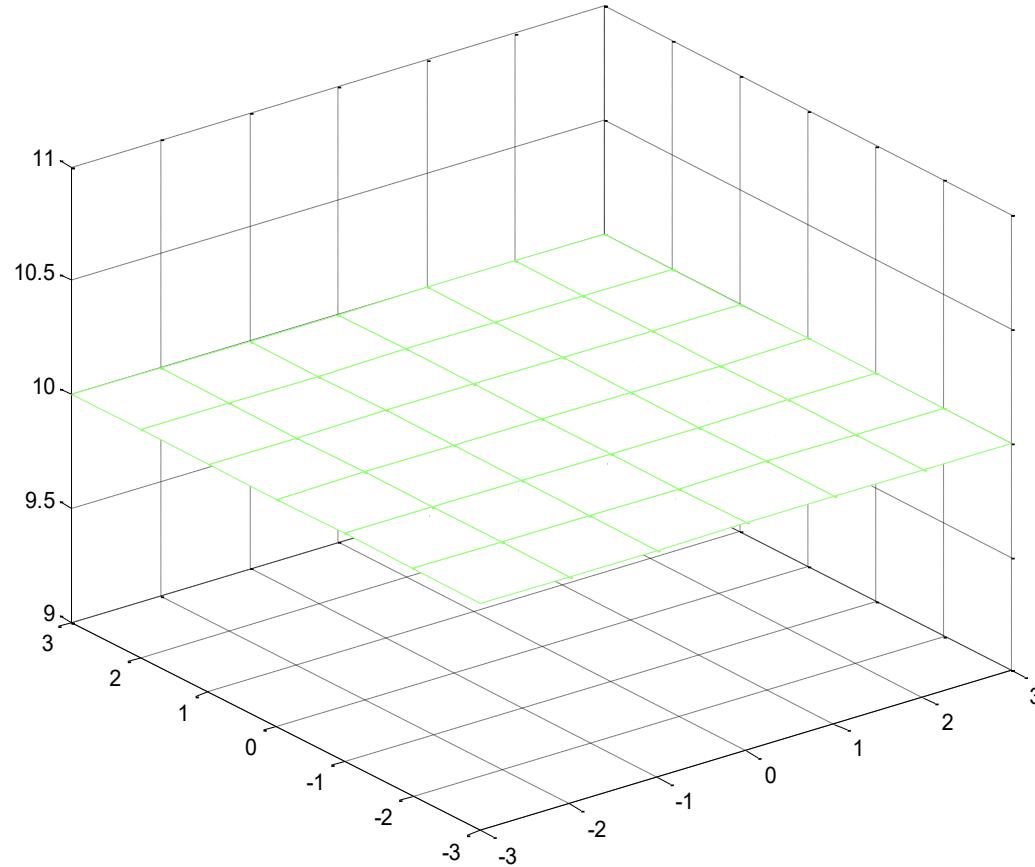
```
Z =
```

```
10 10 10 10 10 10 10
10 10 10 10 10 10 10
10 10 10 10 10 10 10
10 10 10 10 10 10 10
10 10 10 10 10 10 10
10 10 10 10 10 10 10
10 10 10 10 10 10 10
```

