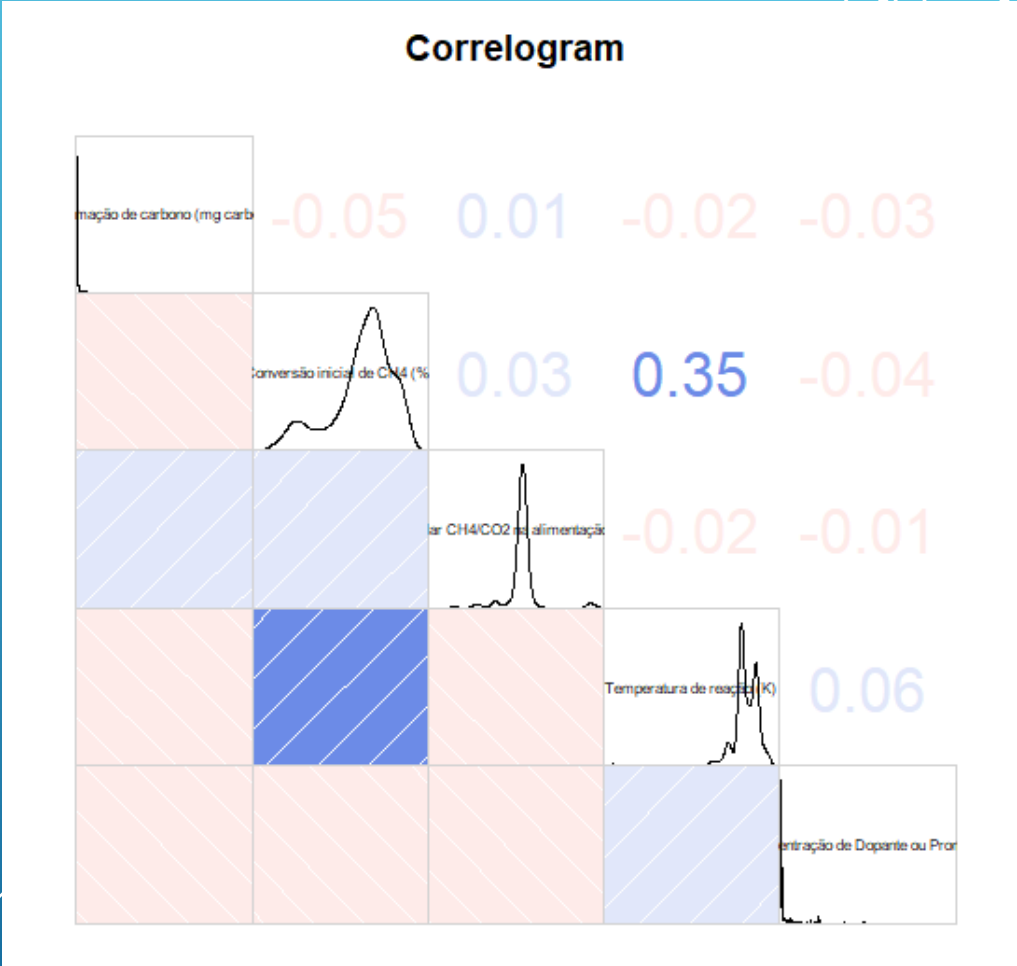
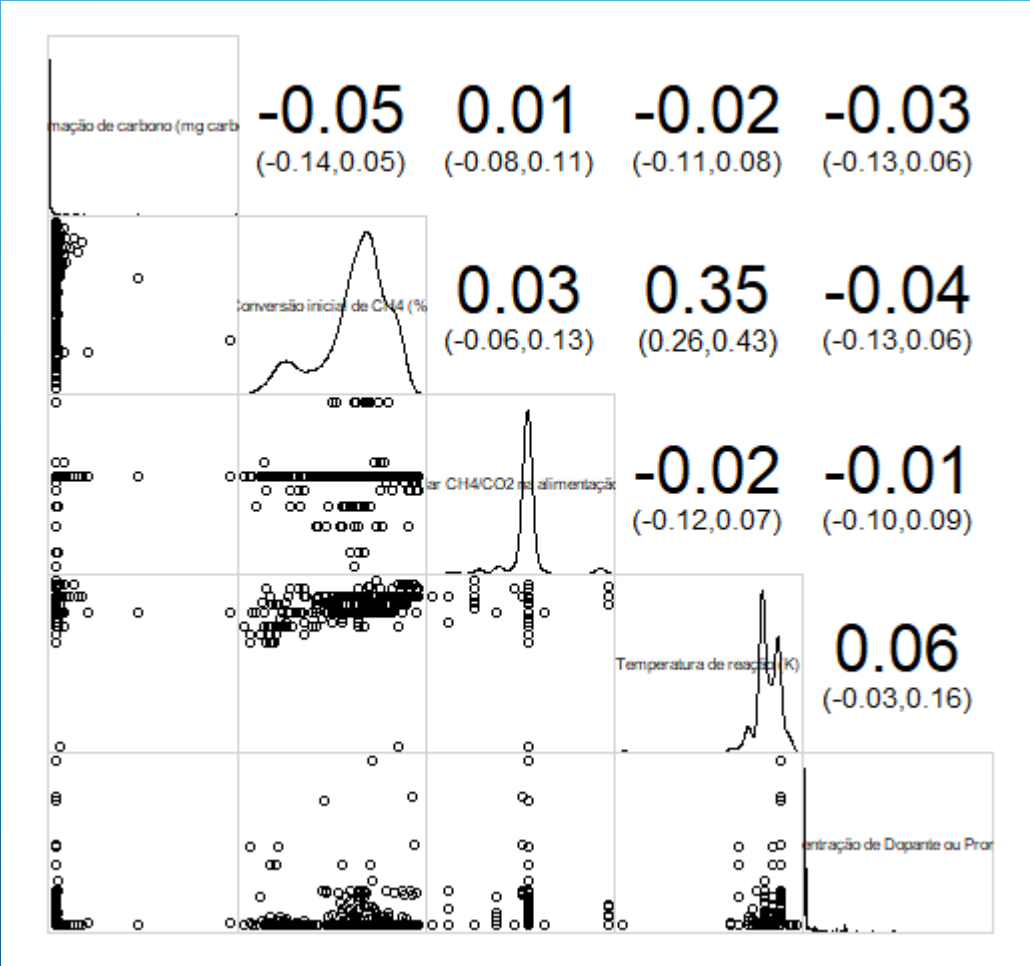


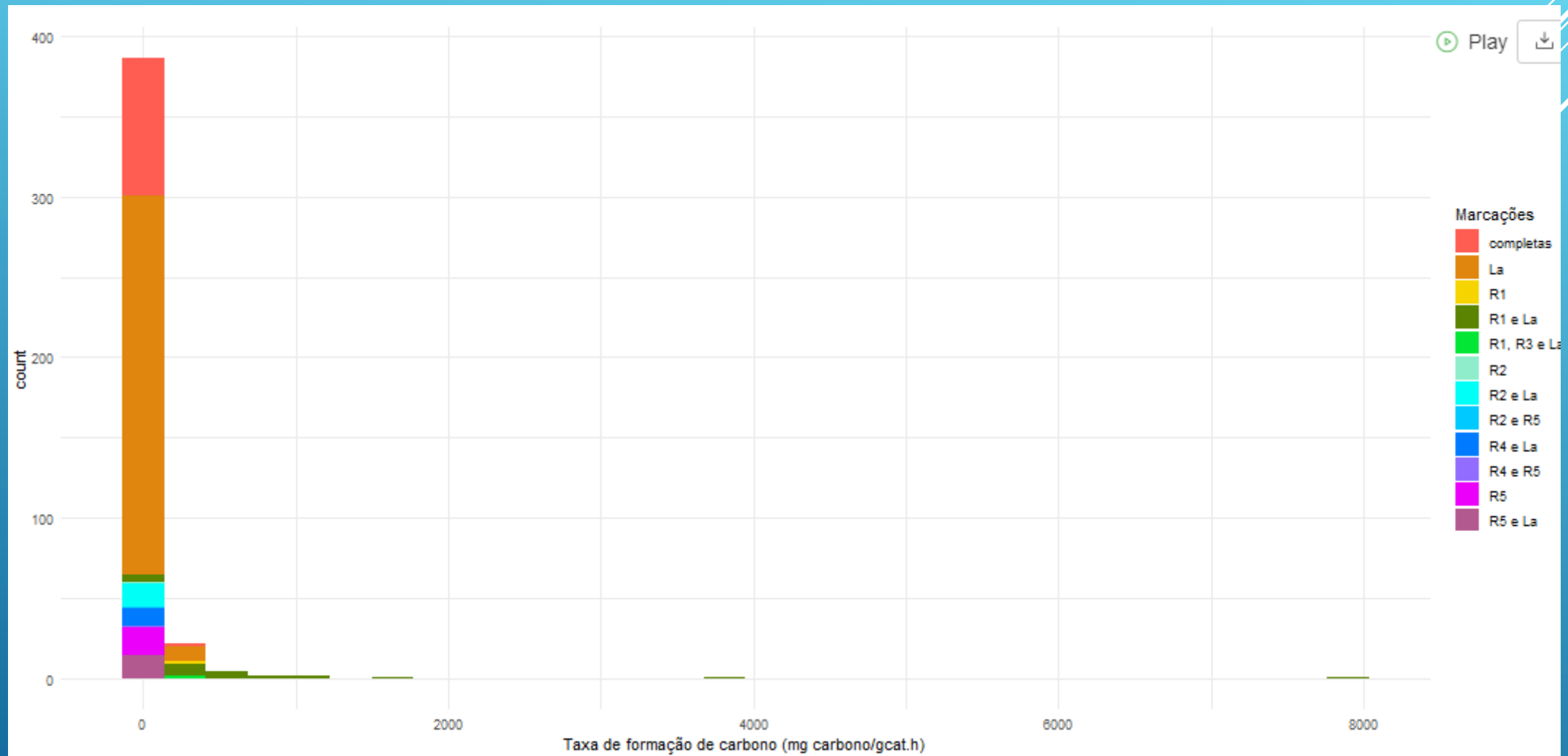
UNIVERSIDADE FEDERAL FLUMINENSE
ESCOLA DE ENGENHARIA
DEPARTAMENTO DE ENGENHARIA QUÍMICA E DE PETRÓLEO

RESULTADOS ANÁLISE EXPLORATÓRIA DE DADOS DO PROCESSO DE REFORMA DO METANO

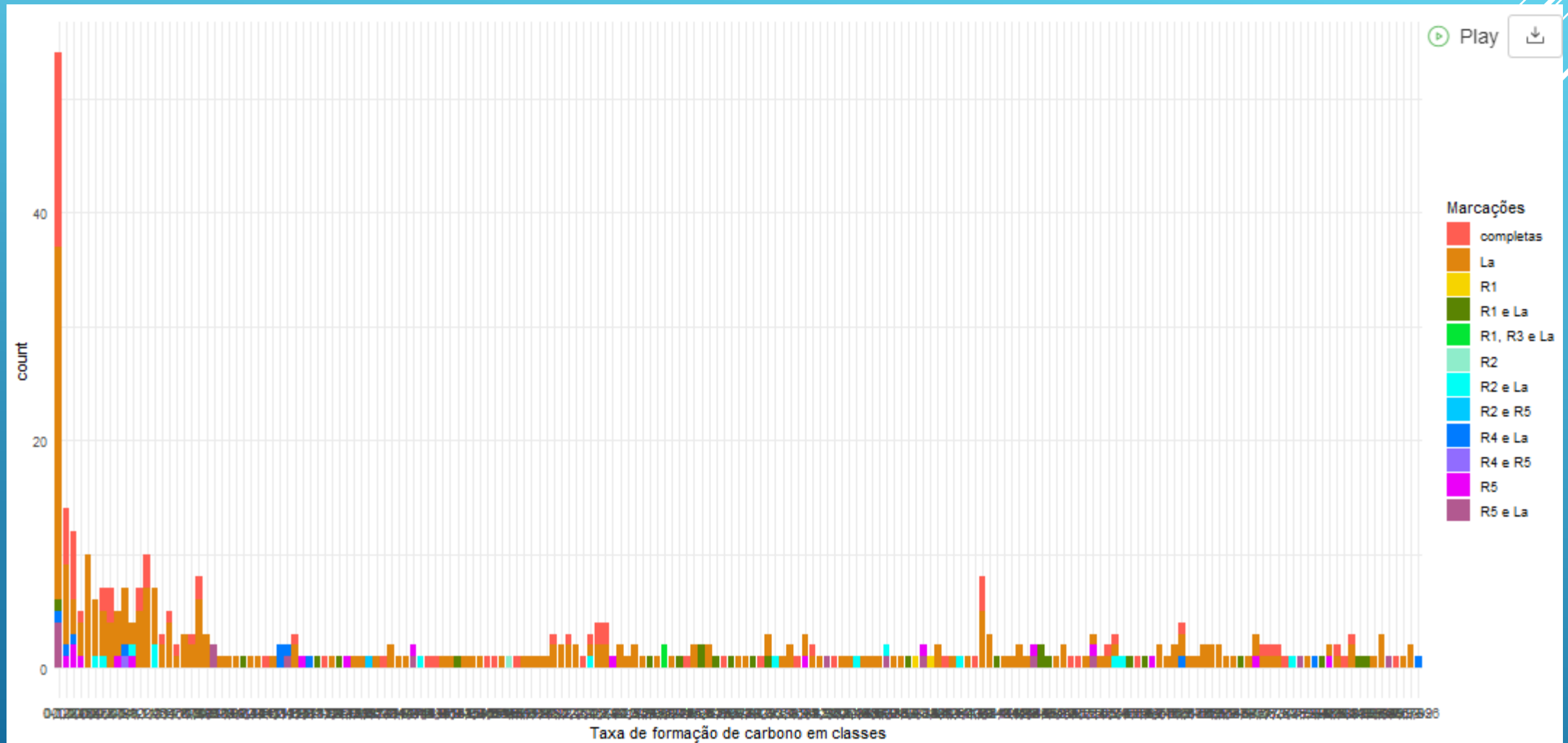
ALUNO : YAGO MIRANDA BENITES
ORIENTADORES: LISIANE VEIGA MATTOS
JOÃO FELIPE MITRE DE ARAUJO

Dados da planilha taxa de formação data_dt. As correlações foram afetadas pelas muitas lacunas existentes.

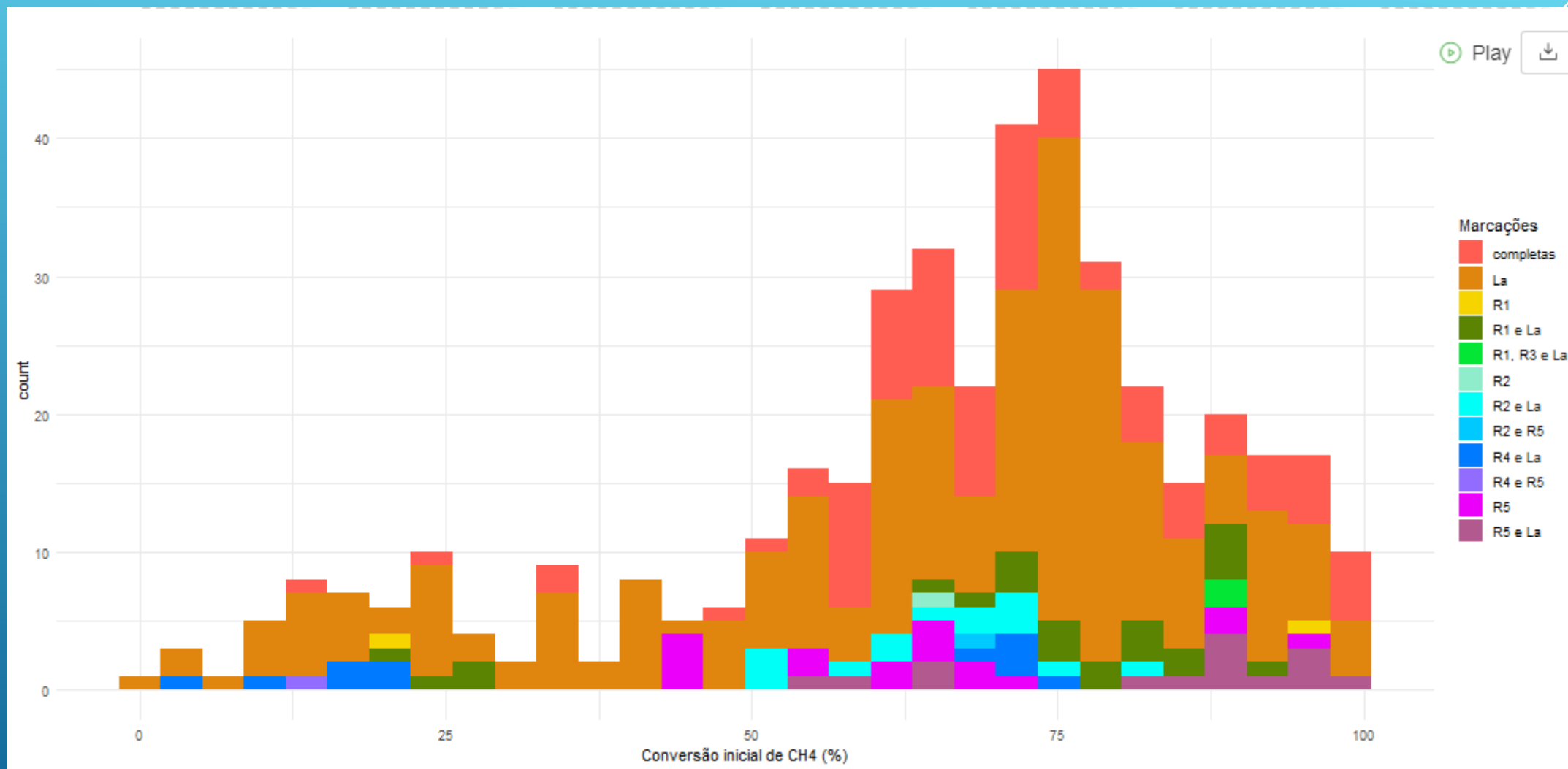




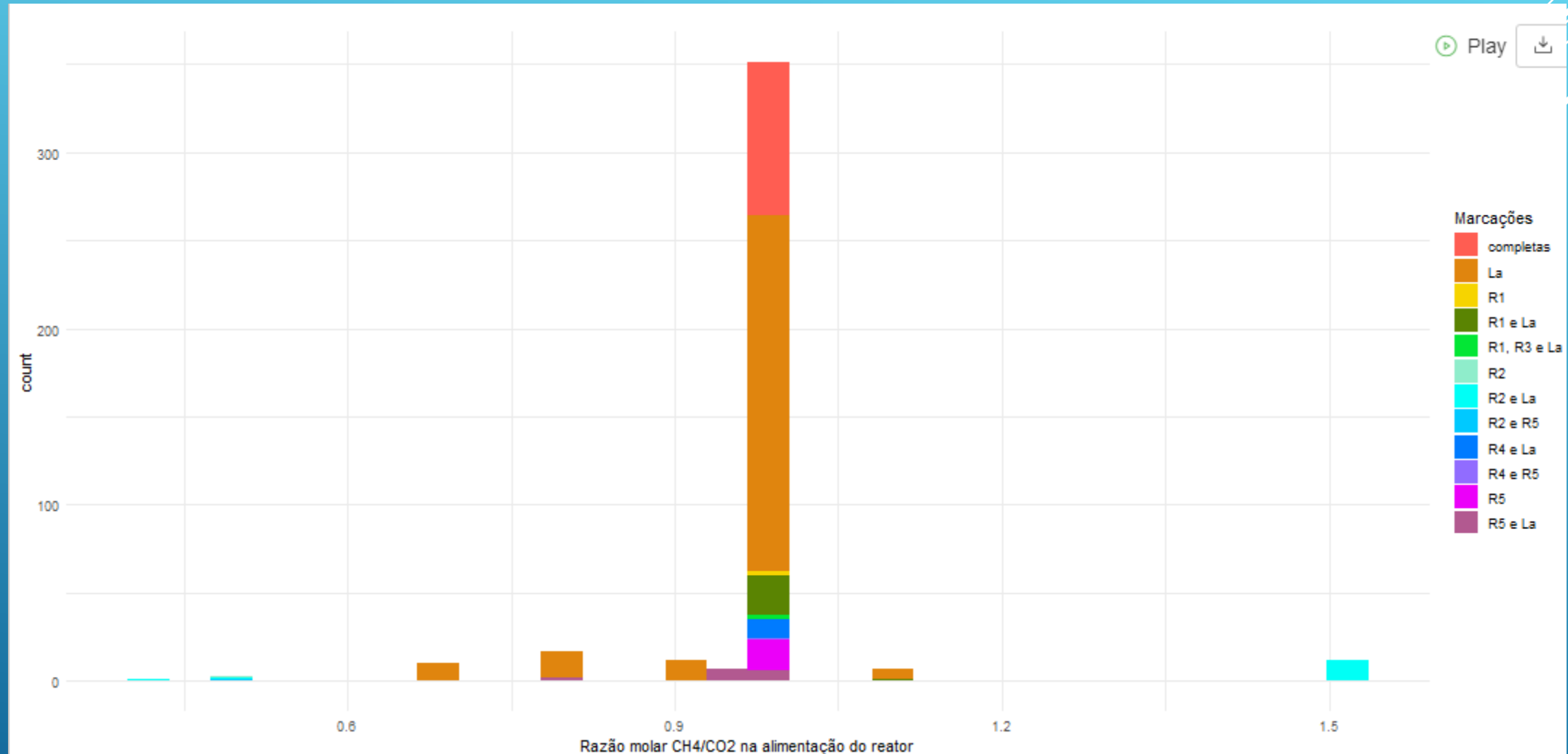
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



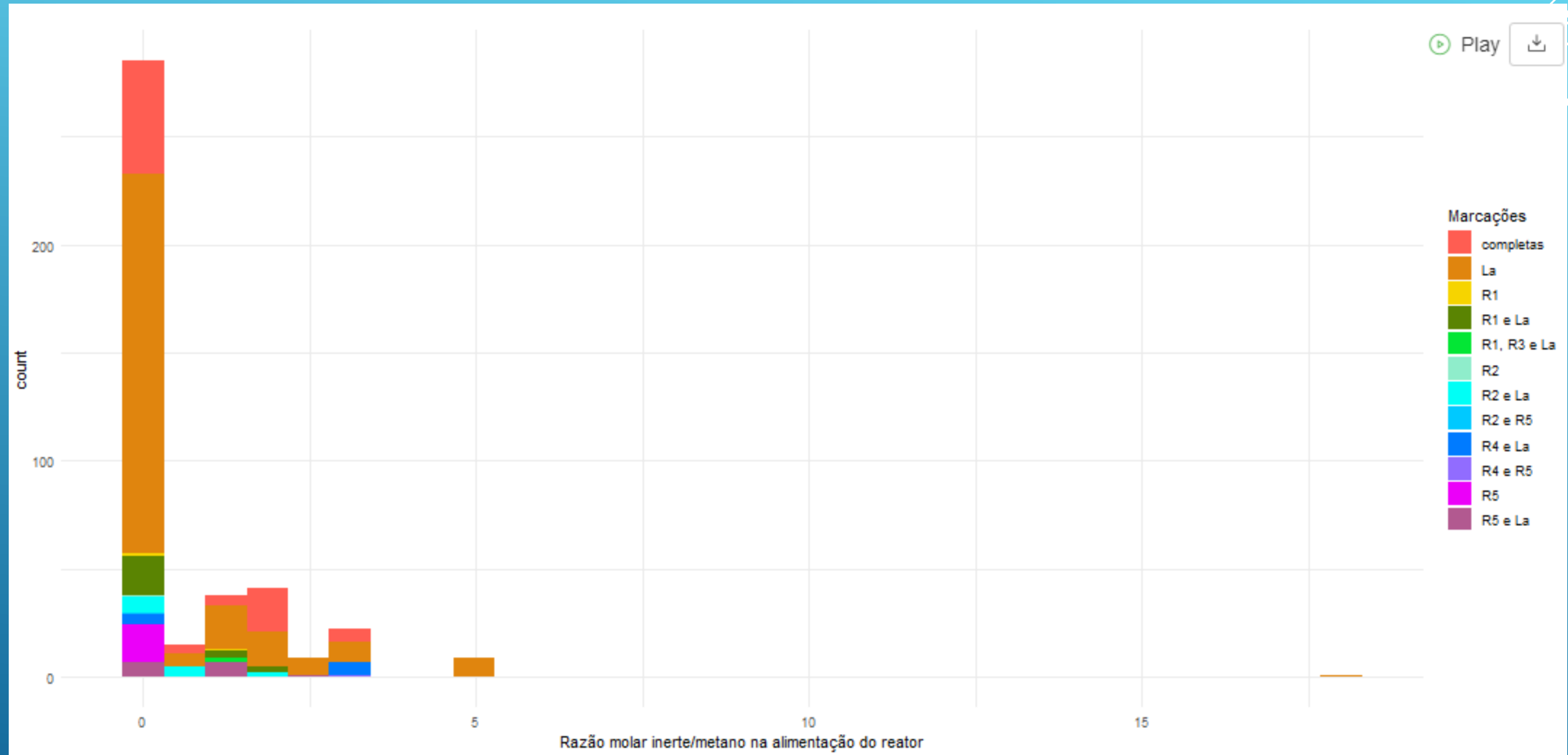
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



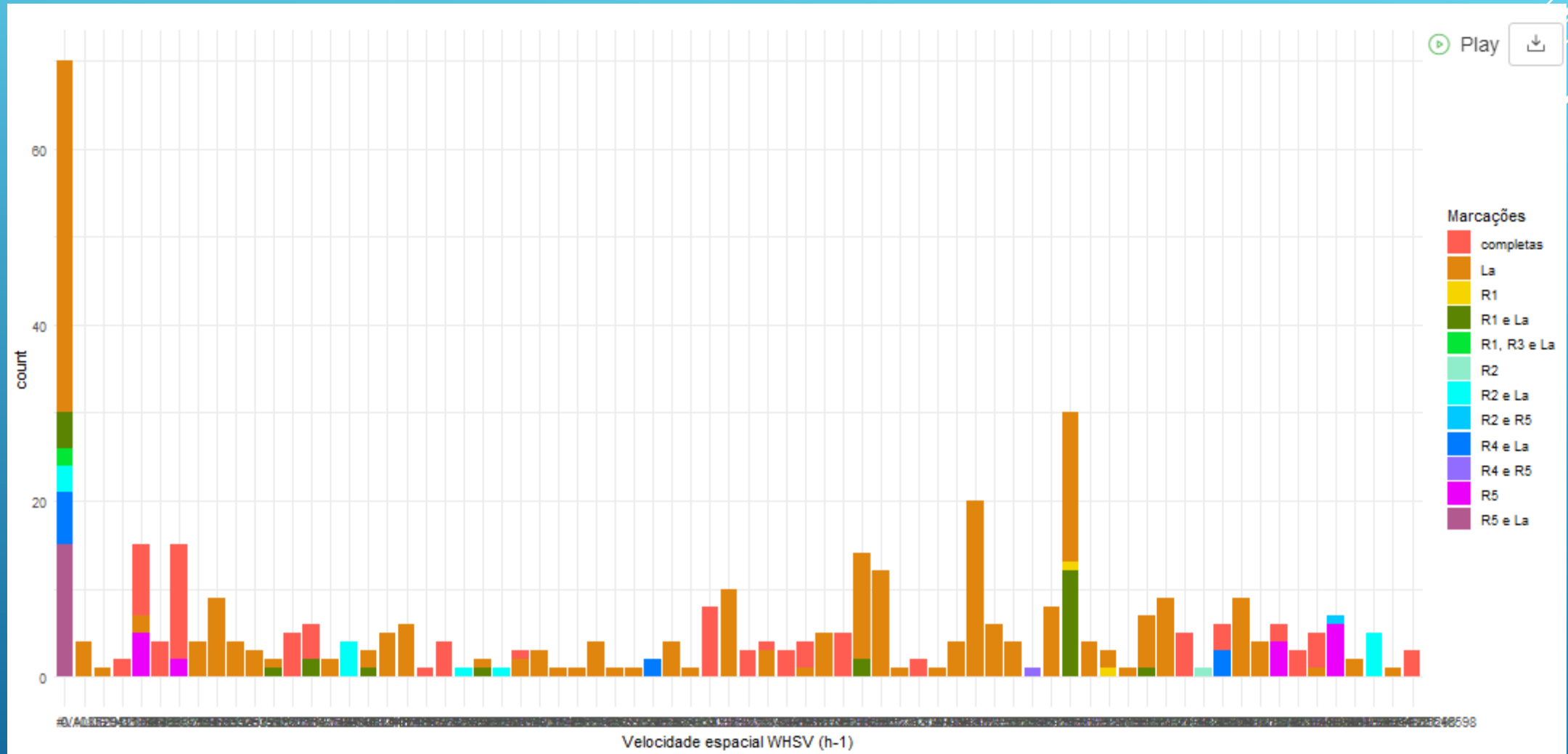
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



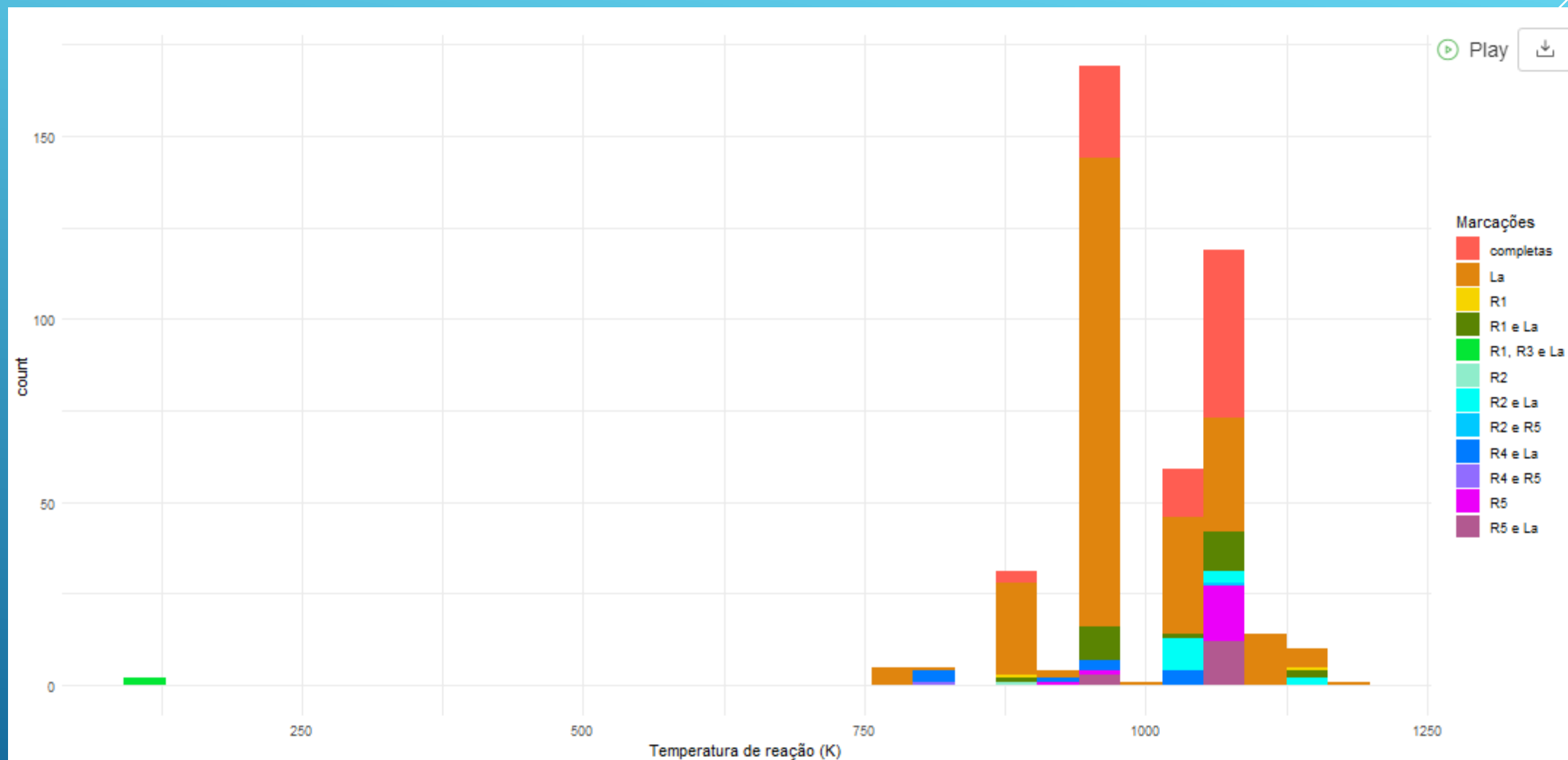
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



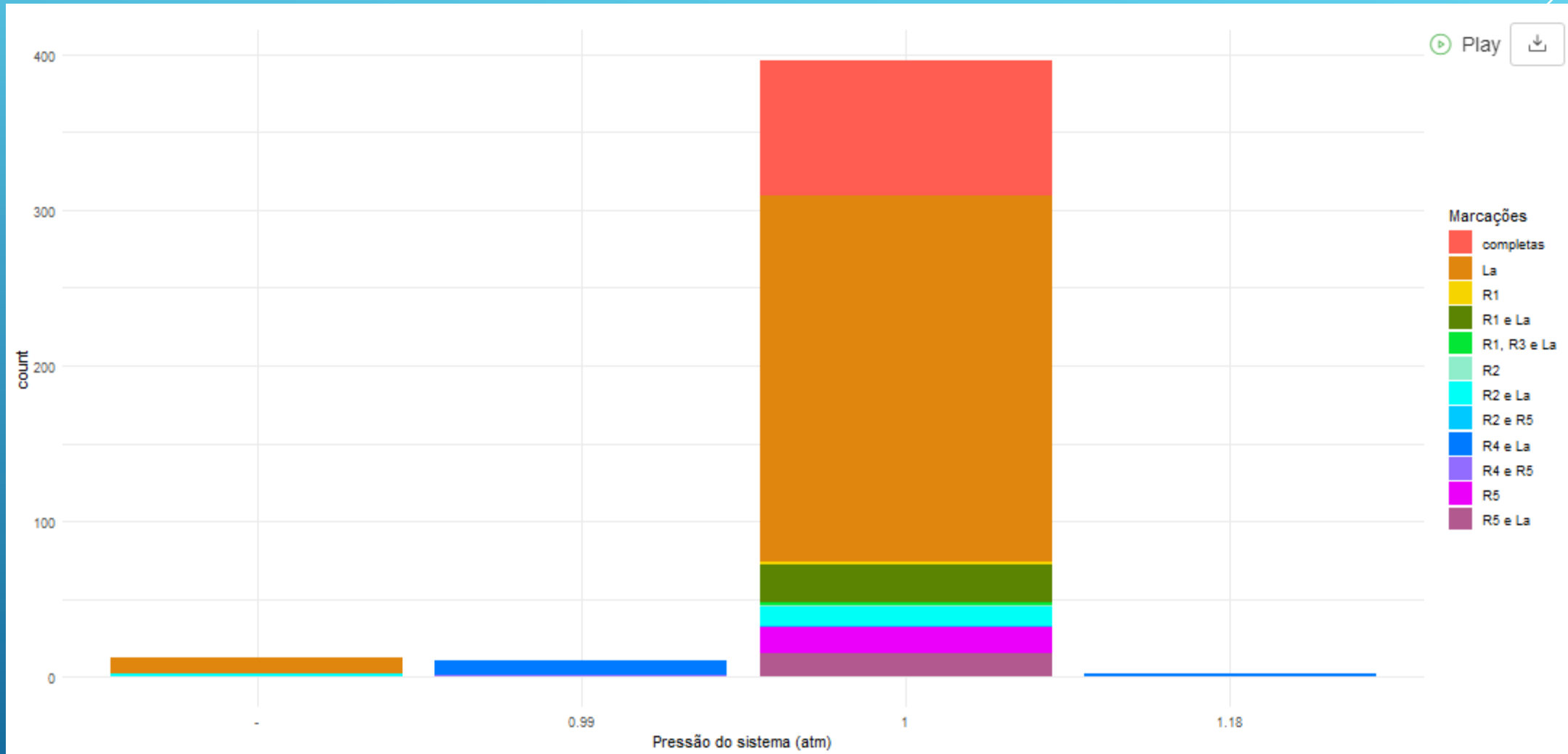
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



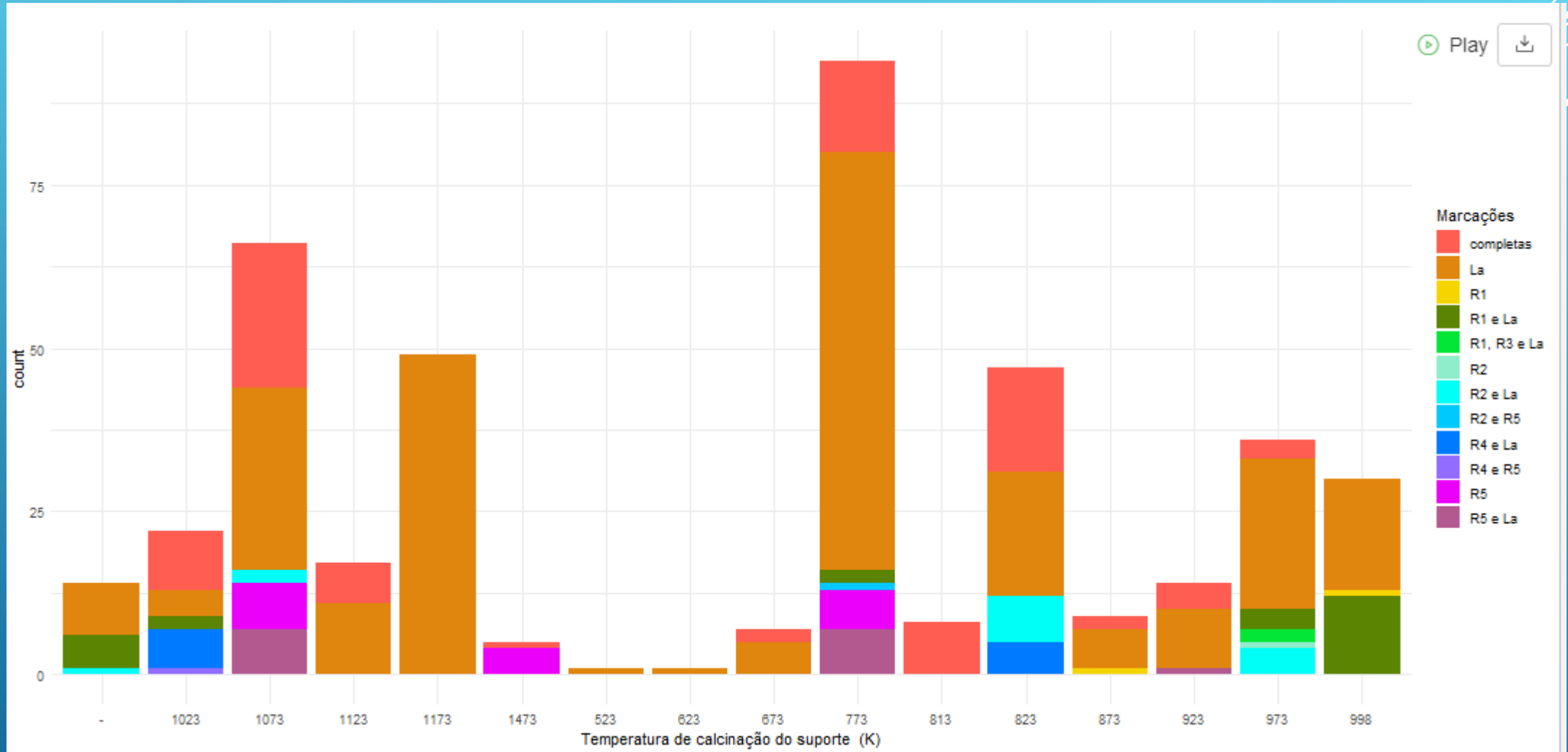
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



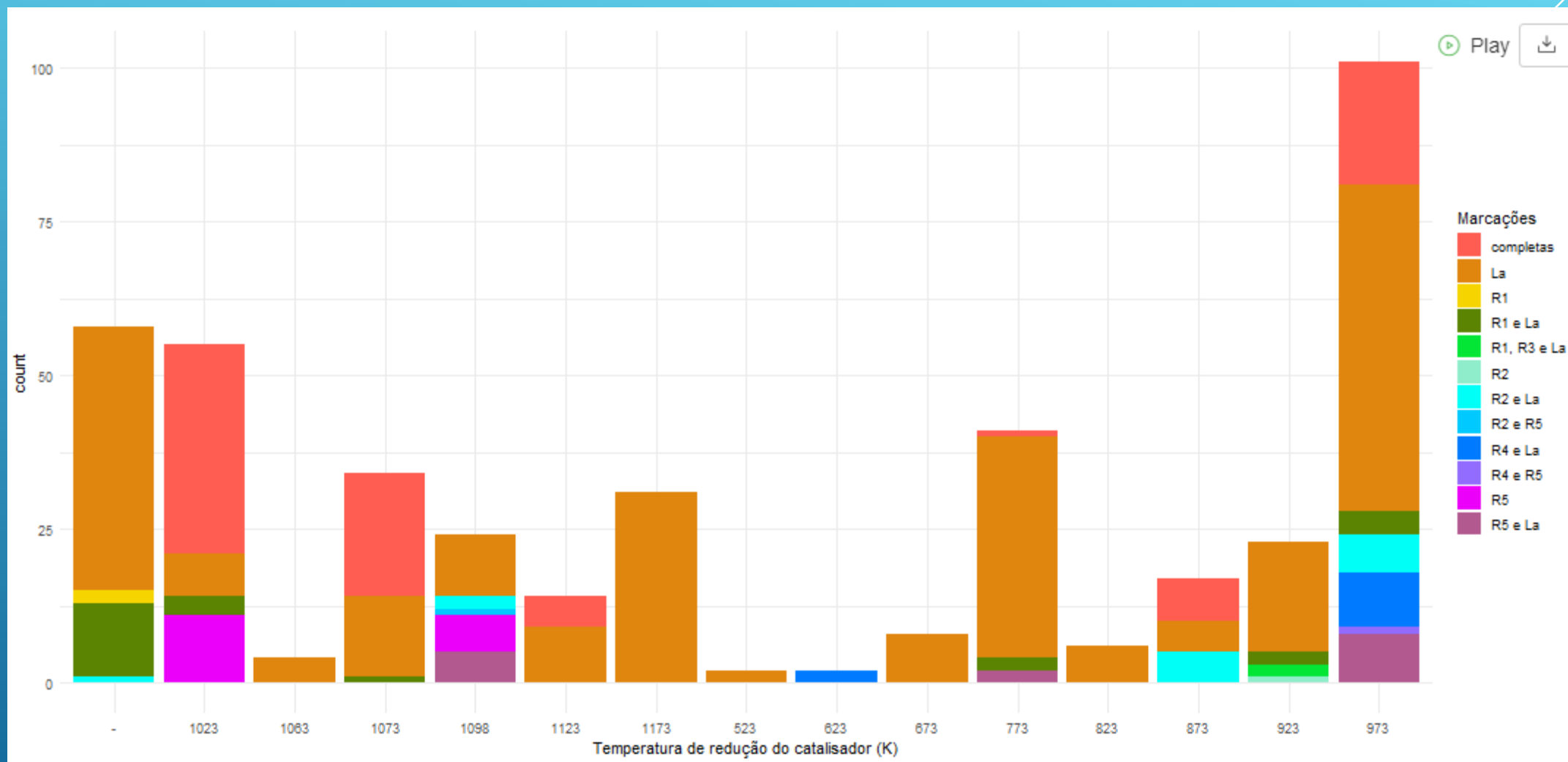
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



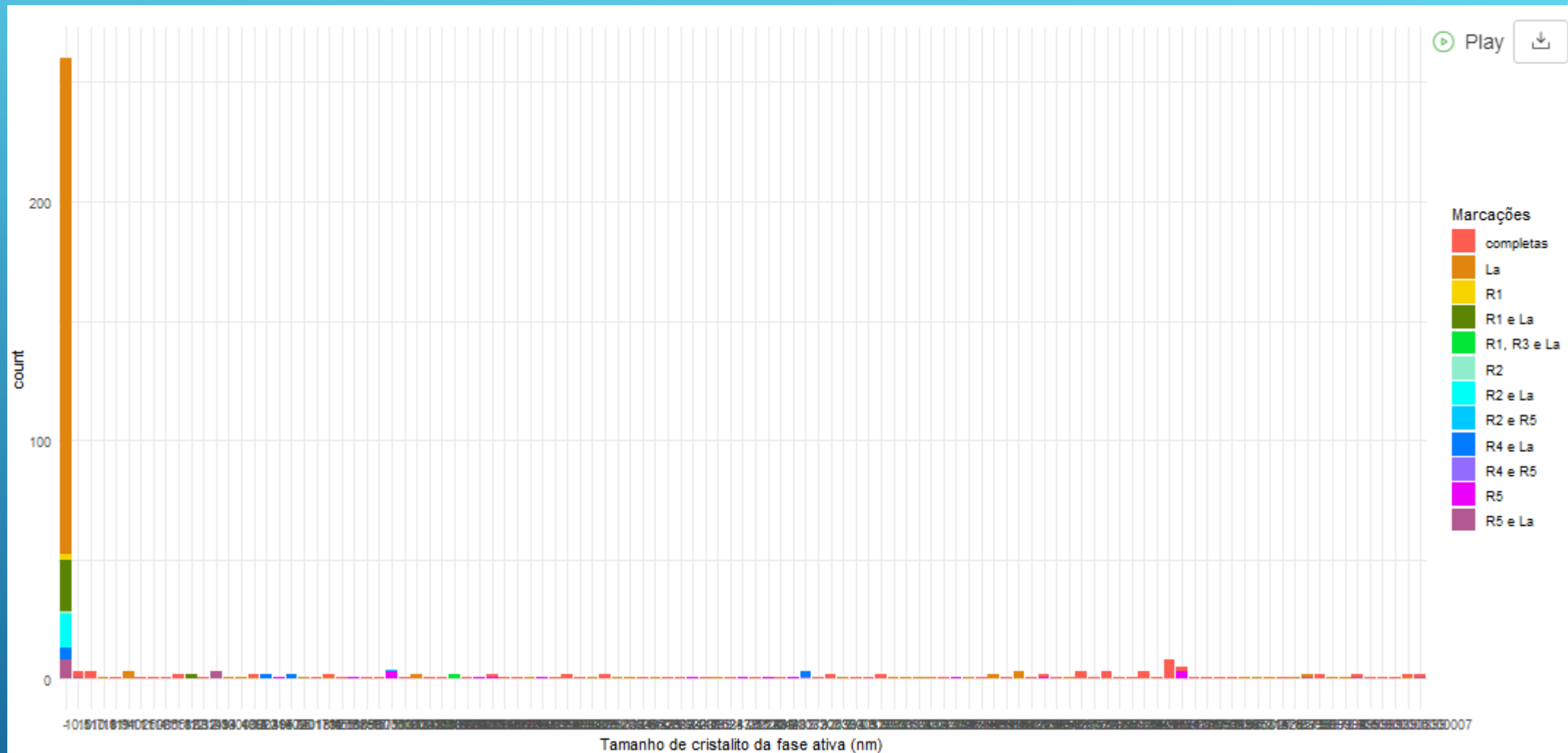
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



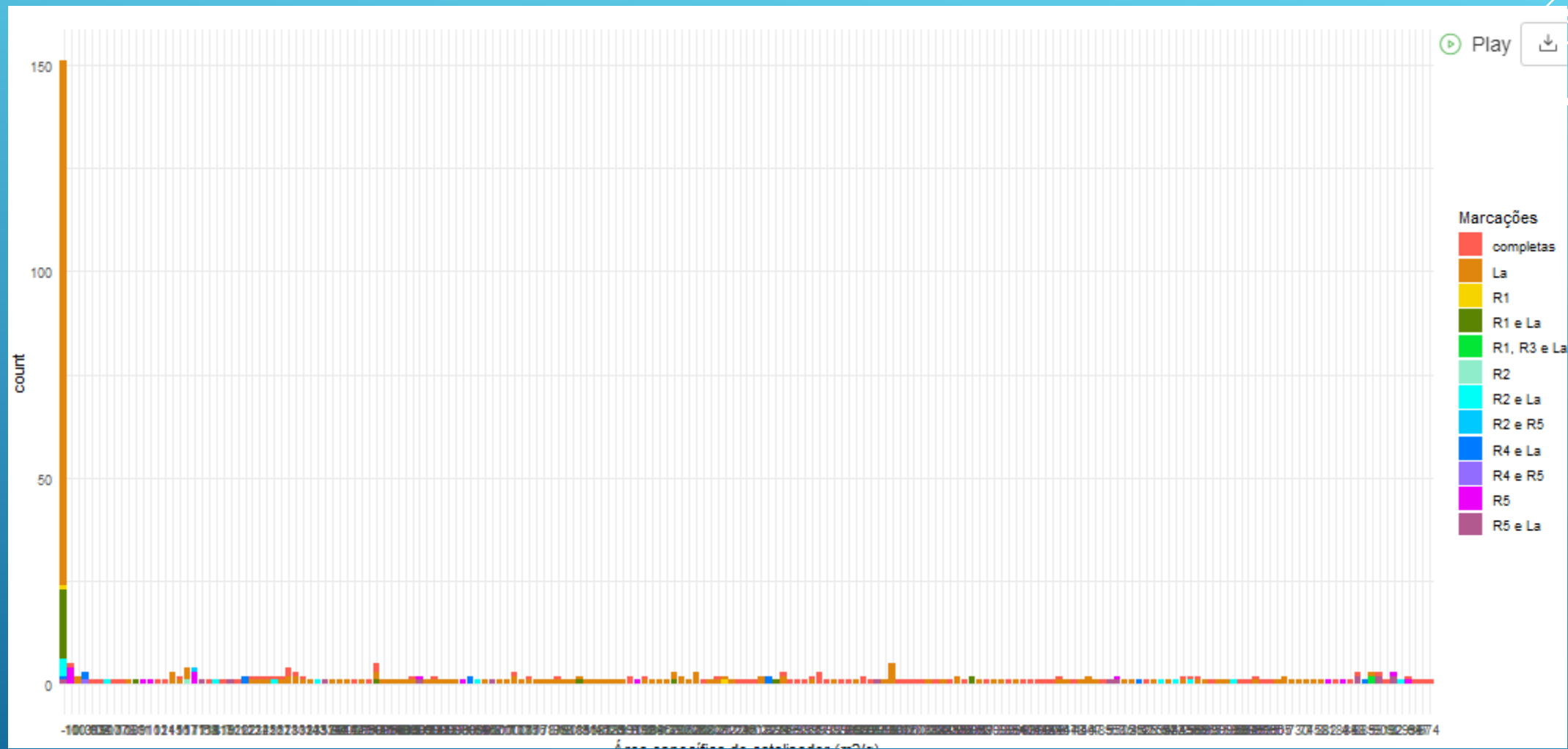
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



