Relacion Masa Radio para exoplanetas

Calculos para reproducir resultados de https://arxiv.org/abs/2311.12593v2

```
In[ ]:= SetDirectory[NotebookDirectory[]]
        establece direct··· directorio de cuaderno
```

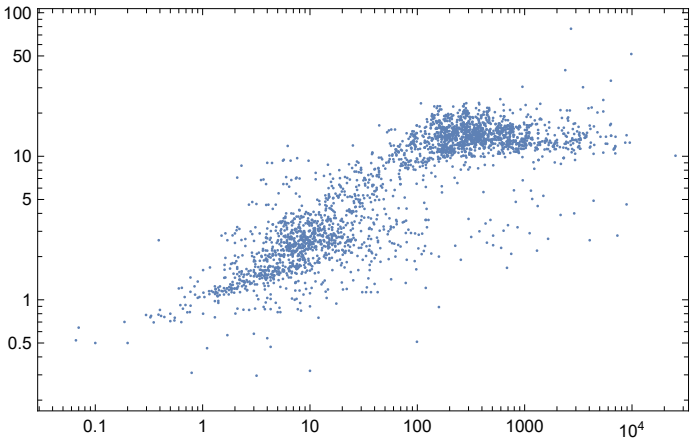
```
Out[ ]= /Users/michel/Library/CloudStorage/OneDrive-uv.cl/cursos/pregrado/Estadisticas/2024/
        Clases
```

```
In[ ]:= exopl = Import["exoplanets-Caltech-11-11-24.csv"];
             importa
```