Funcionamiento de meshgrid

■ Gráfico:

```
>> mesh (X, Y, Z)
```



Gráficos: contour

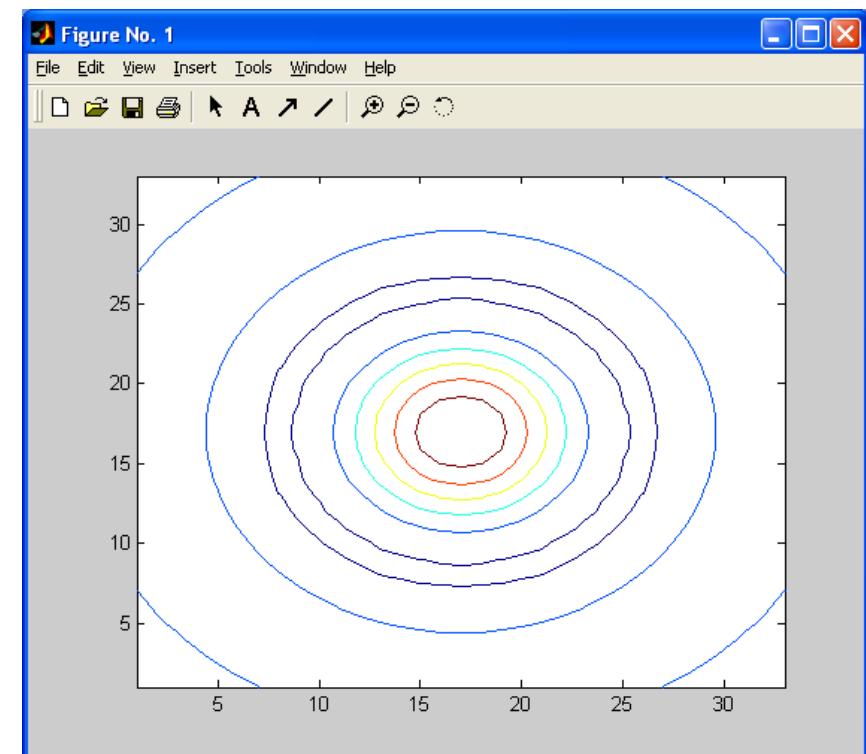
■ Variantes:

`contour(Z)`

`contour(X, Y, Z)`

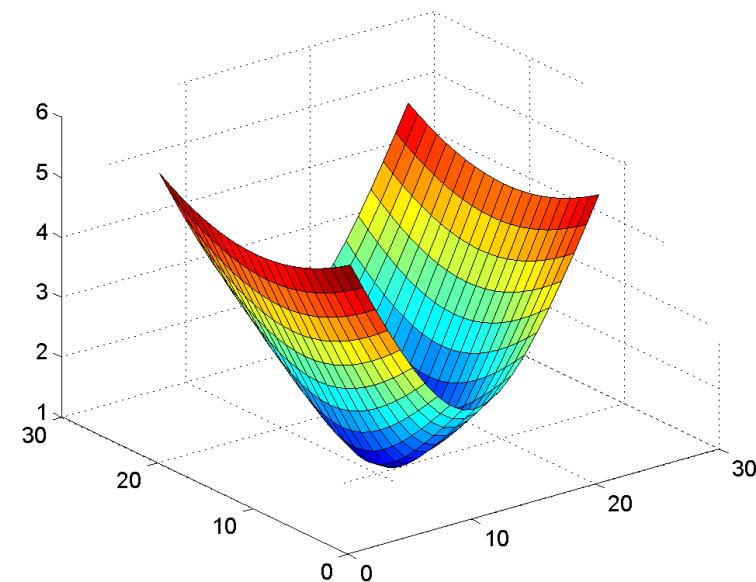
`contour(Z, n)`

`contour(X, Y, Z, n)`



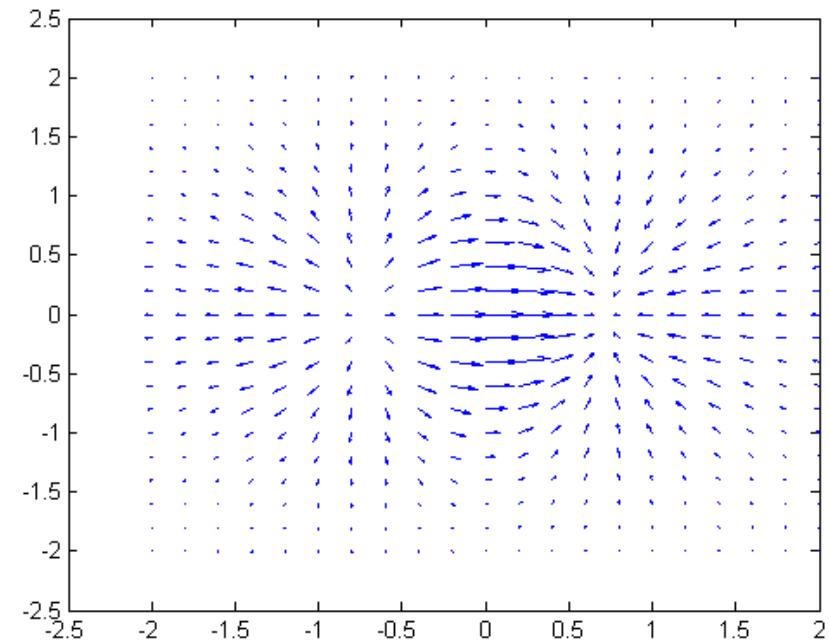
Gráficos: surf

```
x = [-5:.5:5];  
y = x;  
[X, Y] = meshgrid(x, y);  
Z = sqrt(1+0.25*Y.^2+X.^2);  
surf(Z)
```