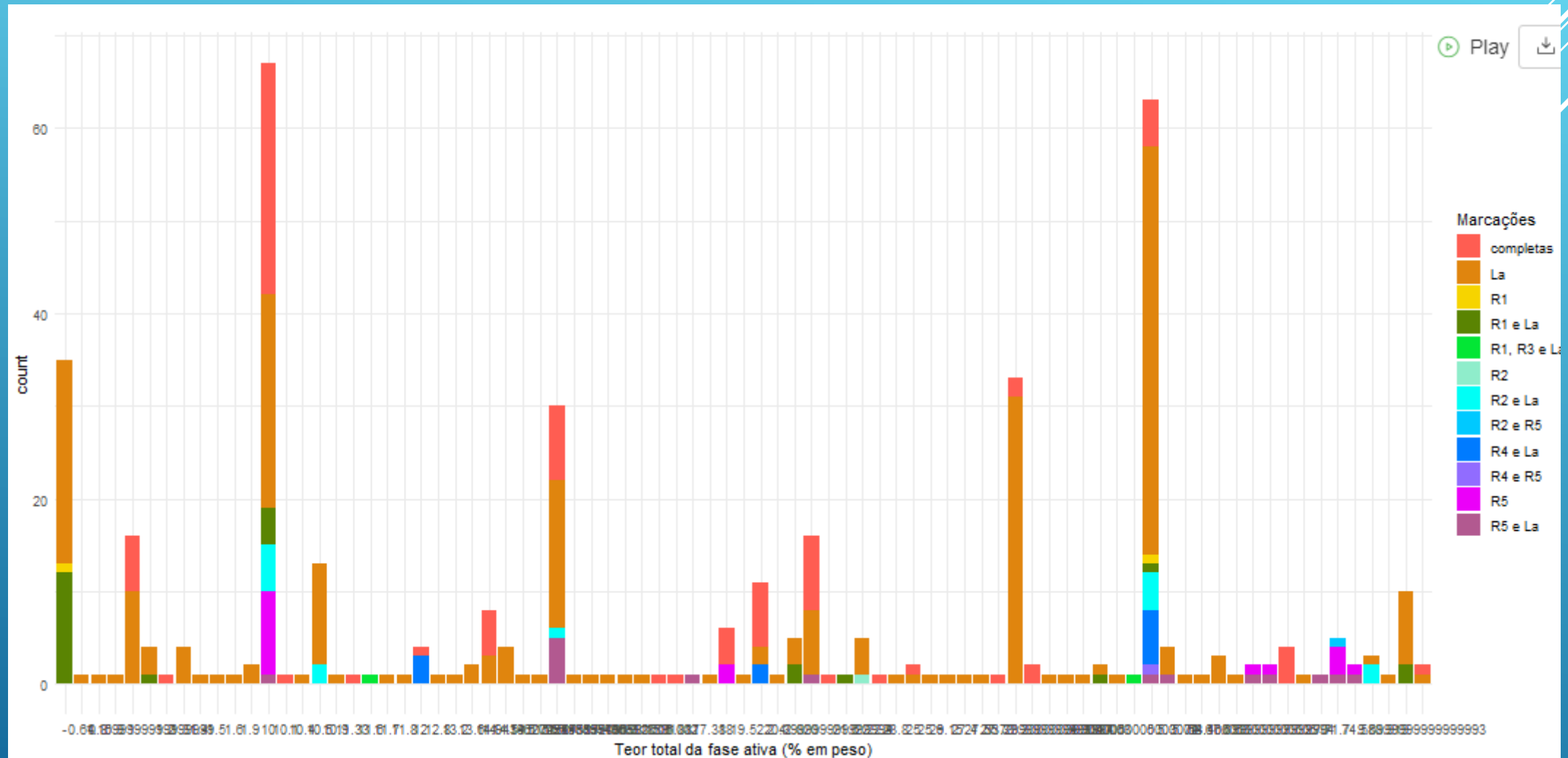
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



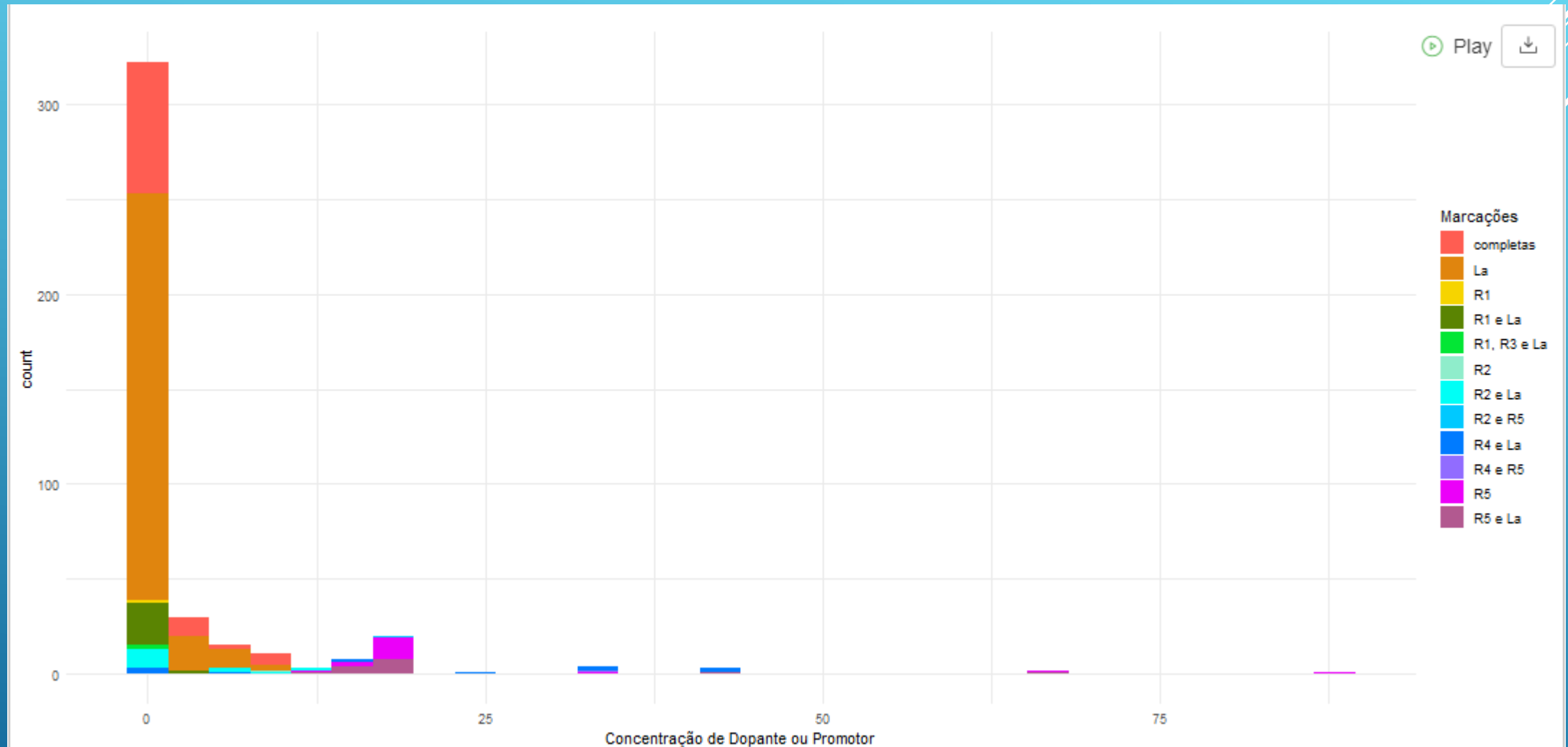
R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna



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R1 Taxa de formação de carbono Valores superiores a 200; R2 Razão molar de alimentação Inferior a 0,6 e superior a 1,2; R3 Temperatura de reação inferior a 750; R4 Pressão do sistema diferente de 1 (Variável se torna unitária vai ser retirada); R5 Concentração dopante ou promotor superior a 12,5; La Lacuna

Suporte	Contagem de Suporte
Al ₂ O ₃	180
CeO ₂	49
Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5}	25
SiO ₂	23
Hidrotalcita	15
Al ₂ O ₃ CeO ₂	14
SBA-15	10
MCM-41	8
ZSM-5	8
HZSM-5	7
MgO	7
ZrO ₂	6
TiO ₂	5
BaTiO ₃ Al ₂ O ₃	4
La ₂ NiO ₄ γ-Al ₂ O ₃	4
Zeólita Silicalite	4
CeZrO ₂	3
MgO ZrO ₂	3
TiO ₂ SiO ₂	3
Zeólita-Y	3
La _{0.8} Sr _{0.2} Ni _{0.8} Co _{0.2} O ₃	2
La _{0.8} Sr _{0.2} Ni _{0.8} Cr _{0.2} O ₃	2
La _{0.8} Sr _{0.2} Ni _{0.8} Cu _{0.2} O ₃	2
Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5} YSZ	2
SiO ₂ (ITQ-6)	2
ZSM	2
γ-Al ₂ O ₃	2
AlSBA-15	1
BaTiO ₃	1
CeSiO ₂ LaNiO ₃	1
Co-Al-Mg-O	1
CoCeOx	1
CoEuOx	1
CoLaOx	1
Total	420

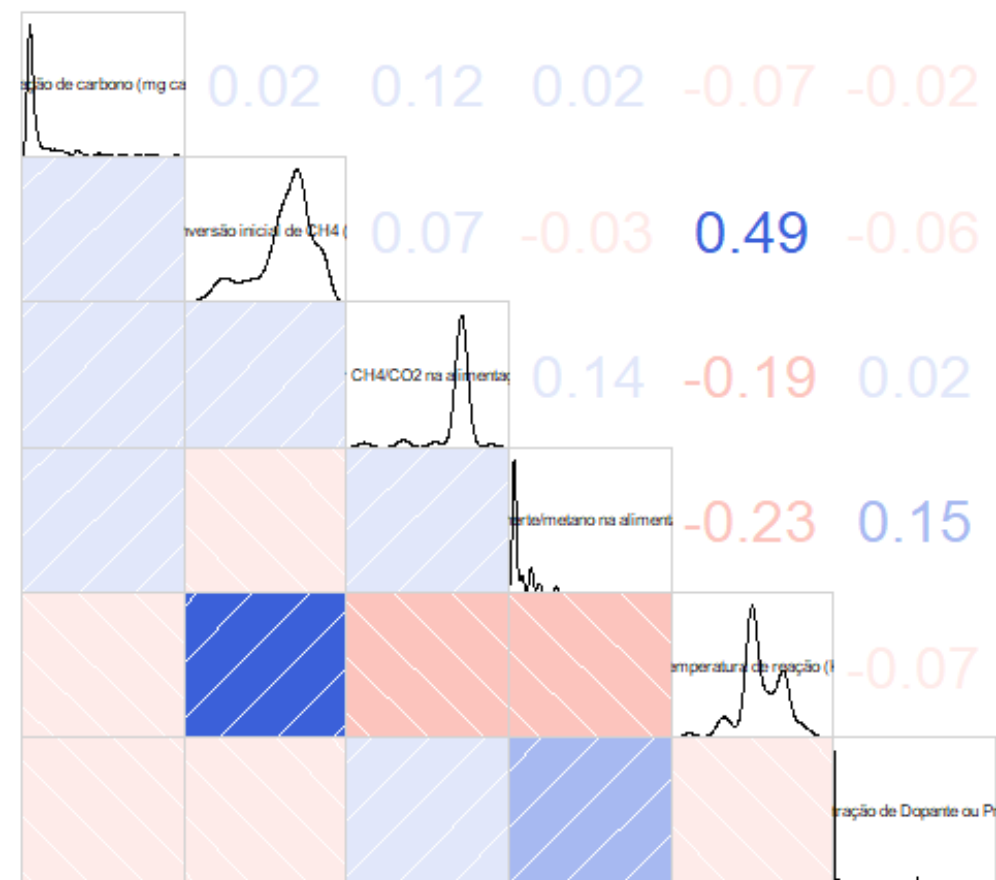
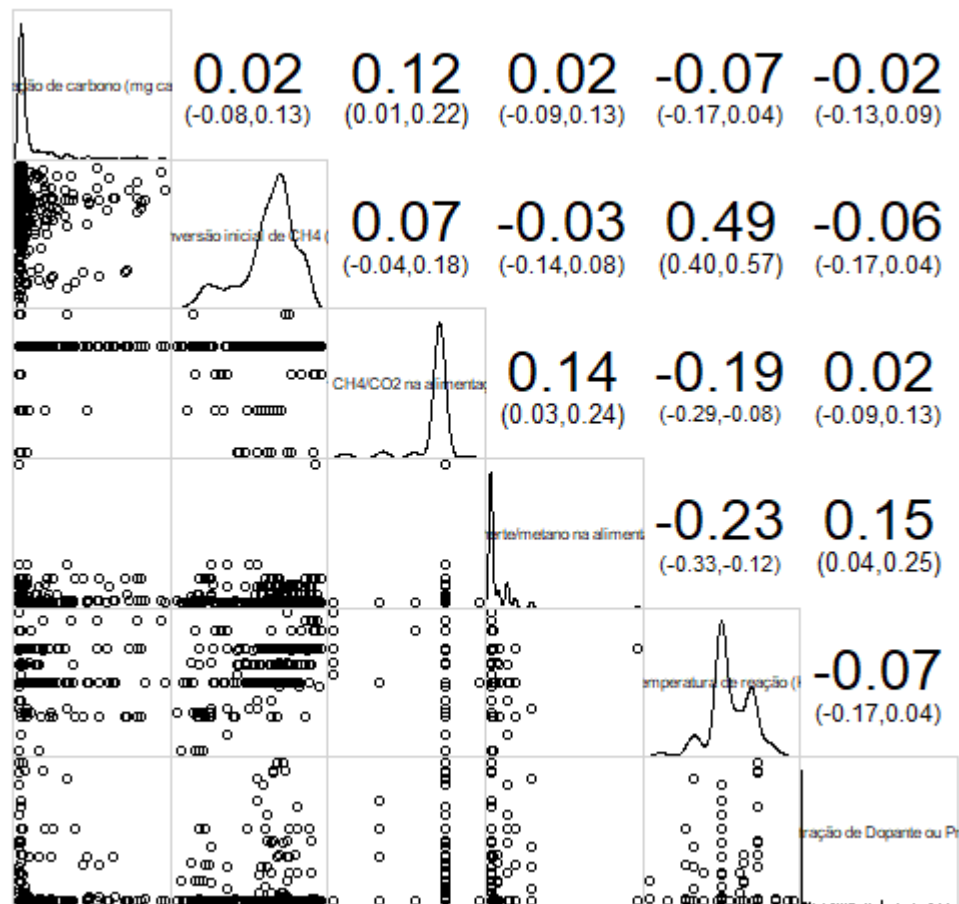
CoLaOx	1
CoSmOx	1
CoYbOx	1
GdCe Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5}	1
La _{0.8} Sr _{0.2} NiO ₃	1
LaNiO ₃	1
LaNiO ₃ Al ₂ O ₃	1
Ni-Al-Mg-O	1
Ni-Co-Al-Mg-O	1
Ni-Cu-Al-Mg-O	1
Ni-Fe-Al-Mg-O	1
NiMgOx	1
Ni-Mn-Al-Mg-O	1
SiO ₂ MCM-41	1
SrCe Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5}	1
ThO ₂	1
Y ₂ O ₃	1
YCe Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5}	1
ZSM-15	1
Total	420

Fase Ativa	Contagem de Fase Ativa
Ni	328
Ni Co	20
Co	16
Cu Ni	13
Mo Ni	10
Pt	9
Pd	5
Rh	5
Pt Ni	3
Rh Ni	3
Cr Ni	2
Ru	2
Ca Ni	1
K Ni	1
Mn Ni	1
Sn Ni	1
Total	420

Dopante ou Promotor	Contagem de Dopante ou Promotor
none	282
Zr	25
Gd	18
Ce	13
Ca	11
Pr	11
Ca Ce	8
V	8
Yb	8
La	6
Nb	5
K	4
Mn Zr	4
Mn	3
Y	3
Ce Zr	2
Mg	2
Sm	2
Sn	2
Co	1
Rh	1
Rh La	1
Total	420

Análise retirando os dados pouco relevantes

database 332 obs. of 19 variables



Fase Ativa	Contagem de Fase Ativa
Ni	260
Ni Co	19
Co	15
Mo Ni	10
Pt	9
Pd	5
Pt Ni	3
Rh Ni	3
Rh	2
Ru	2
Ca Ni	1
K Ni	1
Mn Ni	1
Sn Ni	1
Total	332

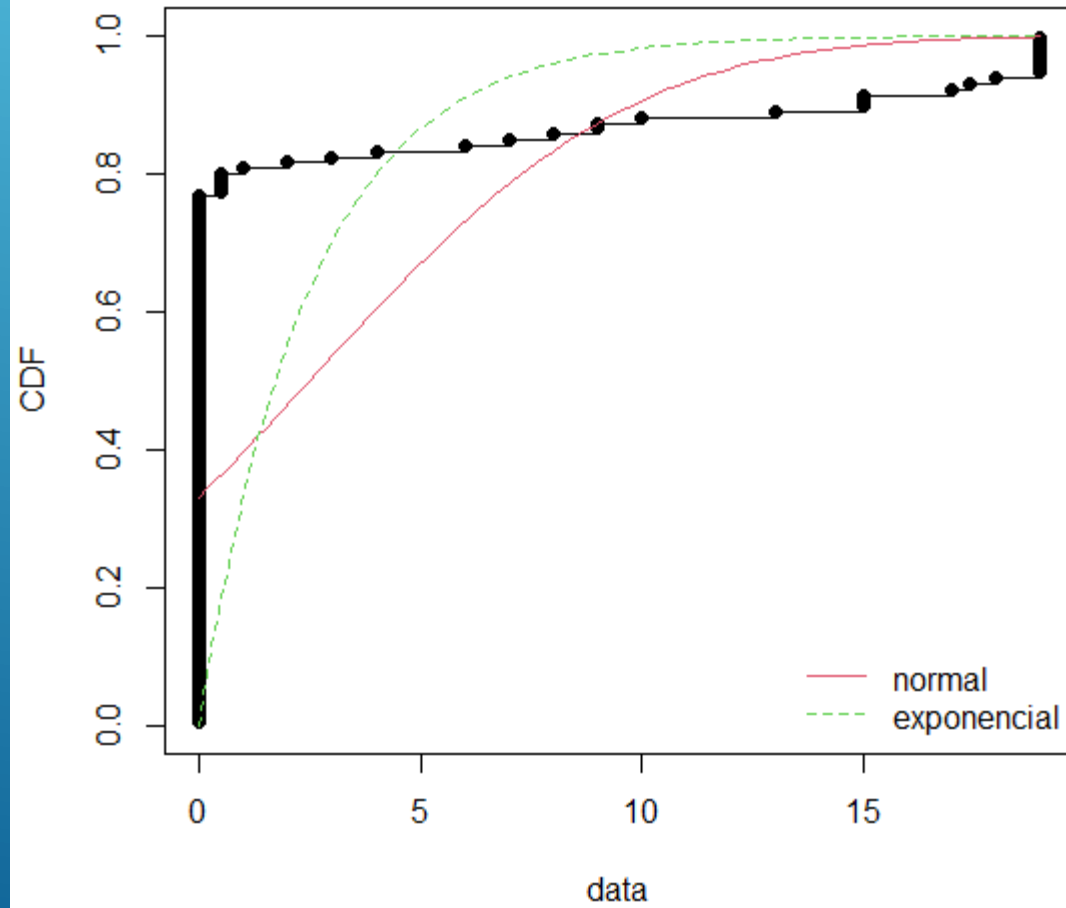
Dopante ou Promotor	Contagem de Dopante ou Promotor
none	246
Zr	12
Ca	10
Ca Ce	8
Ce	8
Yb	8
V	7
Gd	5
Mn Zr	4
K	3
La	3
Mn	3
Nb	3
Ce Zr	2
Mg	2
Pr	2
Sn	2
Y	2
Co	1
Sm	1
Total	332

Suporte	Contagem de Suporte
Al ₂ O ₃	166
SiO ₂	19
Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5}	17
Al ₂ O ₃ CeO ₂	13
CeO ₂	10
Hidrotalcita	9
MCM-41	8
HZSM-5	7
SBA-15	7
ZSM-5	7
MgO	6
TiO ₂	5
ZrO ₂	5
BaTiO ₃ Al ₂ O ₃	4
La ₂ NiO ₄ γ-Al ₂ O ₃	4
Zeólita Silicalite	4
CeZrO ₂	3
MgO ZrO ₂	3
TiO ₂ SiO ₂	3
Zeólita-Y	3
La _{0.8} Sr _{0.2} Ni _{0.8} Co _{0.2} O ₃	2
SiO ₂ (ITQ-6)	2
ZSM	2
AlSBA-15	1
BaTiO ₃	1
CeSiO ₂ LaNiO ₃	1
Co-Al-Mg-O	1
CoCeOx	1
CoEuOx	1
CoLaOx	1
CoSmOx	1
CoYbOx	1

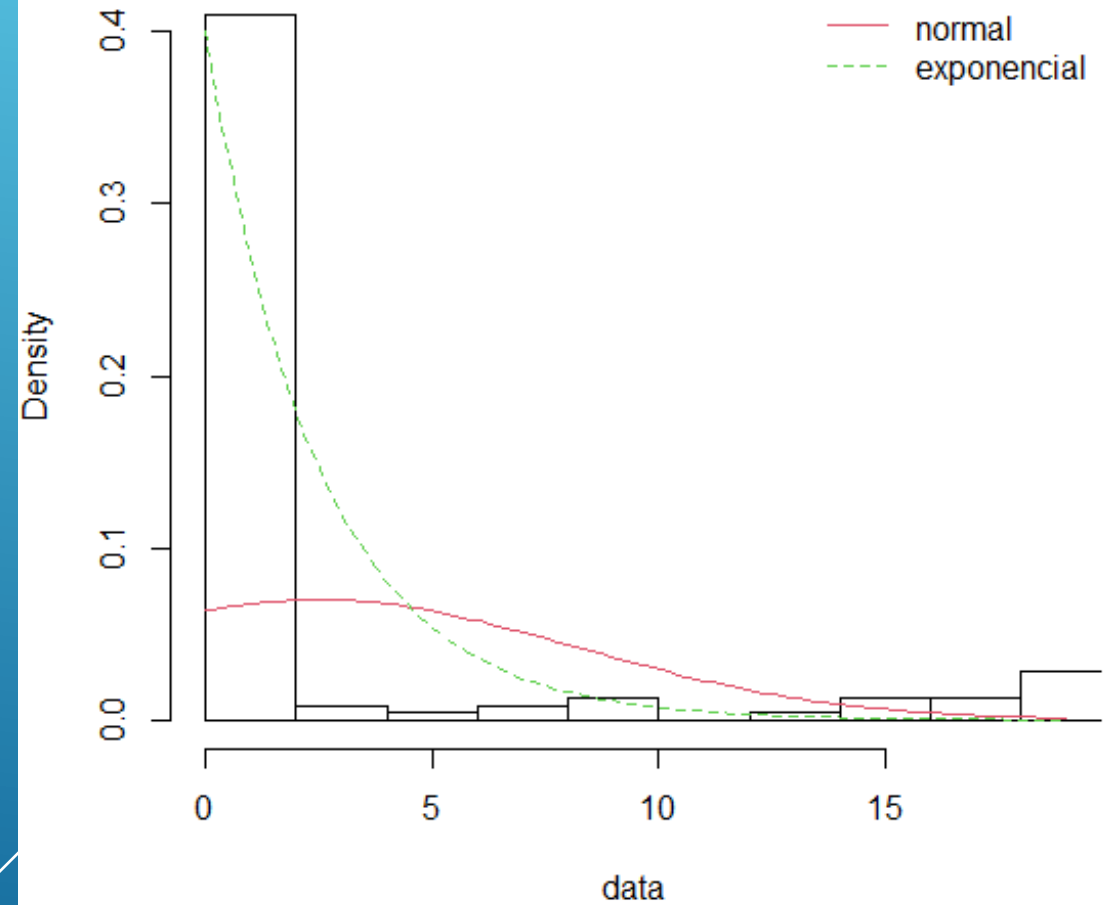
CoYbOx	1
La _{0.8} Sr _{0.2} NiO ₃	1
LaNiO ₃	1
LaNiO ₃ Al ₂ O ₃	1
Ni-Al-Mg-O	1
Ni-Co-Al-Mg-O	1
Ni-Cu-Al-Mg-O	1
Ni-Fe-Al-Mg-O	1
NiMgOx	1
Ni-Mn-Al-Mg-O	1
SiO ₂ MCM-41	1
ThO ₂	1
Y ₂ O ₃	1
ZSM-15	1
γ-Al ₂ O ₃	1
Total	332

Taxa de formação de carbono

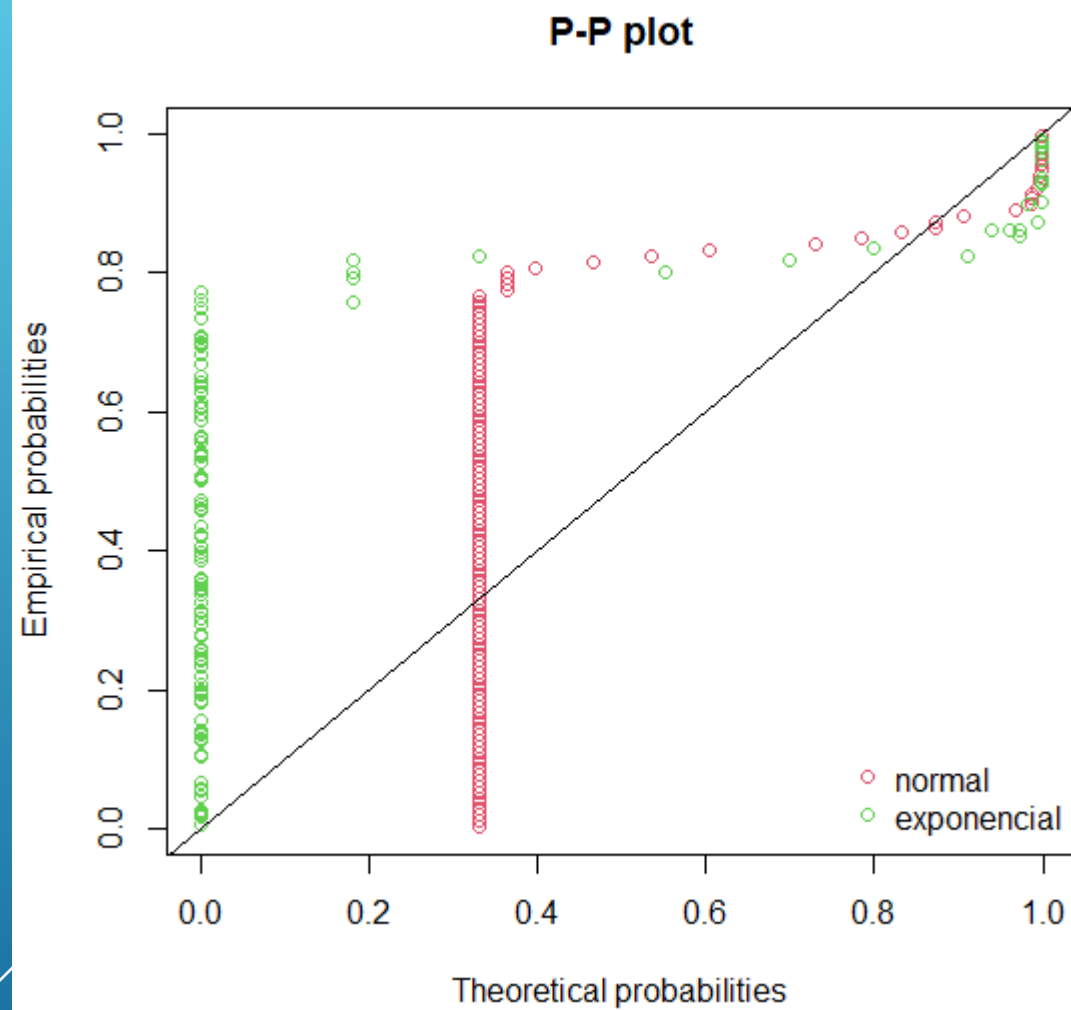
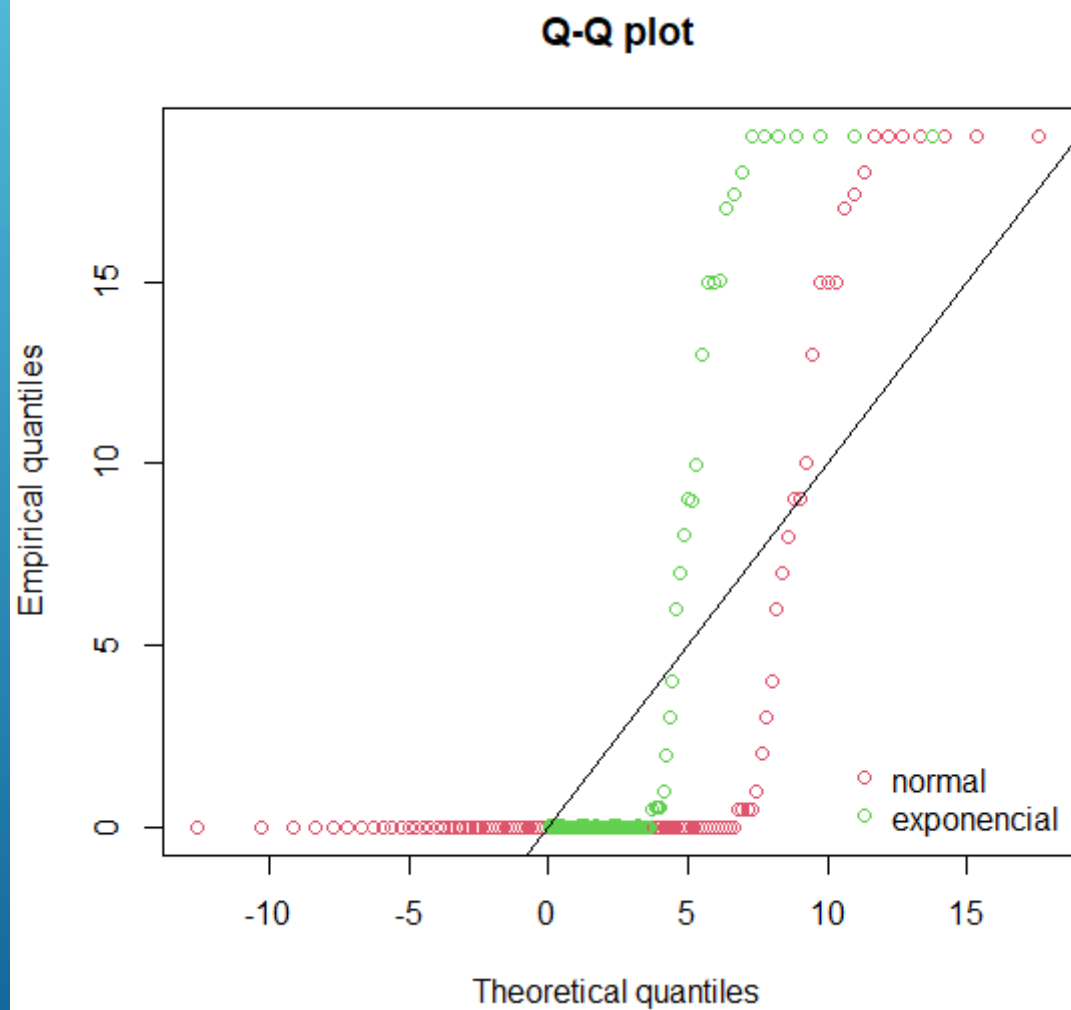
Empirical and theoretical CDFs



Histogram and theoretical densities



Taxa de formação de carbono



Taxa de formação de carbono

Goodness-of-fit statistics

	normal	exponencial
Kolmogorov-Smirnov statistic	0.4400241	0.7704918
Cramer-von Mises statistic	6.1352841	20.4951122
Anderson-Darling statistic	30.3742894	Inf

Goodness-of-fit criteria

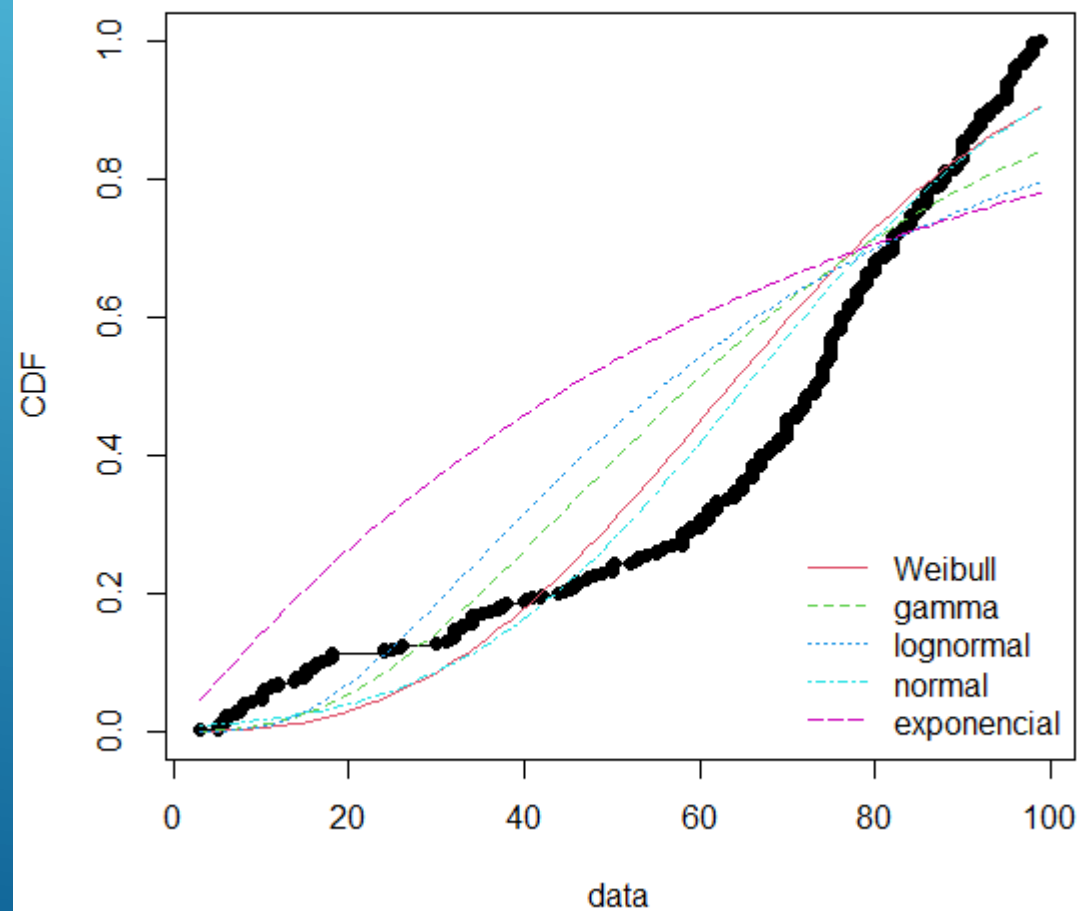
	normal	exponencial
Akaike's Information Criterion	775.0632	469.0945
Bayesian Information Criterion	780.6713	471.8985

Hartigans' dip test for unimodality / multimodality

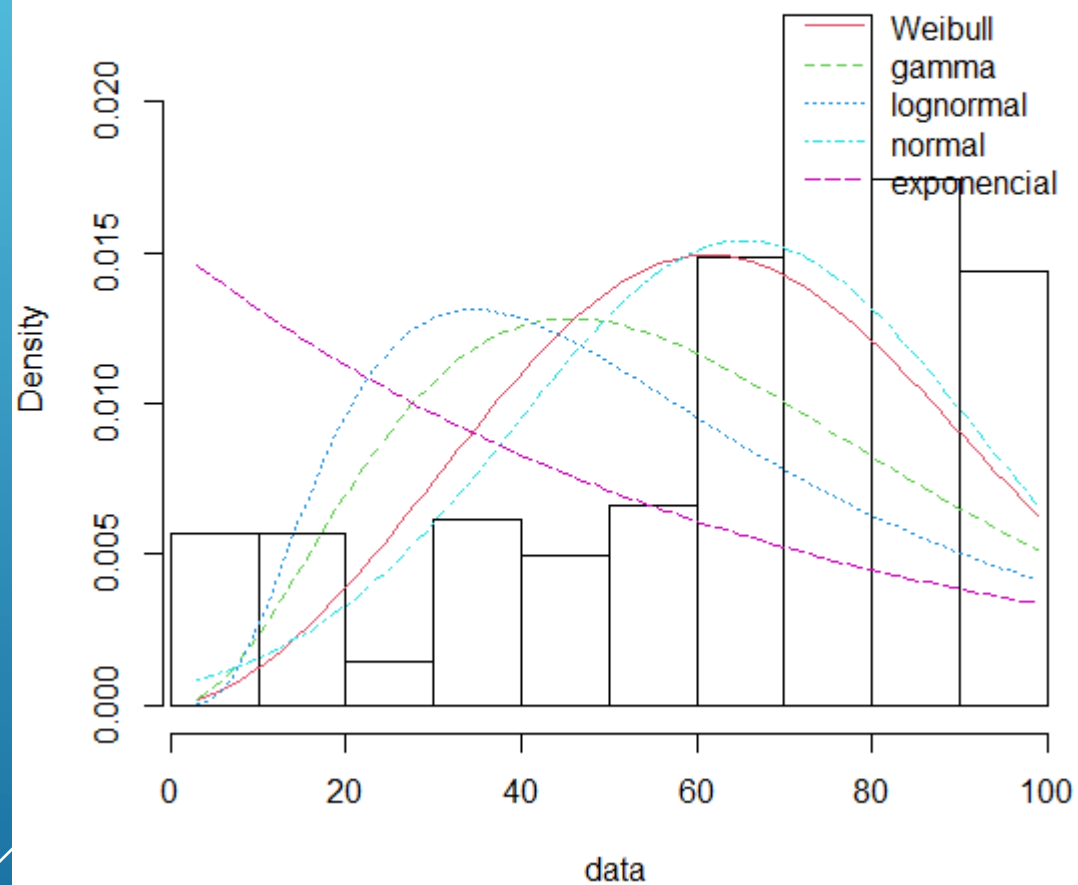
```
data: vari
D = 0.032332, p-value = 0.4955
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.915884
```

Empirical and theoretical CDFs

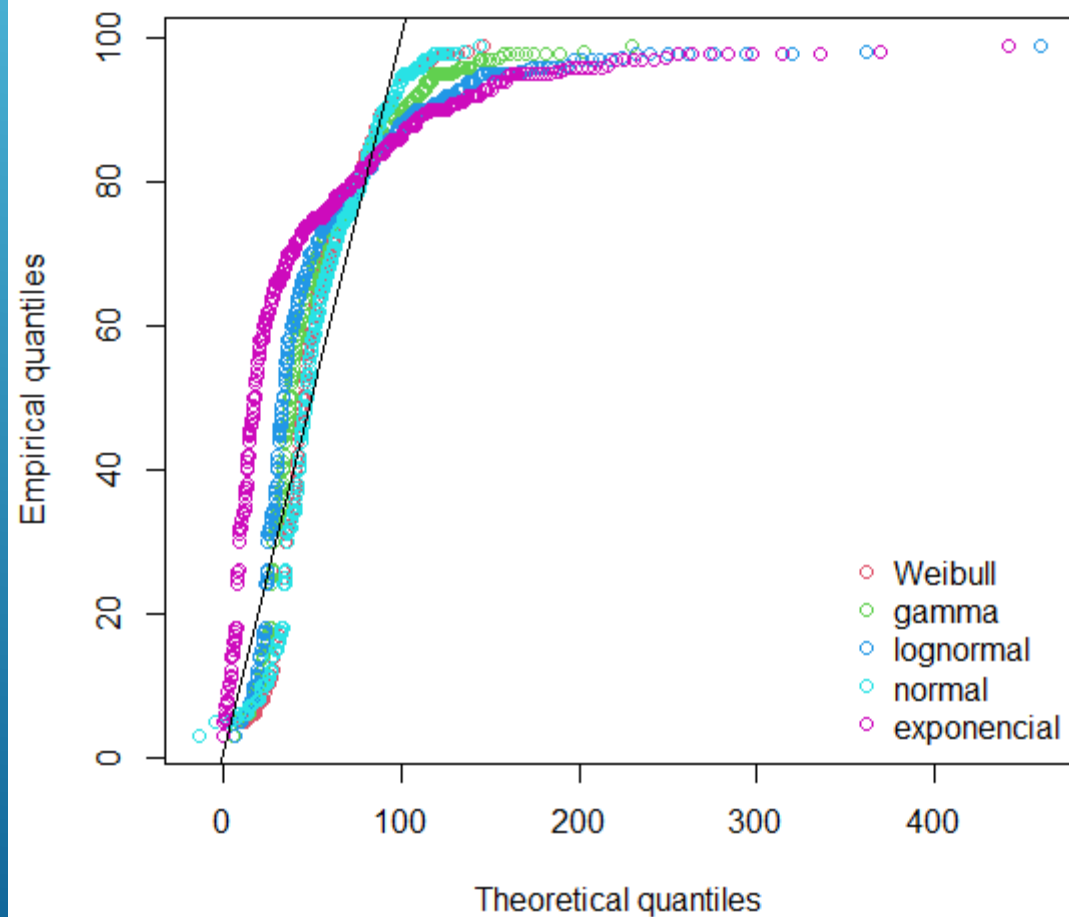


Histogram and theoretical densities

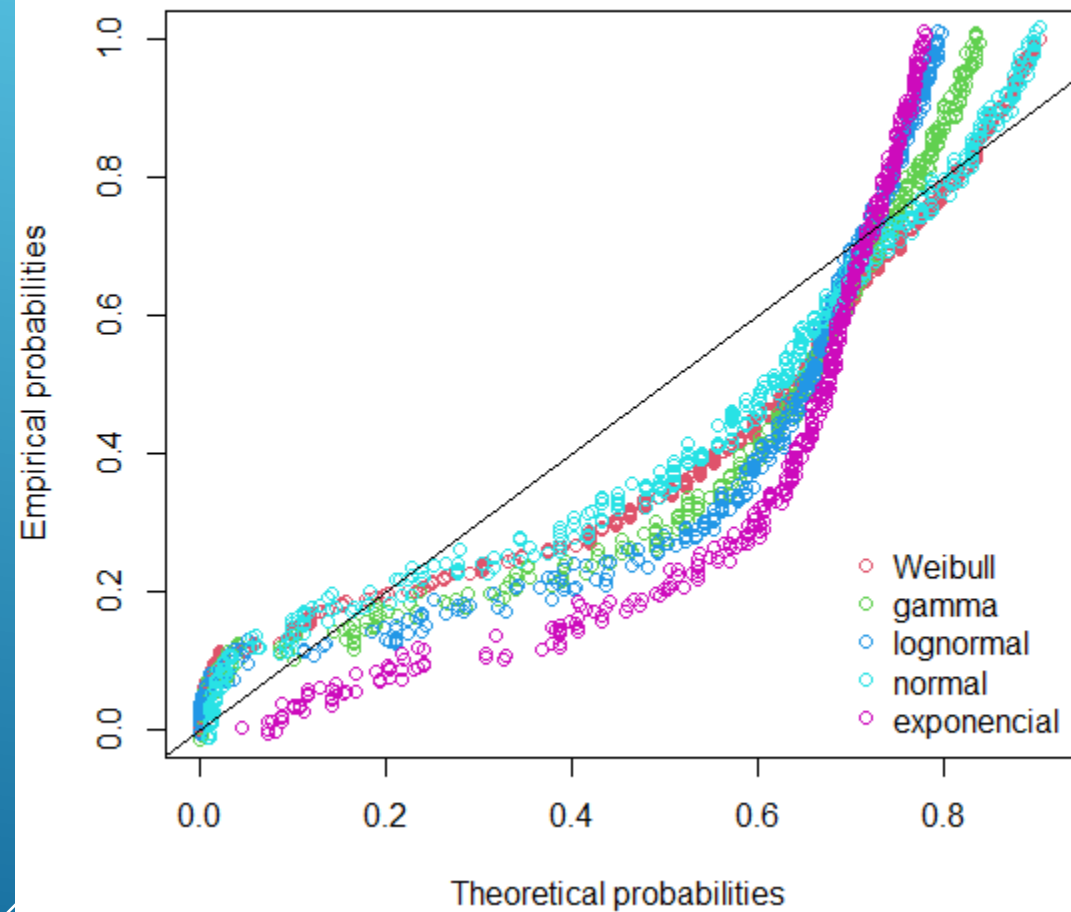


Conversão

Q-Q plot



P-P plot



Conversão

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1730088	0.220494	0.2531879	0.1460129
Cramer-von Mises statistic	3.7044469	6.303203	8.2960821	2.5775971
Anderson-Darling statistic	24.1920609	34.496012	44.7346244	15.6453862

```
exponencial
```

Kolmogorov-Smirnov statistic	0.3191953
Cramer-von Mises statistic	14.4561714
Anderson-Darling statistic	70.3821856

```
Goodness-of-fit criteria
```

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	4021.673	4152.366	4307.524	3966.639
Bayesian Information Criterion	4029.772	4160.466	4315.623	3974.738

```
exponencial
```

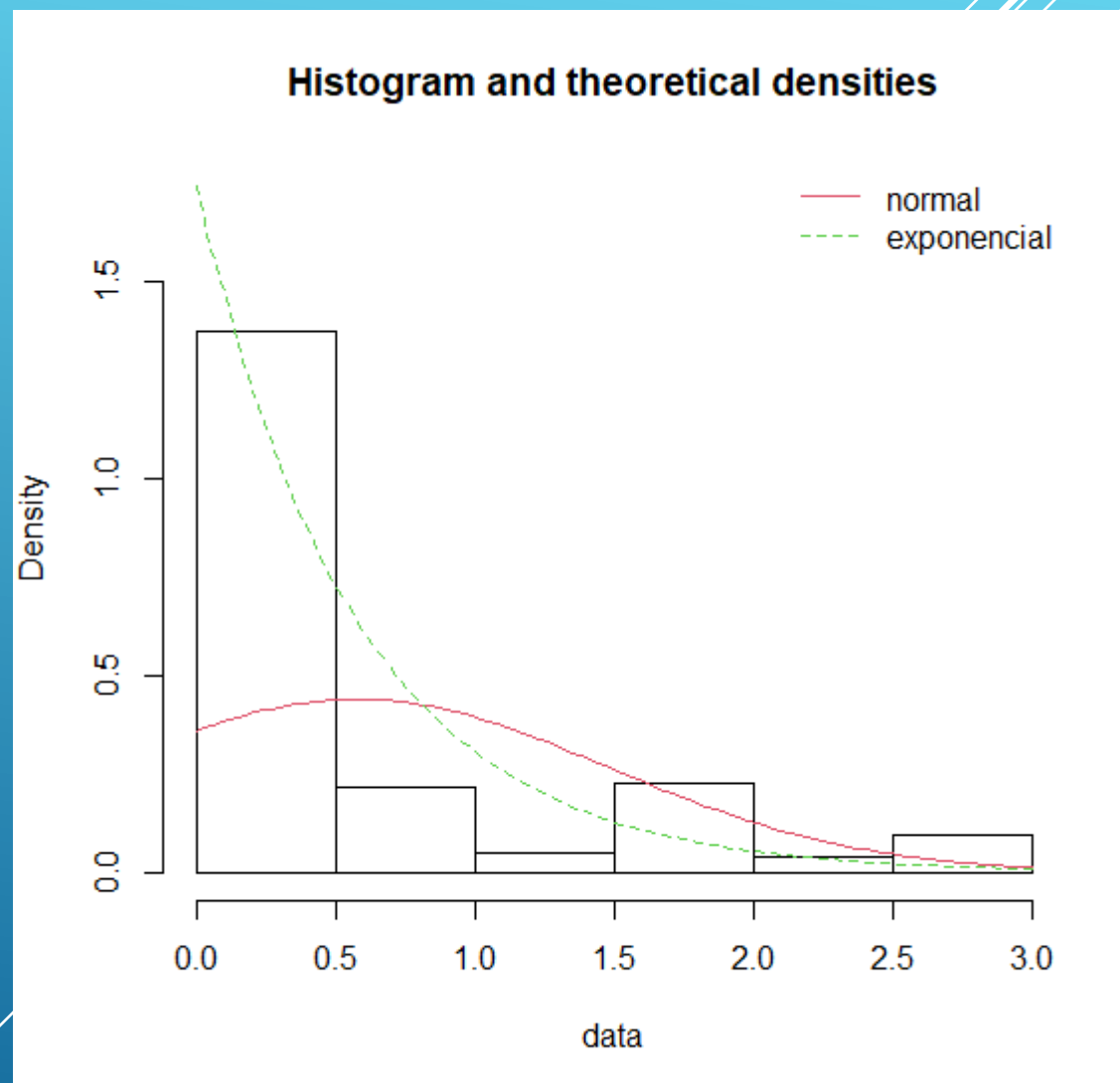
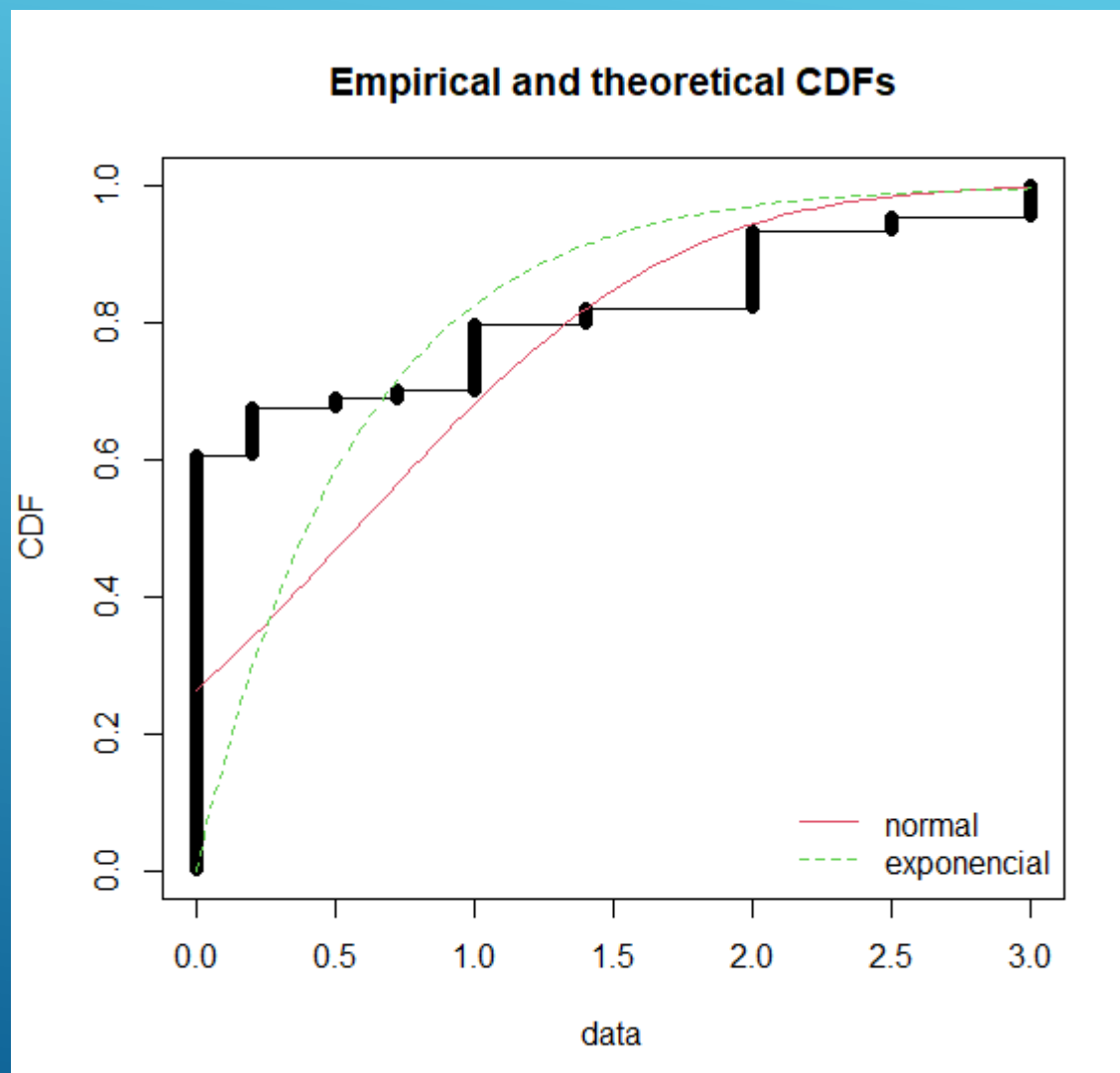
Akaike's Information Criterion	4395.049
Bayesian Information Criterion	4399.099

Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.024175, p-value = 0.08697
alternative hypothesis: non-unimodal, i.e., at least bimodal