In[•]:= **header = exopl[[1]]**

Out[•]= {rowid, pl_name, hostname, pl_letter, hd_name, hip_name, tic_id, gaia_id, default_flag,
sy_snum, sy_pnum, sy_mnum, cb_flag, discoverymethod, disc_year, disc_refname,
disc_pubdate, disc_locale, disc_facility, disc_telescope, disc_instrument,
rv_flag, pul_flag, ptv_flag, tran_flag, ast_flag, obm_flag, micro_flag, etv_flag,
ima_flag, dkin_flag, soltype, pl_controv_flag, pl_refname, pl_orbper, pl_orbpererr1,
pl_orbpererr2, pl_orbperlim, pl_orbsmax, pl_orbsmaxerr1, pl_orbsmaxerr2, pl_orbsmaxlim,
pl_rade, pl_radeerr1, pl_radeerr2, pl_radelim, pl_radj, pl_radjerr1, pl_radjerr2,
pl_radjlim, pl_masse, pl_masseerr1, pl_masseerr2, pl_masselim, pl_massj, pl_massjerr1,
pl_massjerr2, pl_massjlim, pl_msinie, pl_msinieerr1, pl_msinieerr2, pl_msinielim,
pl_msinij, pl_msinijerr1, pl_msinijerr2, pl_msinijlim, pl_cmasse, pl_cmasseerr1,
pl_cmasseerr2, pl_cmasselim, pl_cmassj, pl_cmassjerr1, pl_cmassjerr2, pl_cmassjlim,
pl_bmasse, pl_bmasseerr1, pl_bmasseerr2, pl_bmasselim, pl_bmassj, pl_bmassjerr1,
pl_bmassjerr2, pl_bmassjlim, pl_bmassprov, pl_dens, pl_denserr1, pl_denserr2,
pl_denslim, pl_orbeccen, pl_orbeccenerr1, pl_orbeccenerr2, pl_orbeccenlim, pl_insol,
pl_insolerr1, pl_insolerr2, pl_insollim, pl_eqt, pl_eqterr1, pl_eqterr2, pl_eqtlim,
pl_orbincl, pl_orbinclerr1, pl_orbinclerr2, pl_orbincllim, pl_tranmid, pl_tranmiderr1,
pl_tranmiderr2, pl_tranmidlim, pl_tsystemref, ttv_flag, pl_imppar, pl_impparerr1,
pl_impparerr2, pl_impparlim, pl_trandep, pl_trandeperr1, pl_trandeperr2, pl_trandeplim,
pl_trandur, pl_trandurerr1, pl_trandurerr2, pl_trandurlim, pl_ratdor, pl_ratdorerr1,
pl_ratdorerr2, pl_ratdorlim, pl_ratror, pl_ratrorerr1, pl_ratrorerr2, pl_ratrorlim,
pl_occdep, pl_occdeperr1, pl_occdeperr2, pl_occdeplim, pl_orbtper, pl_orbtpererr1,
pl_orbtpererr2, pl_orbtperlim, pl_orblper, pl_orblpererr1, pl_orblpererr2,
pl_orblperlim, pl_rvamp, pl_rvamperr1, pl_rvamperr2, pl_rvamplim, pl_projobliq,
pl_projobliqerr1, pl_projobliqerr2, pl_projobliqlim, pl_trueobliq, pl_trueobliqerr1,
pl_trueobliqerr2, pl_trueobliqlim, st_refname, st_spectype, st_teff, st_tefferr1,
st_tefferr2, st_tefflim, st_rad, st_raderr1, st_raderr2, st_radlim, st_mass, st_masserr1,
st_masserr2, st_masslim, st_met, st_meterr1, st_meterr2, st_metlim, st_metratio,
st_lum, st_lumerr1, st_lumerr2, st_lumlim, st_logg, st_loggerr1, st_loggerr2,
st_logglim, st_age, st_ageerr1, st_ageerr2, st_agelim, st_dens, st_denserr1,
st_denserr2, st_denslim, st_vsin, st_vsinerr1, st_vsinerr2, st_vsinlim, st_rotp,
st_rotperr1, st_rotperr2, st_rotplim, st_radv, st_radverr1, st_radverr2, st_radvlim,
sy_refname, rastr, ra, decstr, dec, glat, glon, elat, elon, sy_pm, sy_pmerr1, sy_pmerr2,
sy_pmra, sy_pmraerr1, sy_pmraerr2, sy_pmdec, sy_pmdecerr1, sy_pmdecerr2, sy_dist,
sy_disterr1, sy_disterr2, sy_plx, sy_plxerr1, sy_plxerr2, sy_bmag, sy_bmagerr1,
sy_bmagerr2, sy_vmag, sy_vmagerr1, sy_vmagerr2, sy_jmag, sy_jmagerr1, sy_jmagerr2,
sy_hmag, sy_hmagerr1, sy_hmagerr2, sy_kmag, sy_kmagerr1, sy_kmagerr2, sy_umag,
sy_umagerr1, sy_umagerr2, sy_gmag, sy_gmagerr1, sy_gmagerr2, sy_rmag, sy_rmagerr1,
sy_rmagerr2, sy_imag, sy_imagerr1, sy_imagerr2, sy_zmag, sy_zmagerr1, sy_zmagerr2,
sy_w1mag, sy_w1magerr1, sy_w1magerr2, sy_w2mag, sy_w2magerr1, sy_w2magerr2, sy_w3mag,
sy_w3magerr1, sy_w3magerr2, sy_w4mag, sy_w4magerr1, sy_w4magerr2, sy_gaiamag,
sy_gaiamagerr1, sy_gaiamagerr2, sy_icmag, sy_icmagerr1, sy_icmagerr2, sy_tmag,
sy_tmagerr1, sy_tmagerr2, sy_kepmag, sy_kepmagerr1, sy_kepmagerr2, rowupdate, pl_pubdate,
releasedate, pl_nnotes, st_nphot, st_nrvc, st_nspec, pl_nespec, pl_ntranspec, pl_ndispec}

```
In[ ]:= Position[header, "pl_masse"]
        posición
Out[ ]= {{51}}

In[ ]:= header[[51]]
Out[ ]= pl_masse

In[ ]:= Position[header, "pl_rade"]
        posición
Out[ ]= {{43}}

In[ ]:= header[[43]]
Out[ ]= pl_rade

In[ ]:= datMR = Select[Rest@exopl, (NumberQ[#[[43]]] && NumberQ[#[[51]]]) &][[All, {51, 43}]];
          selecc··· todos excepto e··· ¿número?  ¿número?  todo

In[ ]:= Length@datMR
        longitud
Out[ ]= 2798

In[ ]:= ListLogLogPlot[datMR, Frame → True]
        representación log log de lista marco verdad
```