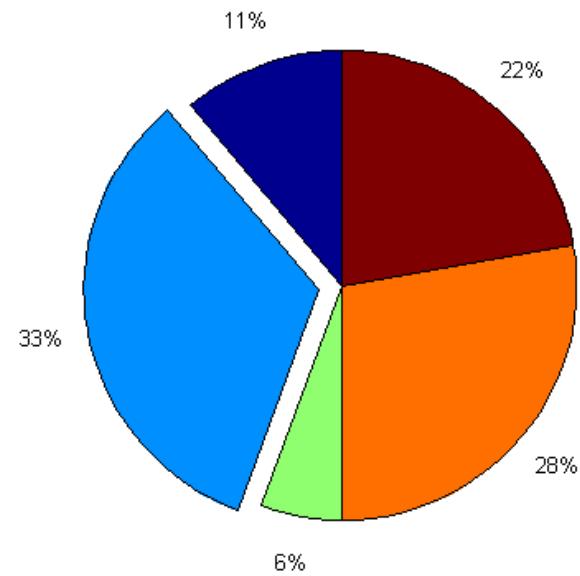
Gráficos: quiver

```
figure
[X,Y] = meshgrid(-2:.2:2);
Z = X.*exp(-X.^2 - Y.^2);
[DX,DY] = gradient(Z,.2,.2);
quiver(X,Y,DX,DY)
```



Gráficos: pie

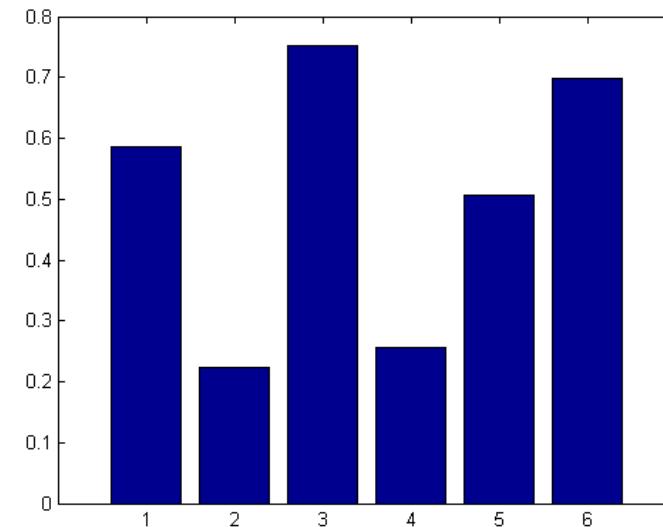
```
x = [1 3 0.5 2.5 2];  
explode = [0 1 0 0 0];  
pie(x,explode)  
colormap jet
```