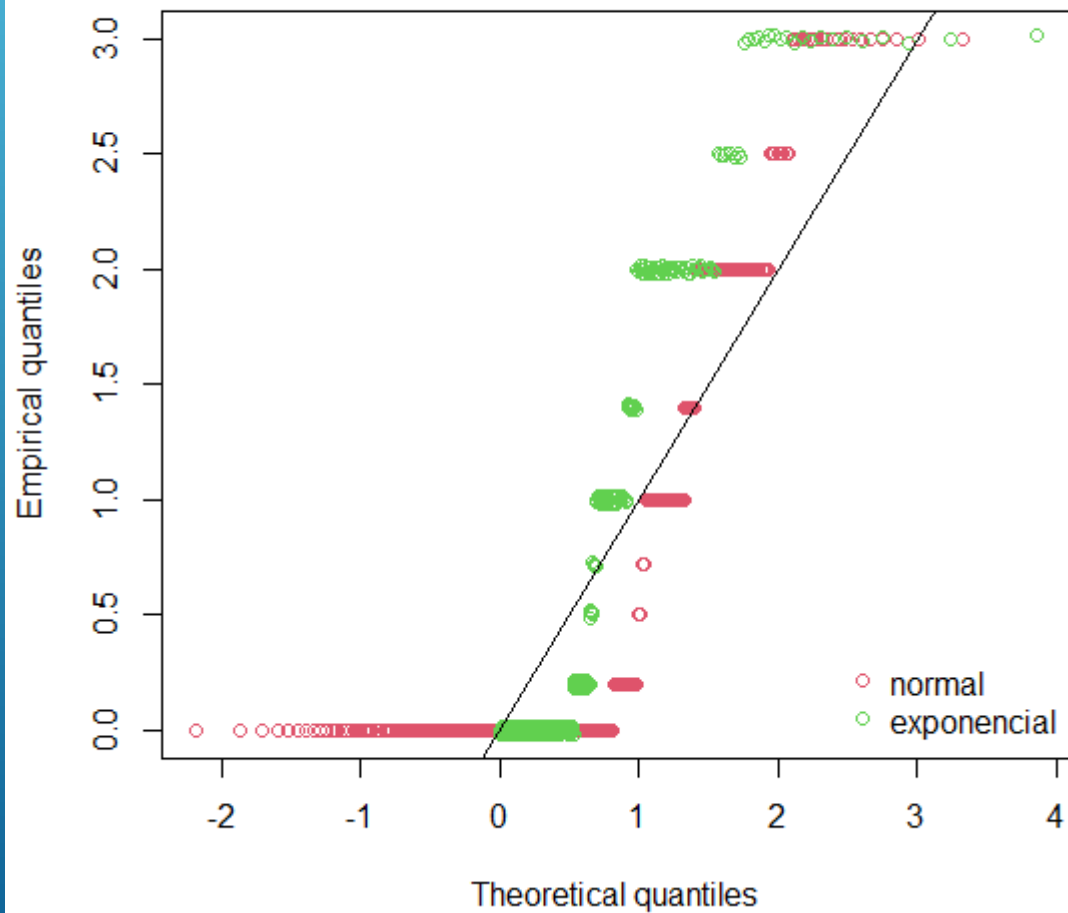
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6520771
```

Razão de inerte

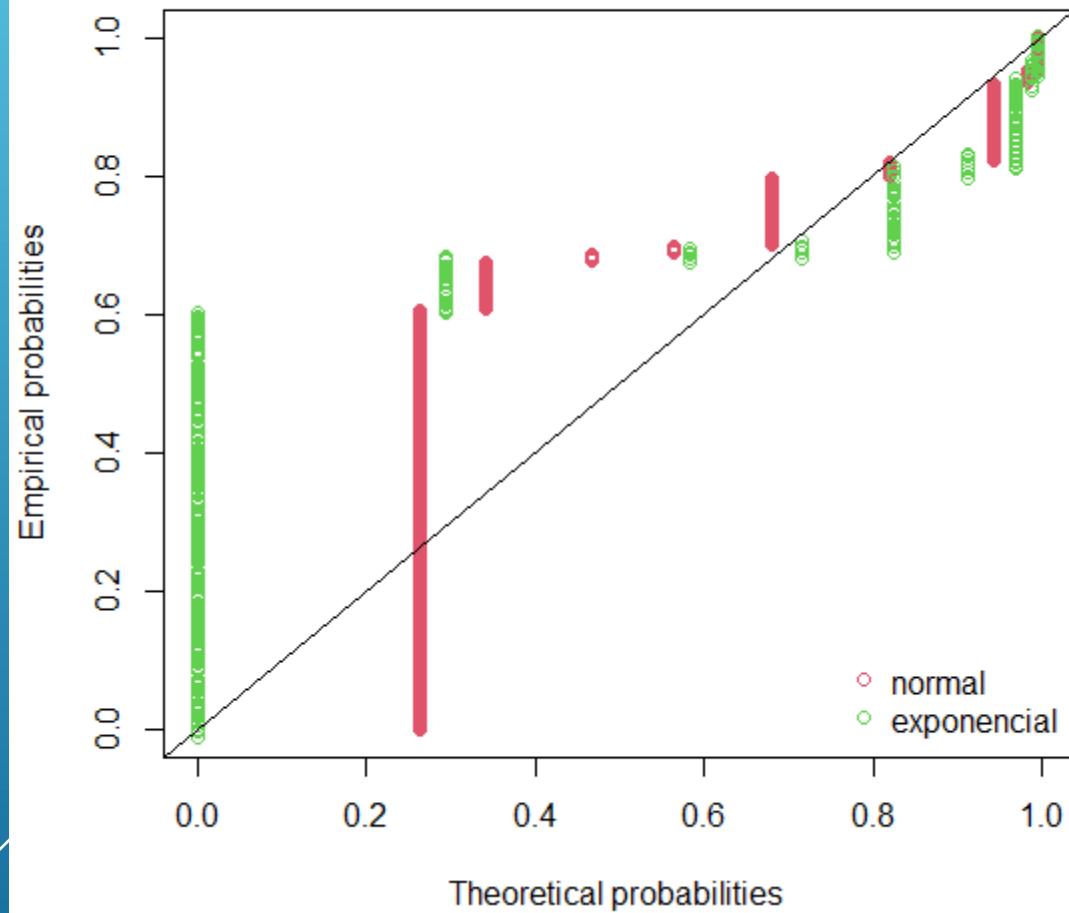


Razão de inerte

Q-Q plot



P-P plot



Razão de inerte

```
Goodness-of-fit statistics
```

	normal	exponencial
Kolmogorov-Smirnov statistic	0.3426444	0.6061321
Cramer-von Mises statistic	11.8231400	36.0161290
Anderson-Darling statistic	62.3213424	Inf


```
Goodness-of-fit criteria
```

	normal	exponencial
Akaike's Information Criterion	1123.824	378.2910
Bayesian Information Criterion	1131.924	382.3408

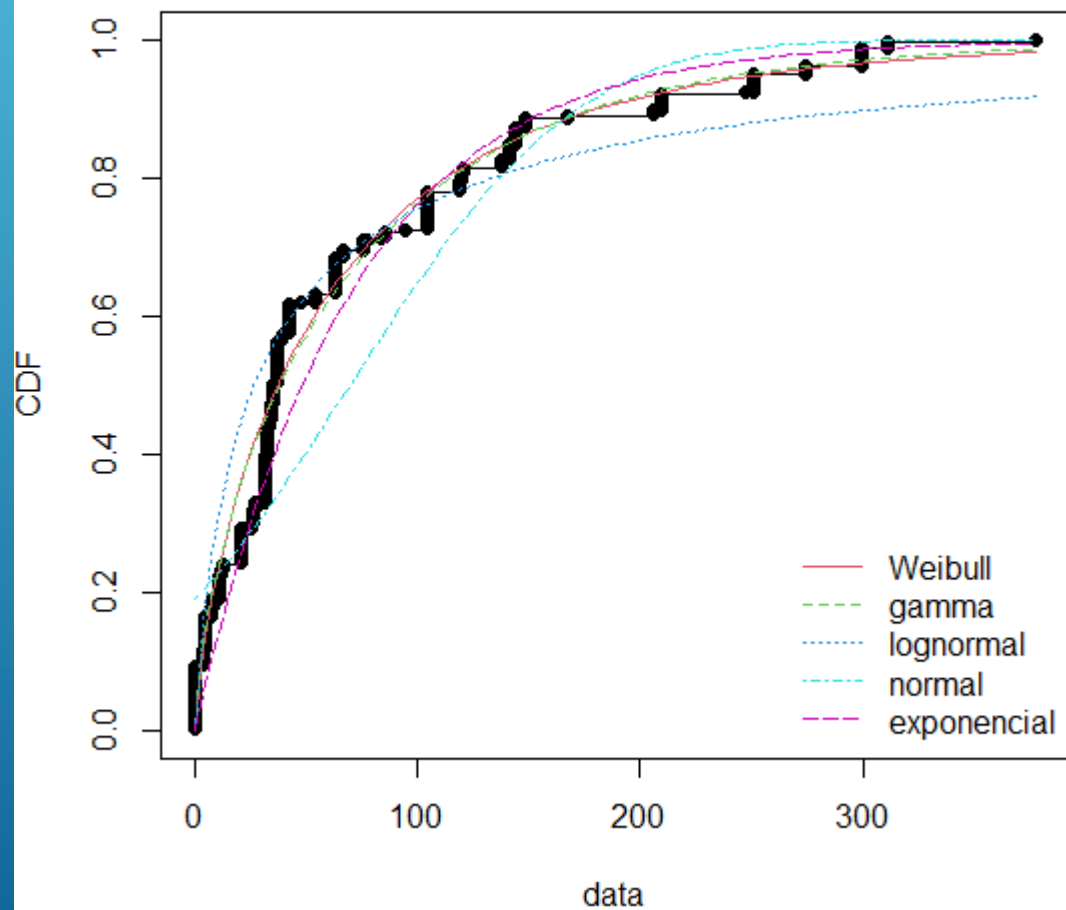
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.056604, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

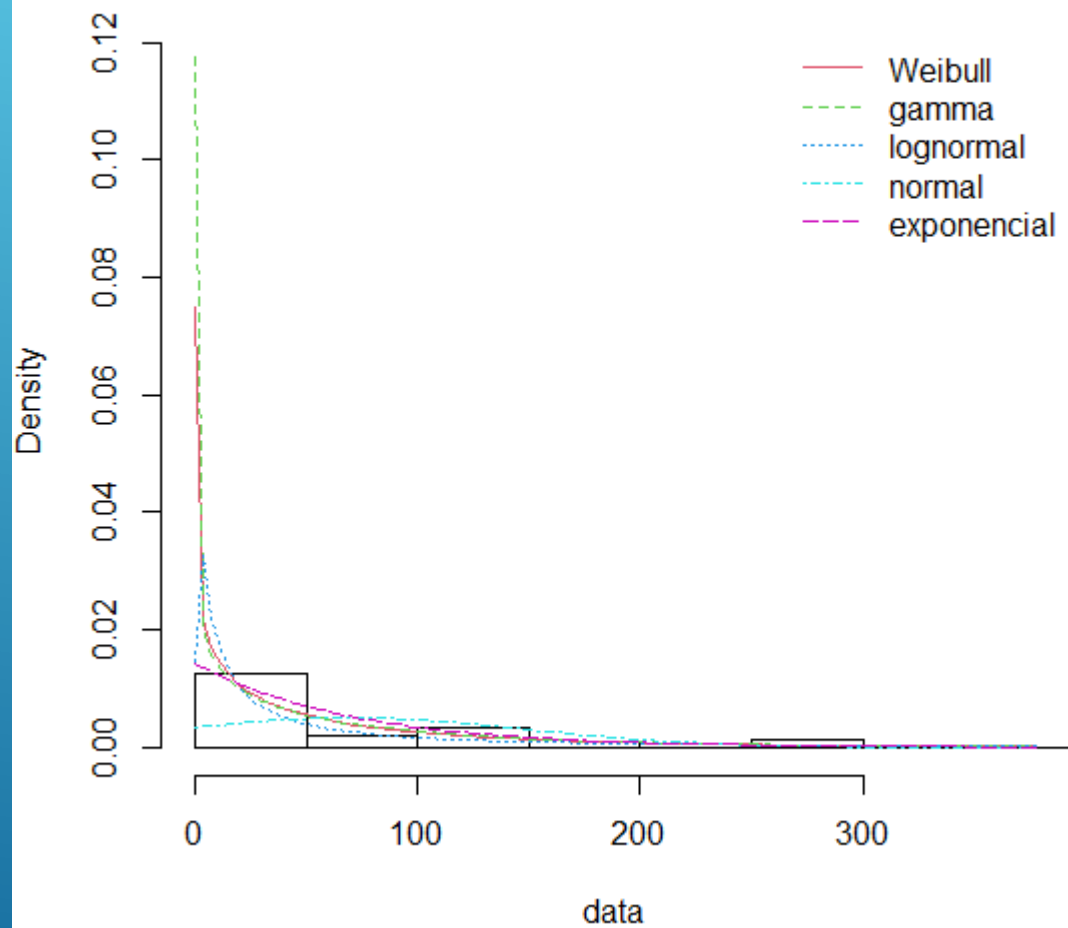
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] TRUE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8091519
```

Velocidade WSHV

Empirical and theoretical CDFs

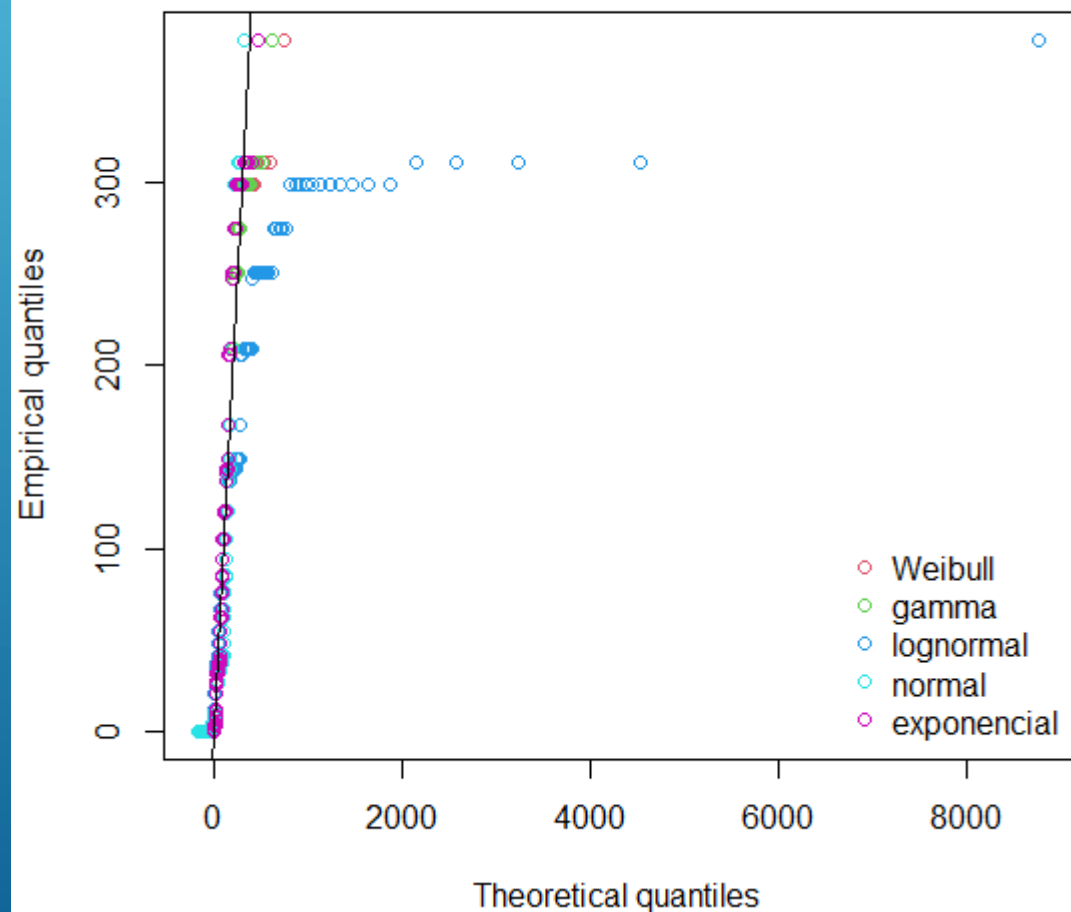


Histogram and theoretical densities

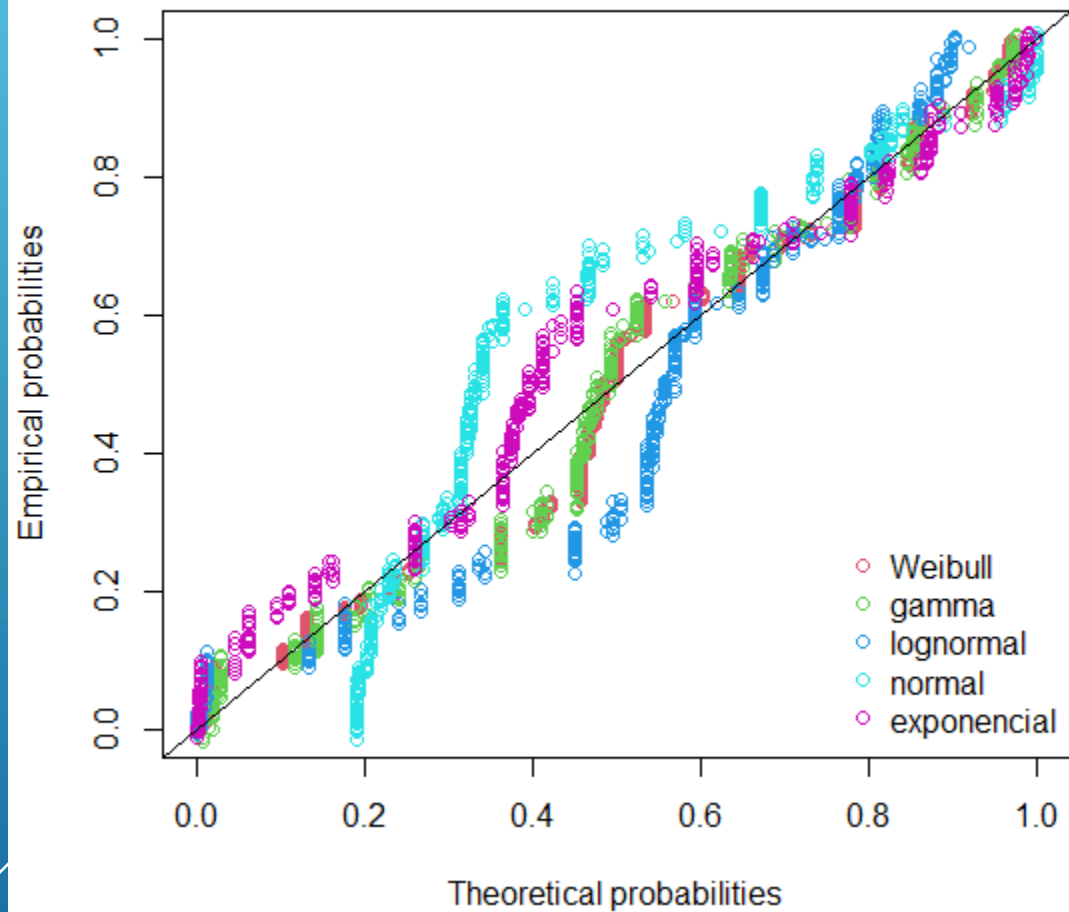


Velocidade WSHV

Q-Q plot



P-P plot



Velocidade WSHV

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1268637	0.1208836	0.2065598	0.254512
Cramer-von Mises statistic	0.9494164	0.9324071	3.2994511	6.031583
Anderson-Darling statistic	6.0934288	5.2311067	19.7534954	33.659738

	exponencial
Kolmogorov-Smirnov statistic	0.1661129
Cramer-von Mises statistic	1.8343148
Anderson-Darling statistic	16.7875260

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	4393.776	4381.799	4538.096	4917.806
Bayesian Information Criterion	4401.875	4389.898	4546.195	4925.906

	exponencial
Akaike's Information Criterion	4448.152
Bayesian Information Criterion	4452.202

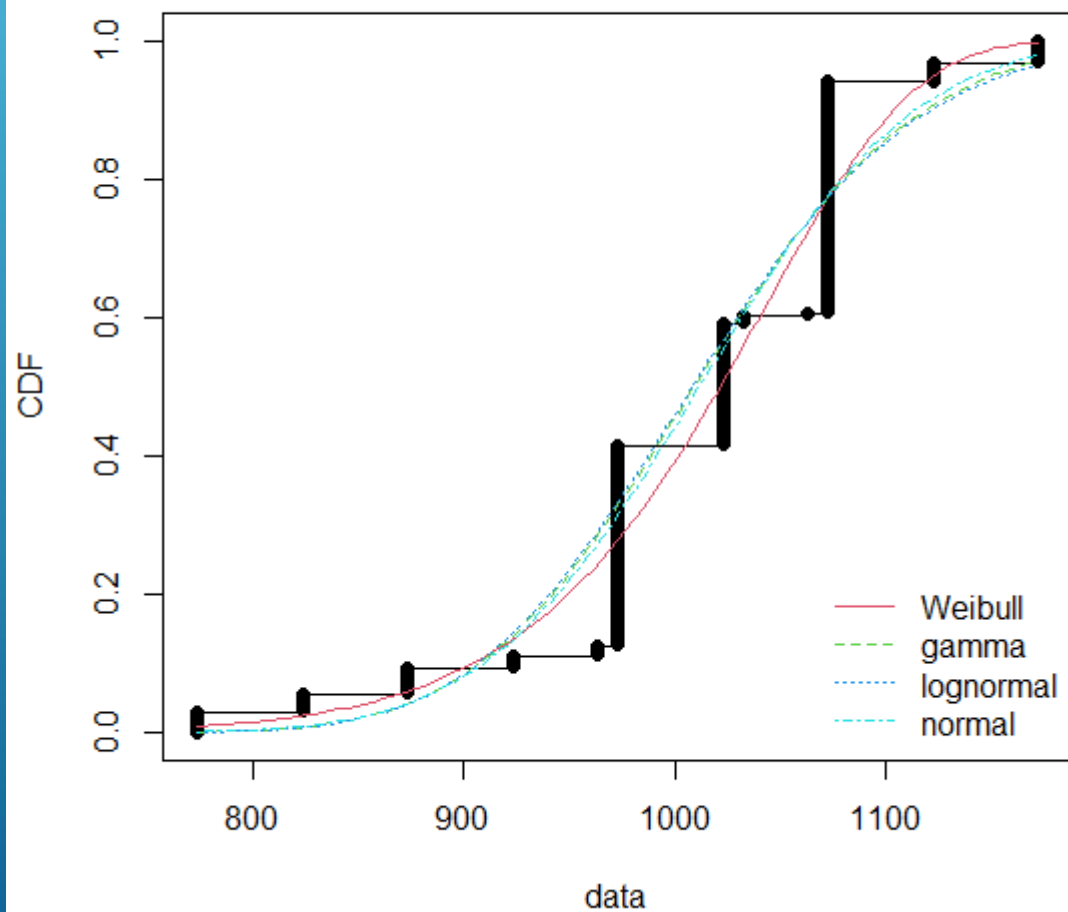
Hartigan's dip test for unimodality / multimodality

```
data: vari
D = 0.059095, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

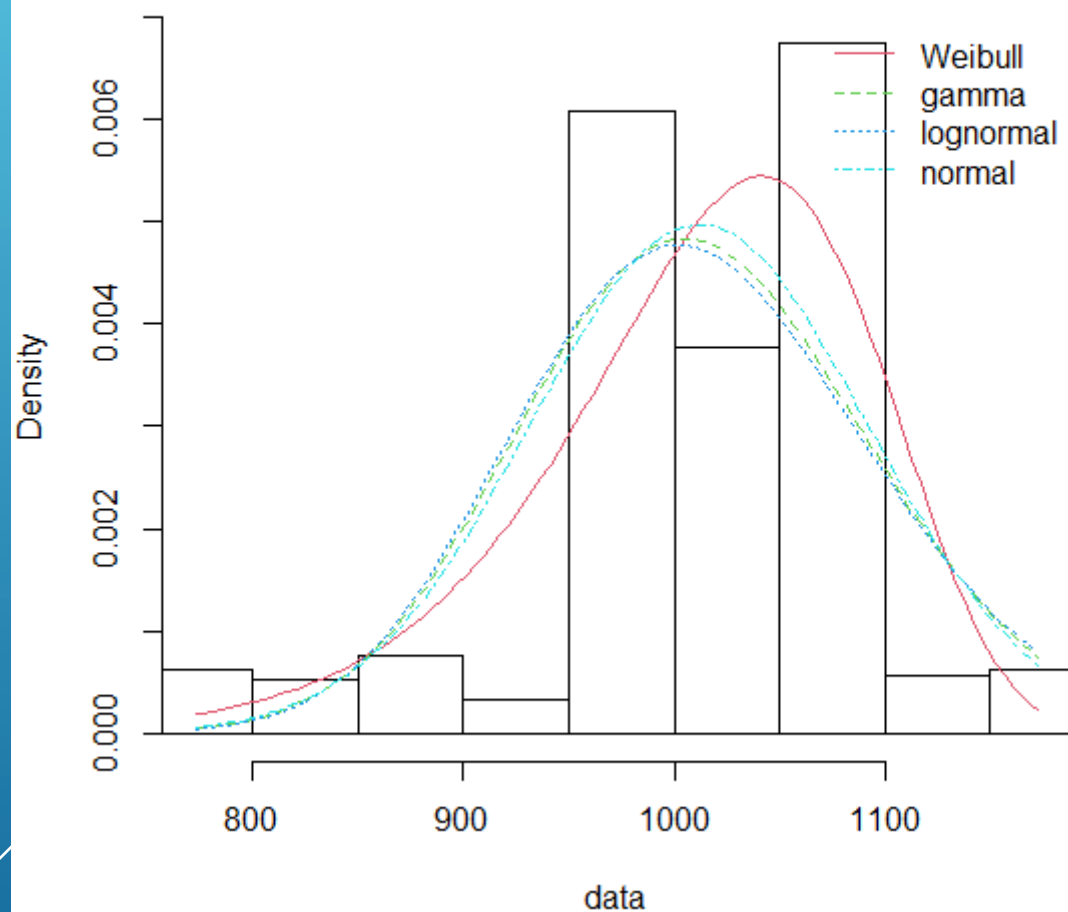
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.7379842
```

Temperatura de reação

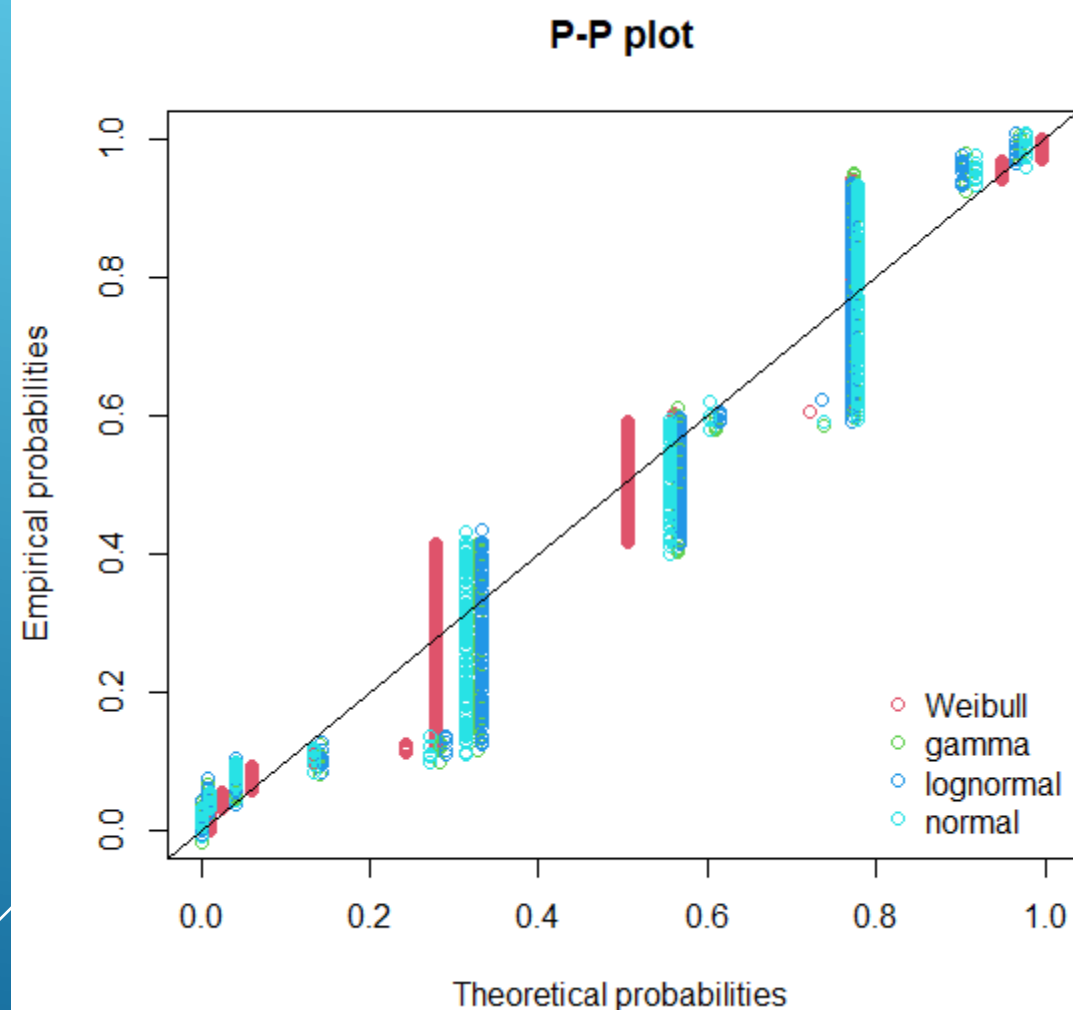
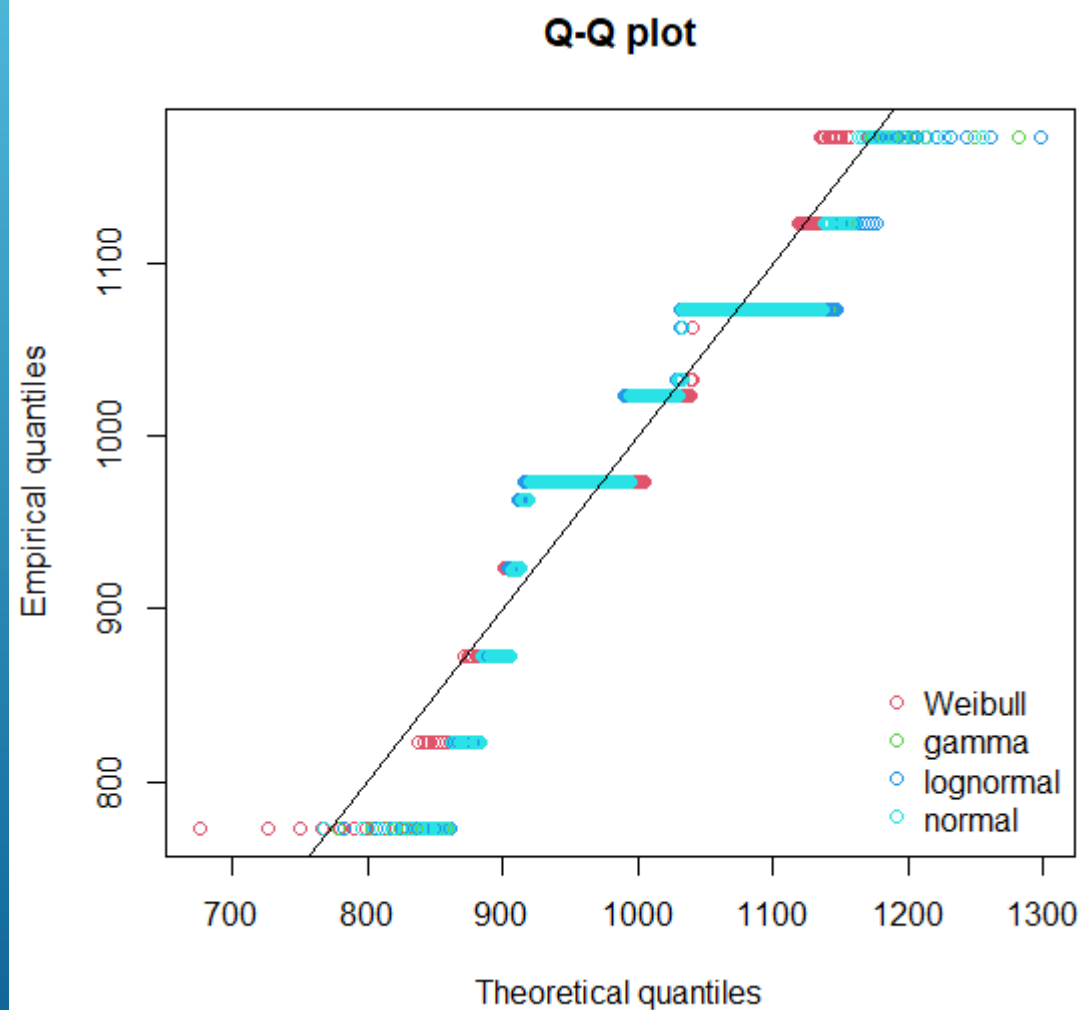
Empirical and theoretical CDFs



Histogram and theoretical densities



Temperatura de reação



Temperatura de reação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1694335	0.2019213	0.2083899	0.1890131
Cramer-von Mises statistic	2.5319173	3.3223016	3.4799907	3.0480907
Anderson-Darling statistic	14.8619980	20.0983322	21.0609613	18.3989988

Goodness-of-fit criteria

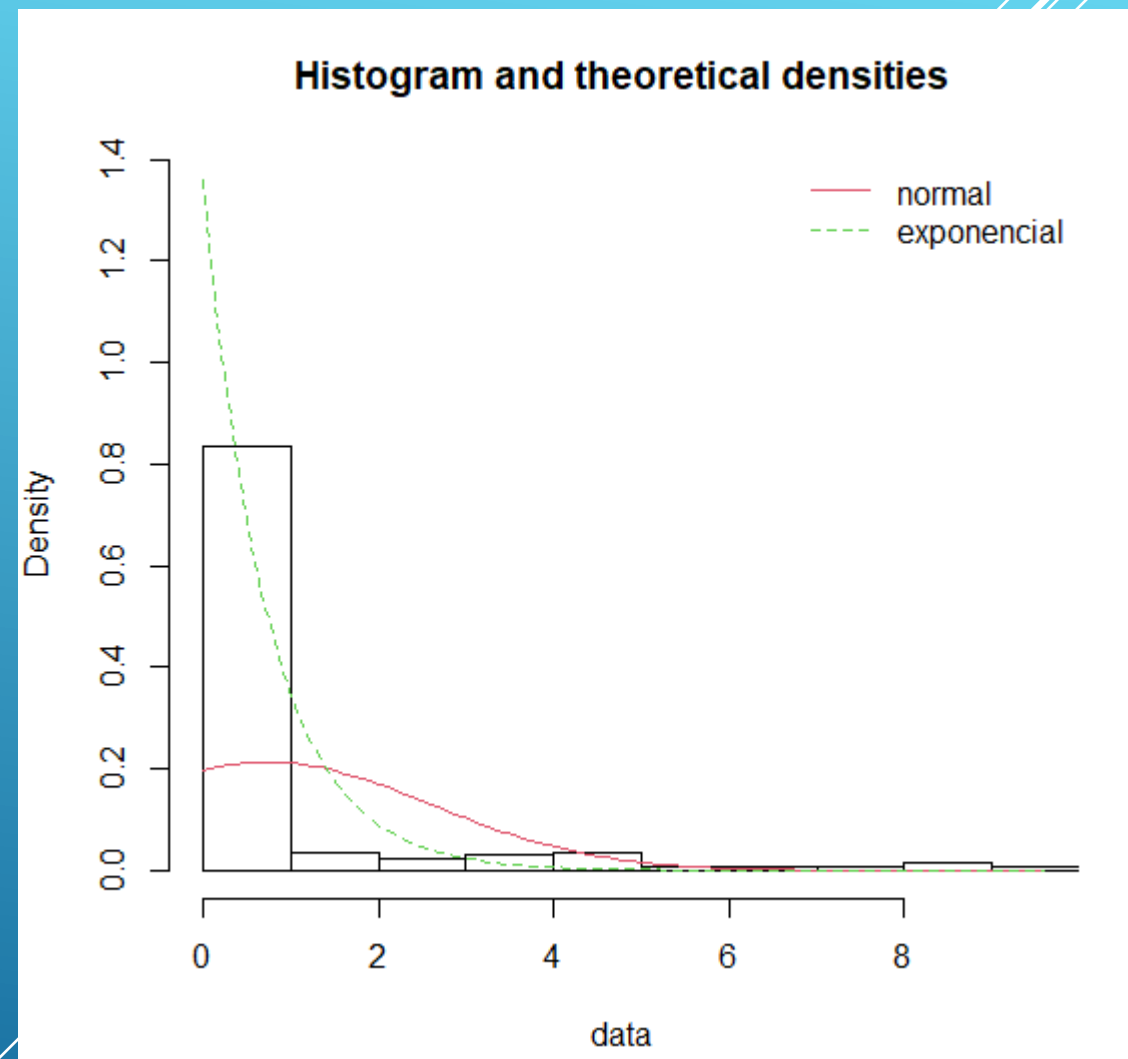
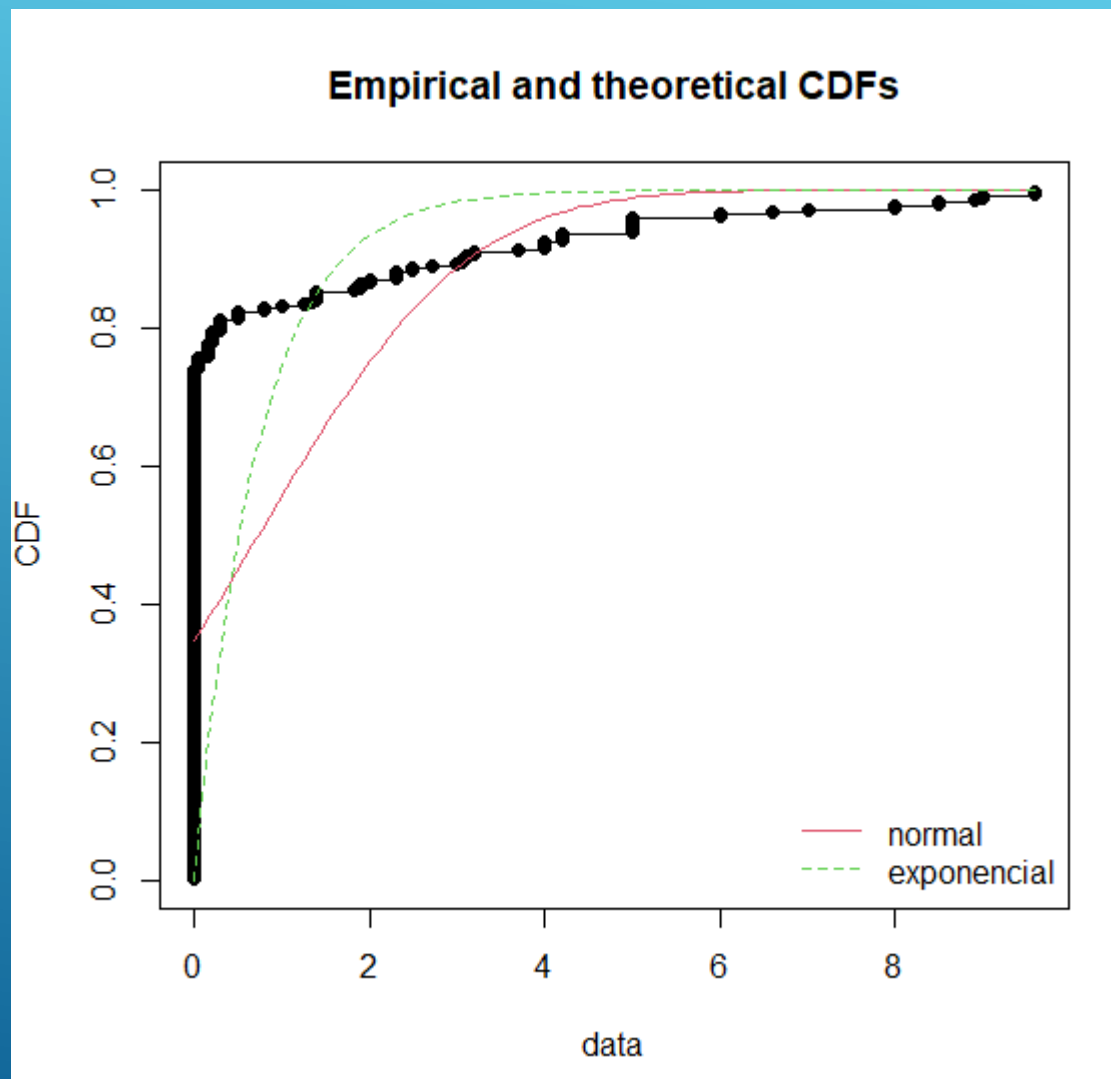
	weibull	gamma	lognormal	normal
Akaike's Information Criterion	4877.358	4949.817	4963.629	4925.565
Bayesian Information Criterion	4885.457	4957.916	4971.729	4933.664

Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.14505, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

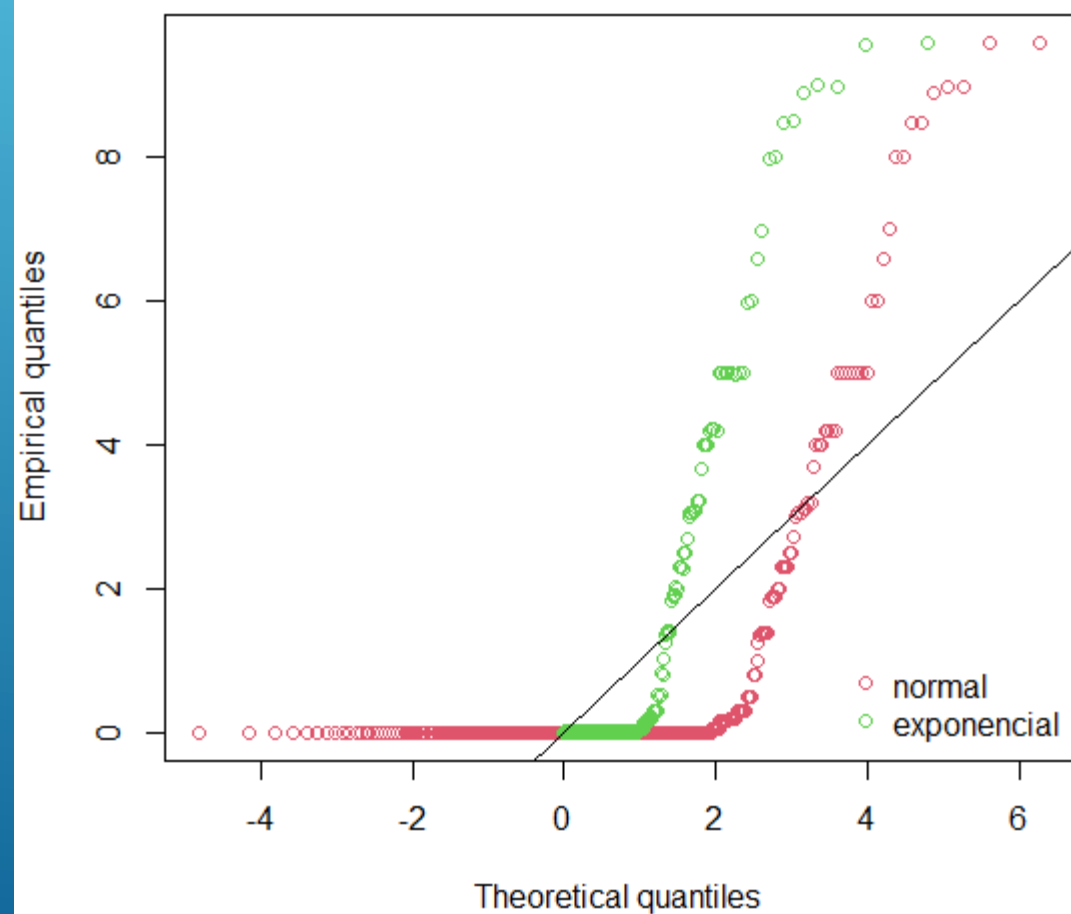
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.4290973
```

Concentração de dopante

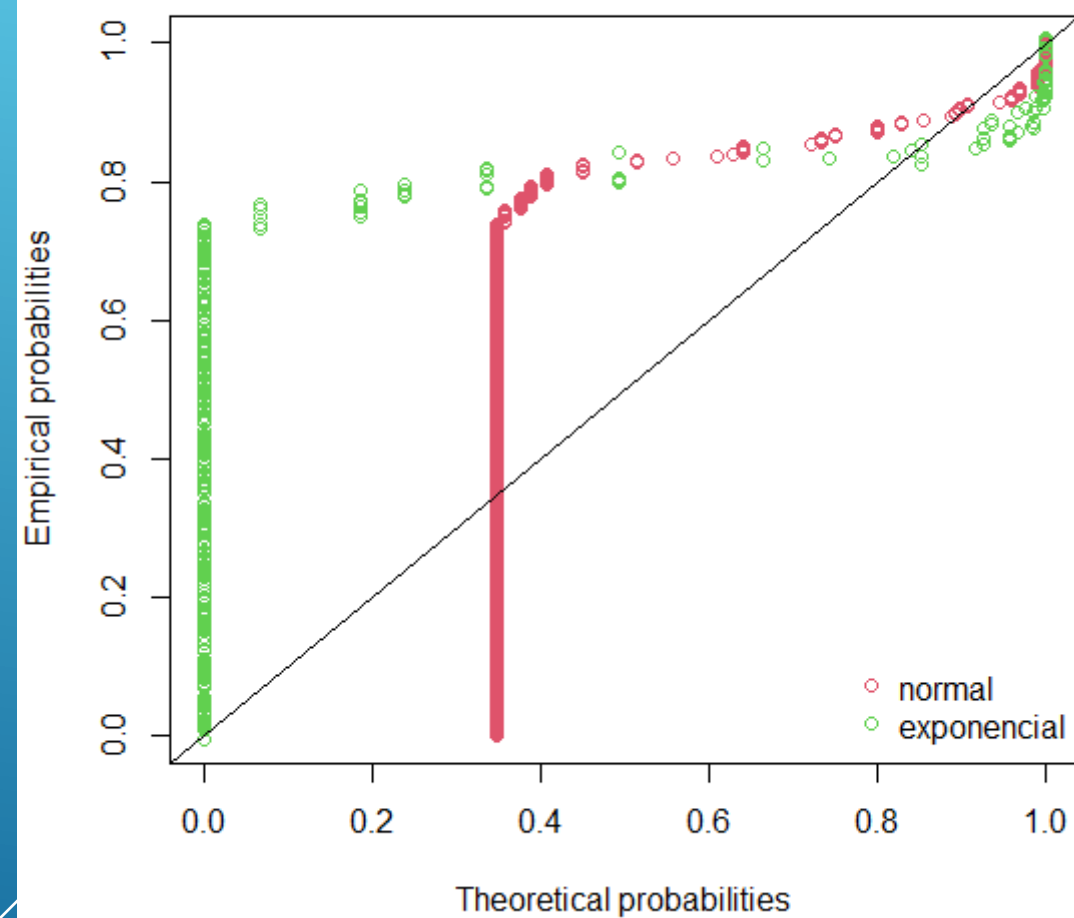


Concentração de dopante

Q-Q plot



P-P plot



Concentração de dopante

Goodness-of-fit statistics

	normal	exponencial
Kolmogorov-Smirnov statistic	0.4079819	0.7409639
Cramer-von Mises statistic	16.3800392	53.6765721
Anderson-Darling statistic	78.5171338	Inf

Goodness-of-fit criteria

	normal	exponencial
Akaike's Information Criterion	1361.798	462.4611
Bayesian Information Criterion	1369.408	466.2663

Hartigans' dip test for unimodality / multimodality

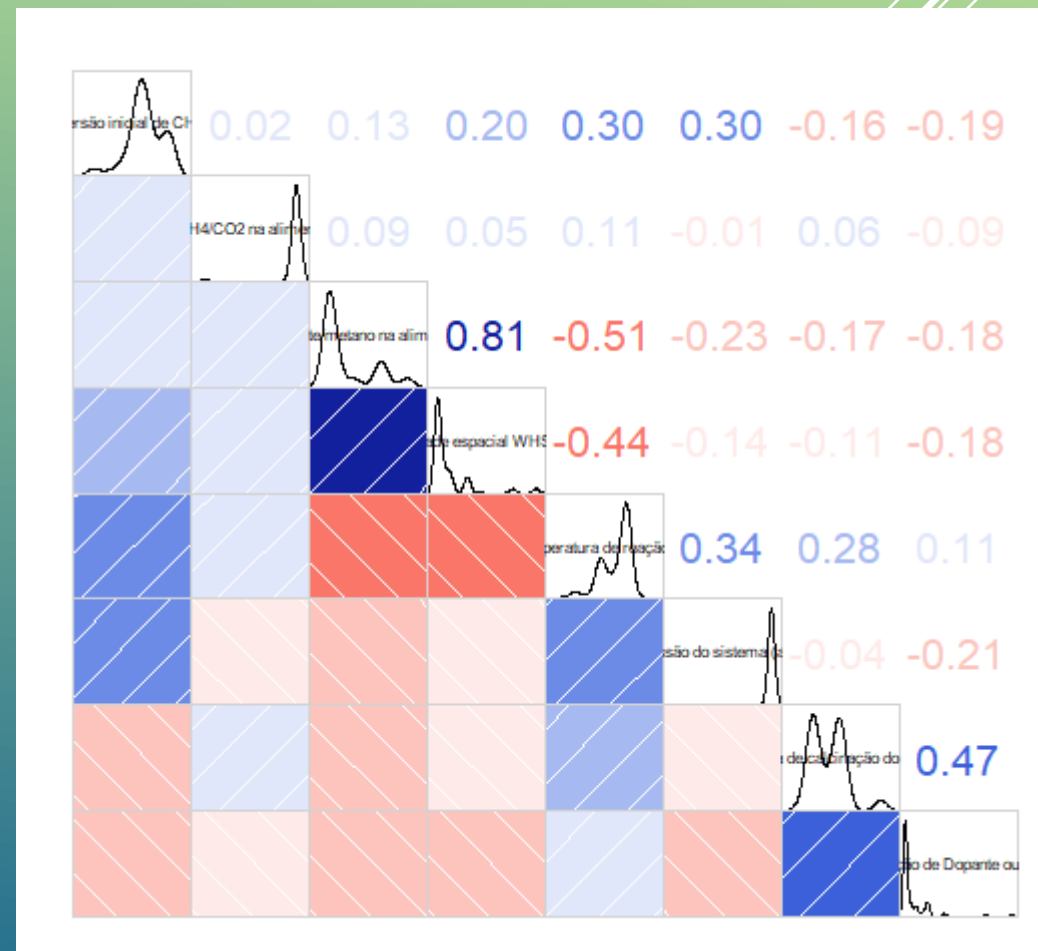
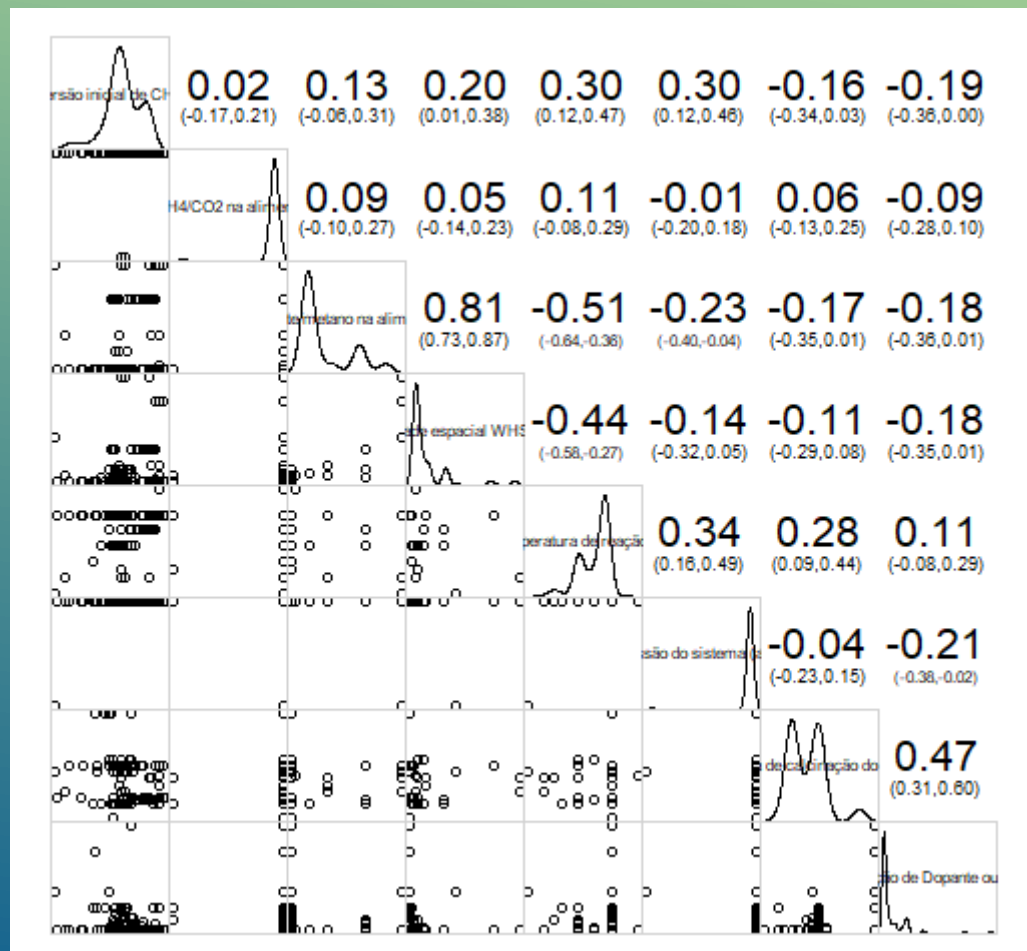
```
data: vari
D = 0.012048, p-value = 0.9922
alternative hypothesis: non-unimodal, i.e., at least bimodal

> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8414531
```


Análise retirando as lacunas

▶ database

109 obs. of 18 variables



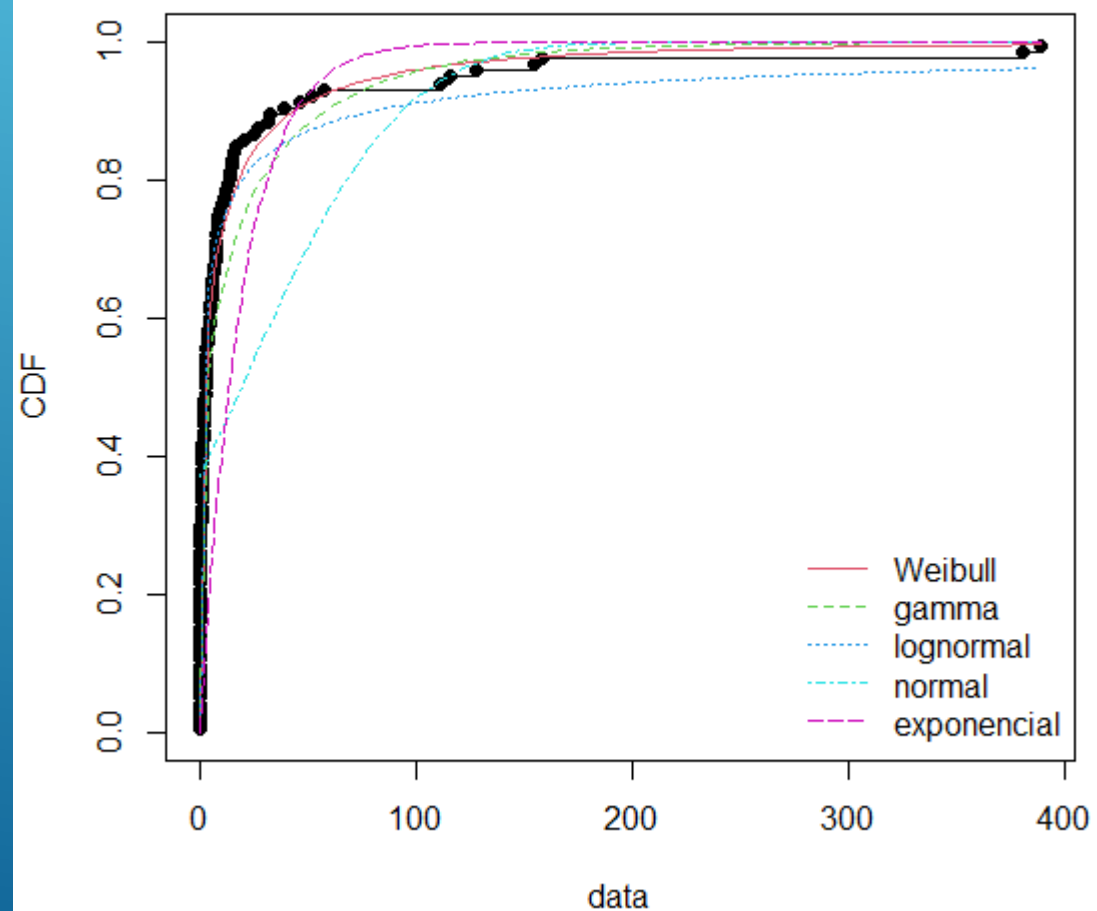
Fase Ativa	Contagem de Fase Ativa
Ni	90
Cu Ni	7
Pt	6
Mo Ni	4
Co	2
Total	109

Dopante ou Promotor	Contagem de Dopante ou Promotor
none	67
Gd	13
Pr	9
Nb	5
Yb	4
Sm	2
Y	2
Zr	2
Ca	1
K	1
Mn	1
Sn	1
V	1
Total	109

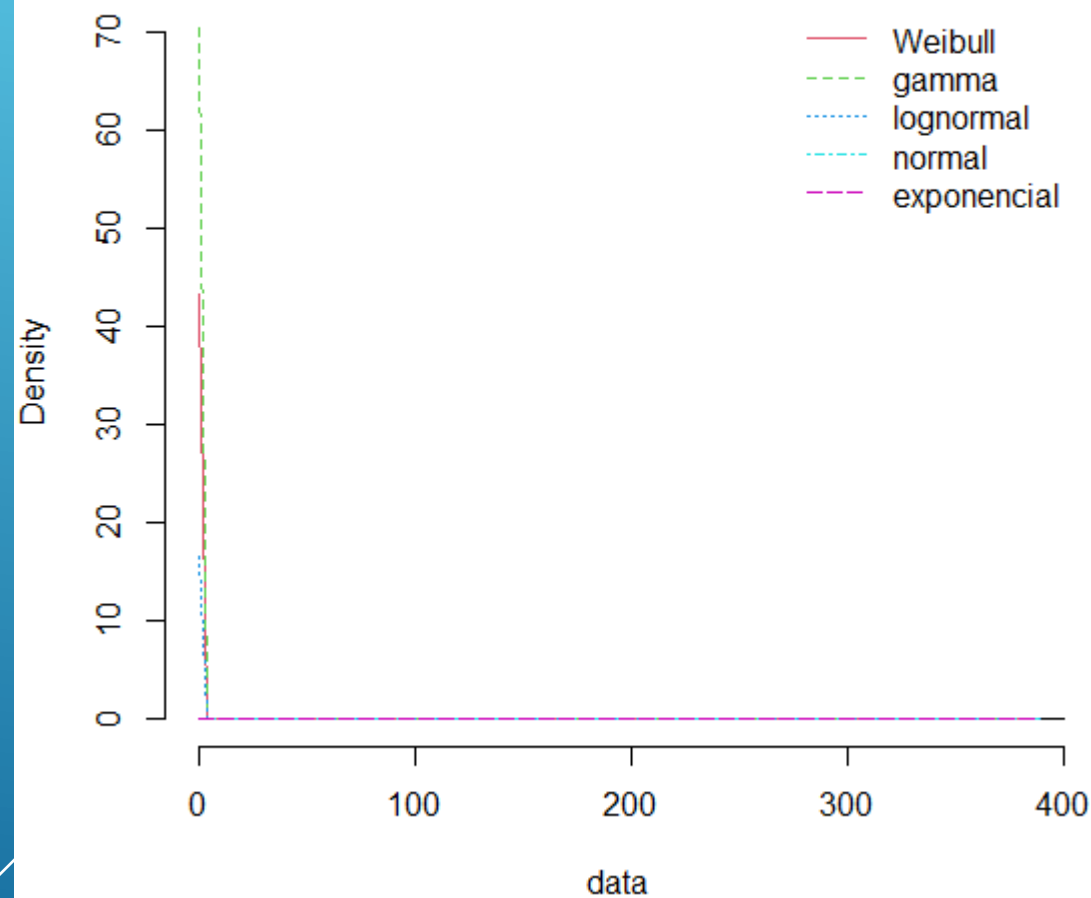
Suporte	Contagem de Suporte
Al ₂ O ₃	30
CeO ₂	25
Al ₂ O ₃ CeO ₂	13
MCM-41	8
SBA-15	7
Hidrotalcita	6
HZSM-5	4
SiO ₂	4
CeZrO ₂	3
TiO ₂ SiO ₂	3
AlSBA-15	1
CeSiO ₂ LaNiO ₃	1
LaNiO ₃	1
LaNiO ₃ Al ₂ O ₃	1
Na _{0.5} La _{0.5} Ni _{0.3} Al _{0.7} O _{2.5}	1
ZrO ₂	1
Total	109

Taxa de formação de carbono

Empirical and theoretical CDFs

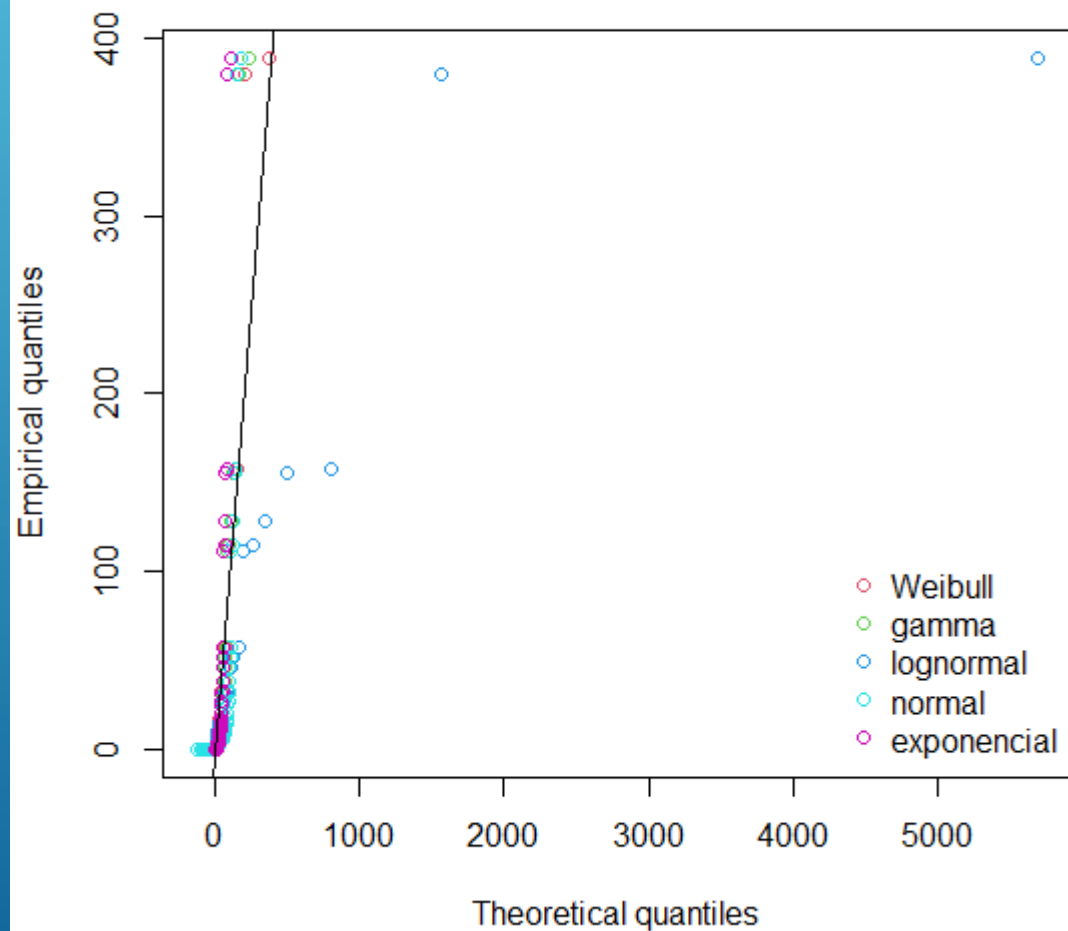


Histogram and theoretical densities

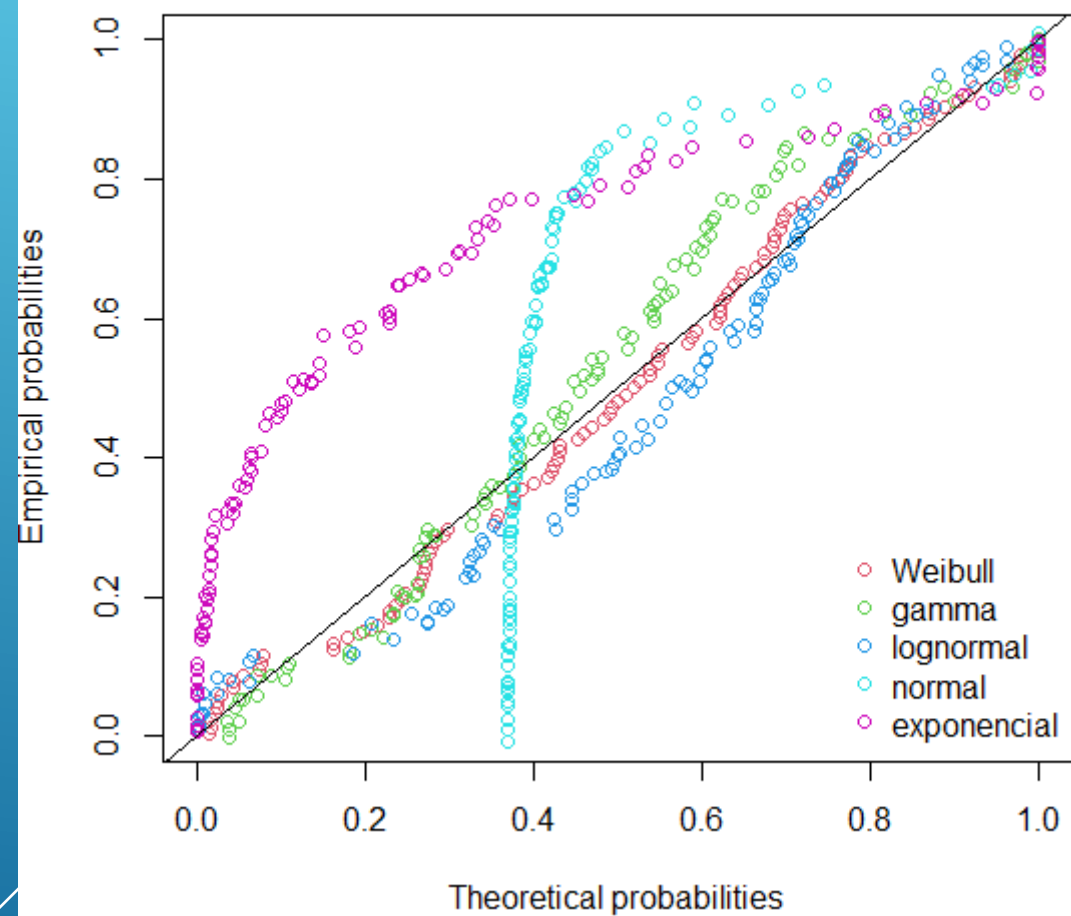


Taxa de formação de carbono

Q-Q plot



P-P plot



Taxa de formação de carbono

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.06300955 0.1390409 0.1231541 0.3697094
Cramer-von Mises statistic 0.09867666 0.4709231 0.4807680 5.3804498
Anderson-Darling statistic 0.70918344 2.5324196 3.0443768 26.0483946
      exponencial
Kolmogorov-Smirnov statistic 0.4104253
Cramer-von Mises statistic 8.5854514
Anderson-Darling statistic 71.0810804

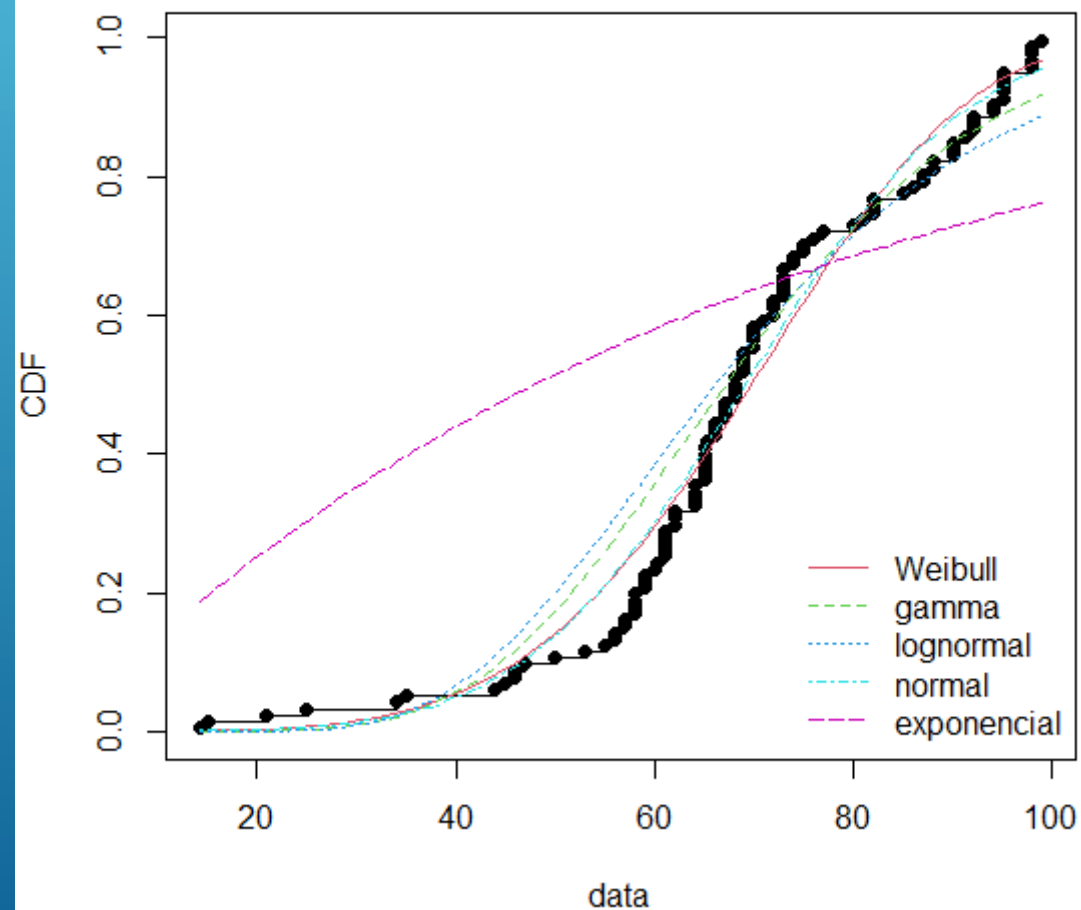
Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 600.4634 615.2110 621.4006 1197.286
Bayesian Information Criterion 605.8461 620.5937 626.7833 1202.669
      exponencial
Akaike's Information Criterion 863.9965
Bayesian Information Criterion 866.6878
```

```
Hartigans' dip test for unimodality / multimodality

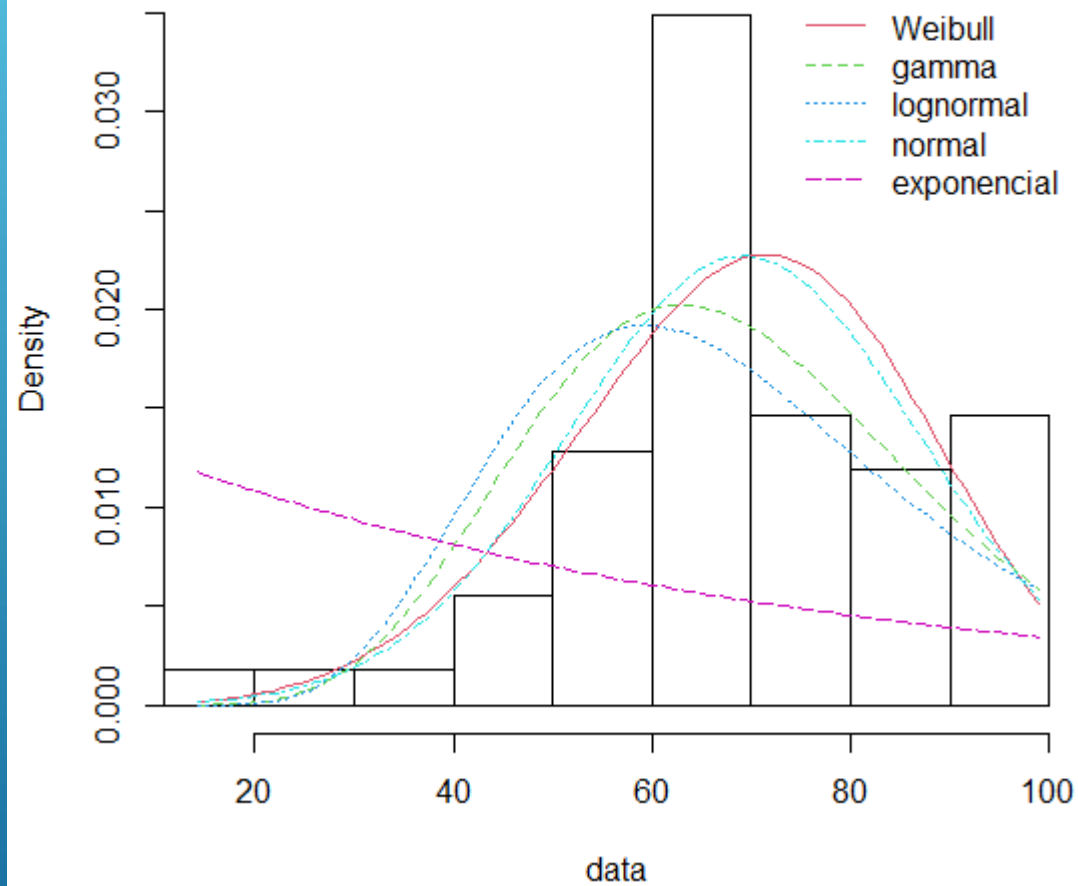
data: vari
D = 0.021679, p-value = 0.9904
alternative hypothesis: non-unimodal, i.e., at least bimodal

> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8506201
```

Empirical and theoretical CDFs

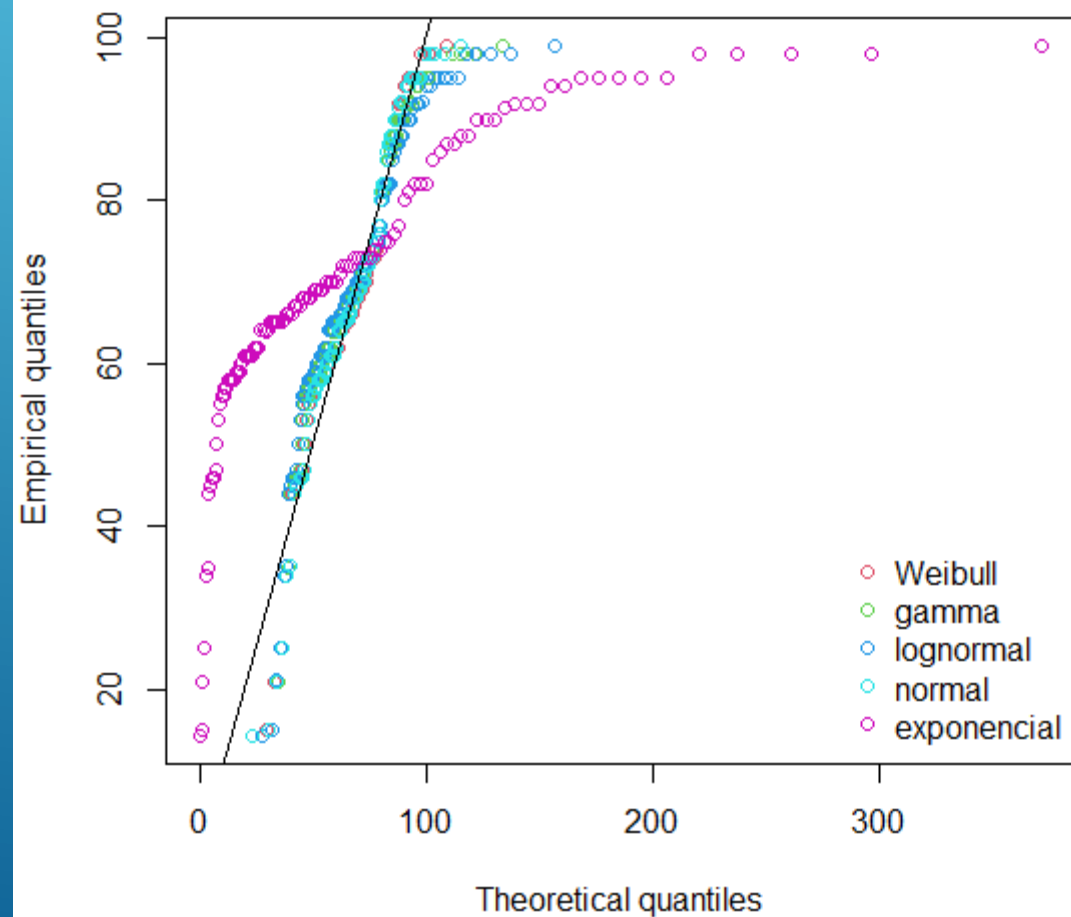


Histogram and theoretical densities

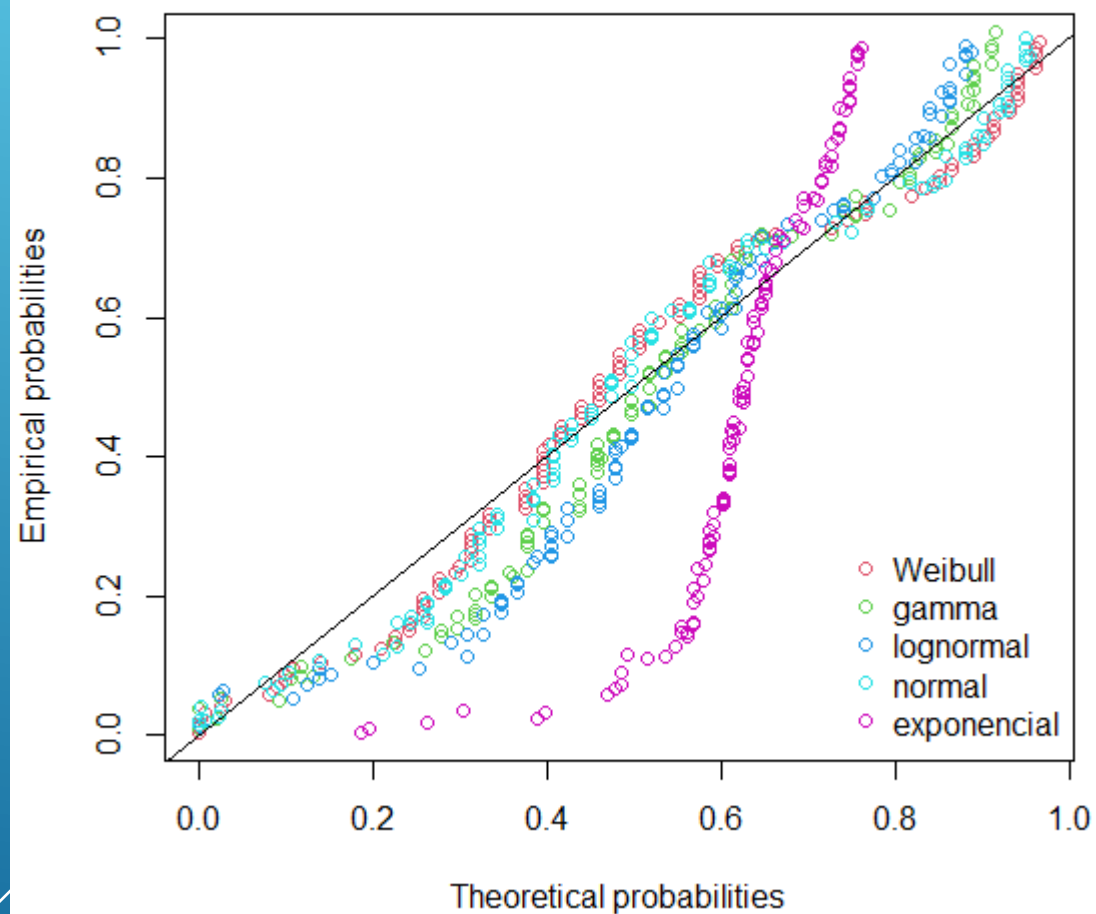


Conversão

Q-Q plot



P-P plot



Conversão

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.09681608	0.1515943	0.1813013	0.09893249
Cramer-von Mises statistic	0.25352125	0.4915498	0.7856974	0.22600036
Anderson-Darling statistic	1.66443482	3.2666674	4.9770959	1.53079365

	exponencial
Kolmogorov-Smirnov statistic	0.4293375
Cramer-von Mises statistic	5.9758980
Anderson-Darling statistic	28.5004635

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	937.5511	964.9576	987.1017	938.3701
Bayesian Information Criterion	942.9338	970.3403	992.4844	943.7528

	exponencial
Akaike's Information Criterion	1143.498
Bayesian Information Criterion	1146.190

Hartigans' dip test for unimodality / multimodality

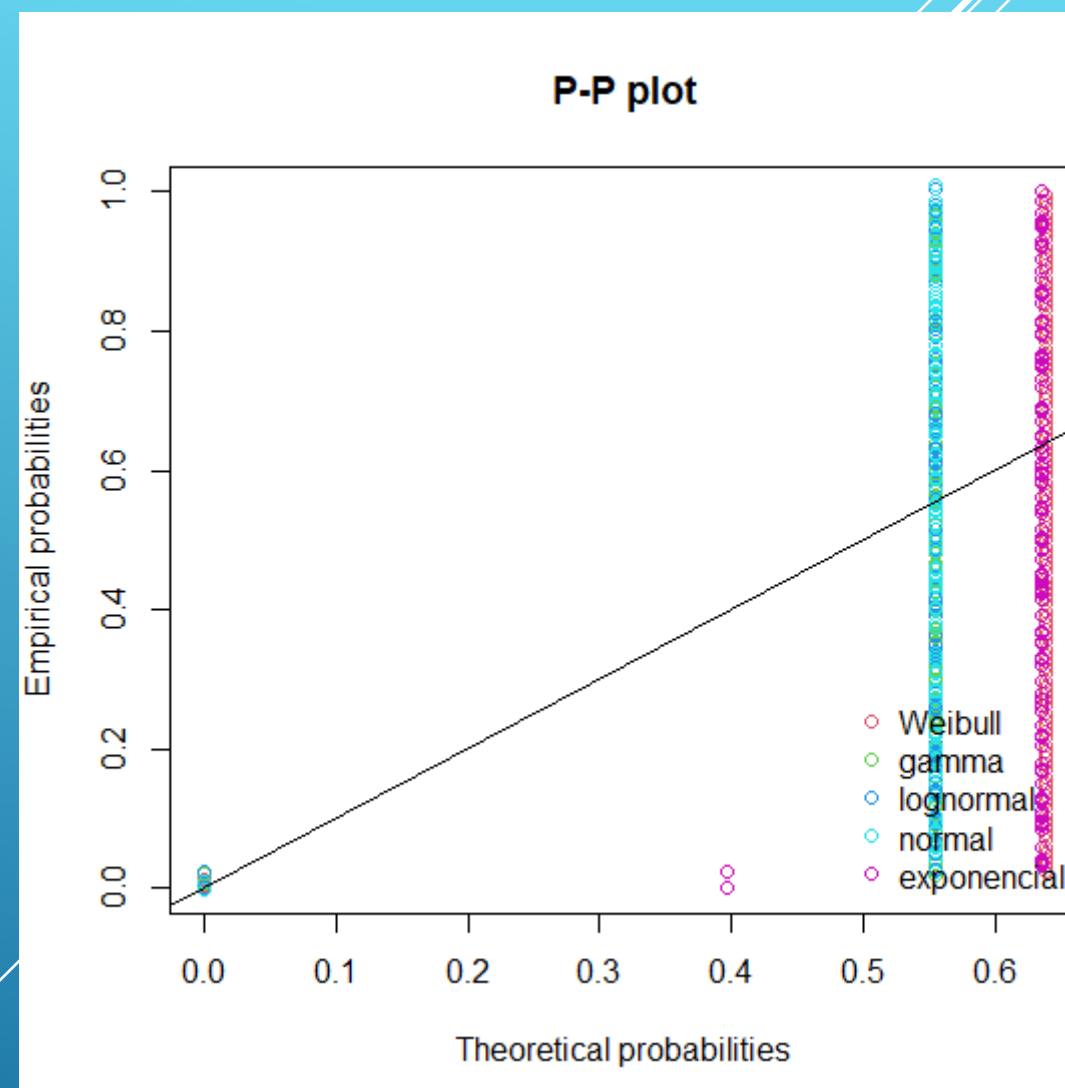
```
data: vari
D = 0.033257, p-value = 0.5434
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.3322276
```


Razão de alimentação

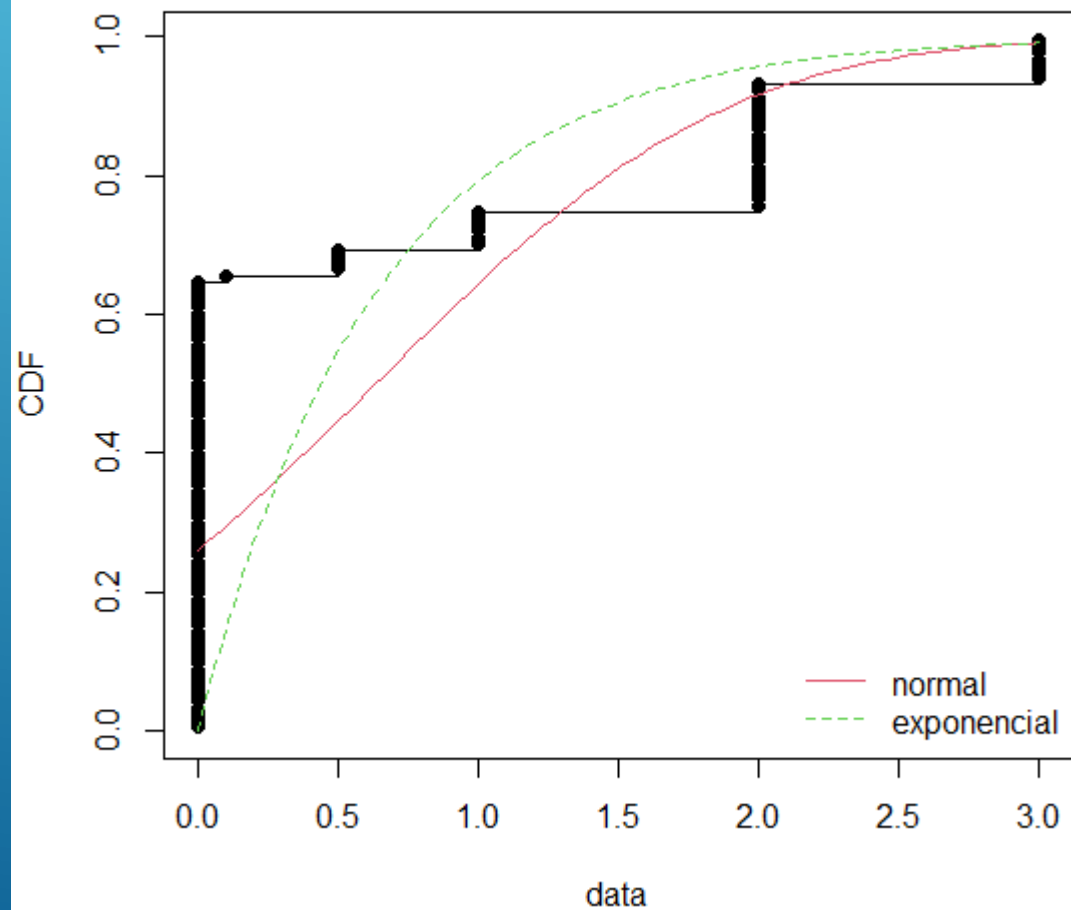
Ocorreu um erro

```
Error in names(Chi2$chisqpvalue) <- names(Chi2$chisqdf) <- fitnames[1] :  
  attempt to set an attribute on NULL
```

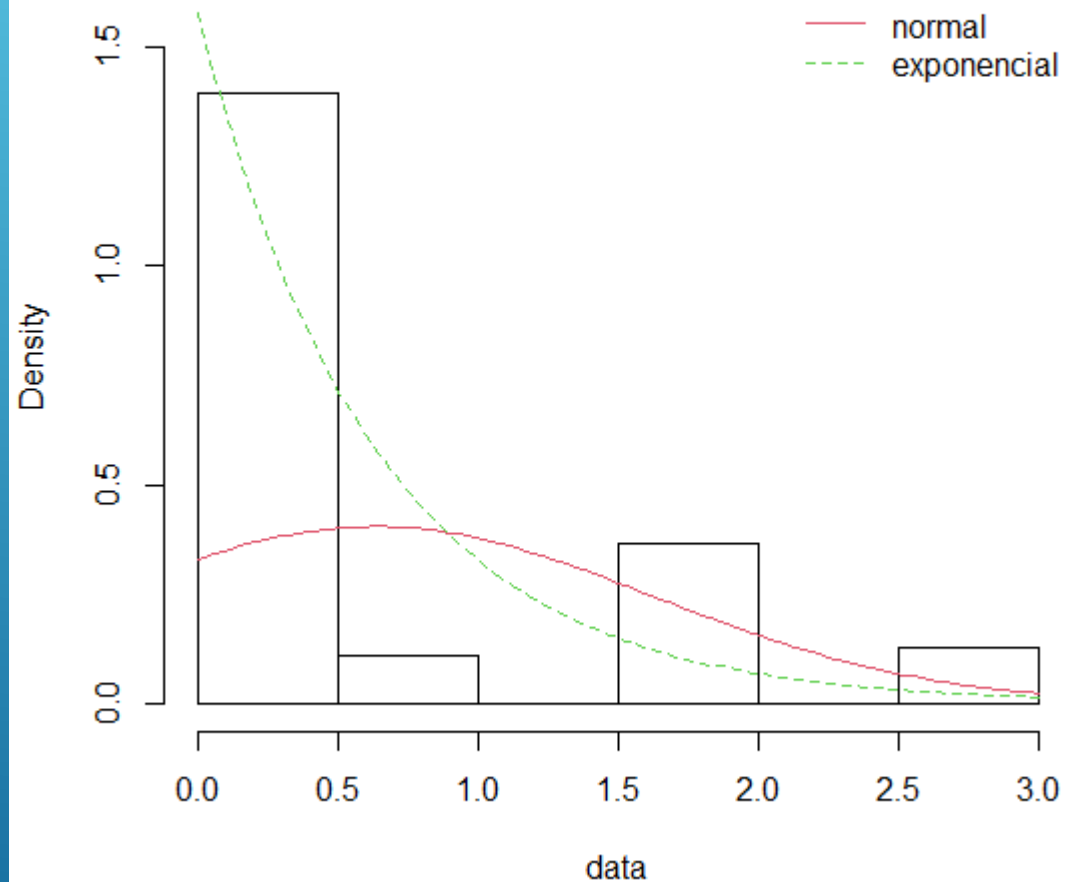


Razão de inerte

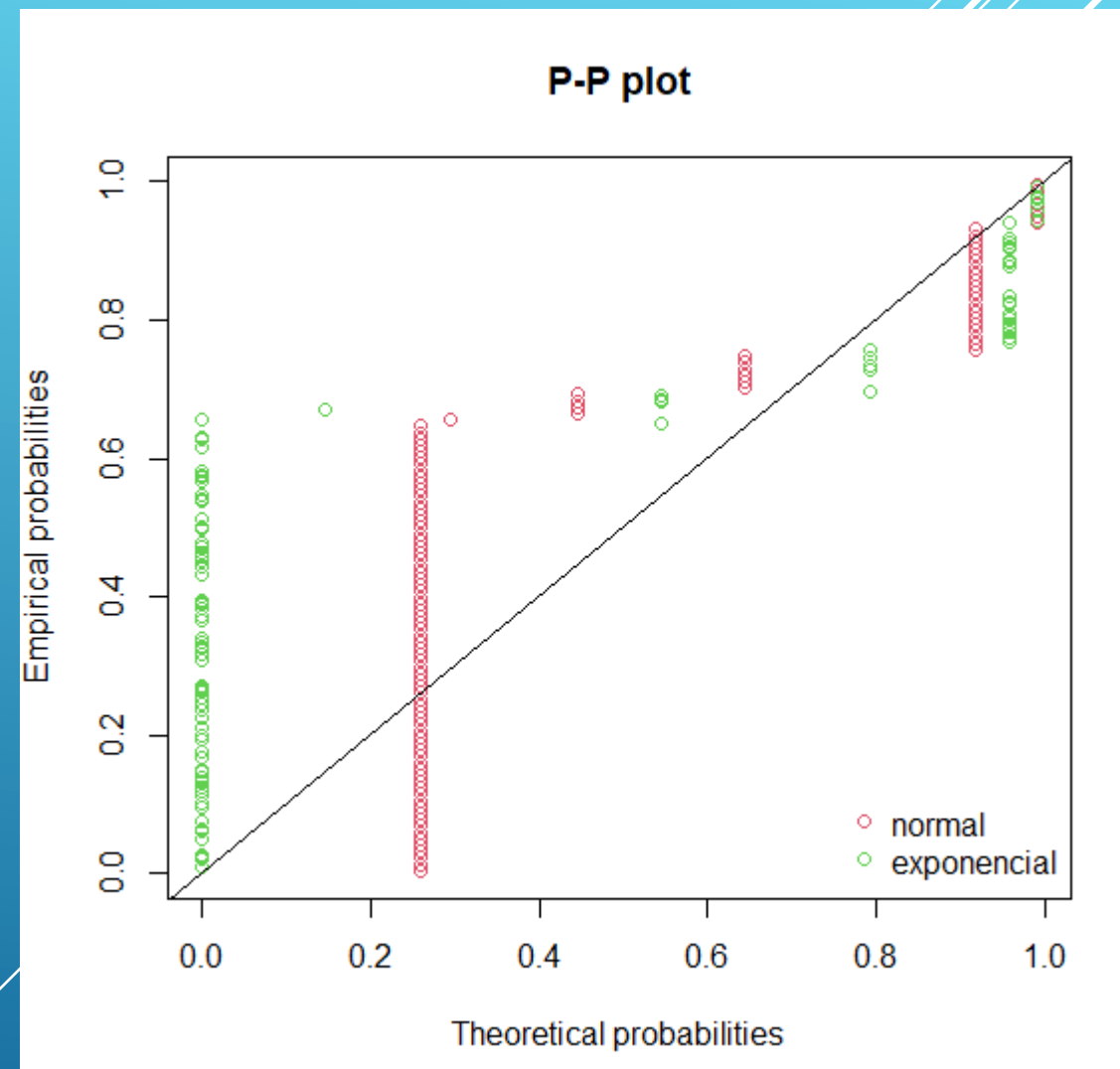
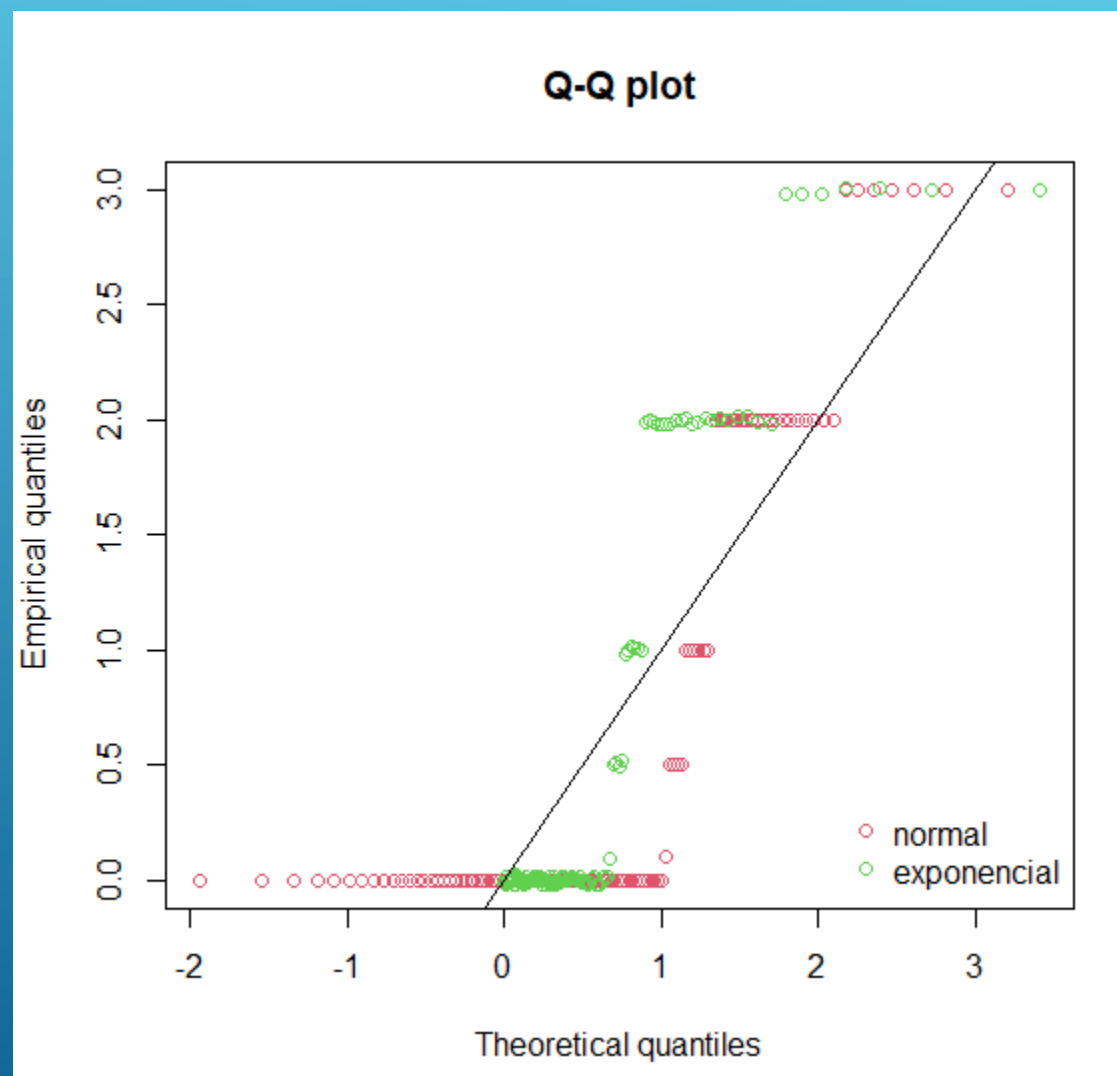
Empirical and theoretical CDFs



Histogram and theoretical densities



Razão de inerte



Razão de inerte

```
Goodness-of-fit statistics
```

	normal	exponencial
Kolmogorov-Smirnov statistic	0.3910156	0.6513761
Cramer-von Mises statistic	3.3700452	10.7222395
Anderson-Darling statistic	17.8093205	Inf

```
Goodness-of-fit criteria
```

	normal	exponencial
Akaike's Information Criterion	310.4965	120.6371
Bayesian Information Criterion	315.8792	123.3284

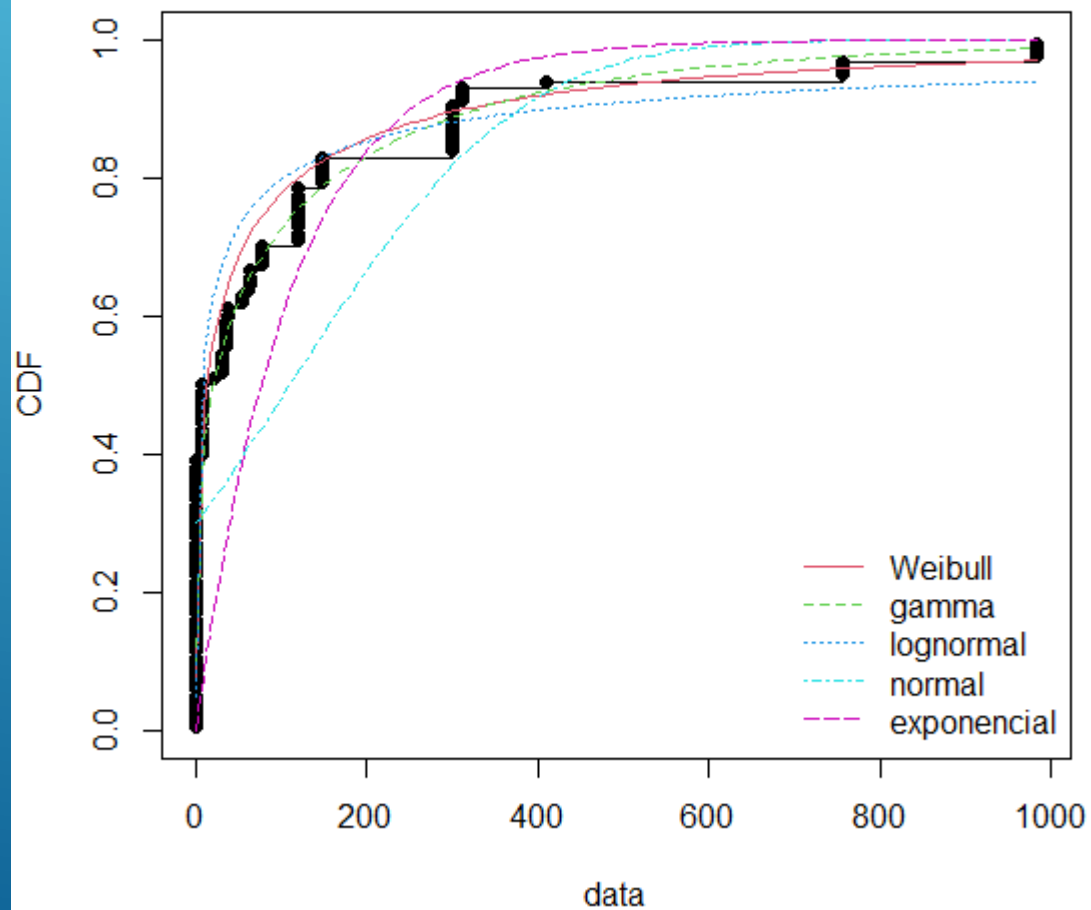
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.091743, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