Out[ ]=

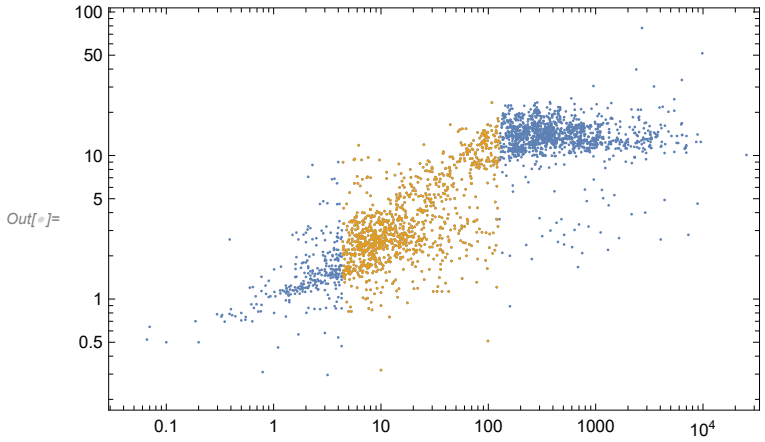
Masa Baja

Masa Intermedia

```
In[ ]:= interMR = Select[datMR, 4.4 ≤ #[[1]] ≤ 127. &];
                  selecciona

In[ ]:= Length@bajaMR
        longitud
Out[ ]= 290
```

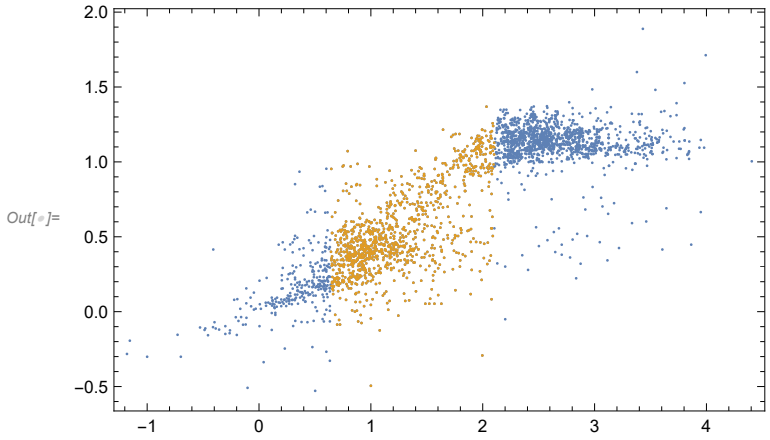
In[•]:=
```
grdatos = ListLogLogPlot[{datMR, interMR}, Frame → True]
```
representación log log de lista marco verdade

Out[•]=



In[•]:=
```
grdatos2 = ListPlot[Log10@{datMR, interMR}, Frame → True, Axes → False]
```
represent··· logaritmo en base 10 marco verd··· ejes falso

Out[•]=



In[•]:=
```
nlf = NonlinearModelFit[interMR, x^a, {a}, x]
```
ajusta a modelo no lineal

Out[•]=
```
FittedModel[ «20» ]
```

In[•]:=
```
Normal[nlf]
```
normal

Out[•]=
$$x^{0.488953}$$

In[•]:=
```
lmf = Fit[Log10@interMR, {x}, x]
```
aju·· logaritmo en base 10

Out[•]=
$$0.437083\, x$$

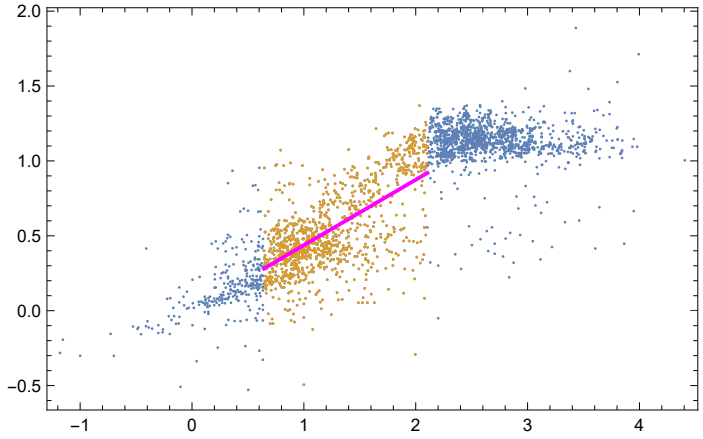
In[•]:=
```
lmf
```

Out[•]=
$$0.437083\, x$$

In[ ]:=
```
grFlog1 = Plot[lmf, {x, Log10[4.4], Log10[127.]}, PlotStyle → Magenta];
```
representación ⋯ | logaritmo en ⋯ | logaritmo en bas⋯ | estilo de repr⋯ | magenta