Gráficos: bar

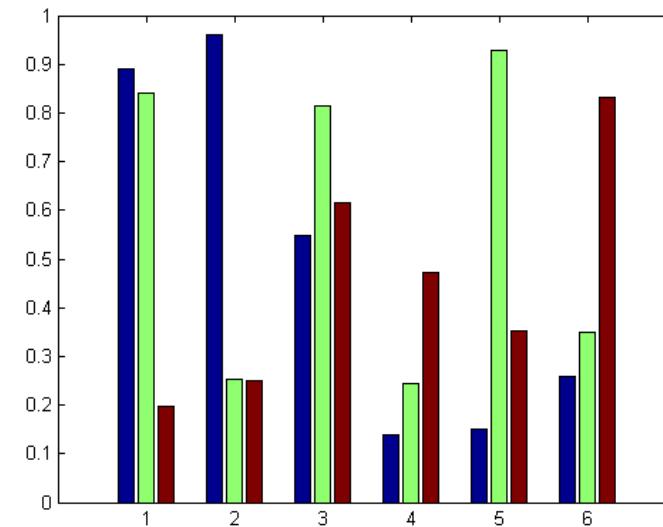
```
A=rand(6,1);
```

```
bar (A)
```



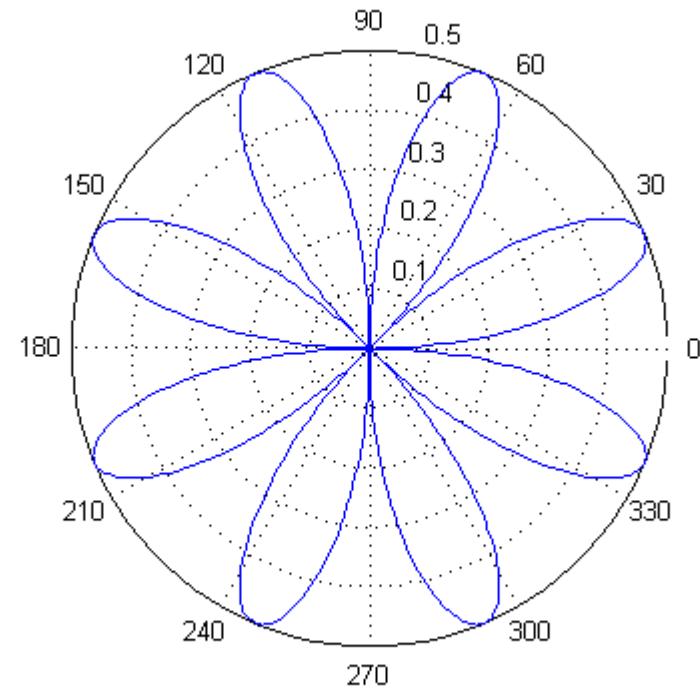
```
A=rand(6,3);
```

```
bar (A)
```



Gráficos: polar

```
figure  
t = 0:.01:2*pi;  
r=sin(2*t).*cos(2*t);  
polar(t,r)
```

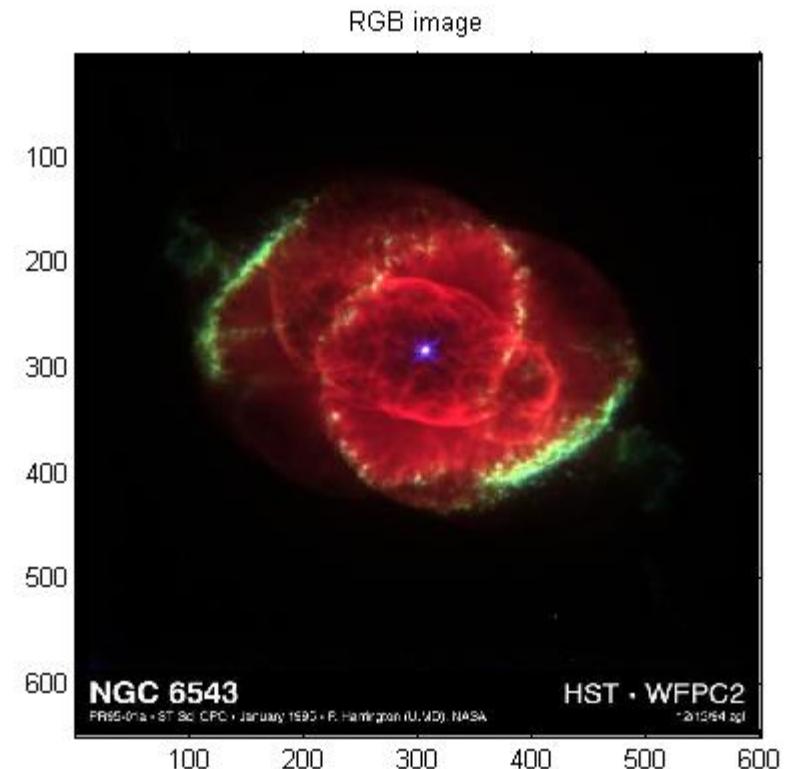


Gráficos: image

```
rgb =  
    imread('ngc6543a.jpg');
```

```
image(rgb);
```

```
title('RGB image')  
axis('square')
```