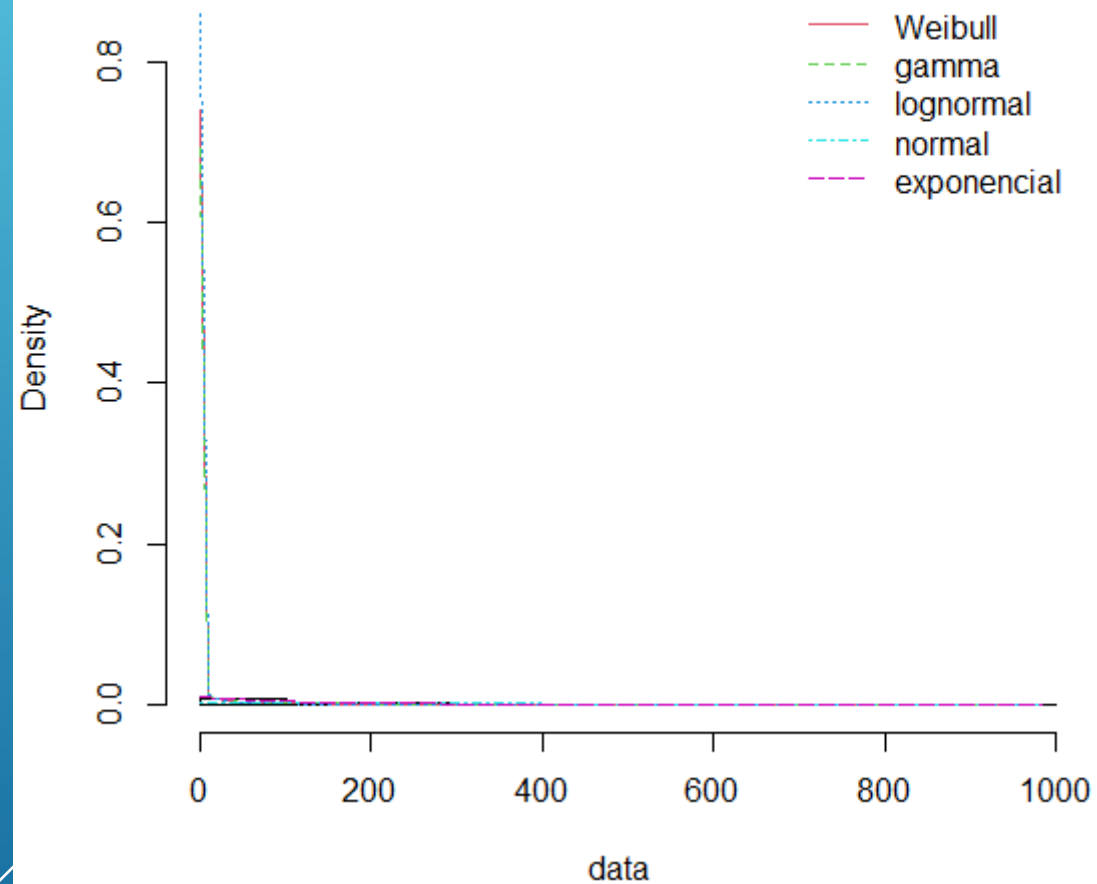
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8146353
```

Velocidade WSHV

Empirical and theoretical CDFs

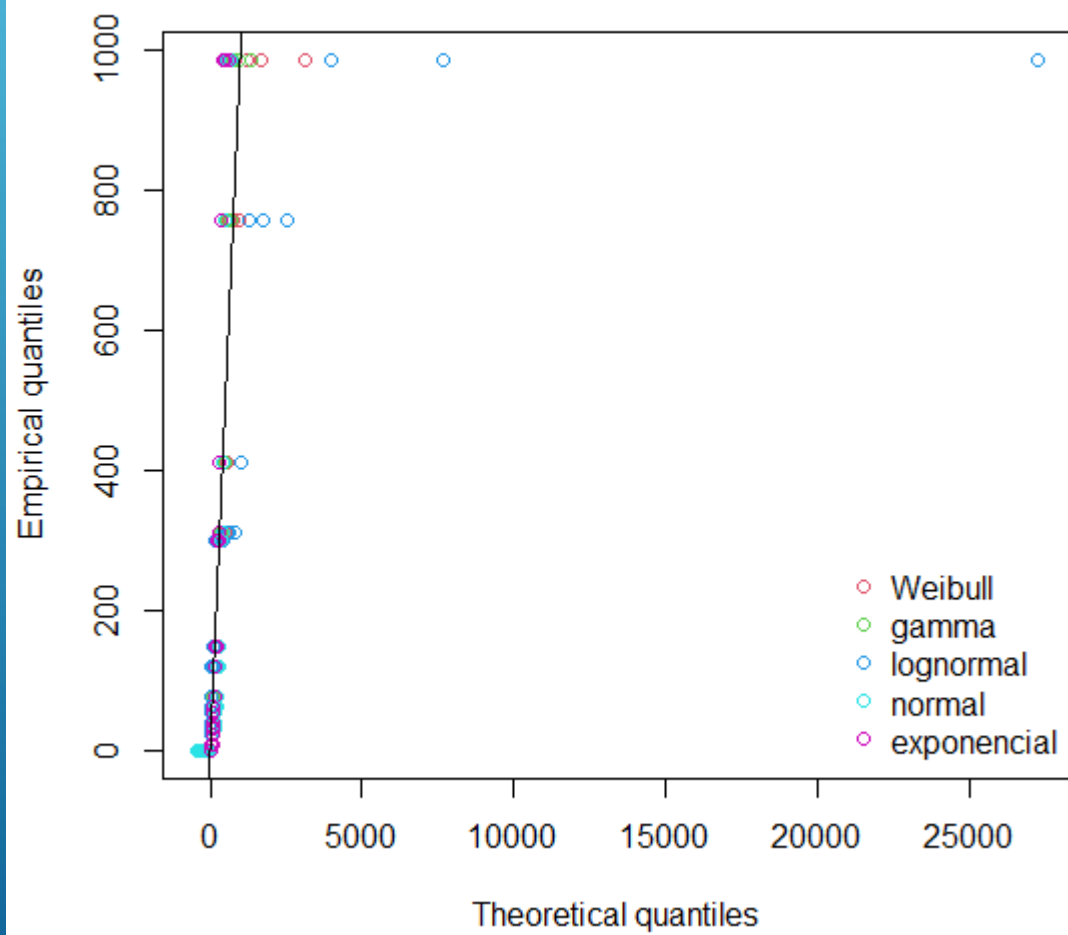


Histogram and theoretical densities

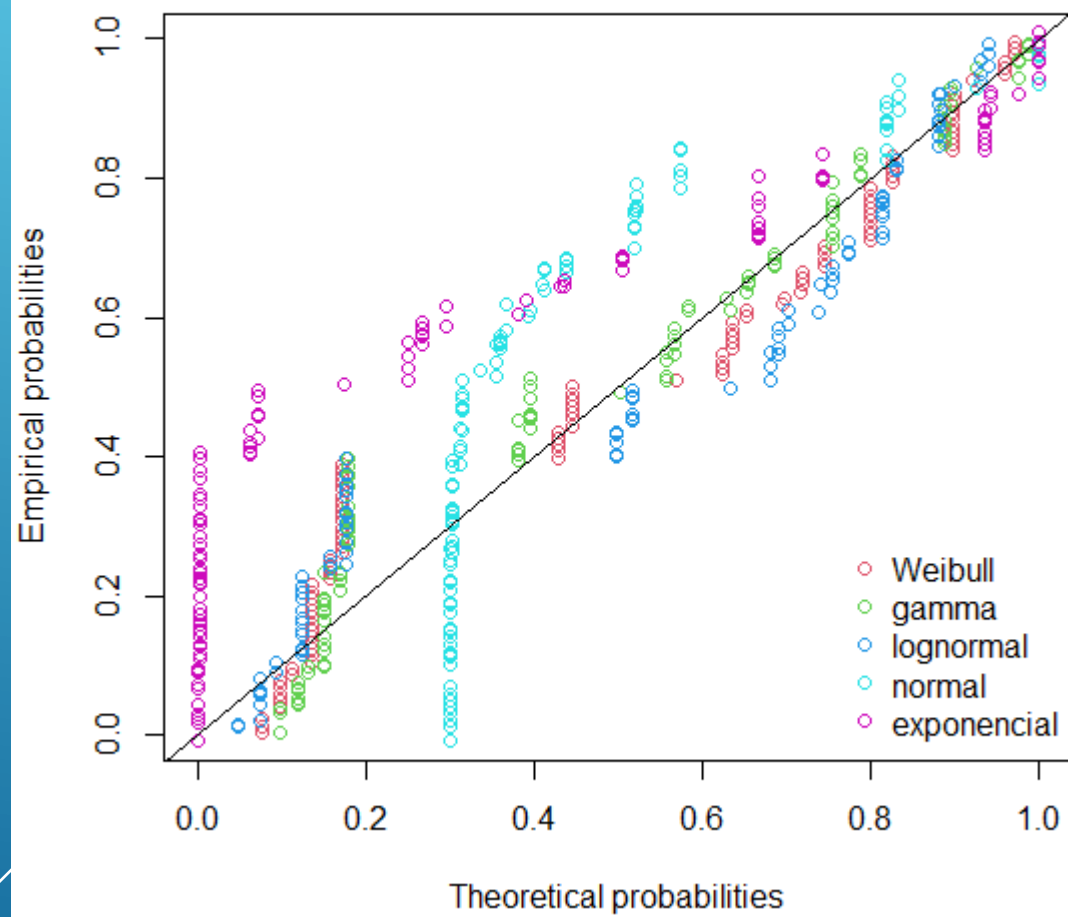


Velocidade WSHV

Q-Q plot



P-P plot



Velocidade WSHV

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2237238	0.2154550	0.2192654	0.3006112
Cramer-von Mises statistic	0.6135860	0.5092725	0.8358892	3.1529815
Anderson-Darling statistic	3.8733156	3.3828894	4.8694563	16.6996559

	exponencial
Kolmogorov-Smirnov statistic	0.4333511
Cramer-von Mises statistic	5.6145926
Anderson-Darling statistic	85.2817482

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	990.5526	991.2694	992.0919	1478.545
Bayesian Information Criterion	995.9353	996.6521	997.4746	1483.928

	exponencial
Akaike's Information Criterion	1243.839
Bayesian Information Criterion	1246.531

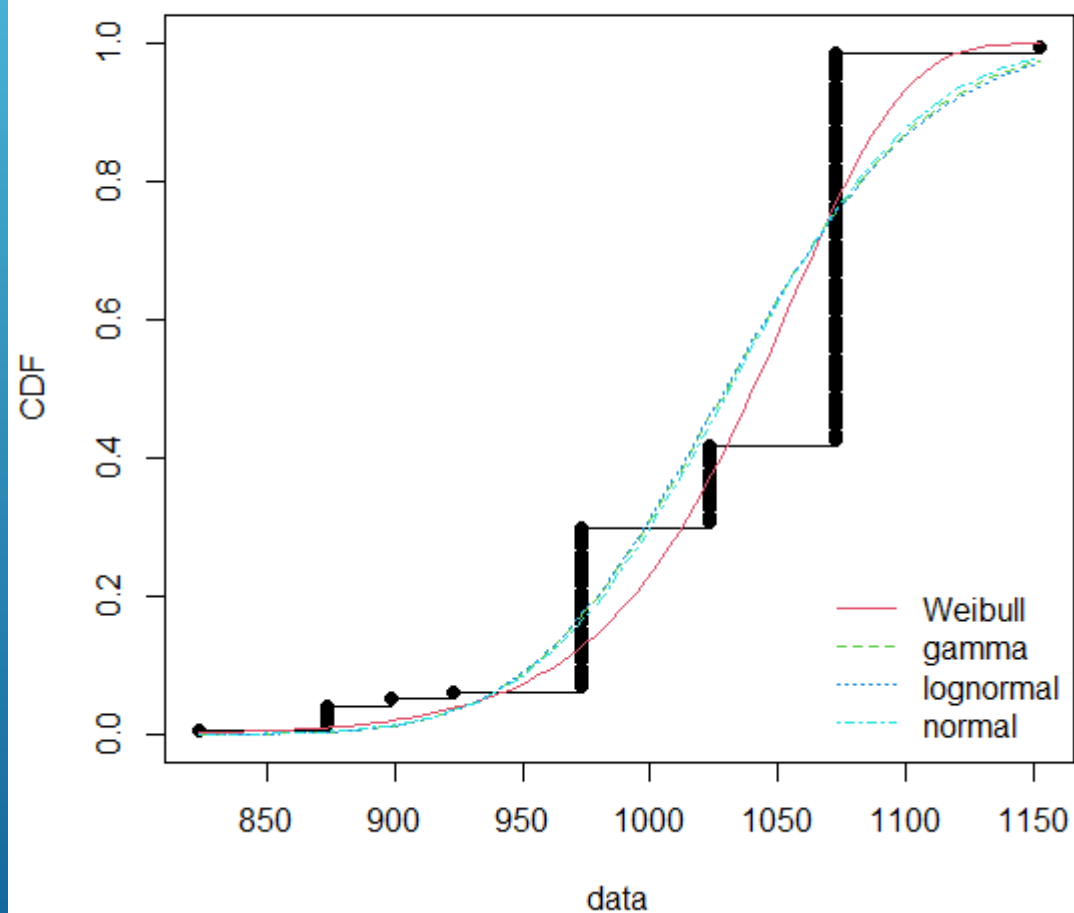
Hartigans' dip test for unimodality / multimodality

```
data: vari  
D = 0.059633, p-value = 0.004938  
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

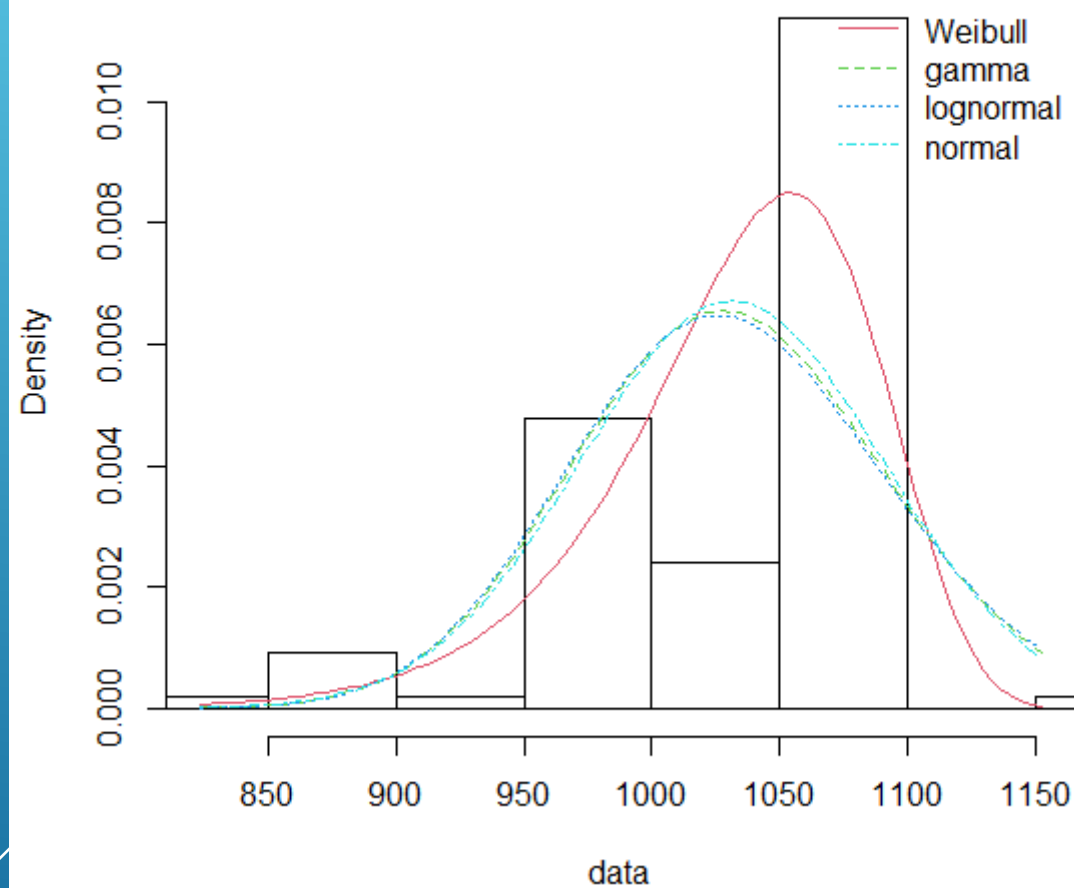
```
> is.amodal(vari)  
[1] FALSE  
> is.unimodal(vari)  
[1] FALSE  
> is.bimodal(vari)  
[1] TRUE  
> is.trimodal(vari)  
[1] FALSE  
> is.iterquad(vari)  
[1] FALSE  
> bimodality_coefficient(vari)  
[1] 0.8071385
```

Temperatura de reação

Empirical and theoretical CDFs

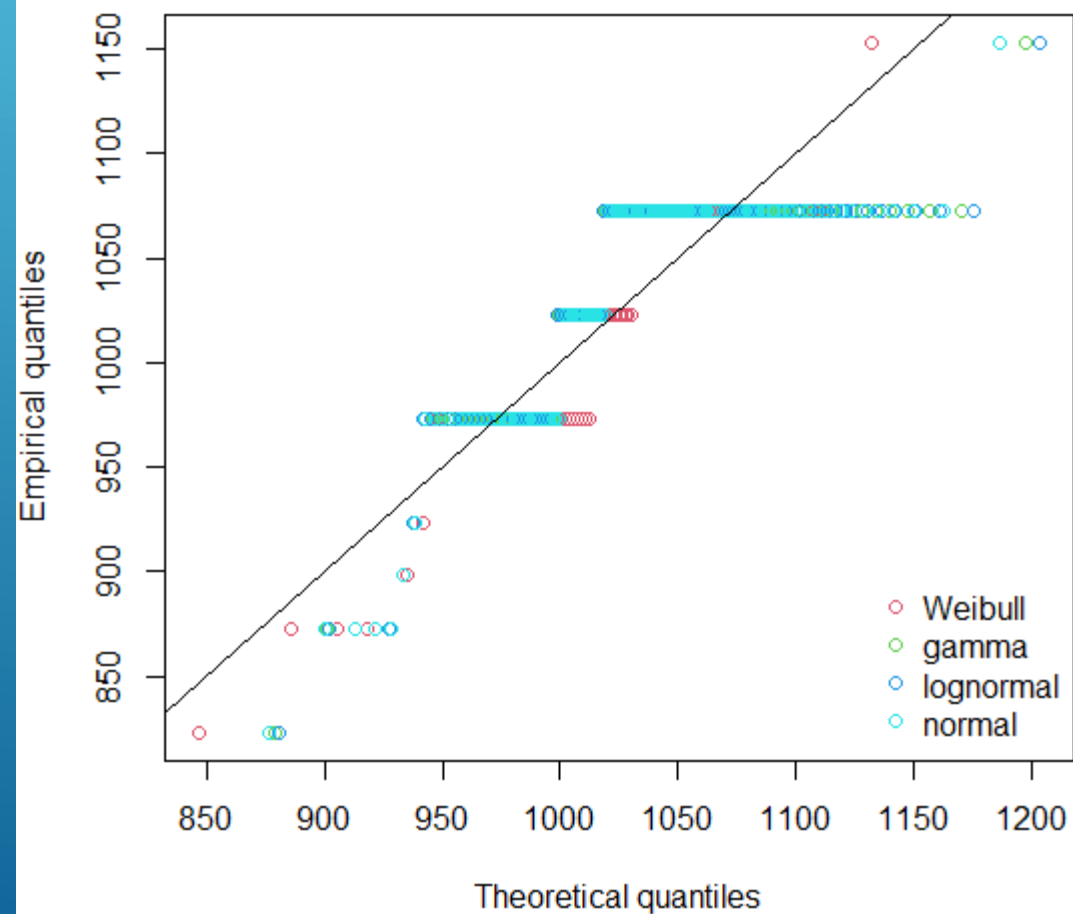


Histogram and theoretical densities

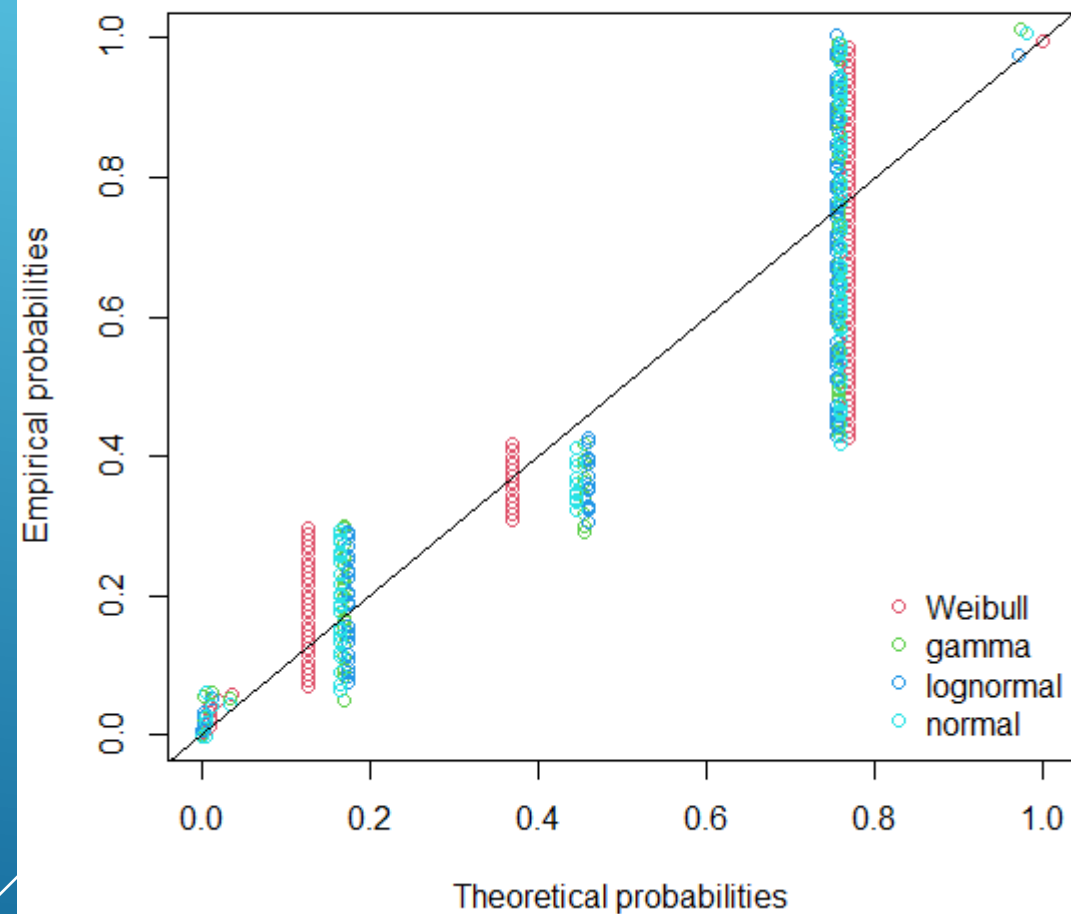


Temperatura de reação

Q-Q plot



P-P plot



Temperatura de reação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.347347	0.3343404	0.3329575	0.3365145
Cramer-von Mises statistic	2.143900	2.0835509	2.0835943	2.0818993
Anderson-Darling statistic	11.998882	11.5457736	11.5559460	11.5264213

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1174.383	1209.210	1212.083	1203.824
Bayesian Information Criterion	1179.766	1214.593	1217.466	1209.206

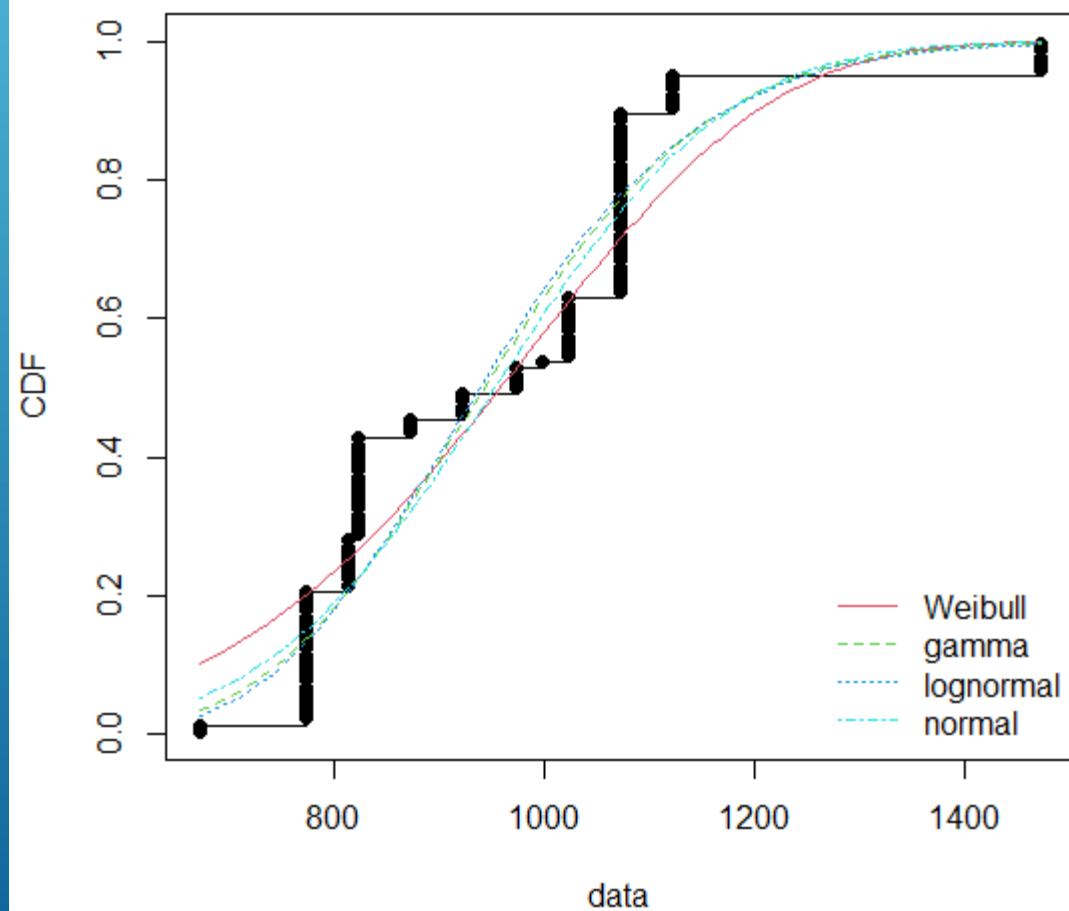
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.11927, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

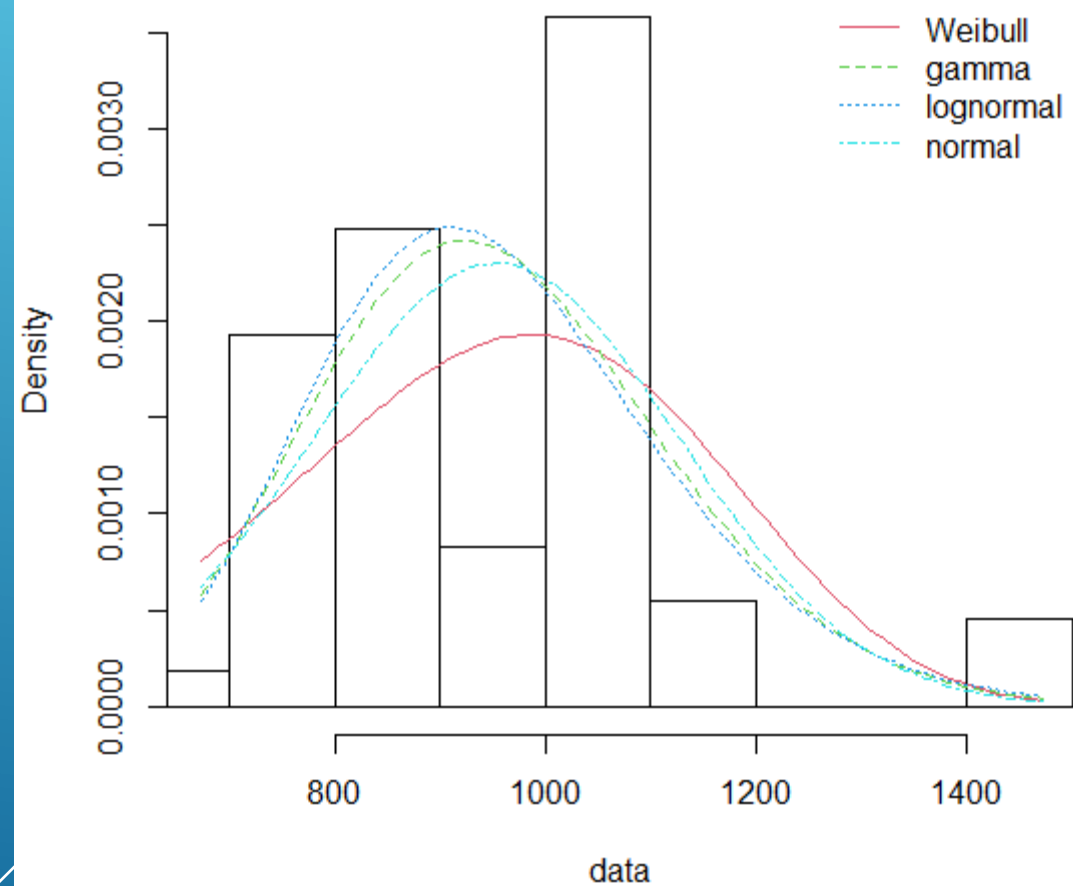
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.5785017
>
```

Temperatura de calcinação

Empirical and theoretical CDFs

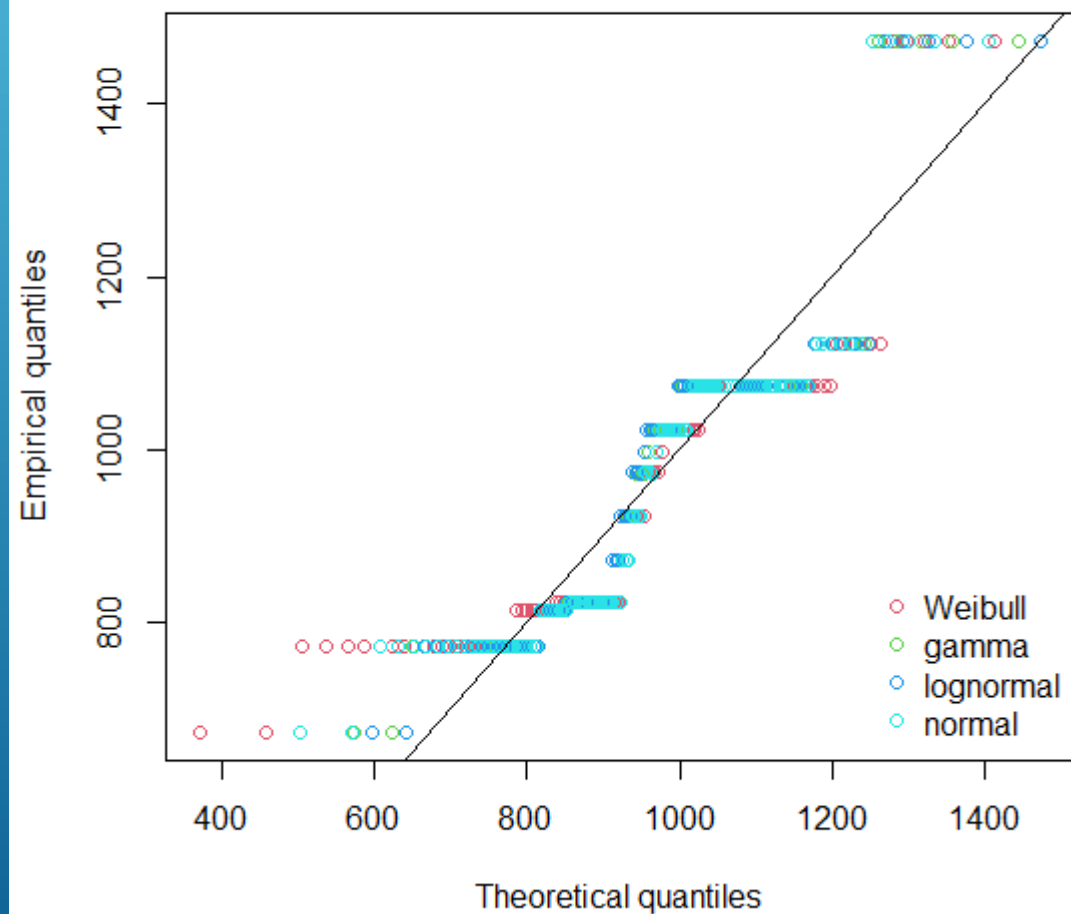


Histogram and theoretical densities

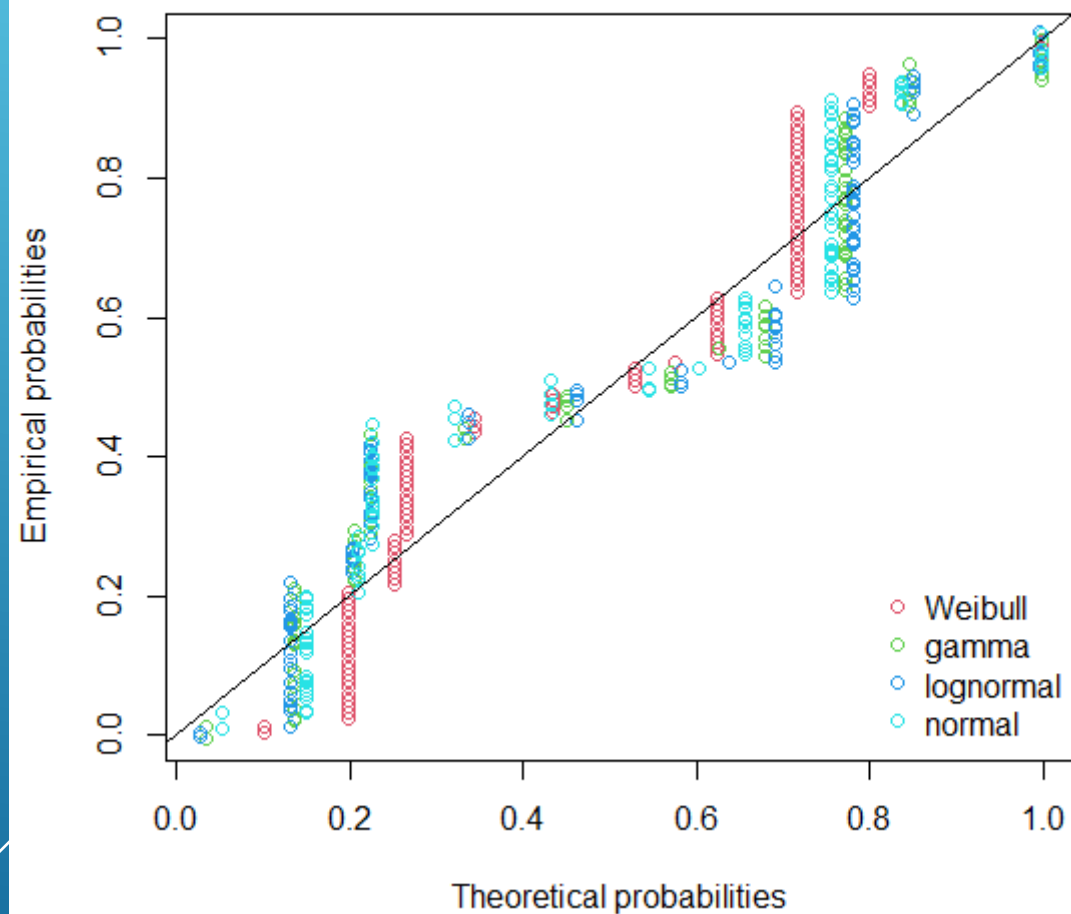


Temperatura de calcinação

Q-Q plot



P-P plot



Temperatura de calcinação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1831509	0.2068556	0.2067812	0.2046888
Cramer-von Mises statistic	0.8082519	0.7791568	0.7988499	0.7606514
Anderson-Darling statistic	5.7703990	4.8839219	4.8582881	5.0950761

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1455.255	1427.172	1423.585	1437.431
Bayesian Information Criterion	1460.638	1432.555	1428.967	1442.814

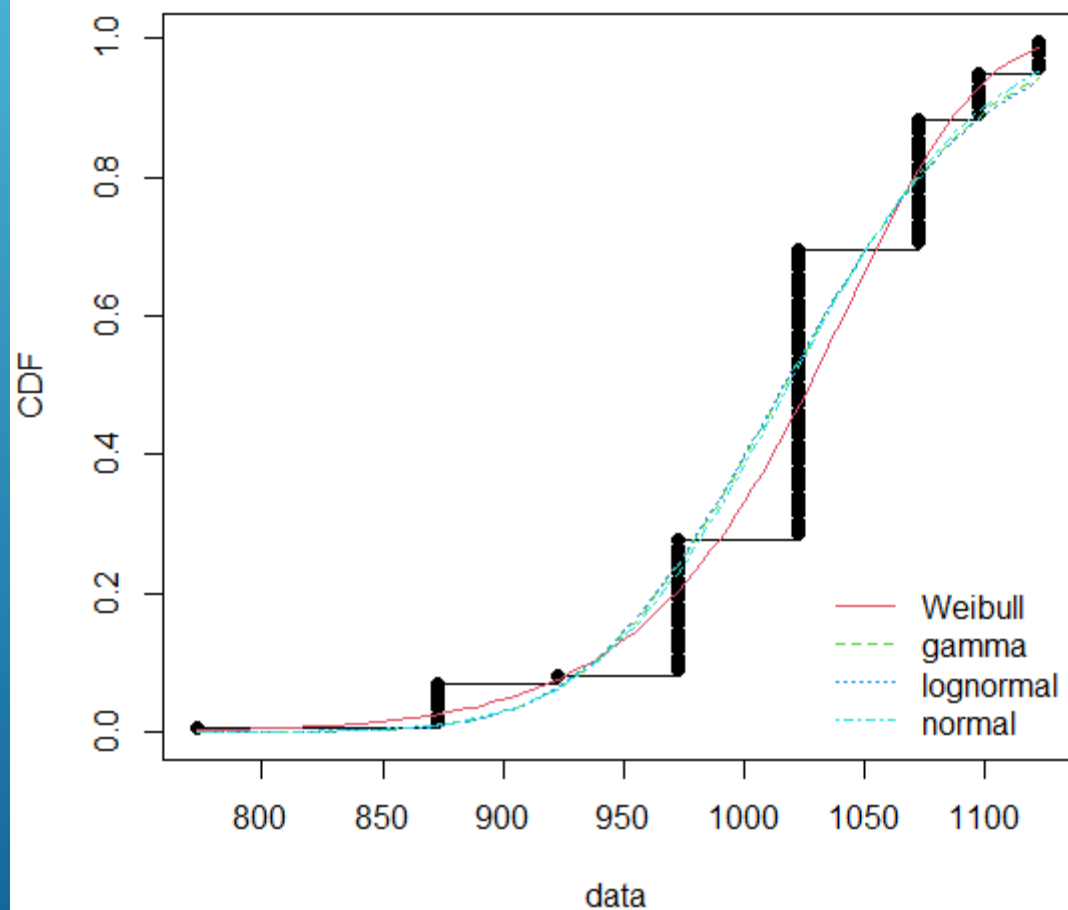
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.13303, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

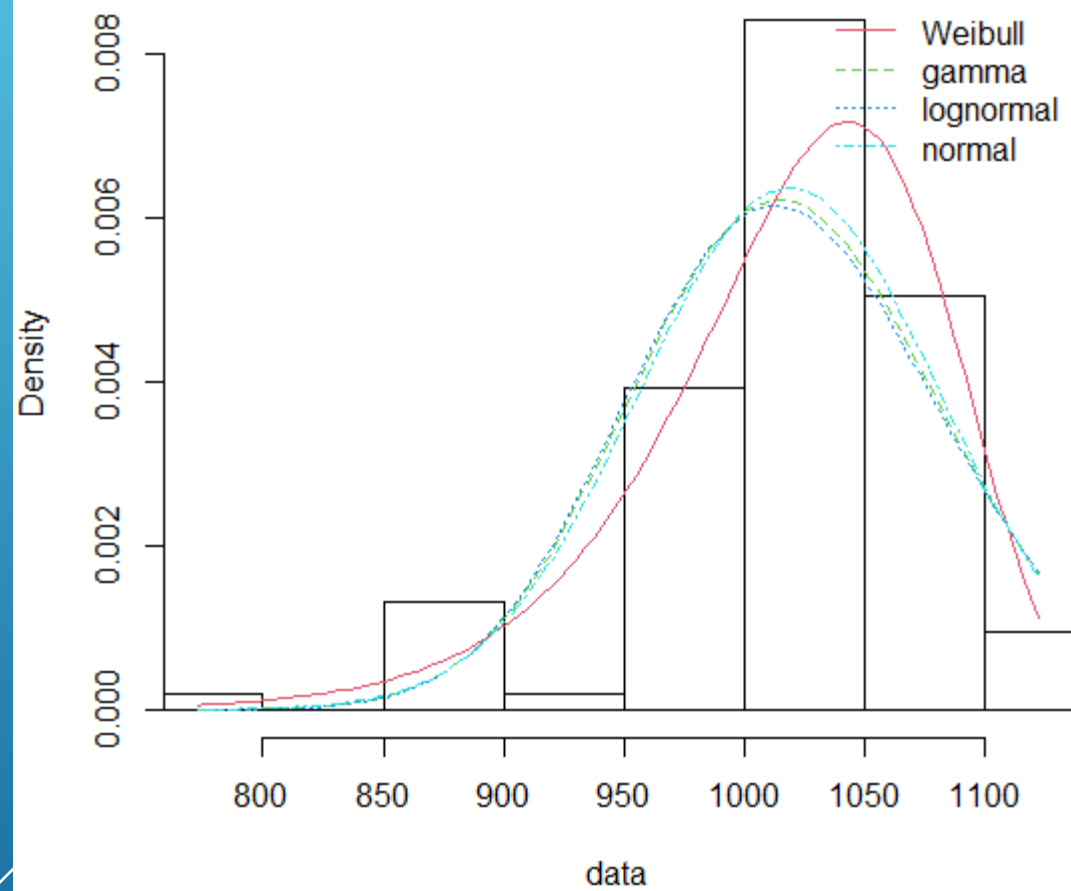
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.4487253
>
```

Temperatura de redução

Empirical and theoretical CDFs

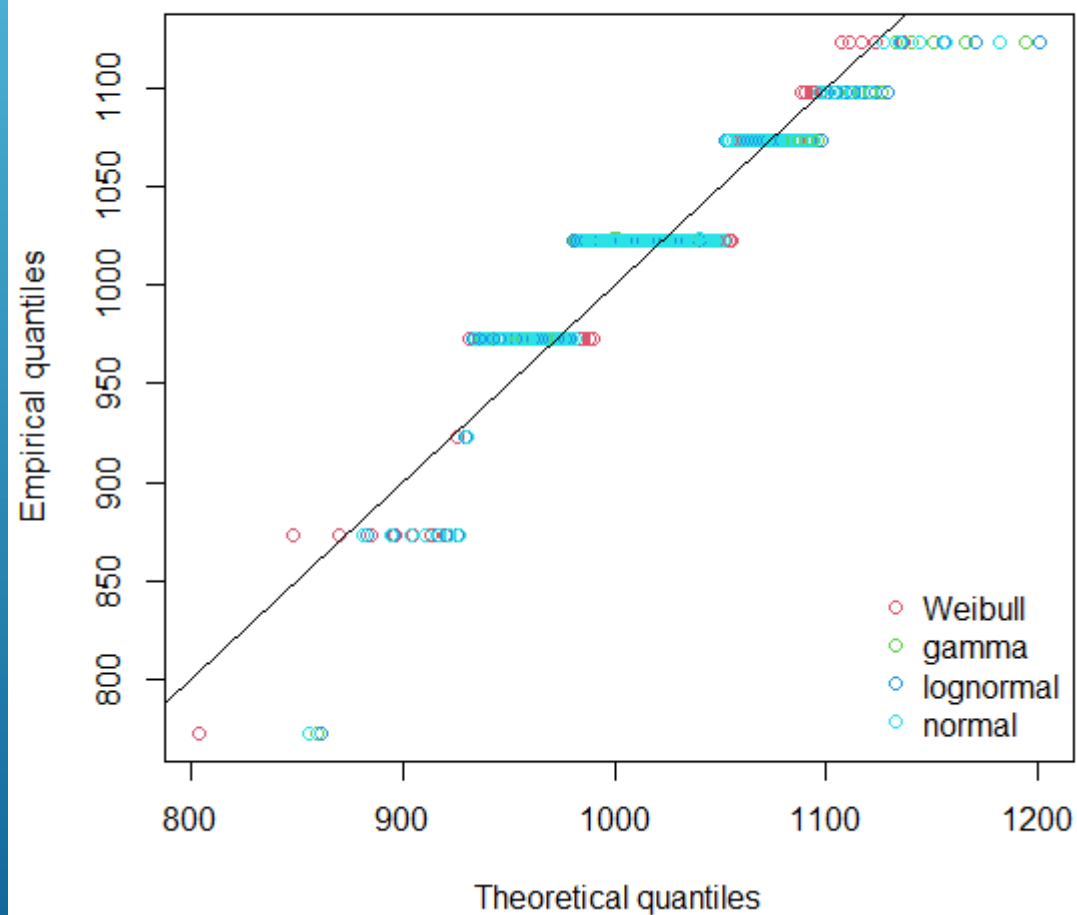


Histogram and theoretical densities

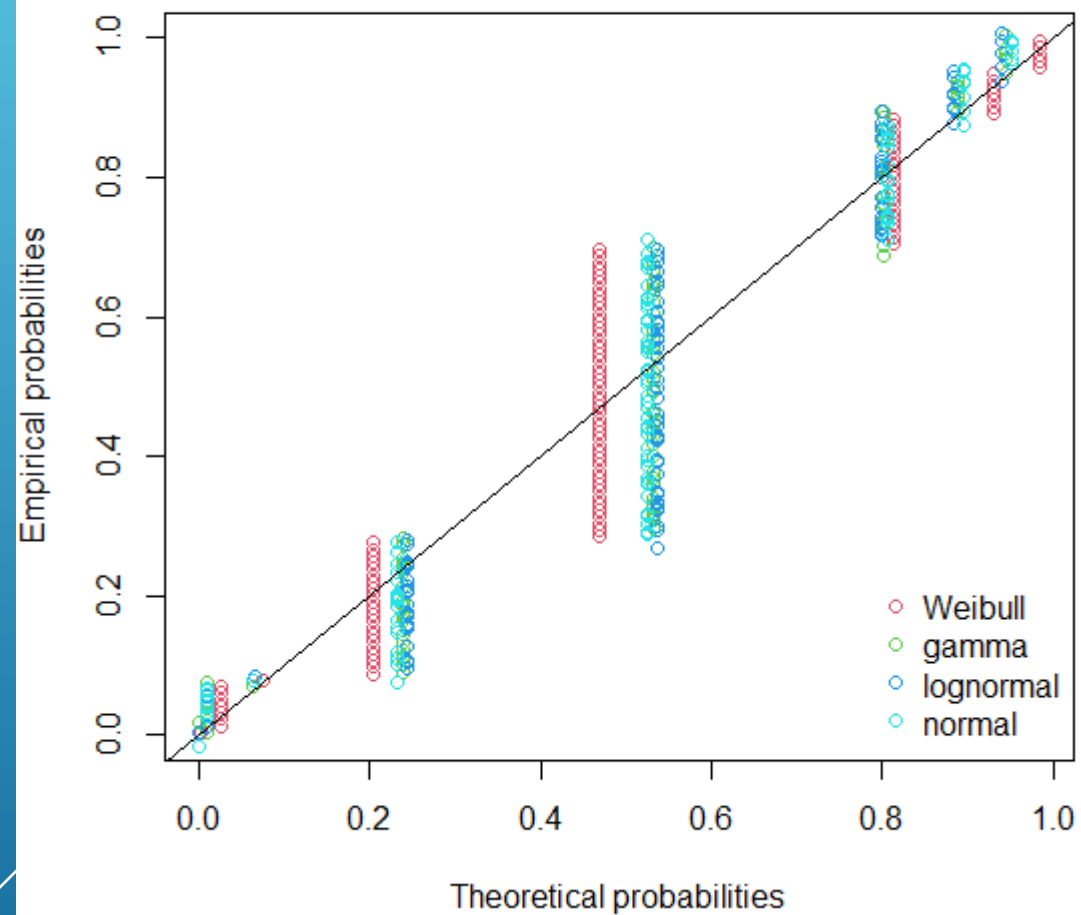


Temperatura de redução

Q-Q plot



P-P plot



Temperatura de redução

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2314795	0.2525438	0.2562426	0.2448956
Cramer-von Mises statistic	0.8352080	0.9668989	0.9965011	0.9166352
Anderson-Darling statistic	3.9774422	5.1313026	5.3242391	4.7918548

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1178.107	1198.349	1201.242	1193.145
Bayesian Information Criterion	1183.453	1203.695	1206.588	1198.490

>

Hartigans' dip test for unimodality / multimodality

data: vari

D = 0.098131, p-value < 2.2e-16

alternative hypothesis: non-unimodal, i.e., at least bimodal

> is.amodal(vari)

[1] FALSE

> is.unimodal(vari)

[1] TRUE

> is.bimodal(vari)

[1] FALSE

> is.trimodal(vari)