In[ ]:=
```
Show[grdatos2, grFlog1]
```
muestra

Out[ ]=

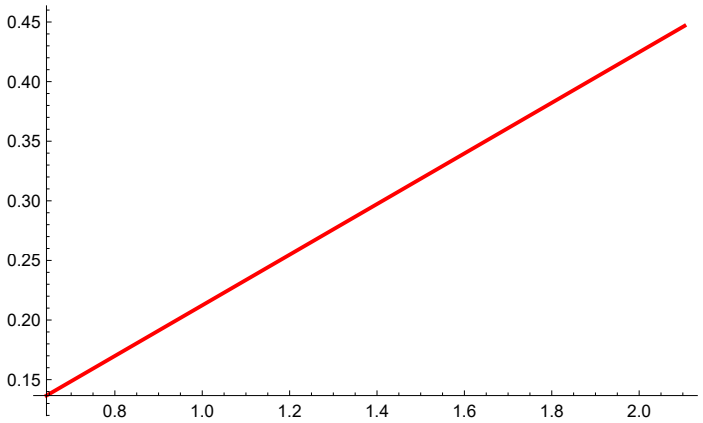


In[ ]:=
```
Log10[Normal[nlf]] // Simplify
```
logar⋯ | normal | simplifica

Out[ ]=
```
0.212349 Log[x]
```

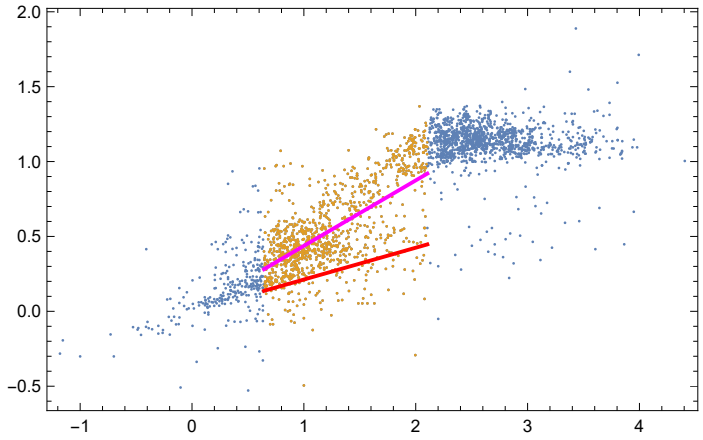
In[ ]:=
```
grFlog2 = Plot[0.21234945770404773` x, {x, Log10[4.4], Log10[127.]}, PlotStyle → Red]
```
representación gráfica | logaritmo en ⋯ | logaritmo en bas⋯ | estilo de repr⋯ | rojo

Out[ ]=



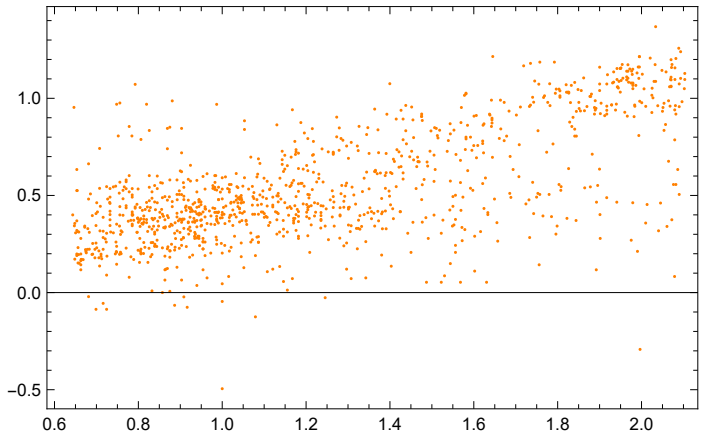
In[ ]:=
```
Show[grdatos2, grFlog1, grFlog2]
```
muestra