Gráficos: image

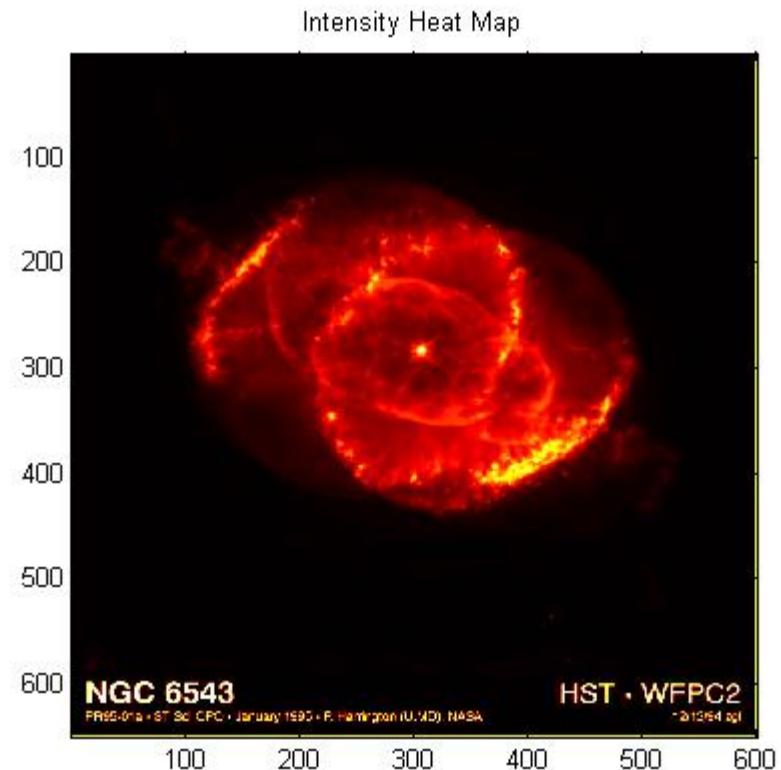
```
rgb = imread('ngc6543a.jpg');  
im = mean(rgb, 3);
```

```
image(im);
```

```
title('Intensity Heat Map')
```

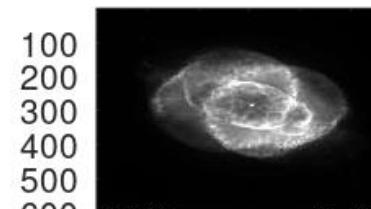
```
colormap(hot(256))
```

```
axis('square')
```

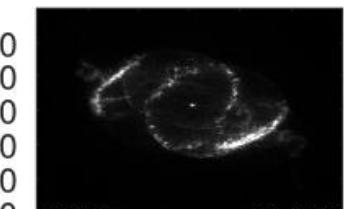


Los 3 canales (r,g,b) de la imagen

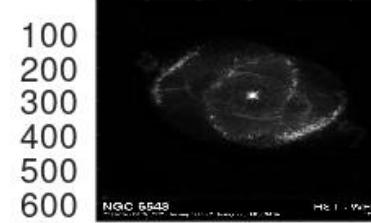
```
rgb = imread('ngc6543a.jpg');
figure
subplot( 2, 2, 1)
image(rgb(:,:,1));
colormap(gray(256))
subplot( 2, 2, 2)
image(rgb(:,:,2));
subplot( 2, 2, 3)
image(rgb(:,:,3));
subplot( 2, 2, 4)
image(rgb);
```



100 200 300 400 500 600



100 200 300 400 500 600



100 200 300 400 500 600



100 200 300 400 500 600