[1] FALSE

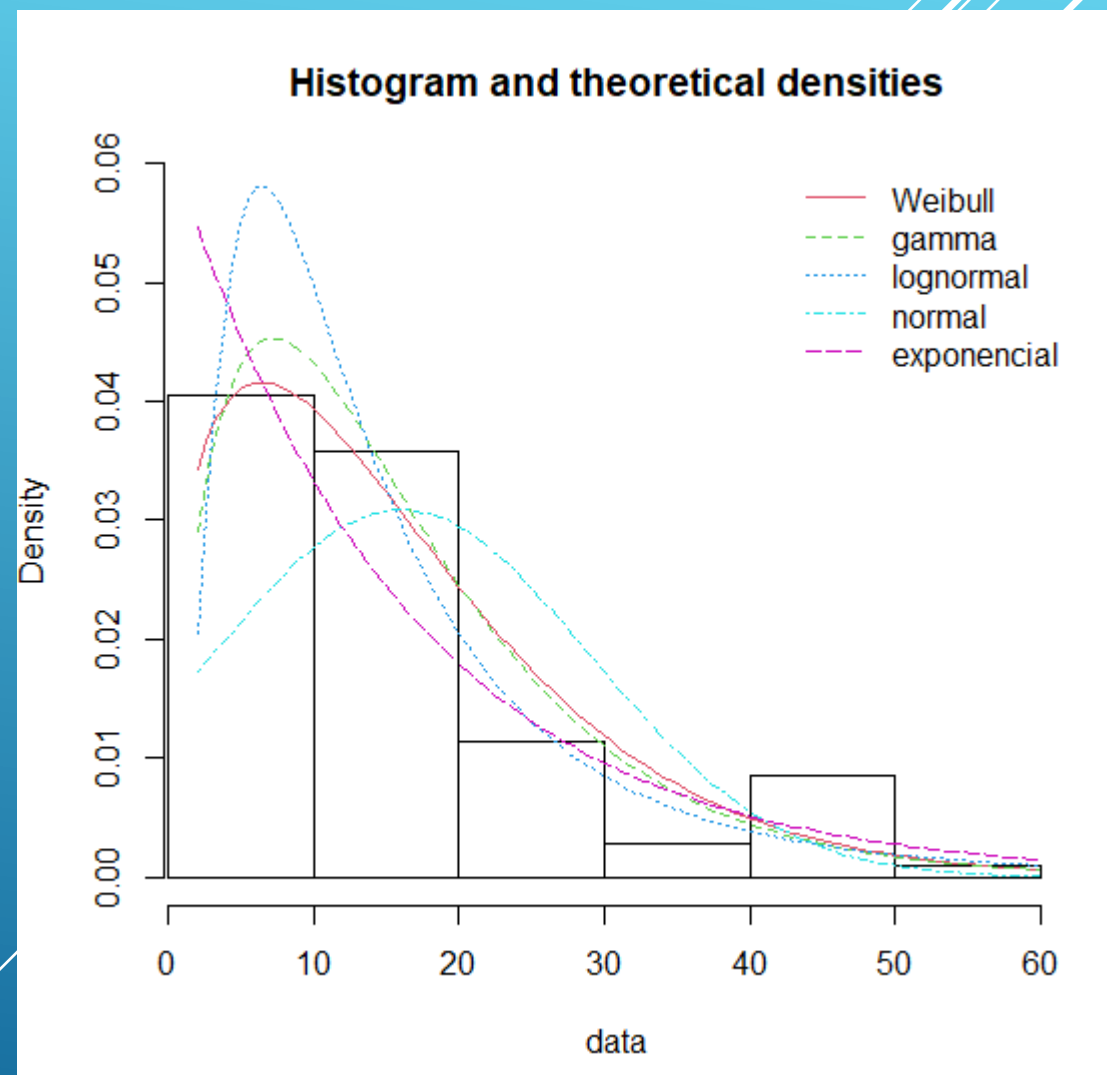
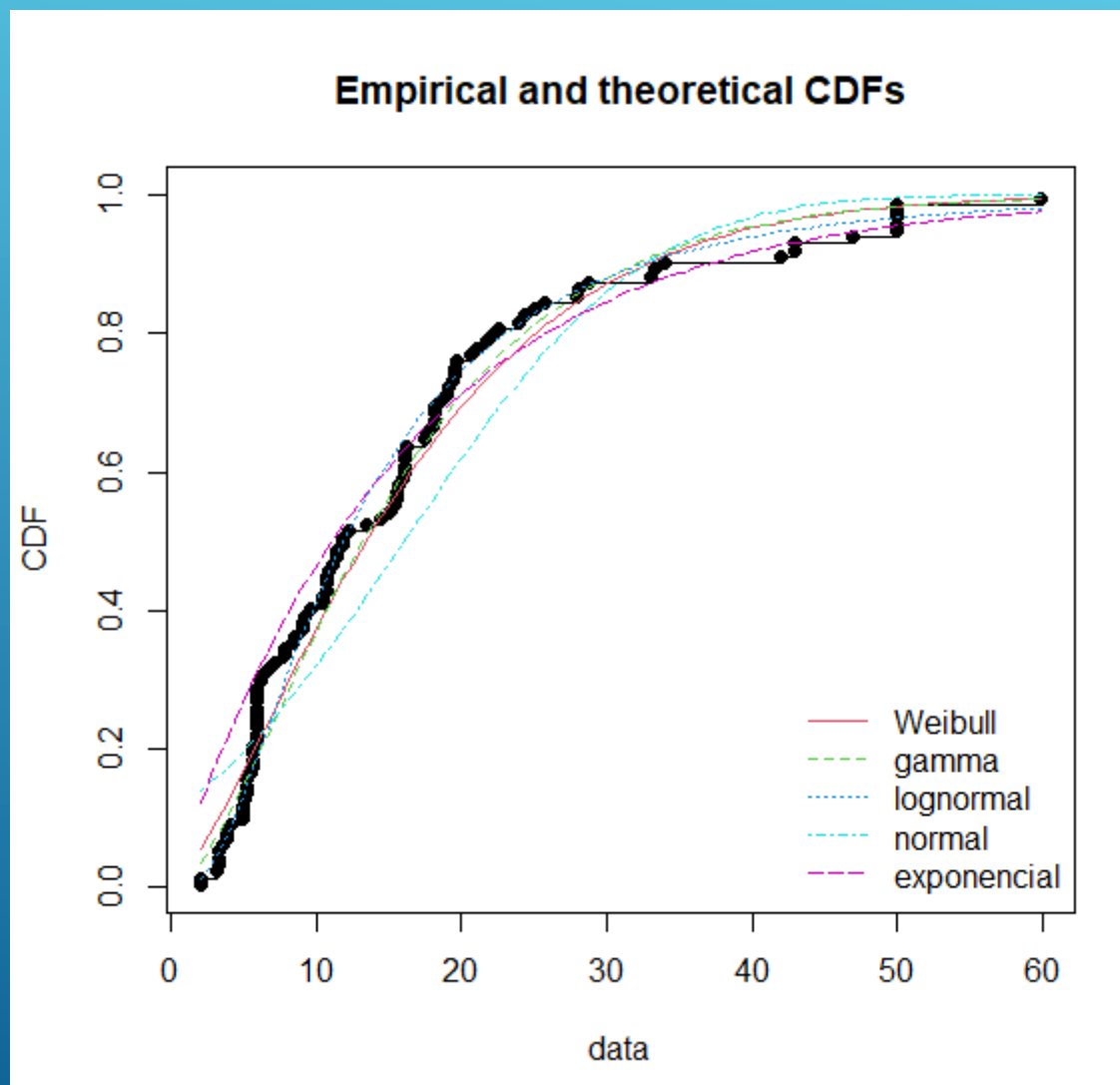
> is.iterquad(vari)

[1] FALSE

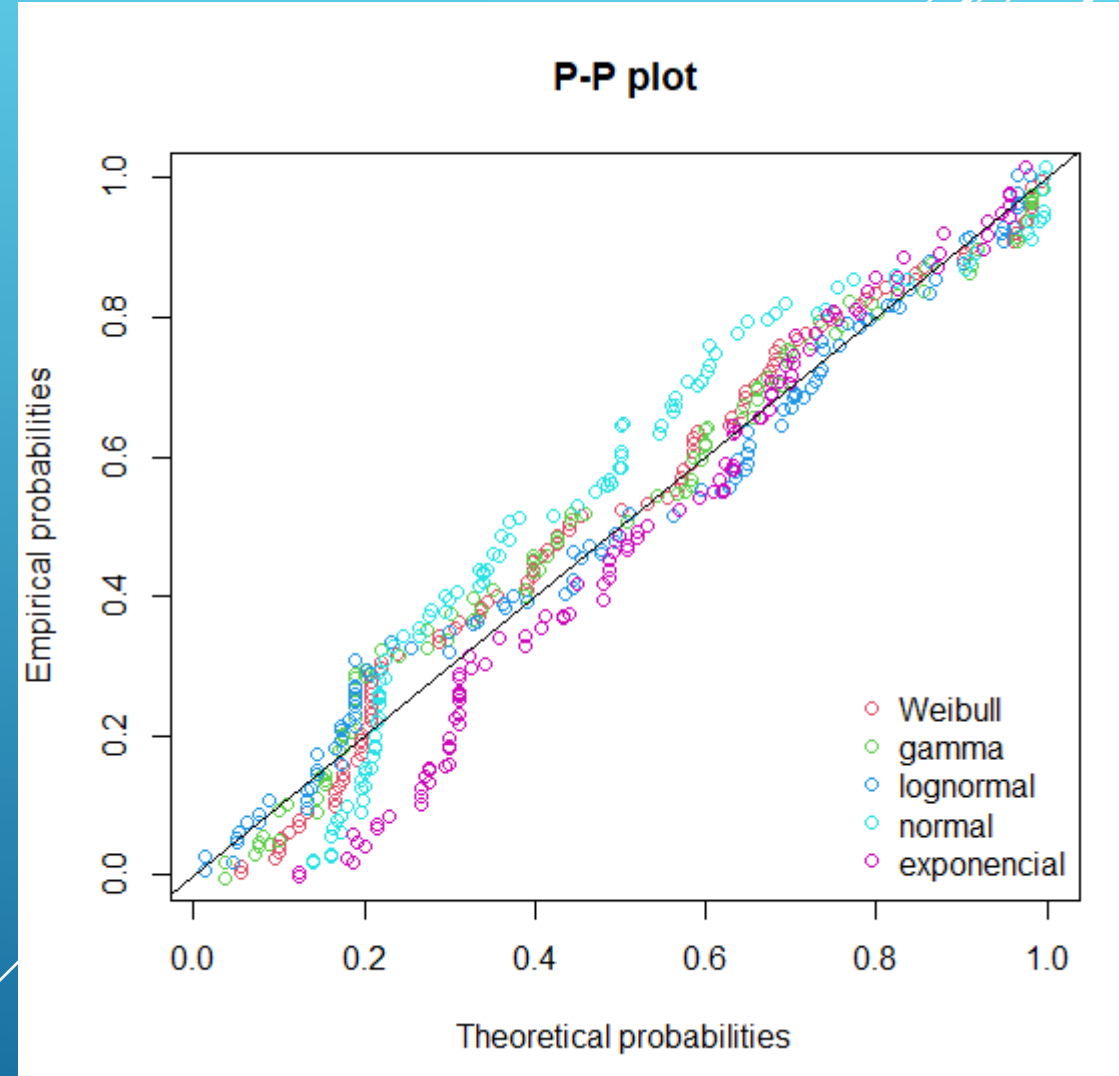
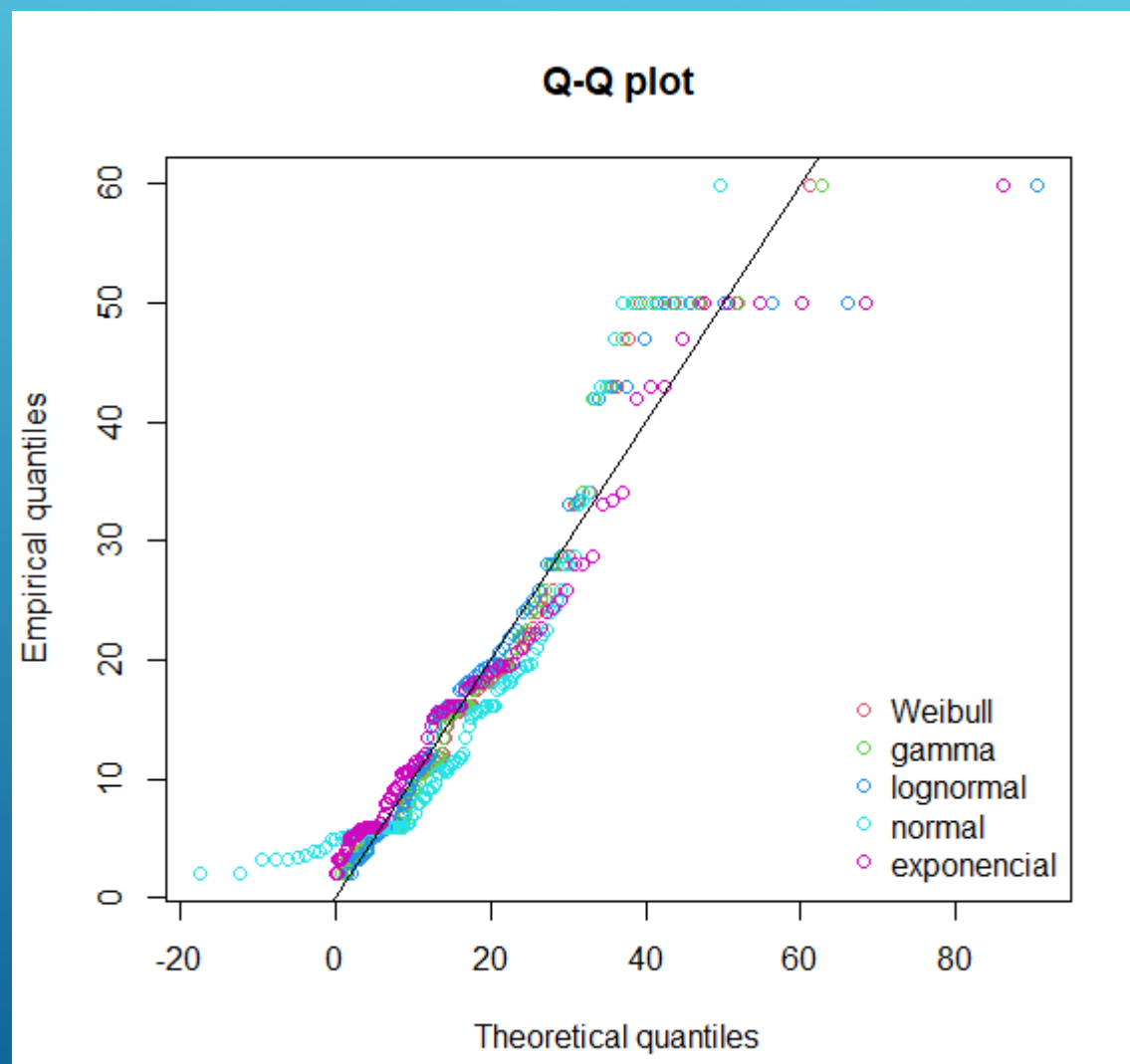
> bimodality_coefficient(vari)

[1] 0.4133321

Tamanho de cristalito da fase ativa



Tamanho de cristalito da fase ativa



Tamanho de cristalito da fase ativa

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.09133338	0.1097149	0.1053735	0.1536445
Cramer-von Mises statistic	0.20425165	0.1871501	0.1347572	0.8703954
Anderson-Darling statistic	1.57222456	1.3594460	0.8177270	5.6440978

```
exponencial
```

Kolmogorov-Smirnov statistic	0.1731925
Cramer-von Mises statistic	0.5503444
Anderson-Darling statistic	3.7721862

```
Goodness-of-fit criteria
```

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	789.9698	785.1256	778.0123	847.2377
Bayesian Information Criterion	795.2967	790.4524	783.3392	852.5646

```
exponencial
```

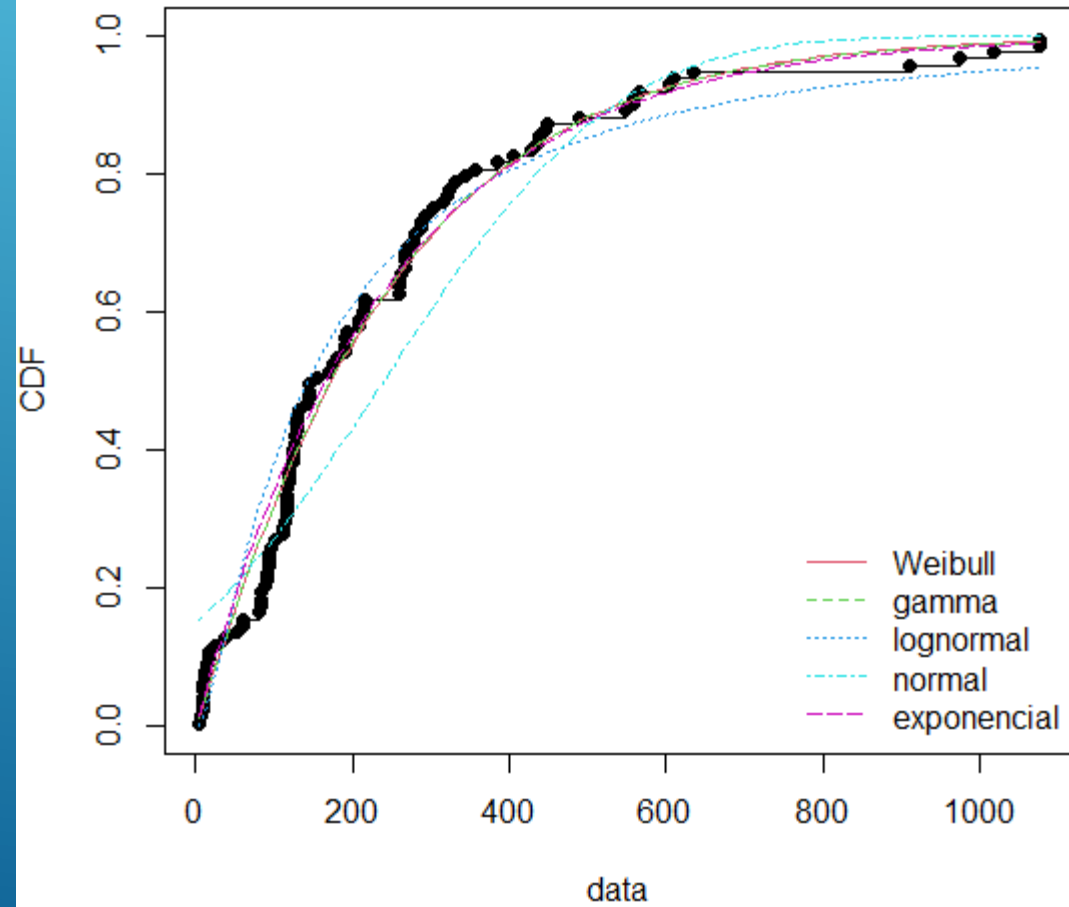
Akaike's Information Criterion	802.5801
Bayesian Information Criterion	805.2435

Hartigan's dip test for unimodality / multimodality

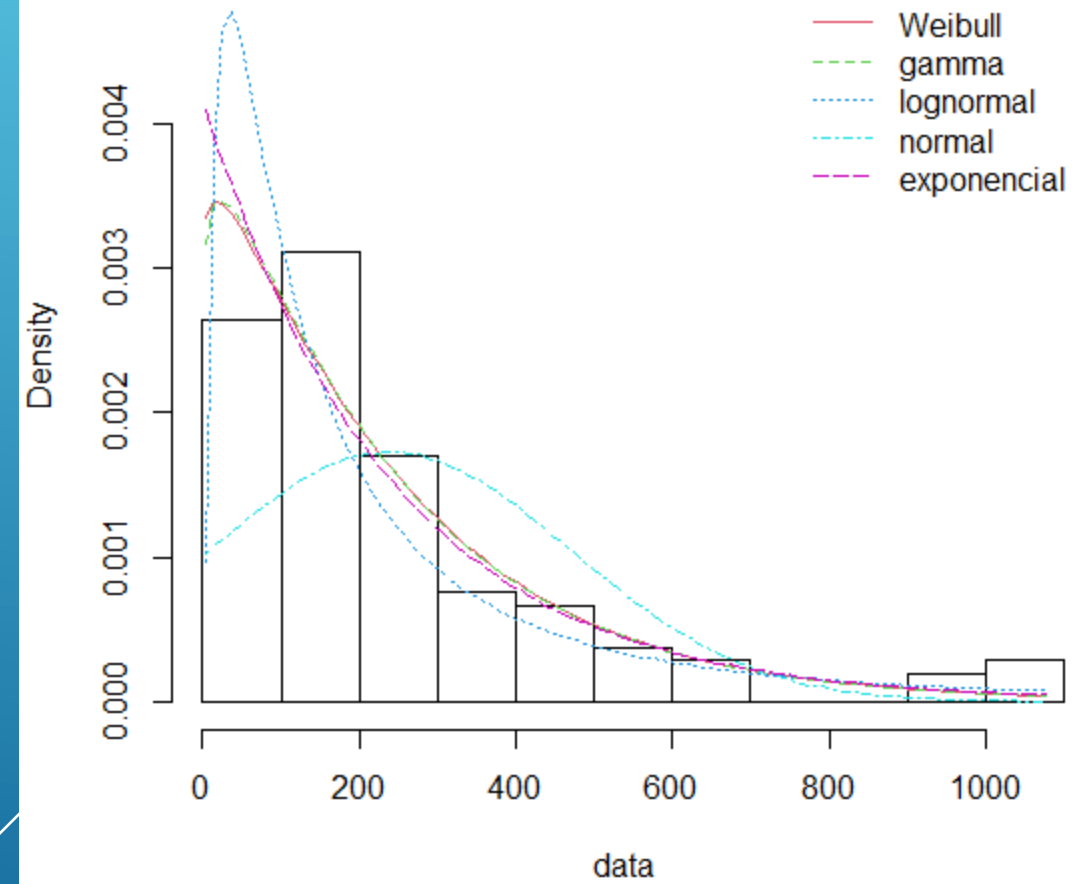
```
data: vari
D = 0.039279, p-value = 0.2799
alternative hypothesis: non-unimodal, i.e., at least bimodal

> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6669682
```

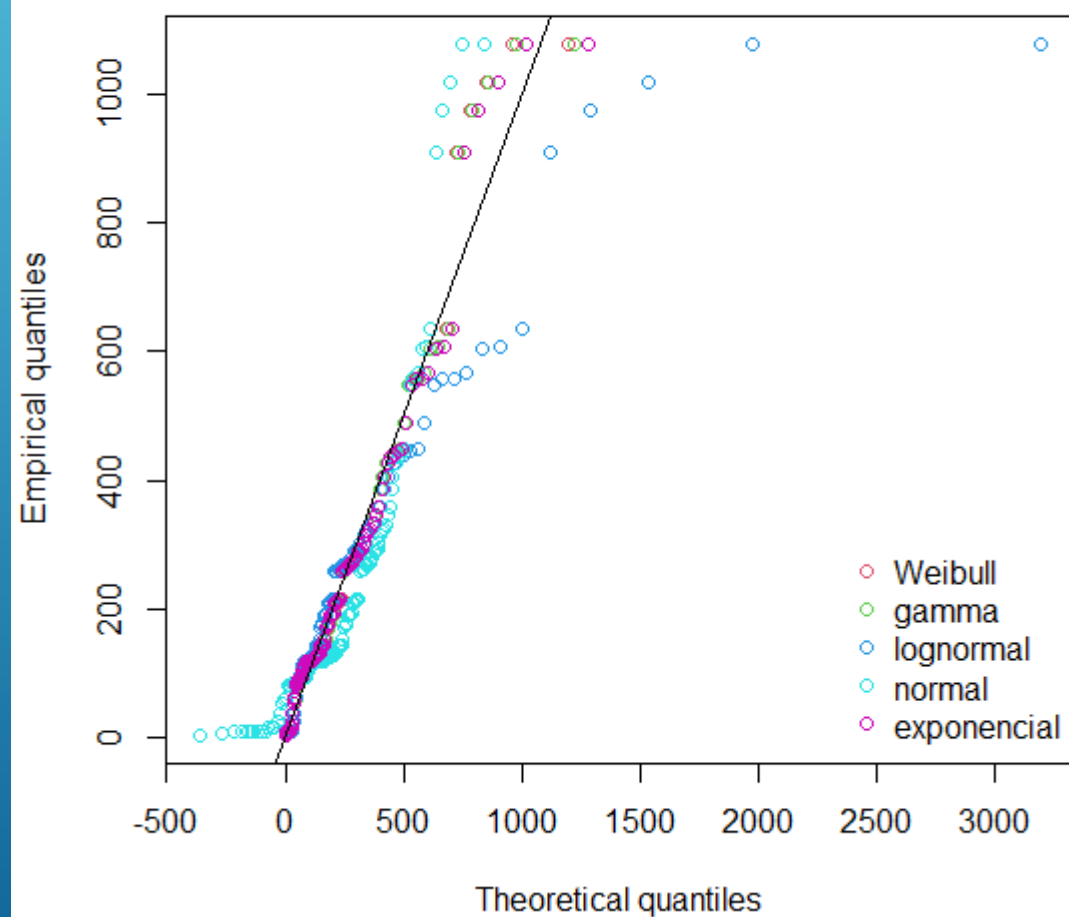
Empirical and theoretical CDFs



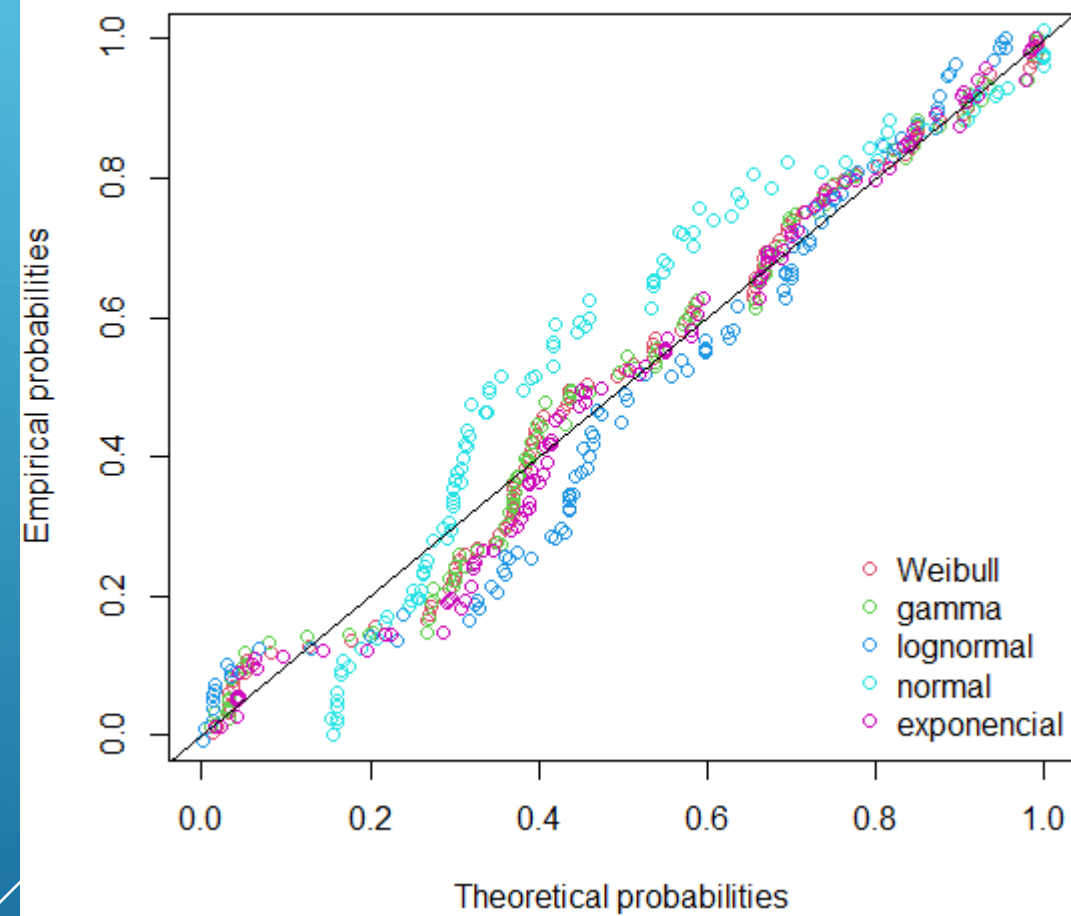
Histogram and theoretical densities



Q-Q plot



P-P plot



Área

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.1060912 0.1059635 0.1580133 0.1620893
Cramer-von Mises statistic  0.1593957 0.1570549 0.4696038 1.0155514
Anderson-Darling statistic  1.0310500 1.0360474 3.0601063 6.0168915
      exponencial
Kolmogorov-Smirnov statistic  0.1265030
Cramer-von Mises statistic    0.2064818
Anderson-Darling statistic    1.1837800

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 1376.953 1376.915 1394.579 1458.524
Bayesian Information Criterion 1382.280 1382.242 1399.906 1463.851
      exponencial
Akaike's Information Criterion  1375.515
Bayesian Information Criterion  1378.179
```

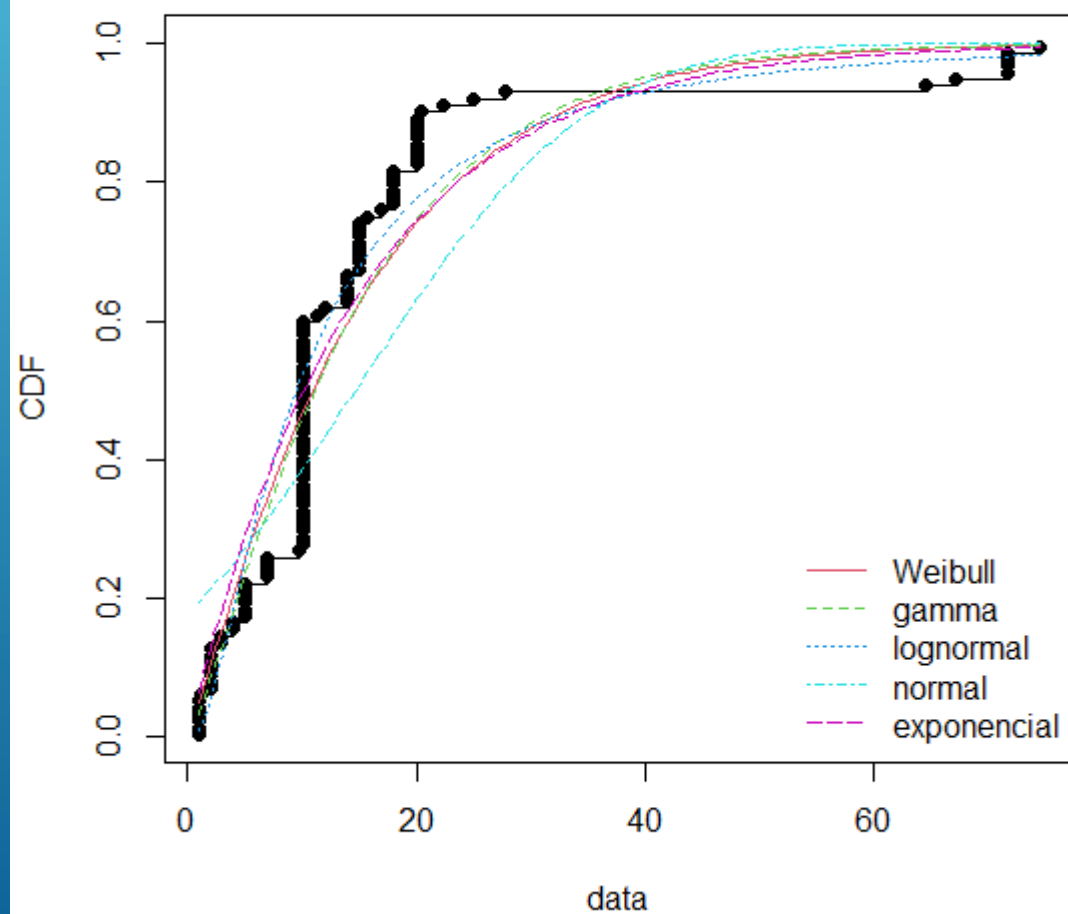
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.044107, p-value = 0.1406
alternative hypothesis: non-unimodal, i.e., at least bimodal

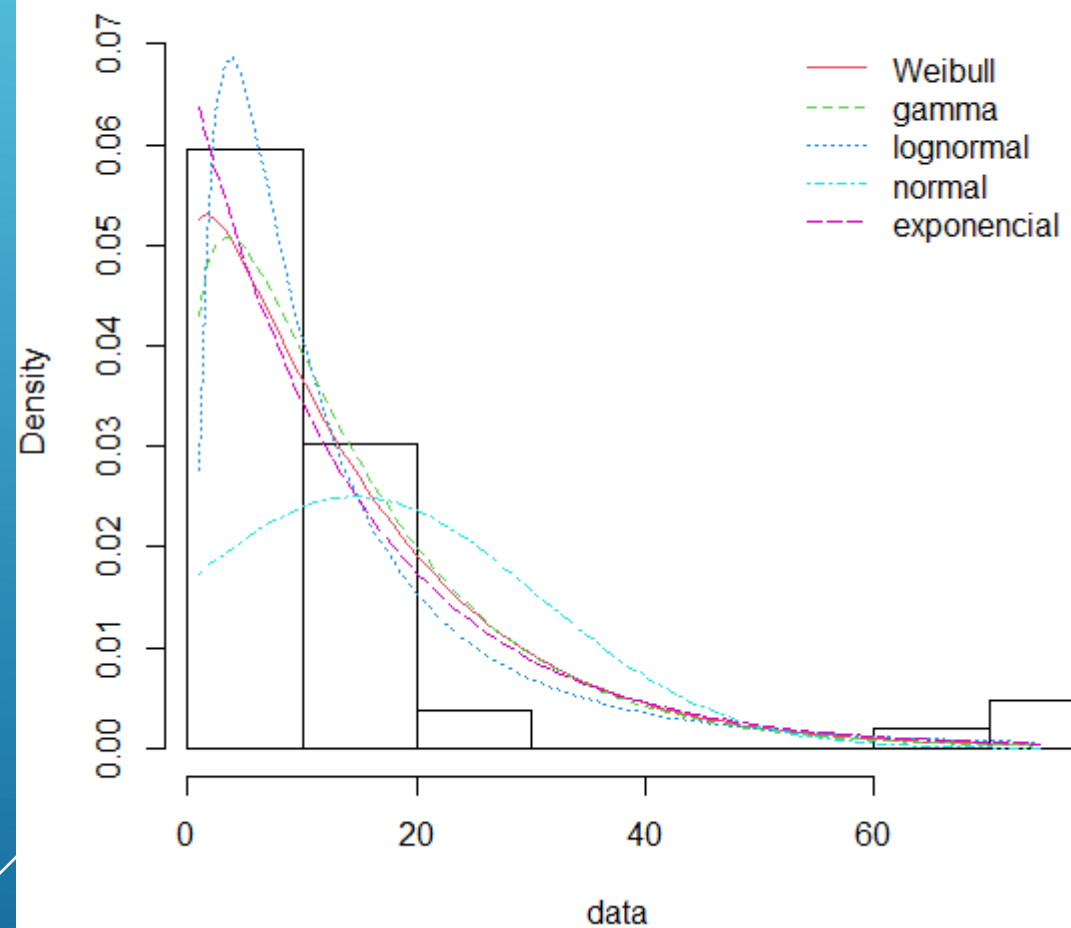
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6587079
>
```

Teor da fase ativa

Empirical and theoretical CDFs

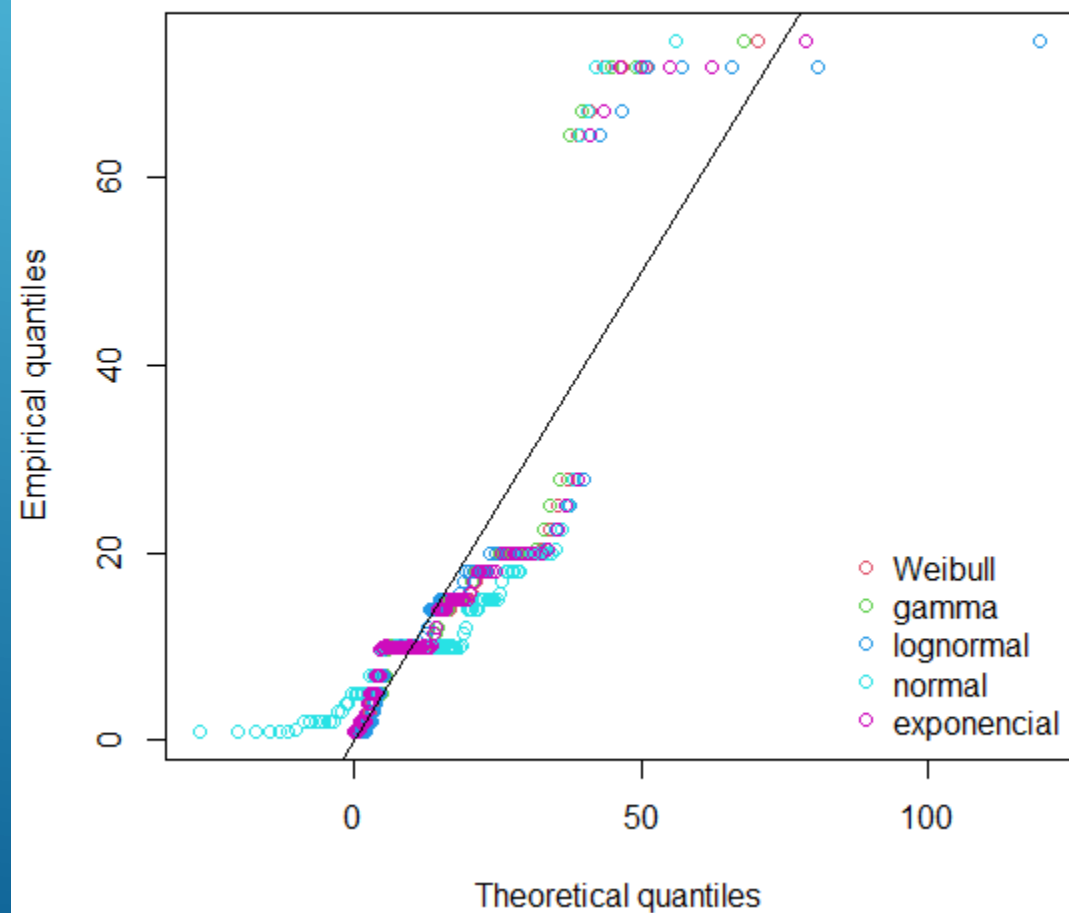


Histogram and theoretical densities

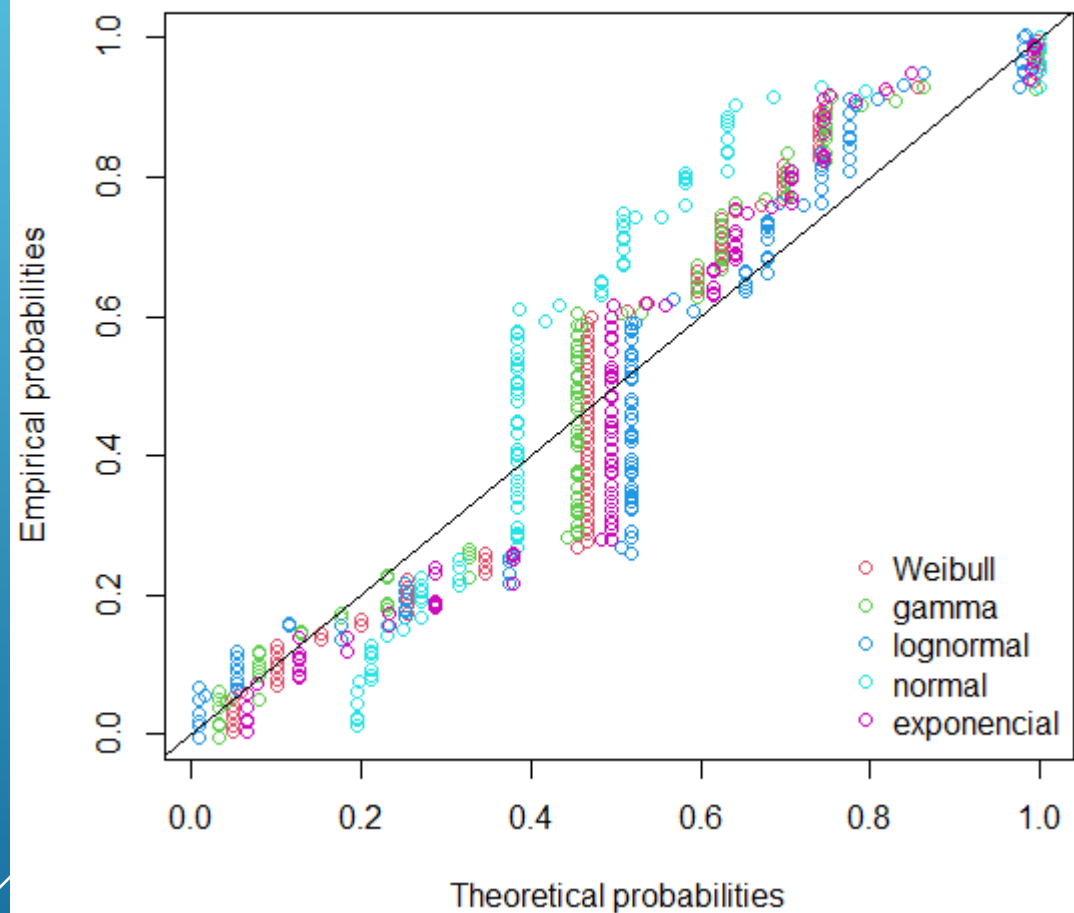


Teor da fase ativa

Q-Q plot



P-P plot



Teor da fase ativa

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1933245	0.1825868	0.2446557	0.2654711
Cramer-von Mises statistic	0.7933500	0.7220207	0.8383817	2.2833798
Anderson-Darling statistic	4.4495752	4.1576165	4.3446395	13.3129722

```
exponencial
```

Kolmogorov-Smirnov statistic	0.2206578
Cramer-von Mises statistic	0.9130088
Anderson-Darling statistic	4.8989738

```
Goodness-of-fit criteria
```

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	783.6985	780.9337	777.6707	892.1351
Bayesian Information Criterion	789.0254	786.2606	782.9976	897.4620

```
exponencial
```

Akaike's Information Criterion	783.3797
Bayesian Information Criterion	786.0431

```
Hartigans' dip test for unimodality / multimodality
```

```
data: vari
```

```
D = 0.052483, p-value = 0.03176
```

```
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> is.amodal(vari)
```

```
[1] FALSE
```

```
> is.unimodal(vari)
```

```
[1] FALSE
```

```
> is.bimodal(vari)
```

```
[1] TRUE
```

```
> is.trimodal(vari)
```

```
[1] FALSE
```

```
> is.iterquad(vari)
```

```
[1] FALSE
```

```
> bimodality_coefficient(vari)
```

```
[1] 0.8229862
```

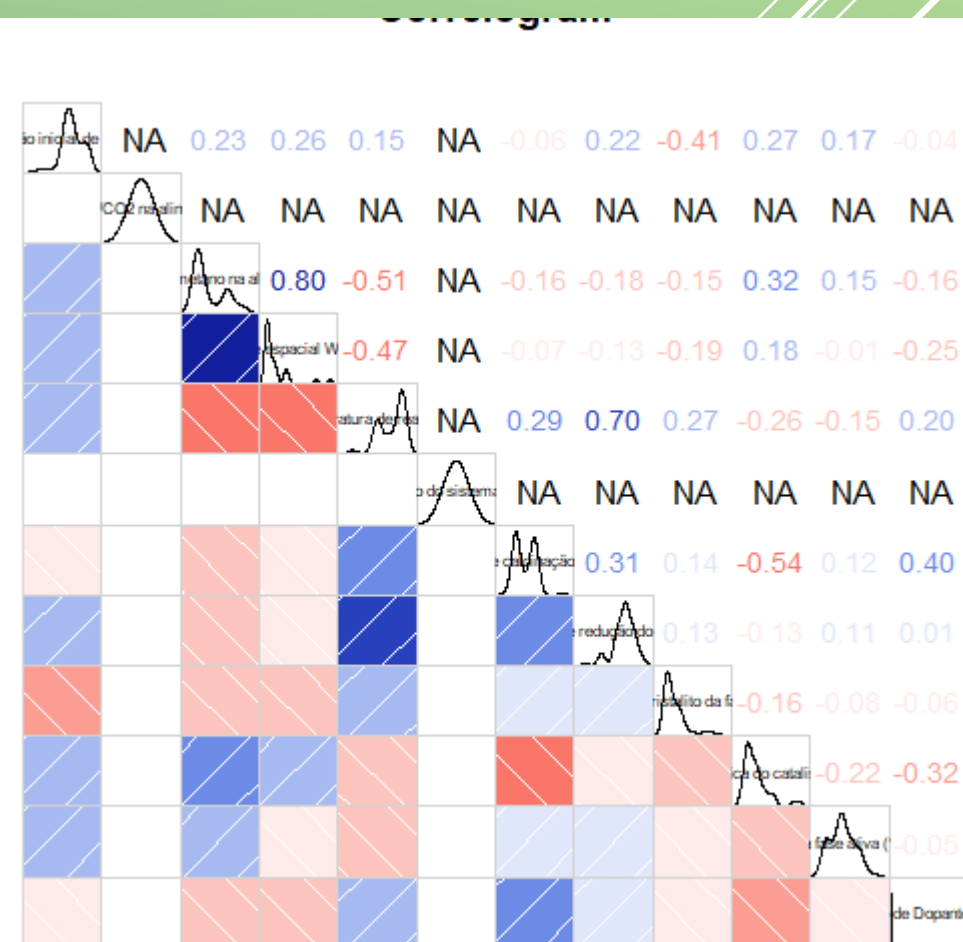
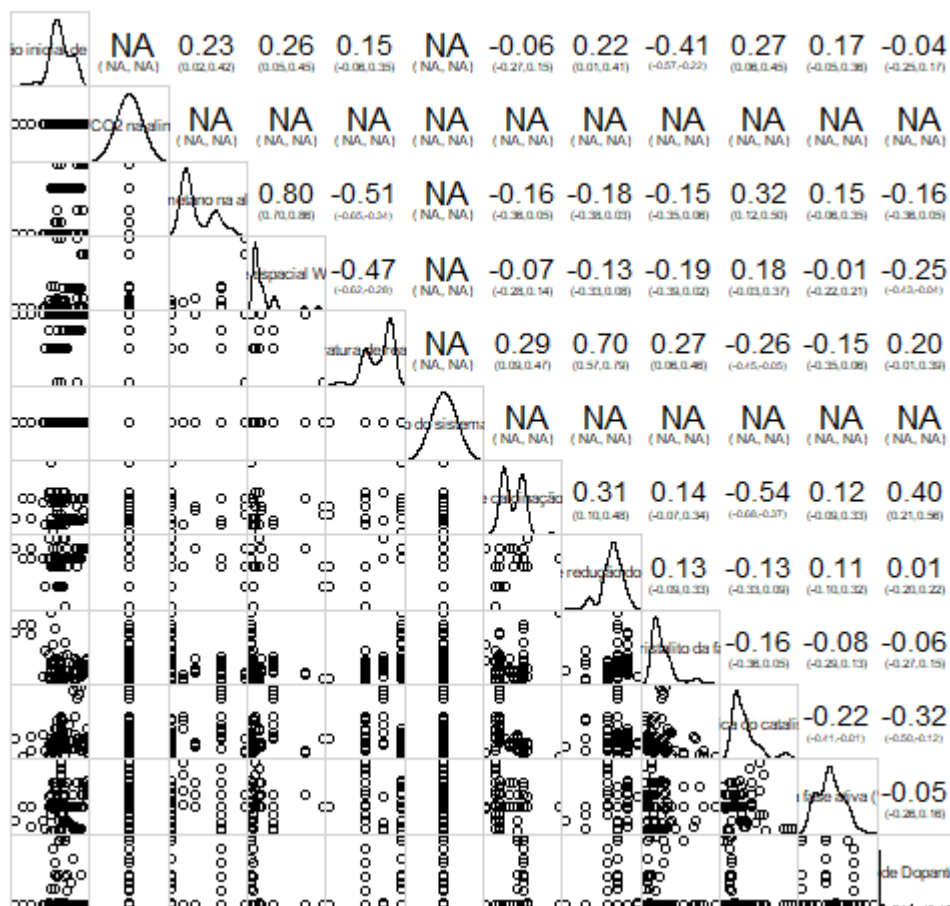
Concentração de dopante

```
> vari <- (database$`Concentração de Dopante ou Promotor`)  
> fitw <- fitdist(vari, "weibull")  
Error in checkparamlist(arg_startfix$start.arg, arg_startfix$fix.arg,  
  'start' should not have NA or NaN values.  
> fitln <- fitdist(vari, "lnorm")  
Error in computing default starting values.  
Error in manageparam(start.arg = start, fix.arg = fix.arg, obs = data,  
  Error in start.arg.default(obs, distname) :  
  values must be positive to fit a lognormal distribution  
> |
```

Análise retirando os dados pouco relevantes e as lacunas

▶ database

87 obs. of 18 variables



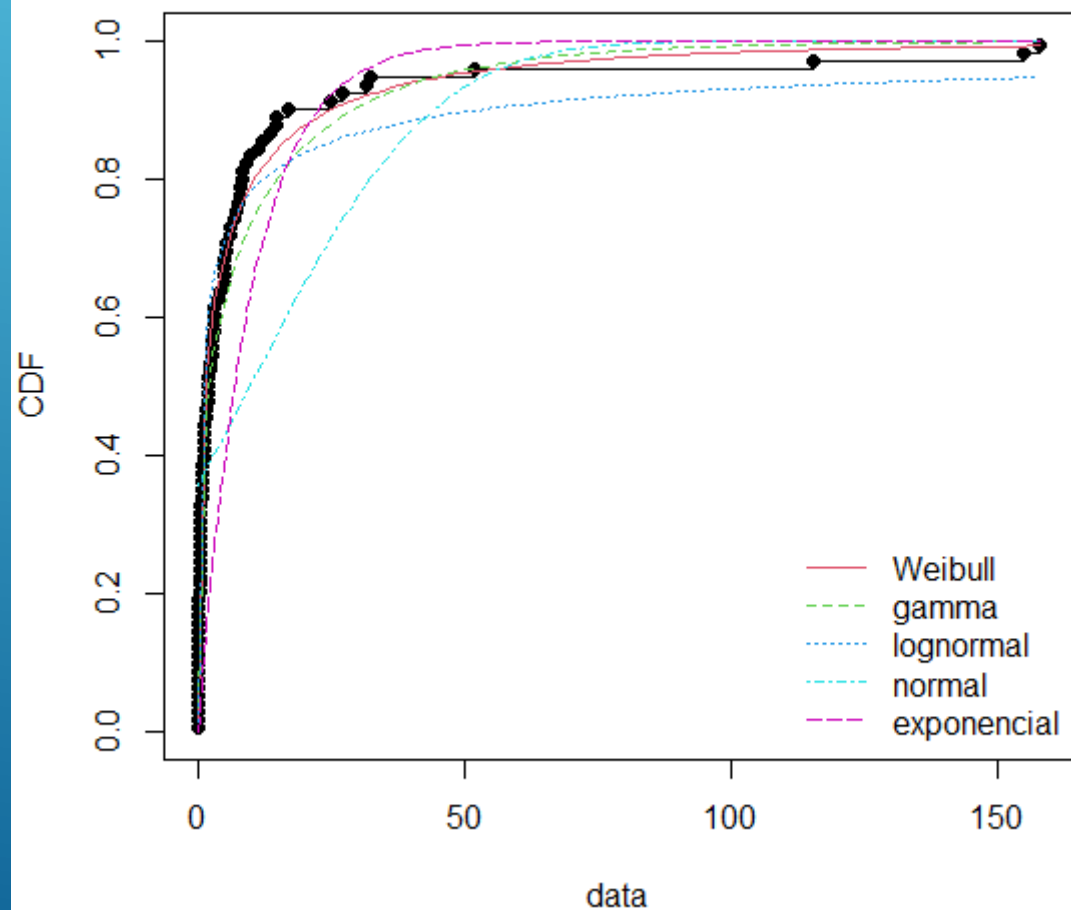
Fase Ativa	Contagem de Fase Ativa
Ni	75
Pt	6
Mo Ni	4
Co	2
Total	87

Dopante ou Promotor	Contagem de Dopante ou Promotor
none	65
Gd	5
Yb	4
Nb	3
Pr	2
Zr	2
Ca	1
K	1
Mn	1
Sm	1
Sn	1
Y	1
Total	87

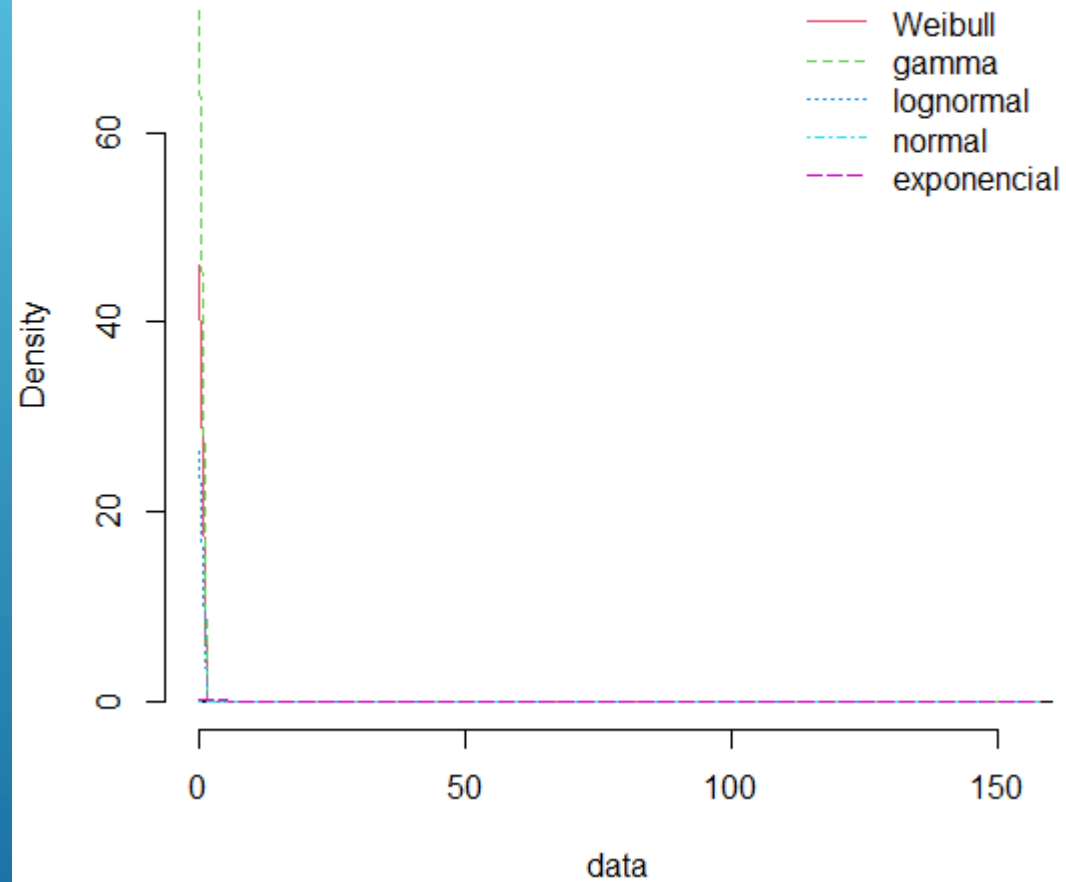
Suporte	Contagem de Suporte
Al ₂ O ₃	29
Al ₂ O ₃ CeO ₂	13
MCM-41	8
SBA-15	7
CeO ₂	6
Hidrotalcita	6
HZSM-5	4
SiO ₂	4
CeZrO ₂	3
TiO ₂ SiO ₂	3
AlSBA-15	1
CeSiO ₂ LaNiO ₃	1
LaNiO ₃	1
LaNiO ₃ Al ₂ O ₃	1
Total	87