Out[ ]=



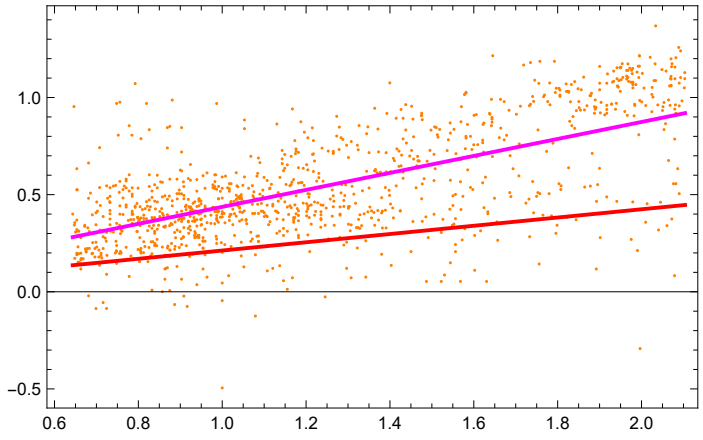
In[ ]:=
```
grinter = ListPlot[Log10@{interMR}, Frame → True, PlotStyle → Orange]
```
represent··· logaritmo en base 10 marco verd··· estilo de repr··· naranja

Out[ ]=



In[ ]:=
```
Show[grinter, grFlog1, grFlog2]
```
muestra

Out[ ]=



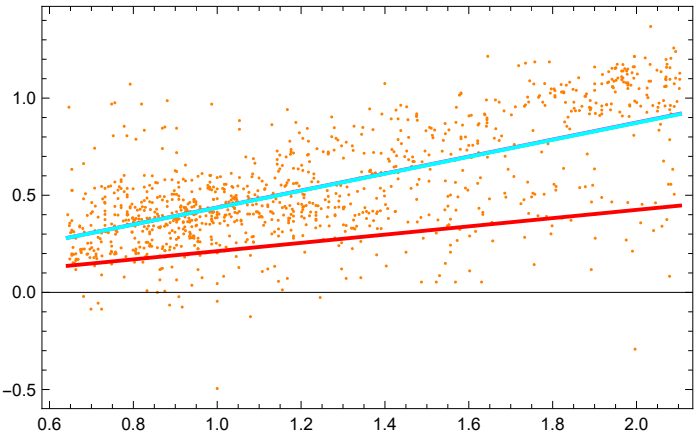
In[ ]:= **FindFormula[Log10@interMR, x]**
encuentra fór··· logaritmo en base 10

Out[ ]= 0.436211 x

In[ ]:= **grFlog3 = Plot[0.4362107191209601` x, {x, Log10[4.4], Log10[127.]}, PlotStyle → Cyan];**
representación gráfica logaritmo en ··· logaritmo en bas··· estilo de repr··· cian

In[ ]:= **Show[grbaja, grFlog1, grFlog2, grFlog3]**
muestra

Out[ ]=



In[ ]:= **FindFormula[bajaMR, x]**
encuentra fórmula

Out[ ]= 1.67006

Localizaciones

In[ ]:= **dist = NormalDistribution[μ, σ]**
distribución normal

Out[ ]= NormalDistribution[μ, σ]

In[ ]:= **Mean[dist]**
media

Out[ ]= μ

In[ ]:= **Expectation[x, x ≈ dist]**
expectación

Out[ ]= μ

In[ ]:= **Integrate[x PDF[dist, x], {x, -∞, ∞}, Assumptions → σ > 0]**
integra función de densidad de probabili··· asunciones

Out[ ]= μ

In[ ]:= **Median[dist]**
mediana

Out[ ]= μ

In[•]:= **StandardDeviation[dist]**
desviación estándar

Out[•]= σ

In[•]:= **Variance[dist]**
varianza

Out[•]= σ^2

In[•]:= **Moment[dist, #] & /@ Range[5]**
momento rango

Out[•]= $\left\{\mu,\ \mu^2+\sigma^2,\ \mu\left(\mu^2+3\sigma^2\right),\ \mu^4+6\mu^2\sigma^2+3\sigma^4,\ \mu\left(\mu^4+10\mu^2\sigma^2+15\sigma^4\right)\right\}$

In[•]:= **Kurtosis[dist]**
apuntamiento

Out[•]= 3

In[•]:= **CentralMoment[dist, #] & /@ Range[5]**
momento central rango

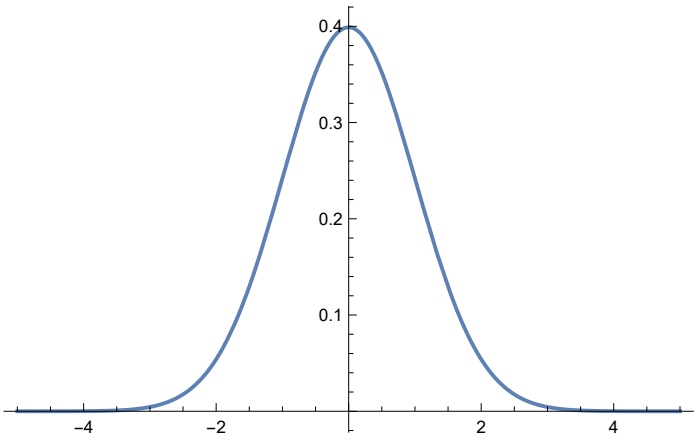
Out[•]= $\left\{0,\ \sigma^2,\ 0,\ 3\sigma^4,\ 0\right\}$

In[•]:= **PDF[dist, x]**
función de densidad de probabilidad

Out[•]= $\frac{e^{-\frac{(x-\mu)^2}{2\sigma^2}}}{\sqrt{2\pi}\ \sigma}$

In[•]:= **Plot[PDF[NormalDistribution[], x], {x, -5, 5}]**
repr··· fun·· distribución normal

Out[•]=



In[•]:= **Probability[x > 0, x ≃ NormalDistribution[]]**
probabilidad distribución normal

Out[•]= $\frac{1}{2}$

In[•]:= **Probability[-1 < x < 1, x ≃ NormalDistribution[]]**
probabilidad distribución normal

Out[•]= $\text{Erf}\left[\frac{1}{\sqrt{2}}\right]$

In[•]:= **% // N**
valor numérico

Out[•]= 0.682689

In[•]:= **Probability[-2 < x < 2, x ≃ NormalDistribution[]]**
probabilidad distribución normal

Out[•]= $\text{Erf}\left[\sqrt{2}\right]$

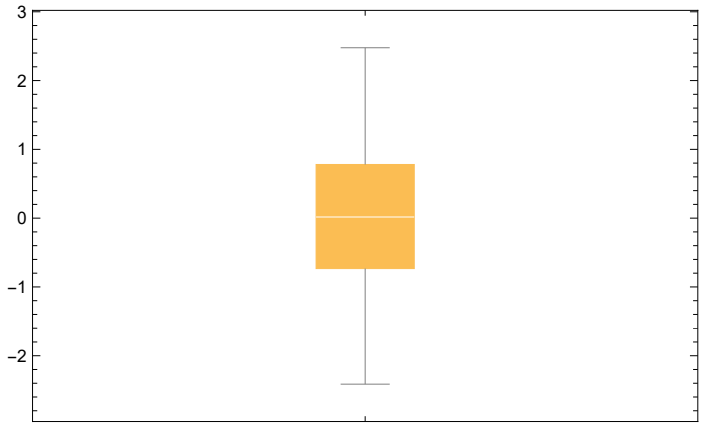
In[•]:= **% // N**
valor numérico

Out[•]= 0.9545

In[•]:= **dat = RandomVariate[NormalDistribution[], 50];**
variable aleatoria distribución normal

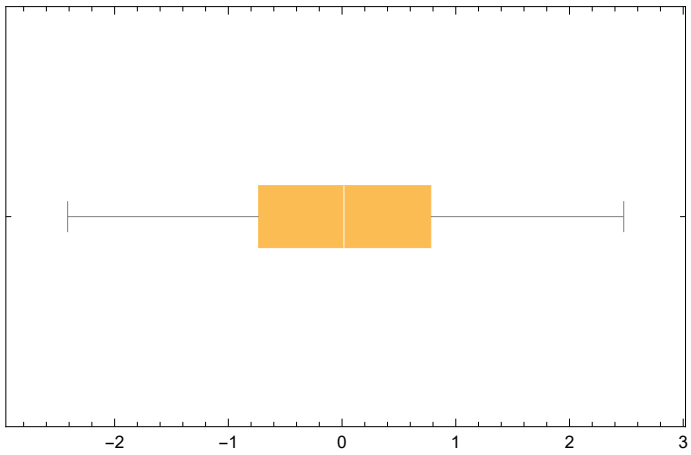
In[•]:= **BoxWhiskerChart[dat]**
diagrama de cajas y bigotes

Out[•]=



In[ ]:= **BoxWhiskerChart[dat, BarOrigin → Left]**
diagrama de cajas y bigotes | origen de barra | izquierc