Taxa de formação de carbono

Empirical and theoretical CDFs

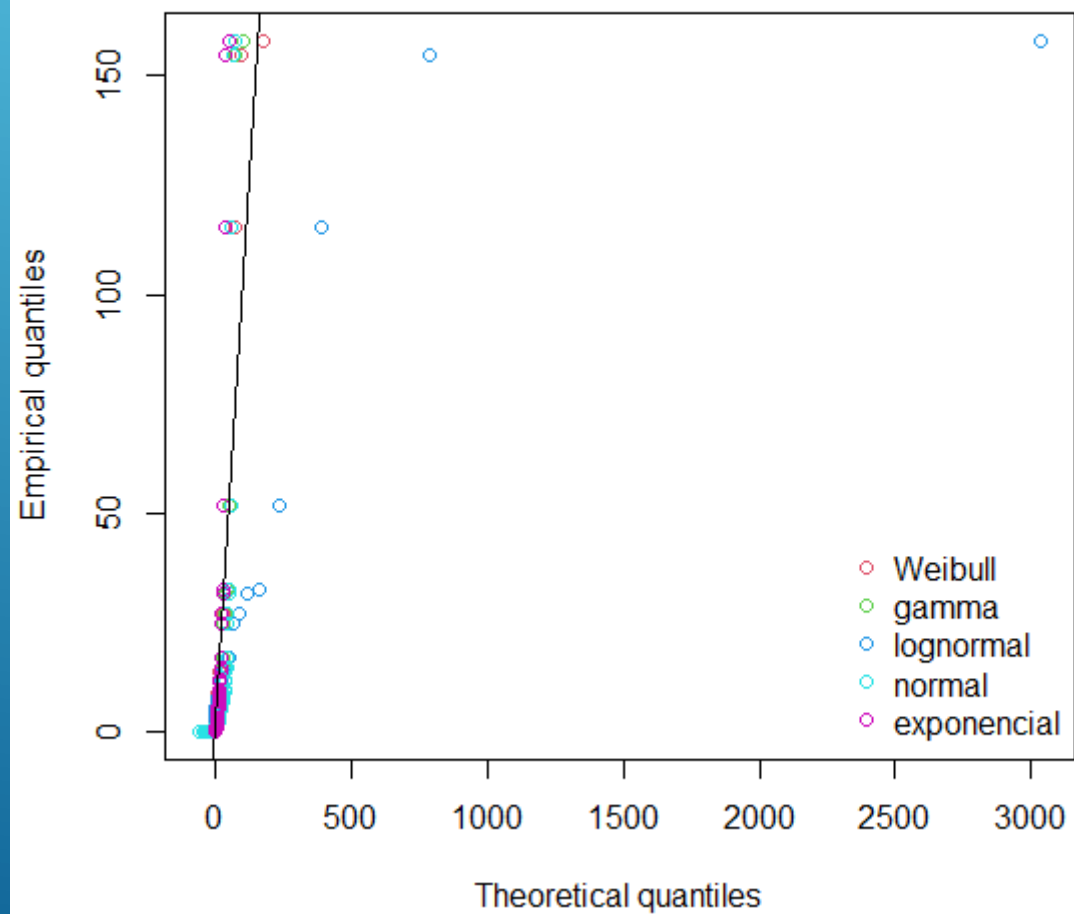


Histogram and theoretical densities

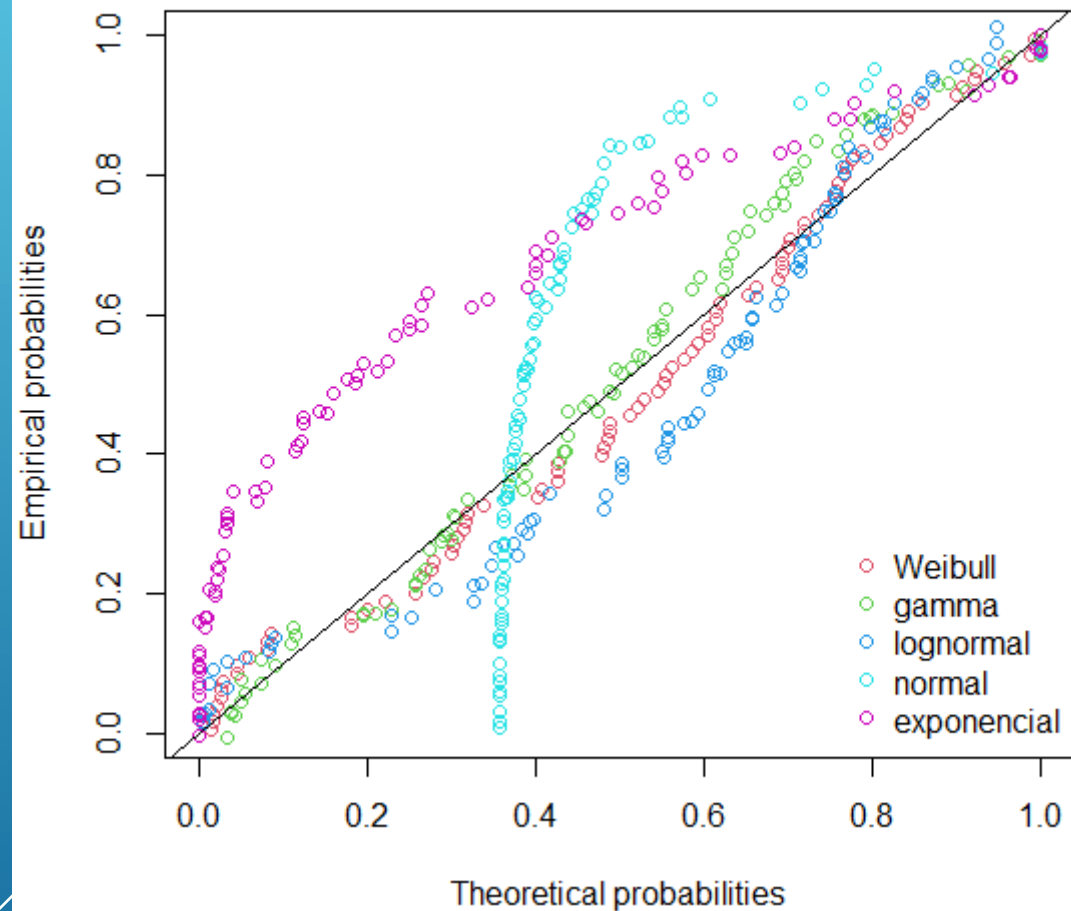


Taxa de formação de carbono

Q-Q plot



P-P plot



Taxa de formação de carbono

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.0865700	0.1092041	0.1577398	0.3573134
Cramer-von Mises statistic	0.1221971	0.1856336	0.5689645	3.8994532
Anderson-Darling statistic	0.8844468	1.2378933	3.4023138	19.6192233

	exponencial
Kolmogorov-Smirnov statistic	0.3487866
Cramer-von Mises statistic	4.6597190
Anderson-Darling statistic	42.4969939

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	395.7438	401.0371	417.6316	822.5394
Bayesian Information Criterion	400.6756	405.9689	422.5634	827.4712

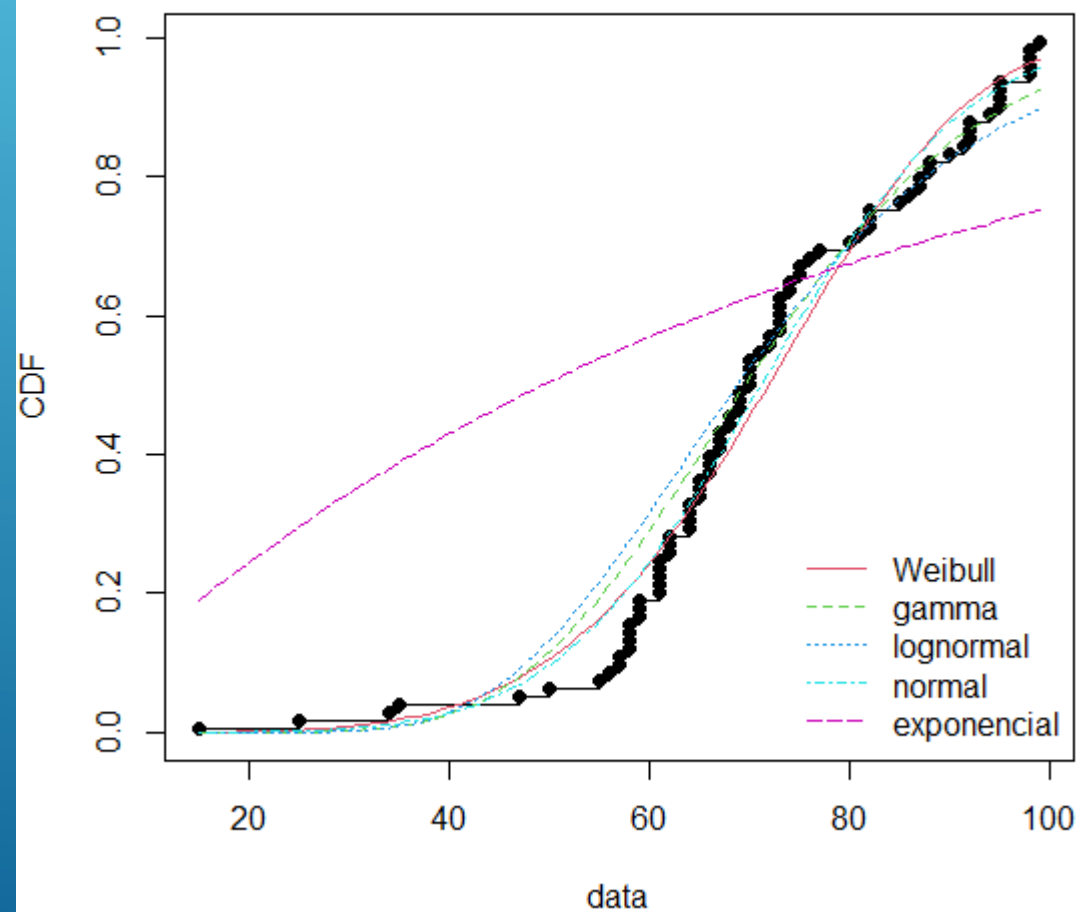
	exponencial
Akaike's Information Criterion	572.5884
Bayesian Information Criterion	575.0543

Hartigans' dip test for unimodality / multimodality

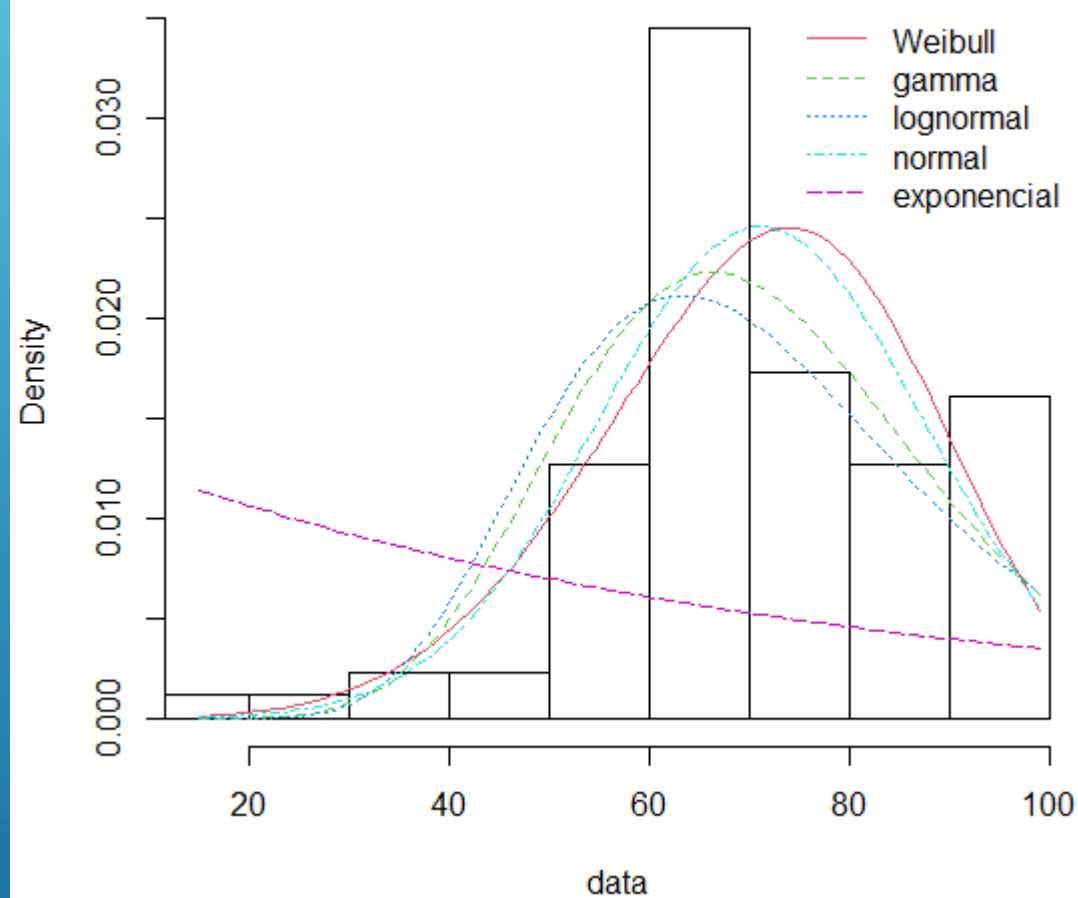
```
data: vari
D = 0.024869, p-value = 0.9851
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8905256
```

Empirical and theoretical CDFs

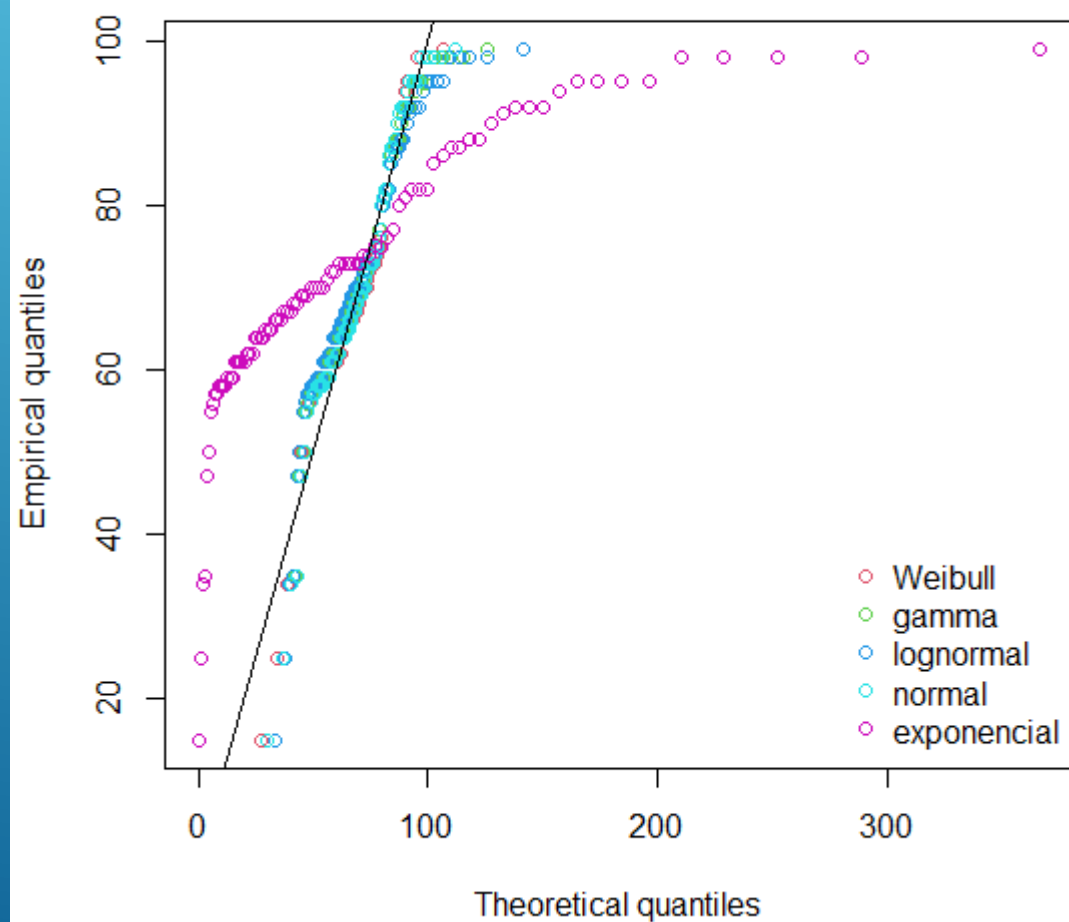


Histogram and theoretical densities

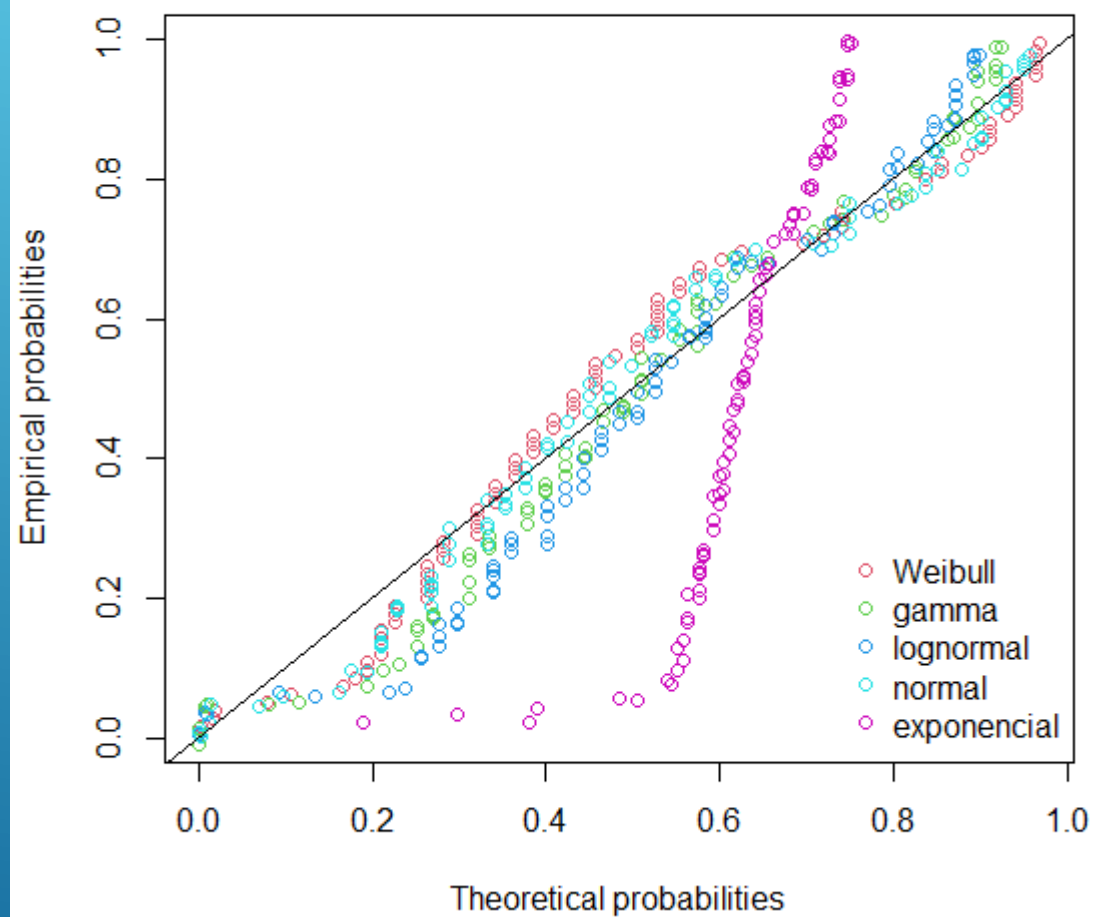


Conversão

Q-Q plot



P-P plot



Conversão

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.1037601 0.1393551 0.1648534 0.1007075
Cramer-von Mises statistic  0.2207743 0.2755024 0.4449442 0.1673704
Anderson-Darling statistic  1.4176217 2.0745392 3.1221319 1.2044677
      exponencial
Kolmogorov-Smirnov statistic 0.4696891
Cramer-von Mises statistic  5.1459509
Anderson-Darling statistic  24.3923558

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 735.1758 753.9103 769.3037 735.8789
Bayesian Information Criterion 740.1076 758.8422 774.2356 740.8107
      exponencial
Akaike's Information Criterion 917.9399
Bayesian Information Criterion 920.4059
```

Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.030651, p-value = 0.8426
alternative hypothesis: non-unimodal, i.e., at least bimodal

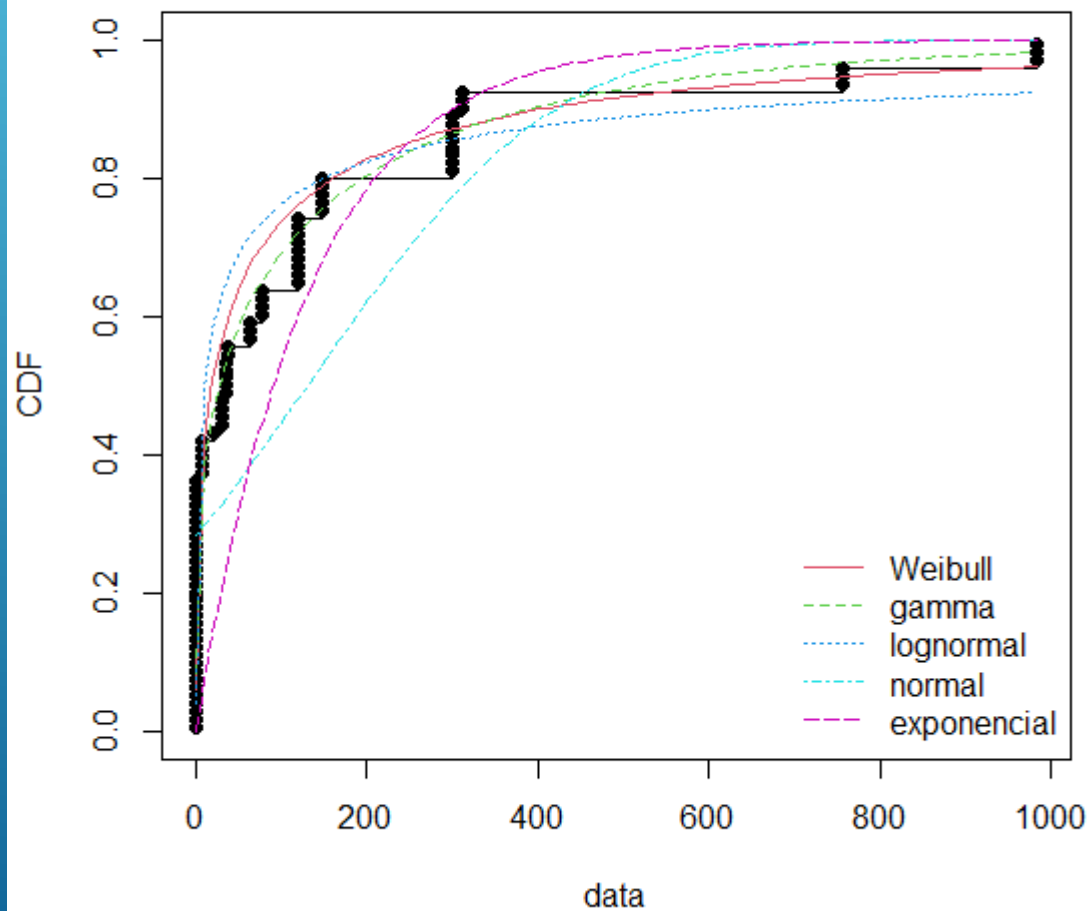
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.2977869
```

Razão de inerte

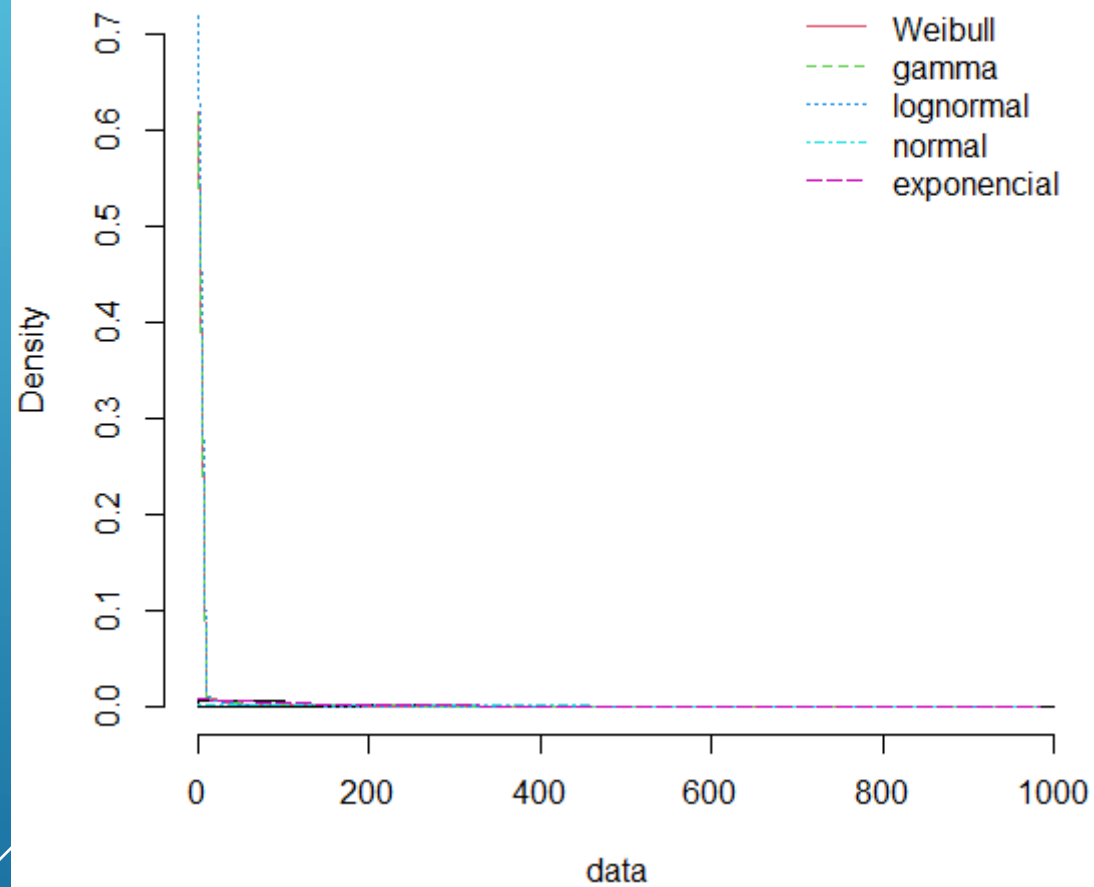
```
<simpleError in optim(par = vstart, fn = fnobj, fix.arg = fix.arg, obs = data,
  gr = gradient, ddistnam = ddistname, hessian = TRUE, method = meth, lower
  lower, upper = upper, ...): function cannot be evaluated at initial parameters>
Error in fitdist(vari, "norm") :
  the function mle failed to estimate the parameters,
    with the error code 100
> vari <- (database$`Razão molar inerte/metano na alimentação do reator`)
> fitw <- fitdist(vari, "weibull")
Error in checkparamlist(arg_startfix$start.arg, arg_startfix$fix.arg, :
  'start' should not have NA or NaN values.
> |
```

Velocidade WSHV

Empirical and theoretical CDFs

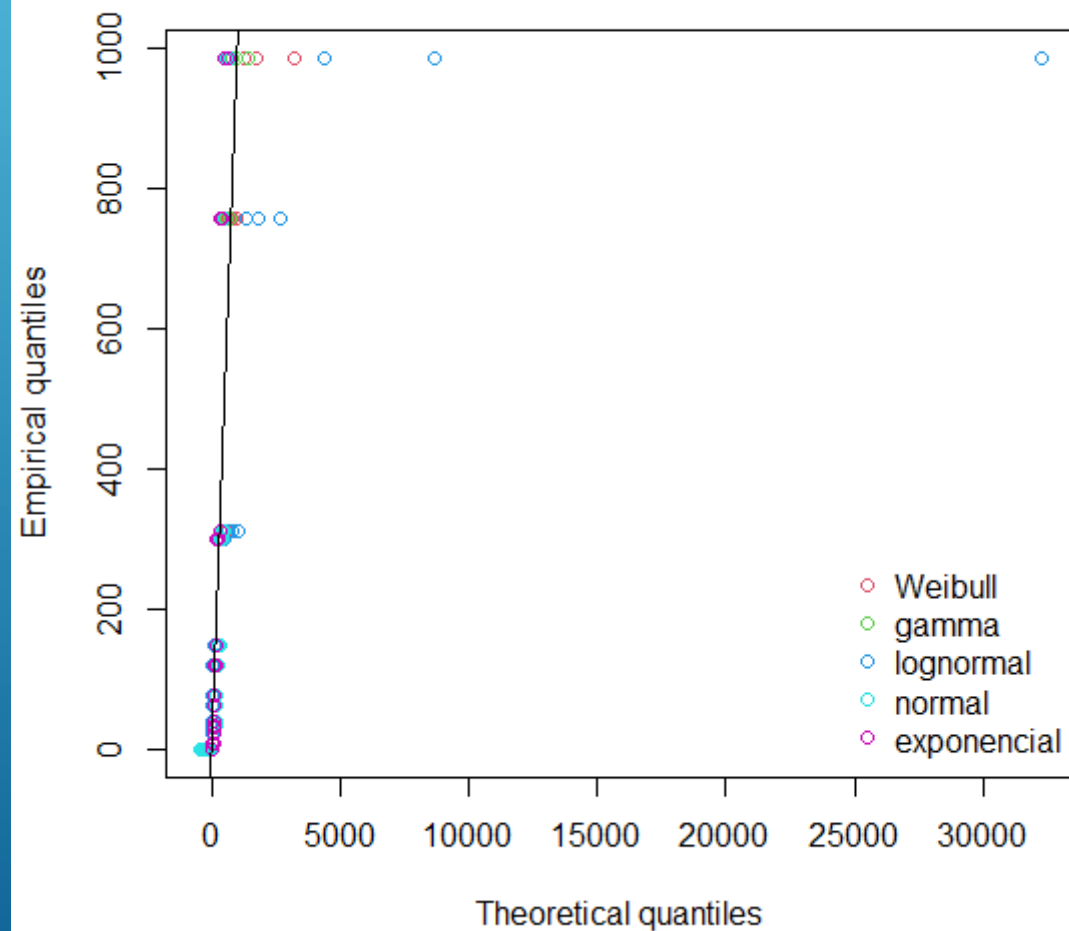


Histogram and theoretical densities

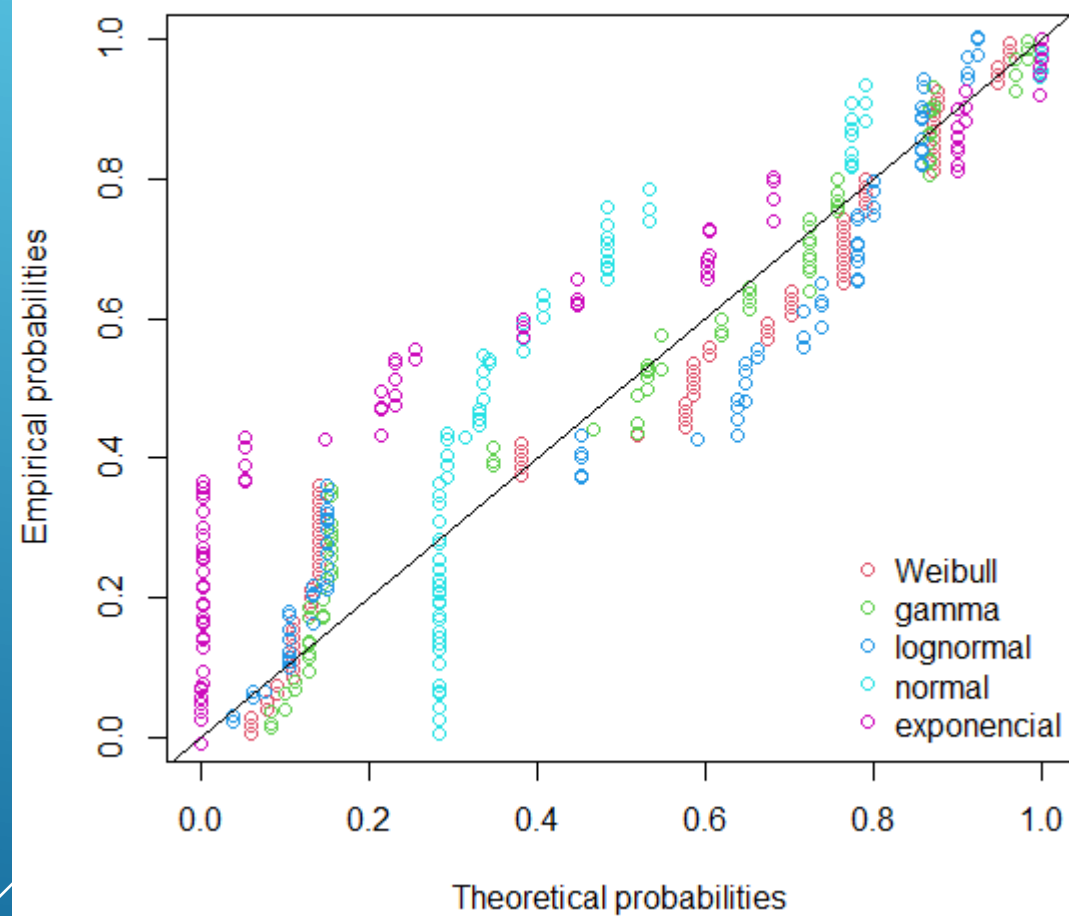


Velocidade WSHV

Q-Q plot



P-P plot



Velocidade WSHV

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2261601	0.2125266	0.2185777	0.2828129
Cramer-von Mises statistic	0.5760807	0.3842912	0.8269952	2.1743114
Anderson-Darling statistic	3.6043884	2.6342589	4.7064850	12.0115111

```
exponencial
```

Kolmogorov-Smirnov statistic	0.3730209
Cramer-von Mises statistic	3.3050659
Anderson-Darling statistic	56.2383796

```
Goodness-of-fit criteria
```

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	849.7371	845.7876	856.4323	1194.158
Bayesian Information Criterion	854.6689	850.7194	861.3641	1199.090

```
exponencial
```

Akaike's Information Criterion	1022.874
Bayesian Information Criterion	1025.340

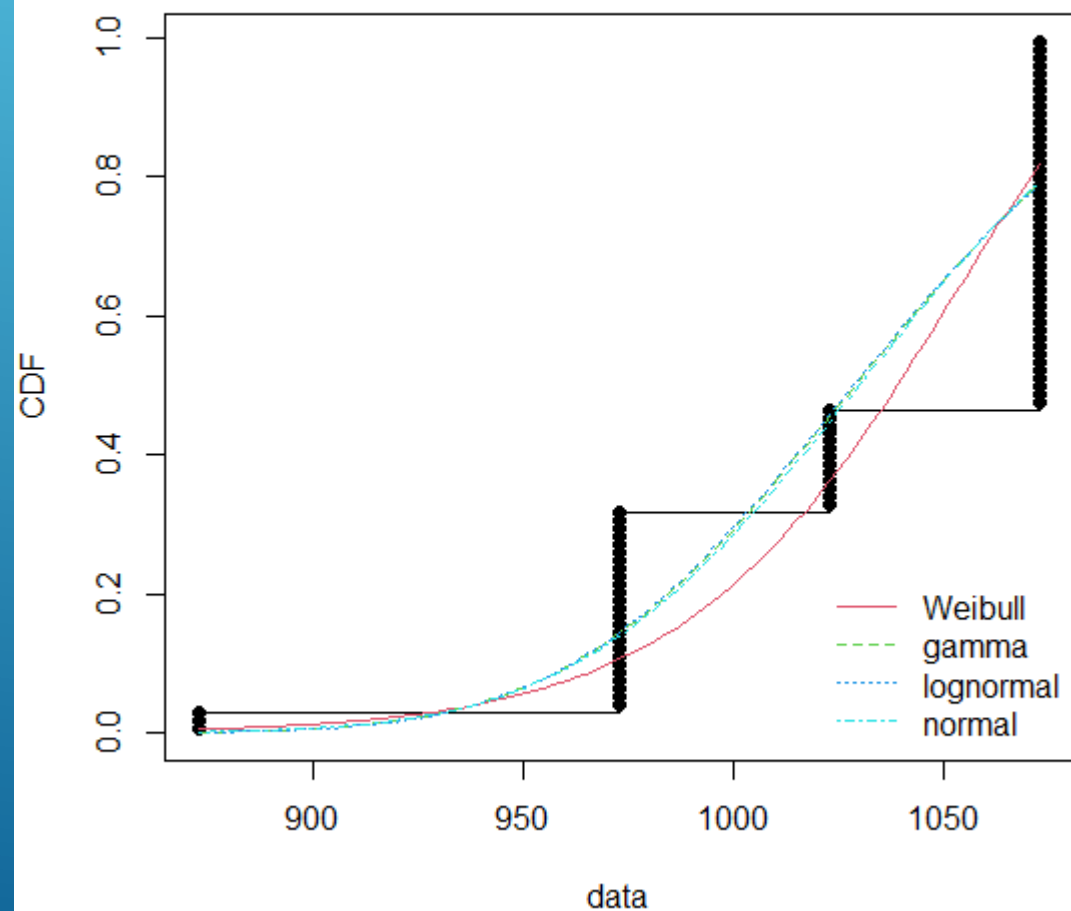
```
Hartigans' dip test for unimodality / multimodality
```

data: vari
D = 0.058571, p-value = 0.02495
alternative hypothesis: non-unimodal, i.e., at least bimodal

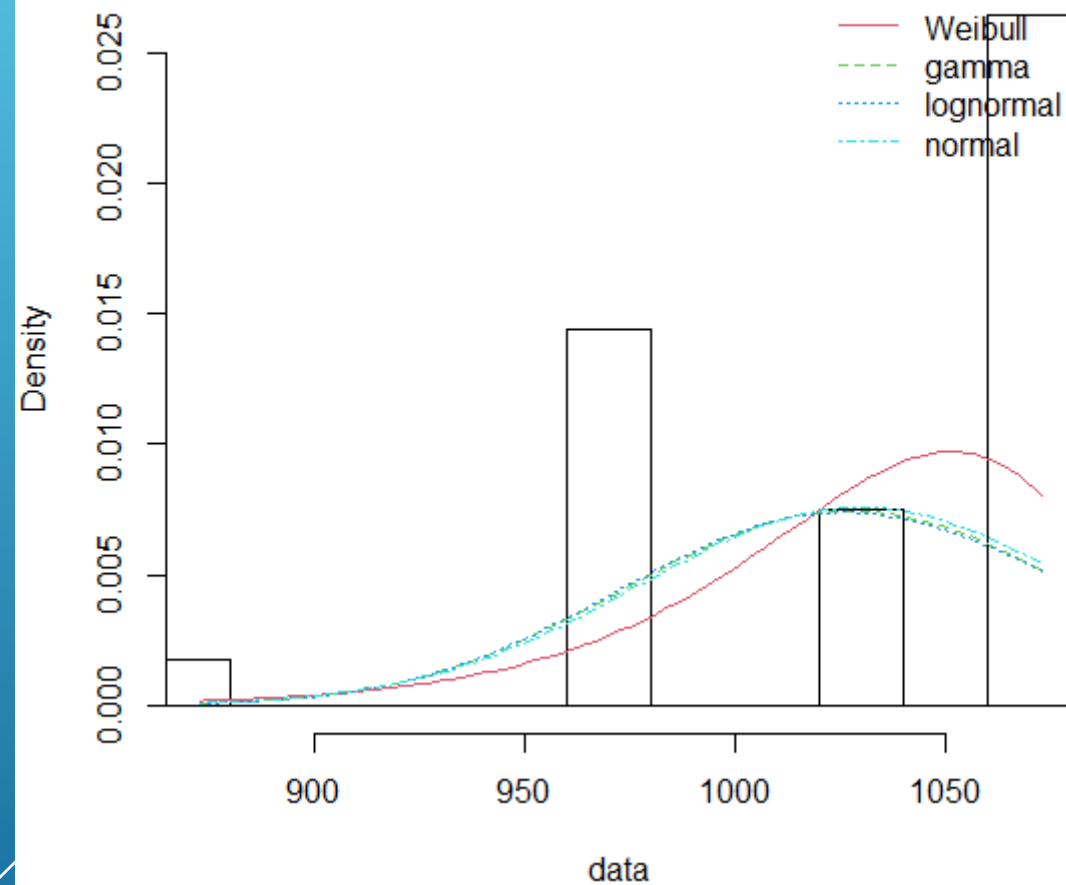
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8014703
```

Temperatura de reação

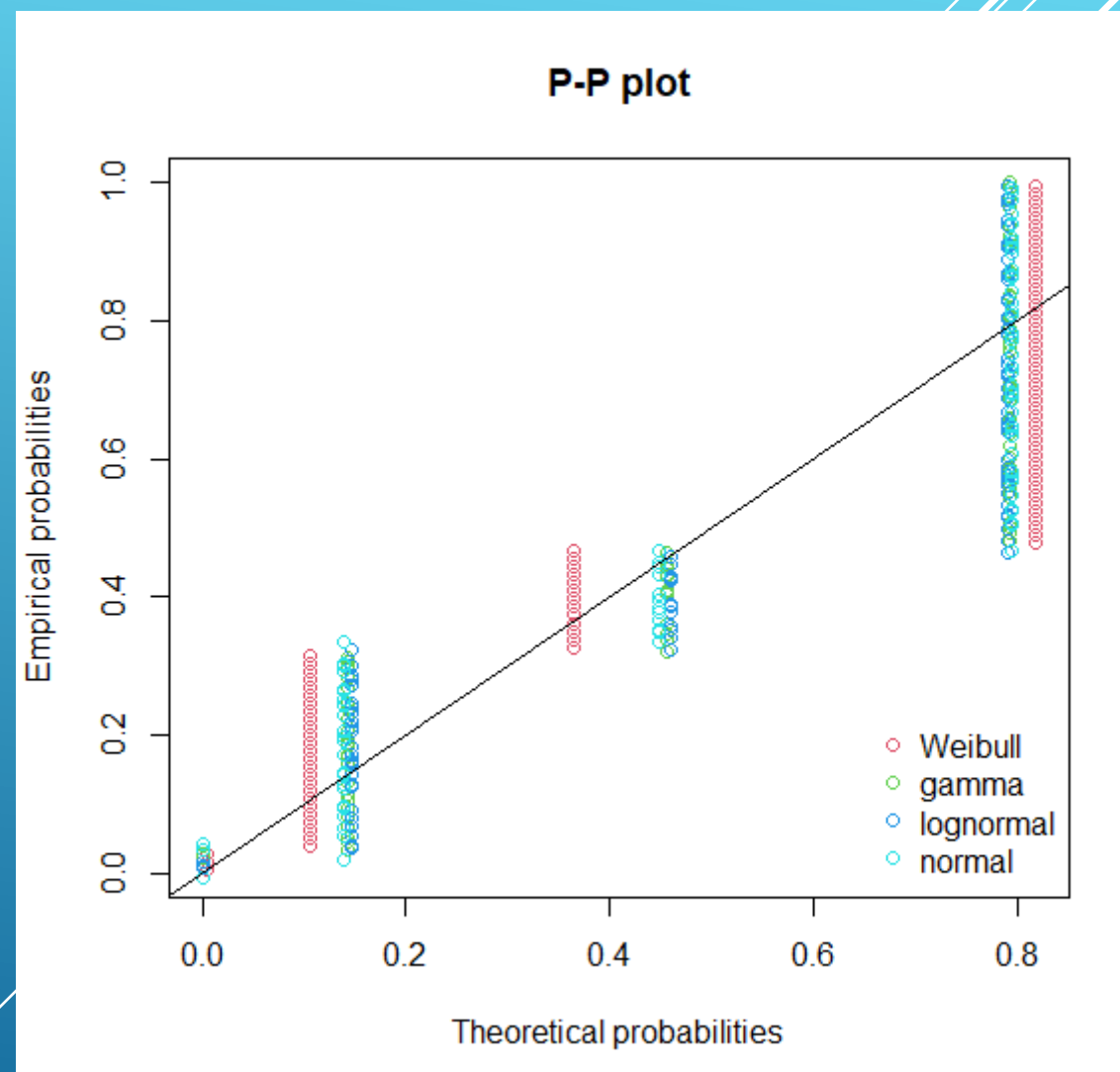
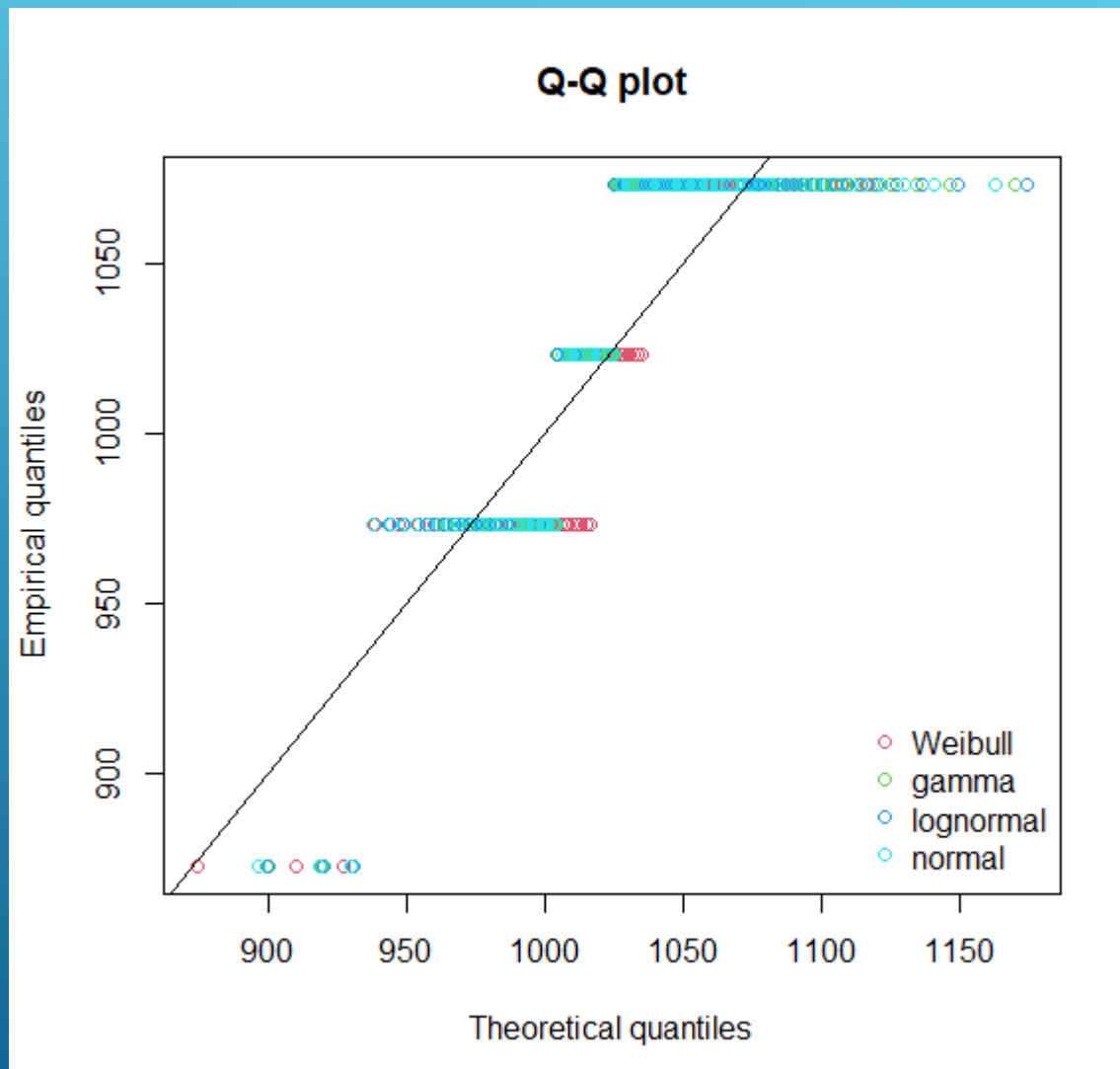
Empirical and theoretical CDFs



Histogram and theoretical densities



Temperatura de reação



Temperatura de reação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.3465455	0.319893	0.3185215	0.3223981
Cramer-von Mises statistic	1.7239009	1.485904	1.4815694	1.4948840
Anderson-Darling statistic	10.7167181	8.965091	8.9342993	9.0282347

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	918.5993	943.5551	945.2023	940.4635
Bayesian Information Criterion	923.5311	948.4869	950.1341	945.3954

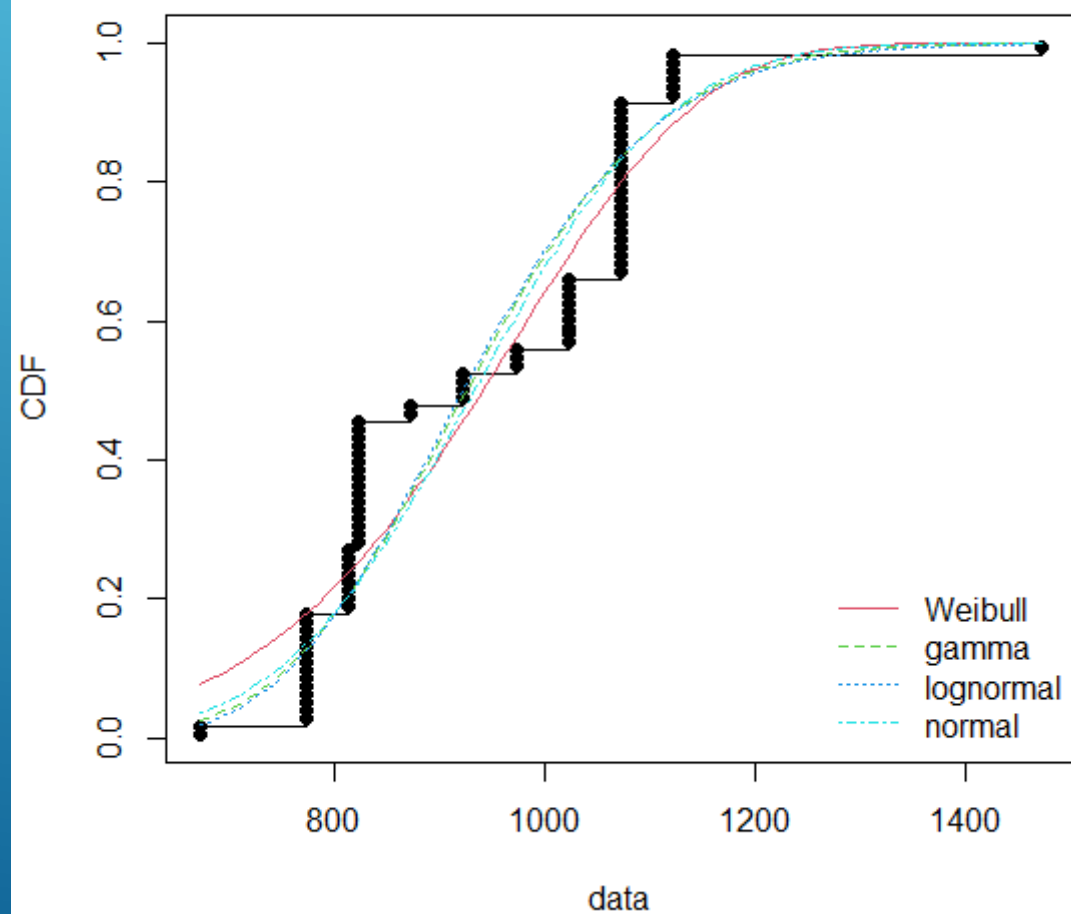
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.14368, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

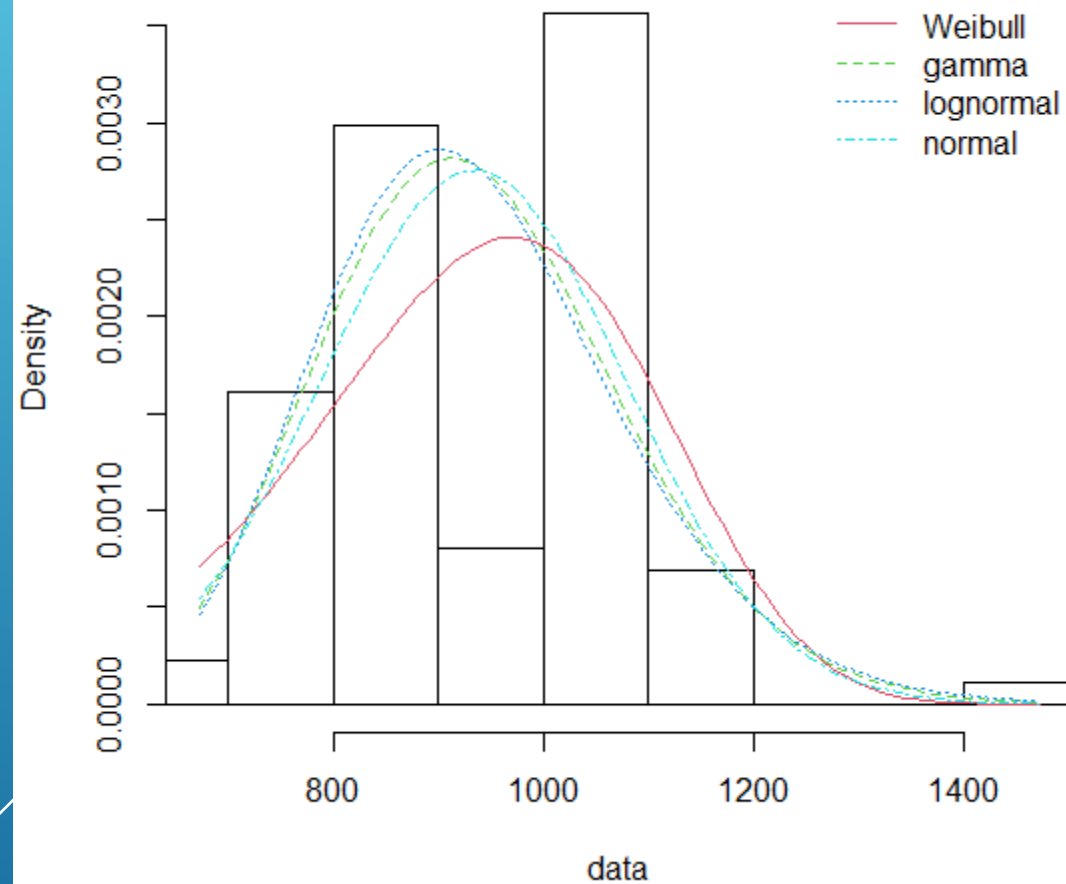
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.5646624
```