Out[ ]=



In[ ]:= **Quartiles[dat]**
cuartiles

Out[ ]= {−0.733161, 0.0167232, 0.780258}

In[ ]:= **Quantile[dat, {.25, .5, .75}]**
cuantil

Out[ ]= {−0.733161, 0.00792299, 0.780258}

In[ ]:= **InterquartileRange[dat]**
rango intercuartil

Out[ ]= 1.51342

In[ ]:= **Quartiles[dat][[3]] − Quartiles[dat][[1]]**
cuartiles cuartiles

Out[ ]= 1.51342

In[ ]:= **Quantile[dat, {.025, .975}]**
cuantil

Out[ ]= {−2.36203, 2.19646}

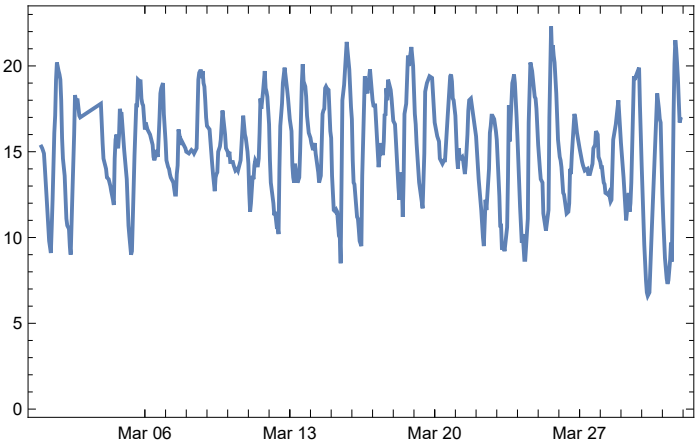
DatosMeteorologicos

In[ ]:= **WeatherData["SCSN", "Temperature"]**
datos meteorológicos

Out[ ]= 8.6 °C

In[ ]:=
```
DateListPlot[WeatherData["SCSN", "Temperature", {2023, 3}], Joined → True]
```
representación ··· datos meteorológicos unido verdade

Out[ ]=

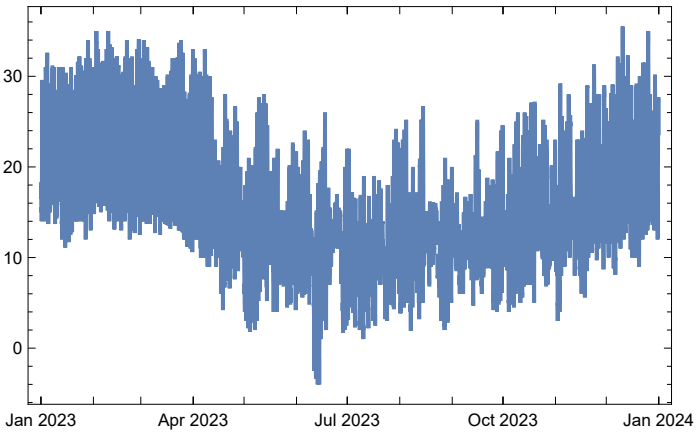


In[ ]:=
```
WeatherData["SCSN", "Properties"]
```
datos meteorológicos propiedades

Out[ ]=
```
{AlternateStandardNames, CloudCoverFraction, CloudHeight, CloudTypes, Conditions,
 Coordinates, DewPoint, Elevation, Humidity, Latitude, Longitude, MaxTemperature,
 MaxWindSpeed, MeanDewPoint, MeanHumidity, MeanPressure, MeanStationPressure,
 MeanTemperature, MeanVisibility, MeanWindChill, MeanWindSpeed, Memberships,
 MinTemperature, NCDCID, PrecipitationAmount, PrecipitationRate, PrecipitationTypes,
 Pressure, PressureTendency, SnowAccumulation, SnowAccumulationRate,
 SnowDepth, StationName, StationPressure, Temperature, TotalPrecipitation,
 Visibility, WBANID, WindChill, WindDirection, WindGusts, WindSpeed, WMOID}
```

In[ ]:=
```
DateListPlot[WeatherData["SCEL", "Temperature", {2023}], Joined → True]
```
representación ··· datos meteorológicos unido verdade

Out[ ]=



In[ ]:=
```
datT = WeatherData["SCEL", "Temperature", {2023}][[2, 1, 1, All, 1]] // Flatten
```
datos meteorológicos todo aplana

In[ ]:=
```
Dimensions@datT
```
dimensiones

Out[ ]=
```
{8613}
```

In[ ]:= **SmoothHistogram@datT**

histograma suave

Out[ ]=