Temperatura de calcinação

Empirical and theoretical CDFs

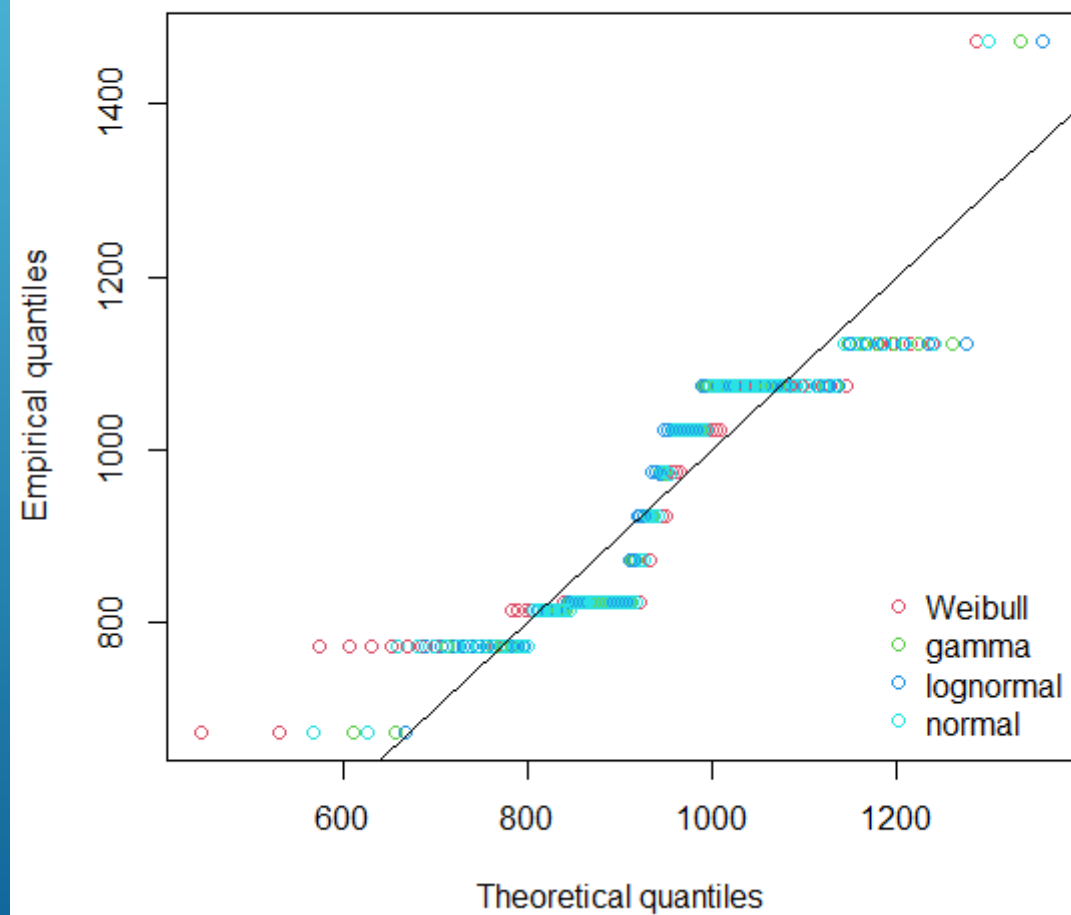


Histogram and theoretical densities

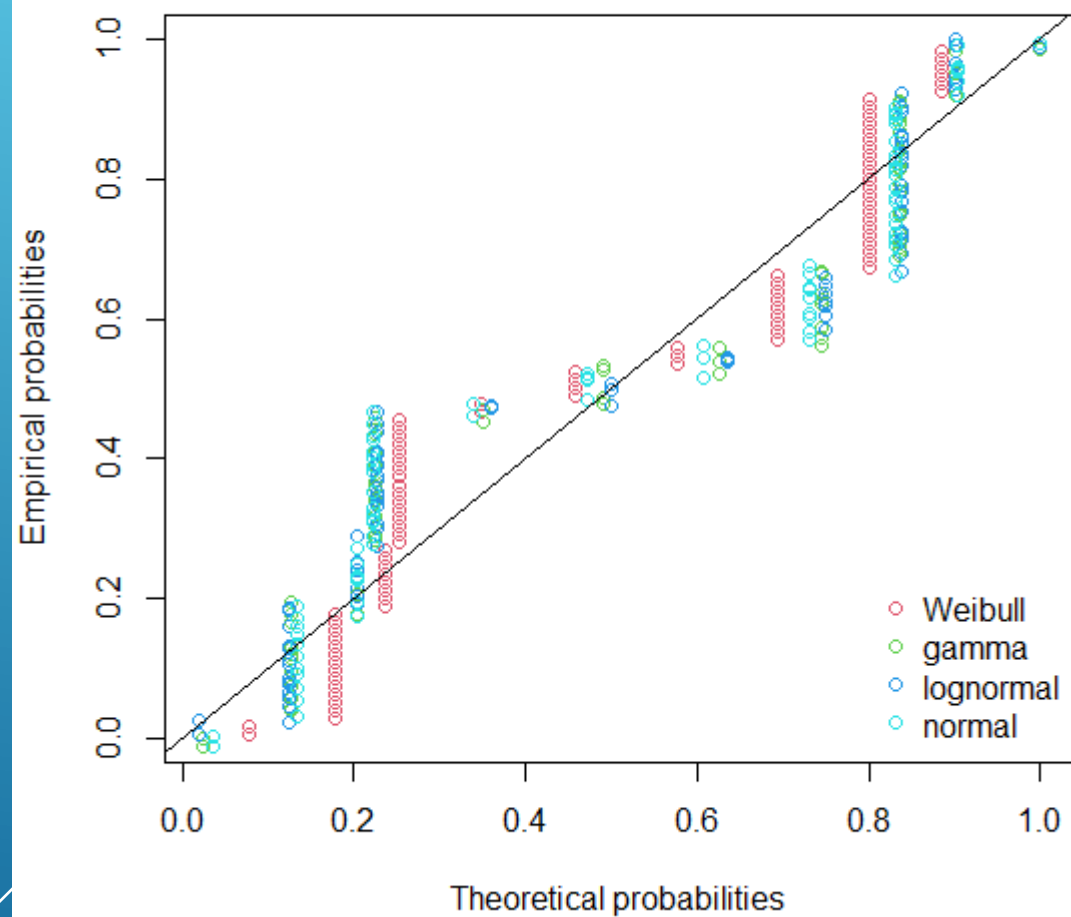


Temperatura de calcinação

Q-Q plot



P-P plot



Temperatura de calcinação

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.2062866 0.2342752 0.2321745 0.2370453
Cramer-von Mises statistic  0.6337443 0.8053480 0.8113350 0.7885161
Anderson-Darling statistic  4.0937554 4.6530538 4.6702958 4.6095953

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 1128.171 1113.175 1112.200 1116.747
Bayesian Information Criterion 1133.103 1118.107 1117.132 1121.679
>
```

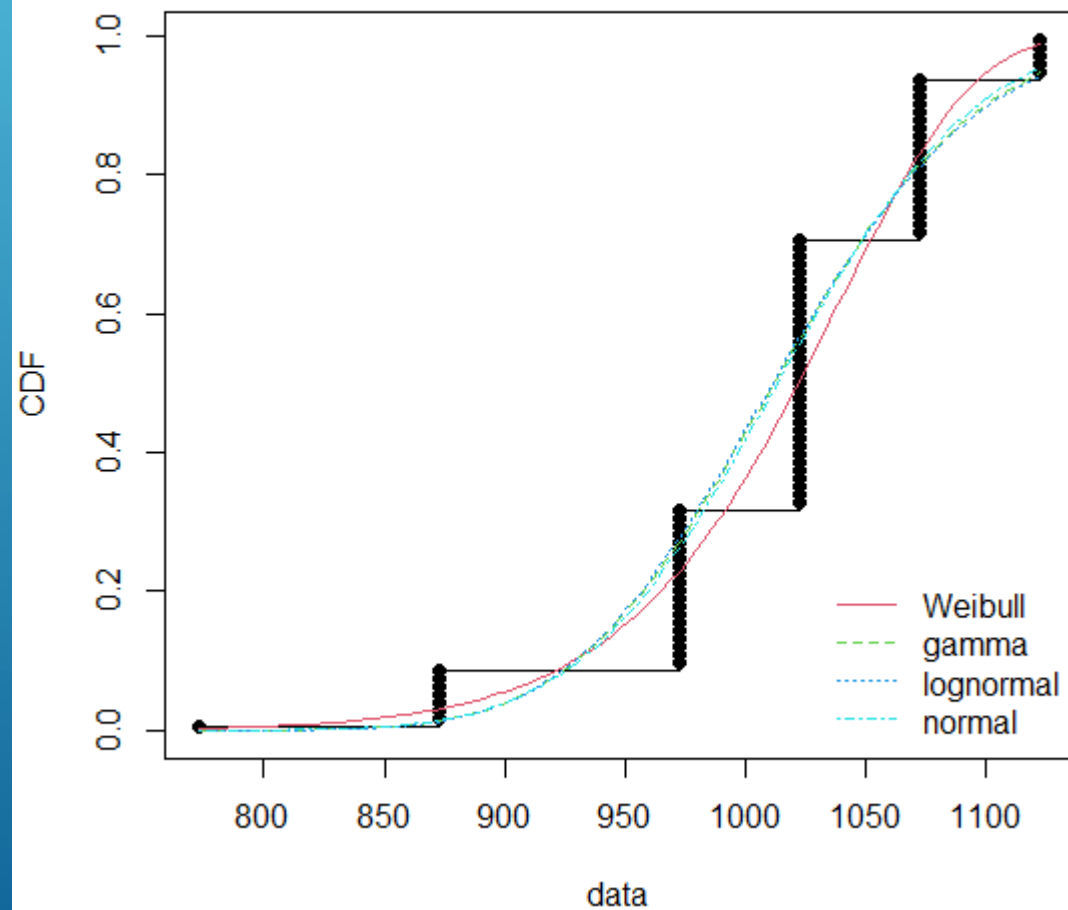
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.13218, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

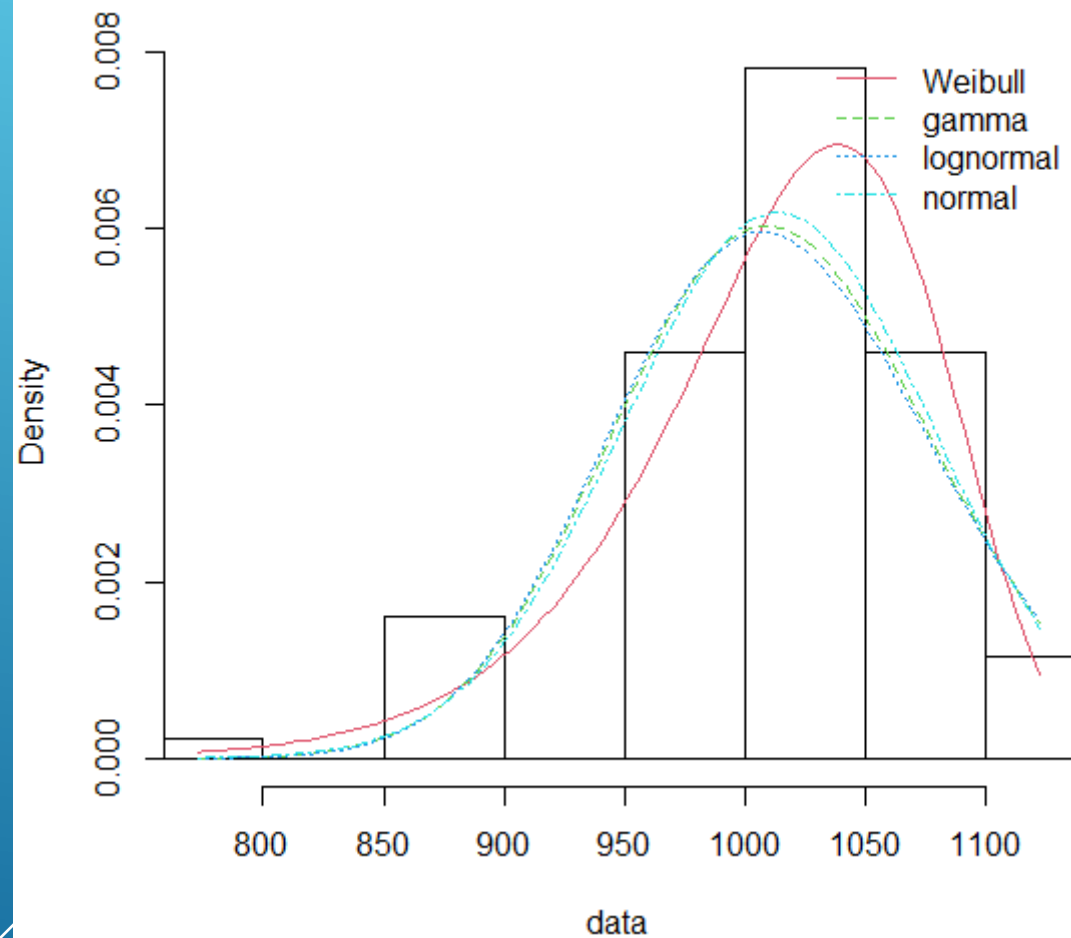
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.3702042
```

Temperatura de redução

Empirical and theoretical CDFs

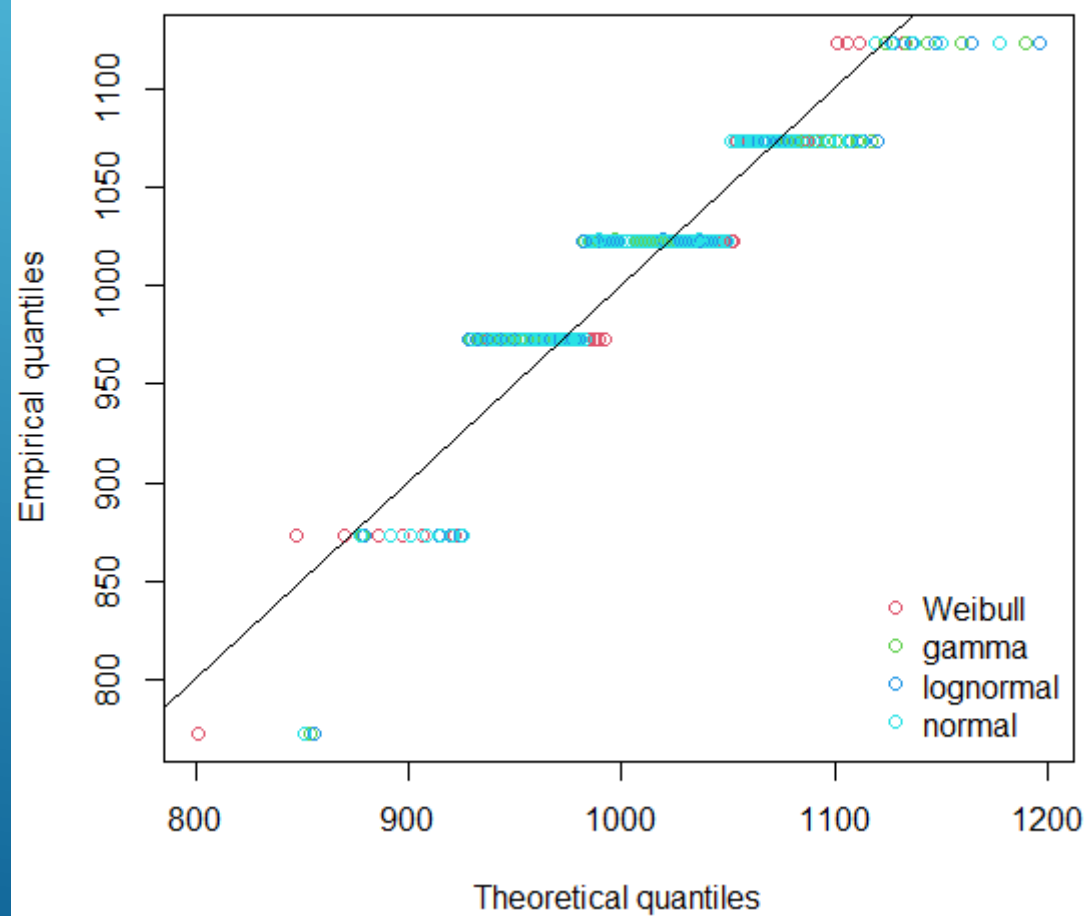


Histogram and theoretical densities

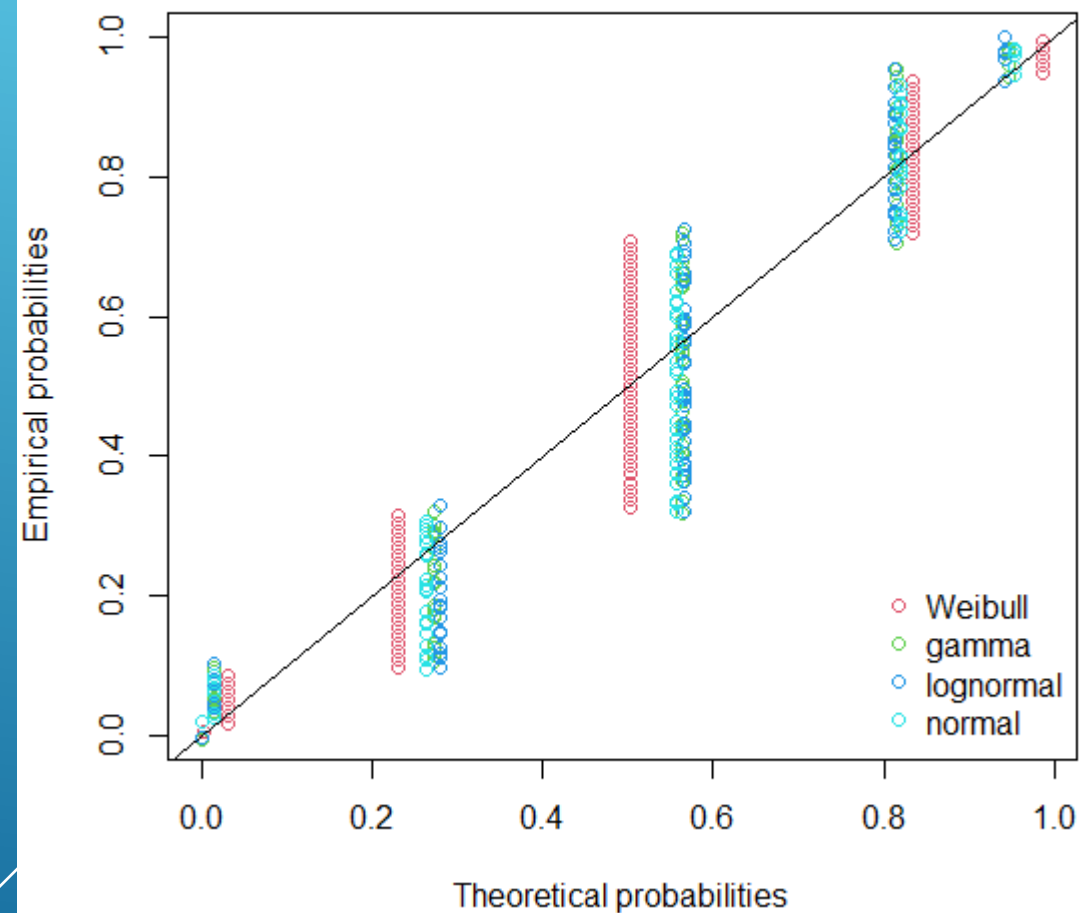


Temperatura de redução

Q-Q plot



P-P plot



Temperatura de redução

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2088051	0.2418125	0.2450047	0.2347893
Cramer-von Mises statistic	0.6361718	0.7921855	0.8196669	0.7434041
Anderson-Darling statistic	3.3583195	4.4492445	4.6168628	4.1460066

```
Goodness-of-fit criteria
```

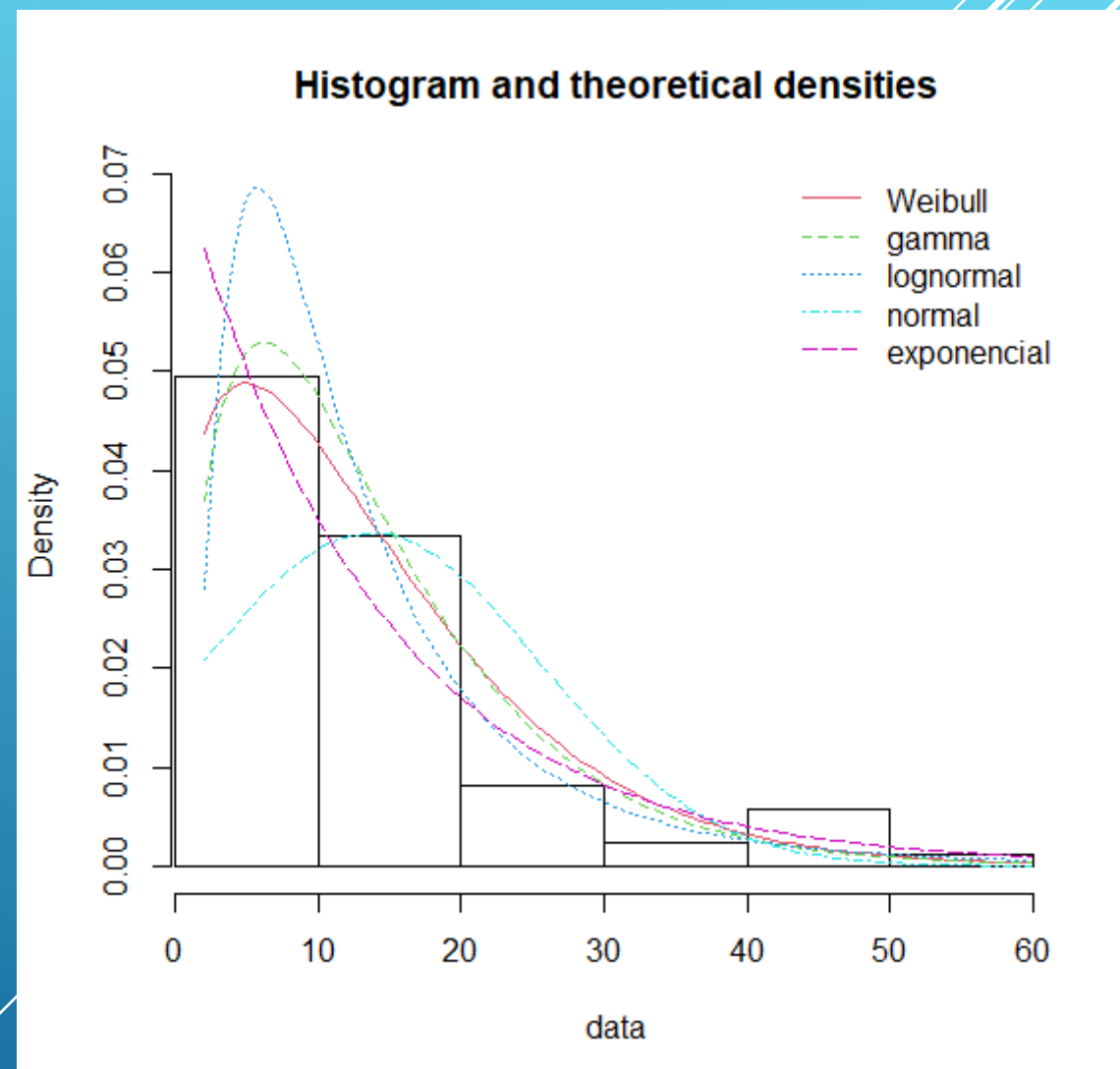
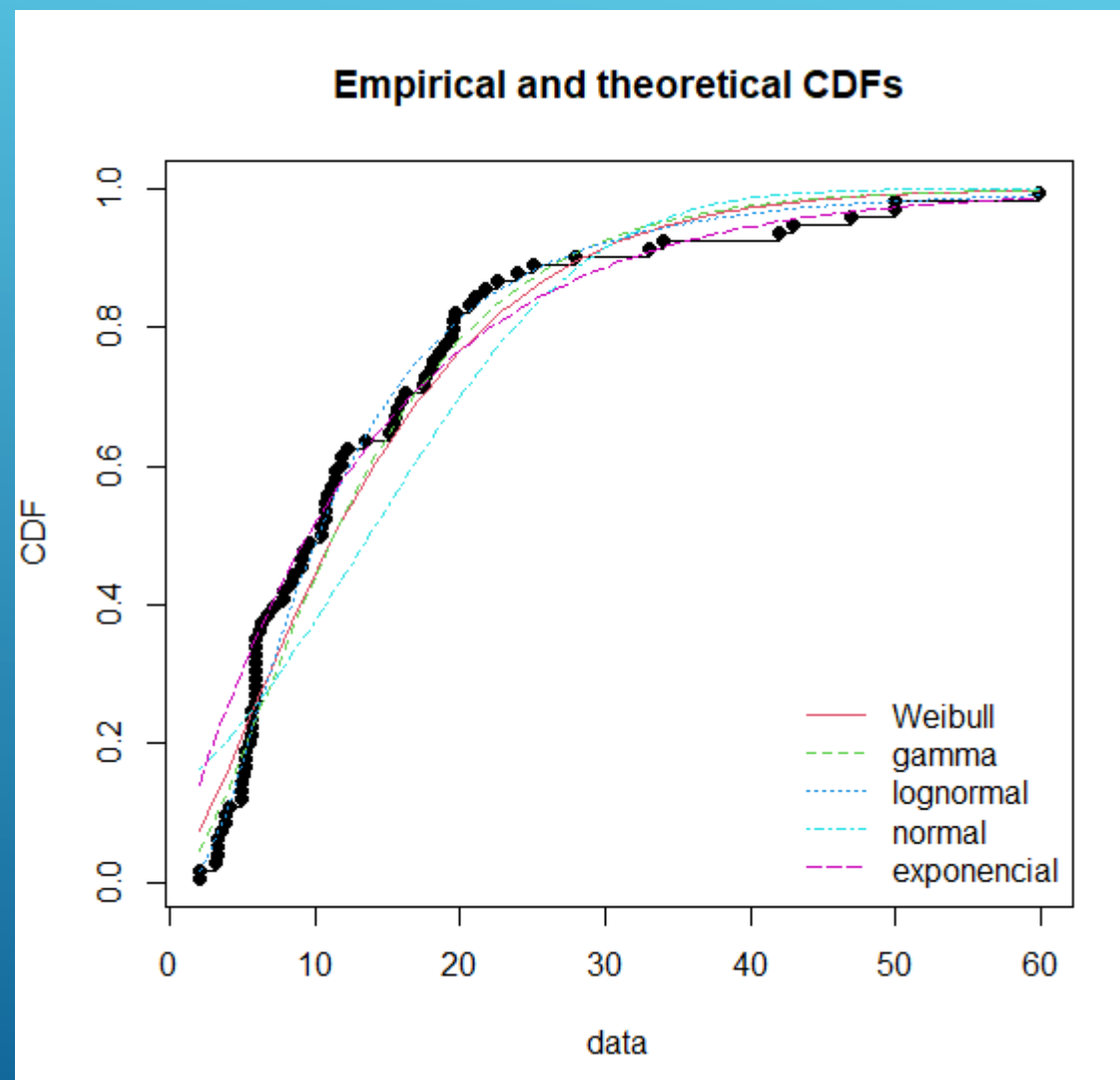
	weibull	gamma	lognormal	normal
Akaike's Information Criterion	963.7900	980.3991	982.8082	976.0636
Bayesian Information Criterion	968.7219	985.3309	987.7400	980.9954

```
Hartigans' dip test for unimodality / multimodality
```

data: vari
D = 0.11494, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

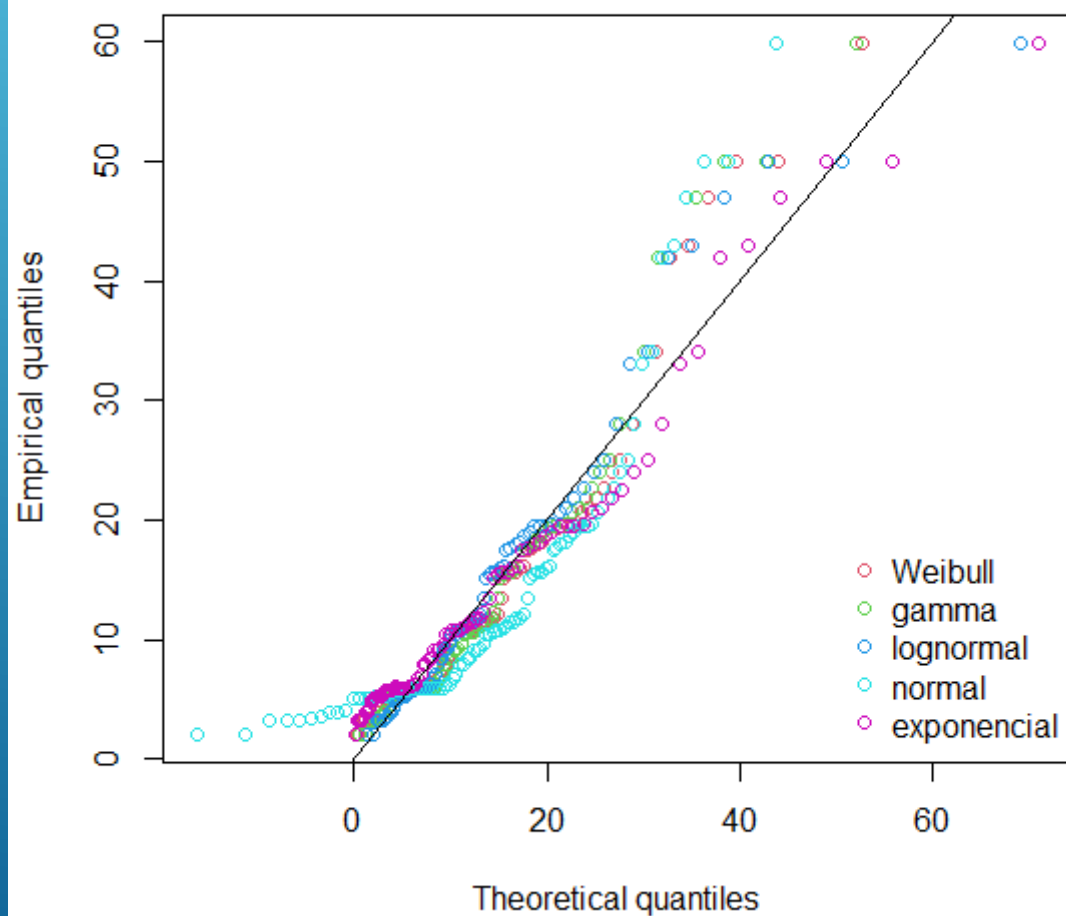
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.4211426
```

Tamanho de cristalito da fase ativa

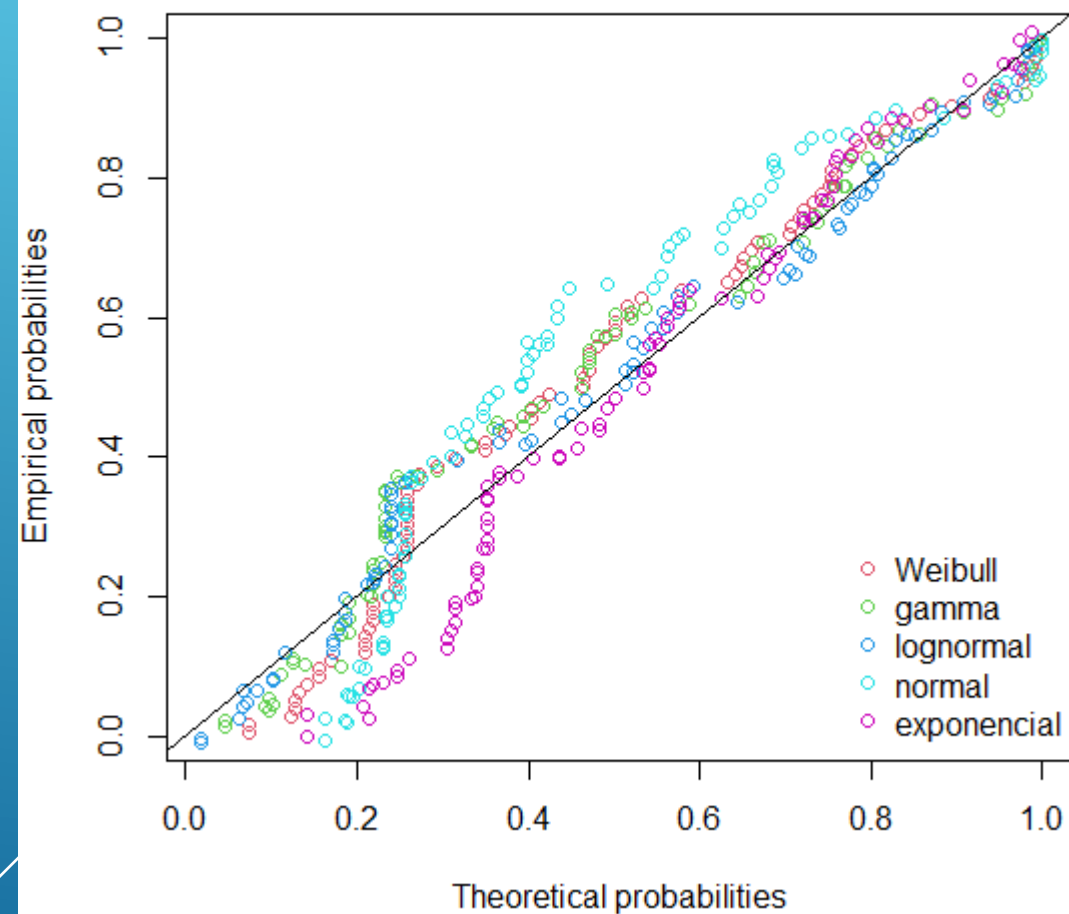


Tamanho de cristalito da fase ativa

Q-Q plot



P-P plot



Tamanho de cristalito da fase ativa

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1065578	0.1305483	0.1194953	0.1863273
Cramer-von Mises statistic	0.2870132	0.2700659	0.1318364	0.9671912
Anderson-Darling statistic	1.9676098	1.7057766	0.7753153	5.9125216

```
exponencial
```

Kolmogorov-Smirnov statistic	0.1897432
Cramer-von Mises statistic	0.5517172
Anderson-Darling statistic	3.6540638

```
Goodness-of-fit criteria
```

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	623.8603	618.1410	606.7549	681.1445
Bayesian Information Criterion	628.7921	623.0728	611.6868	686.0763

```
exponencial
```

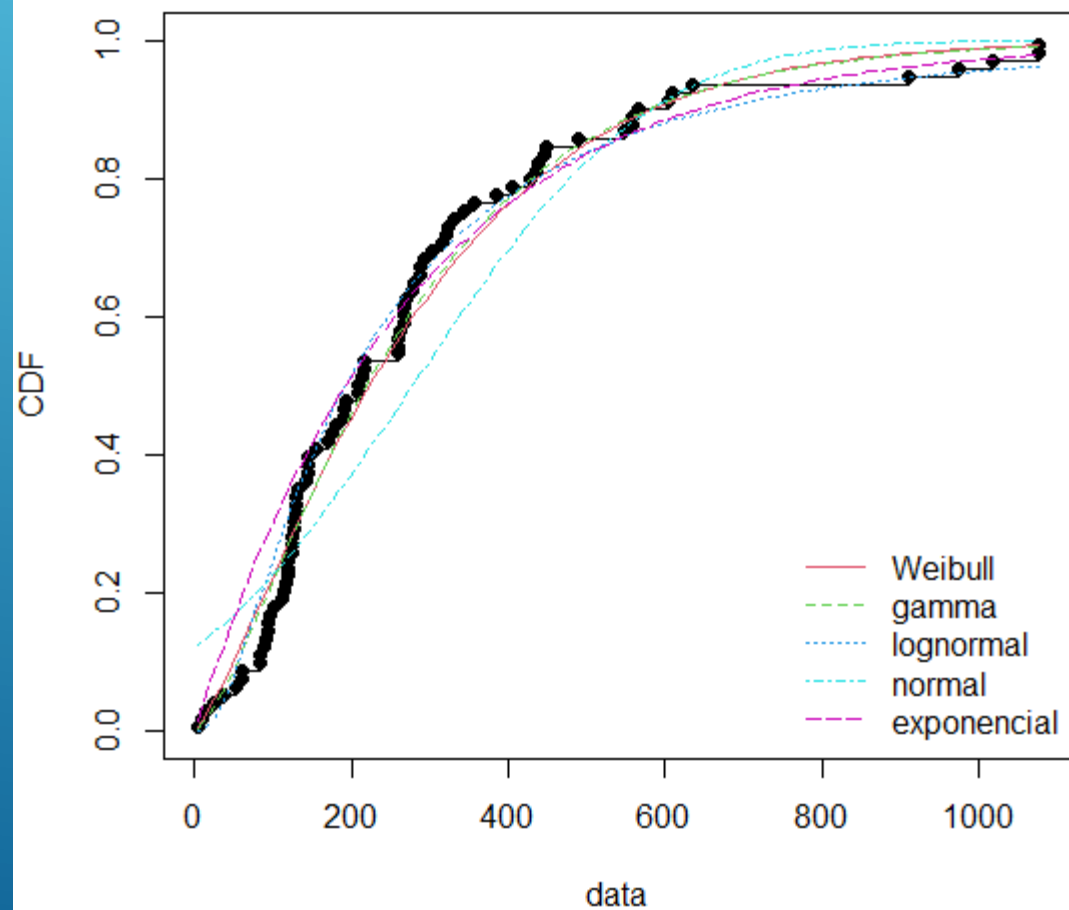
Akaike's Information Criterion	632.1781
Bayesian Information Criterion	634.6440

```
Hartigans' dip test for unimodality / multimodality

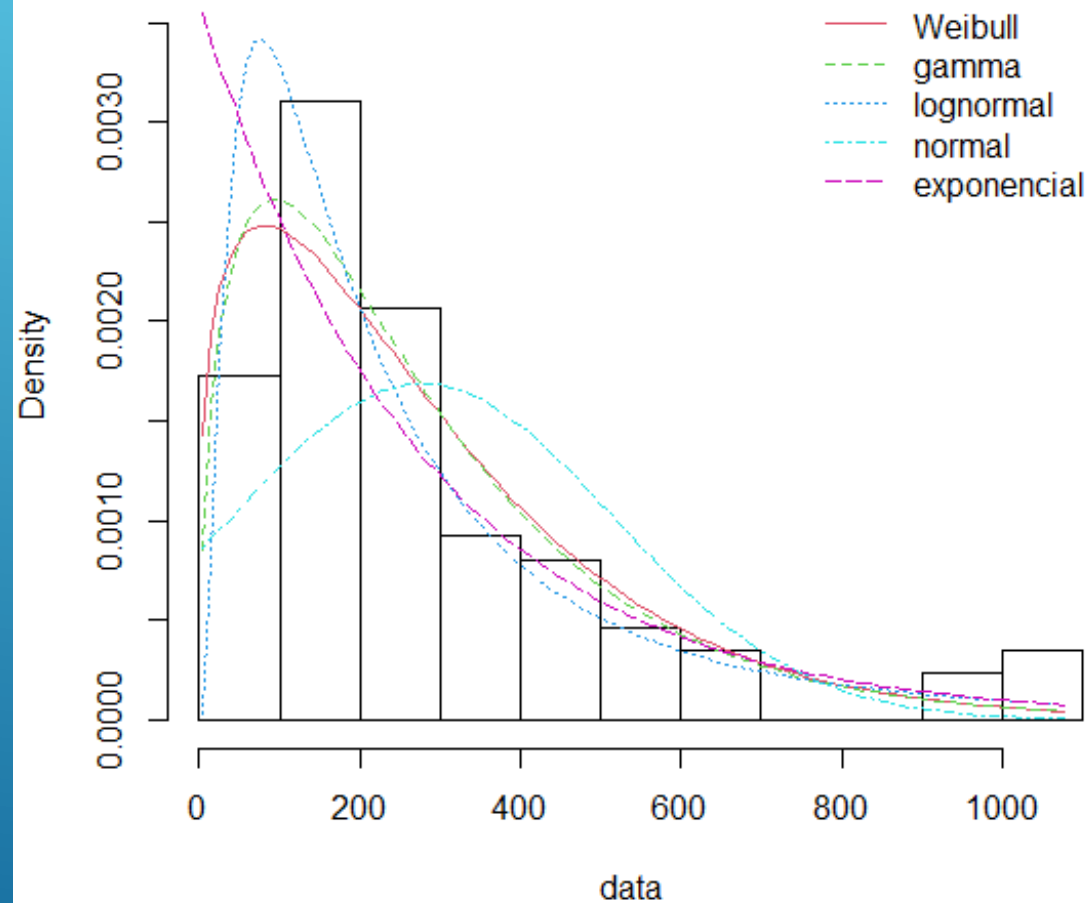
data: vari
D = 0.034747, p-value = 0.6534
alternative hypothesis: non-unimodal, i.e., at least bimodal

> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6875703
```

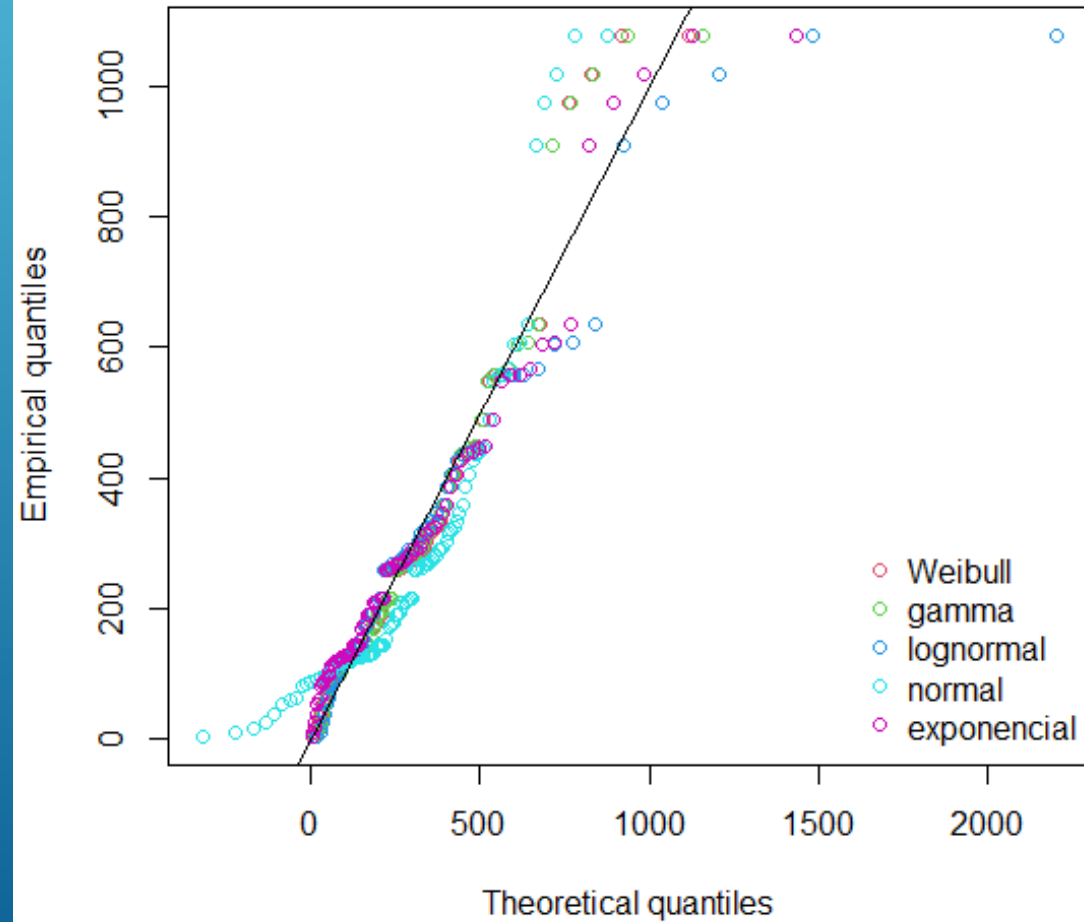
Empirical and theoretical CDFs



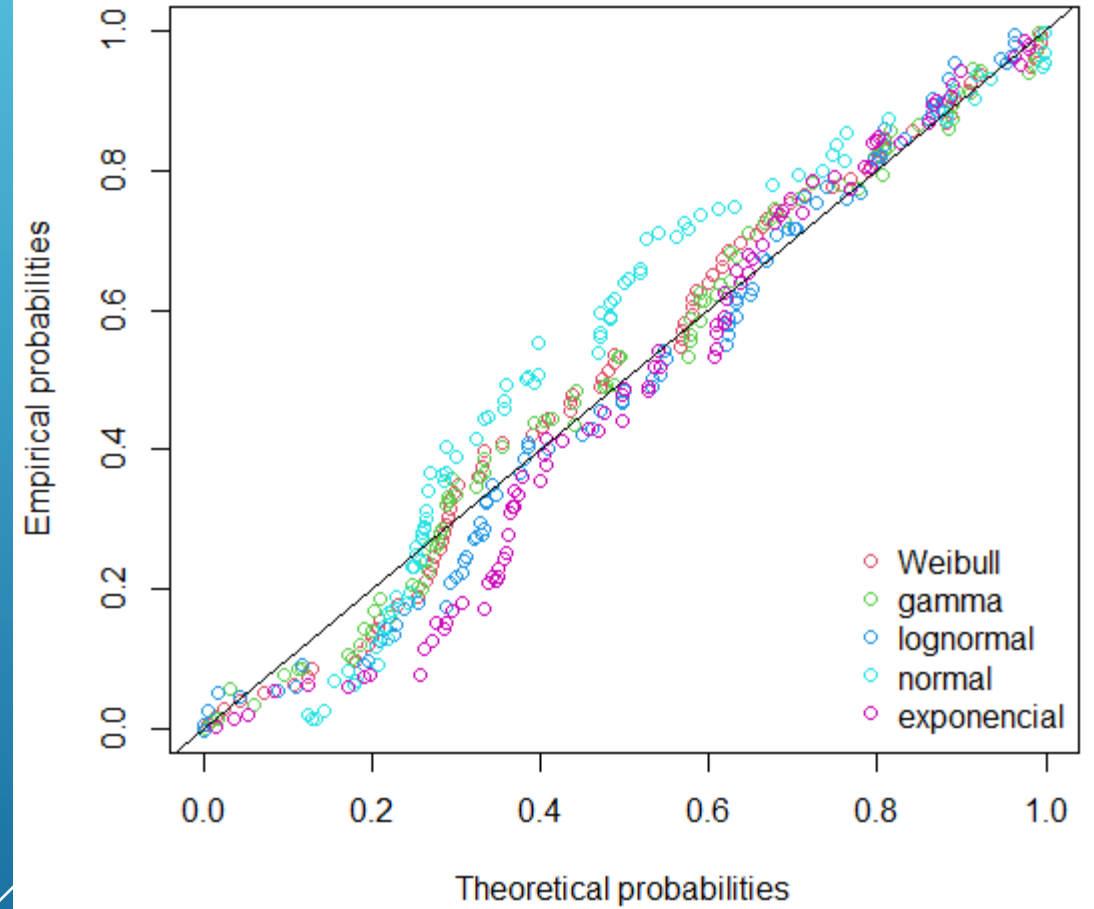
Histogram and theoretical densities



Q-Q plot



P-P plot



Área

```
Goodness-of-fit statistics
```

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.08954866	0.07901138	0.1032713	0.1642024
Cramer-von Mises statistic	0.13447309	0.10281875	0.1560390	0.7631054
Anderson-Darling statistic	0.87534067	0.68860612	1.1676027	4.6628657

```
exponencial
```

Kolmogorov-Smirnov statistic	0.1646566
Cramer-von Mises statistic	0.3895352
Anderson-Darling statistic	2.2879053

```
Goodness-of-fit criteria
```

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1150.458	1149.178	1160.065	1202.258
Bayesian Information Criterion	1155.389	1154.110	1164.997	1207.190

```
exponencial
```

Akaike's Information Criterion	1155.128
Bayesian Information Criterion	1157.594

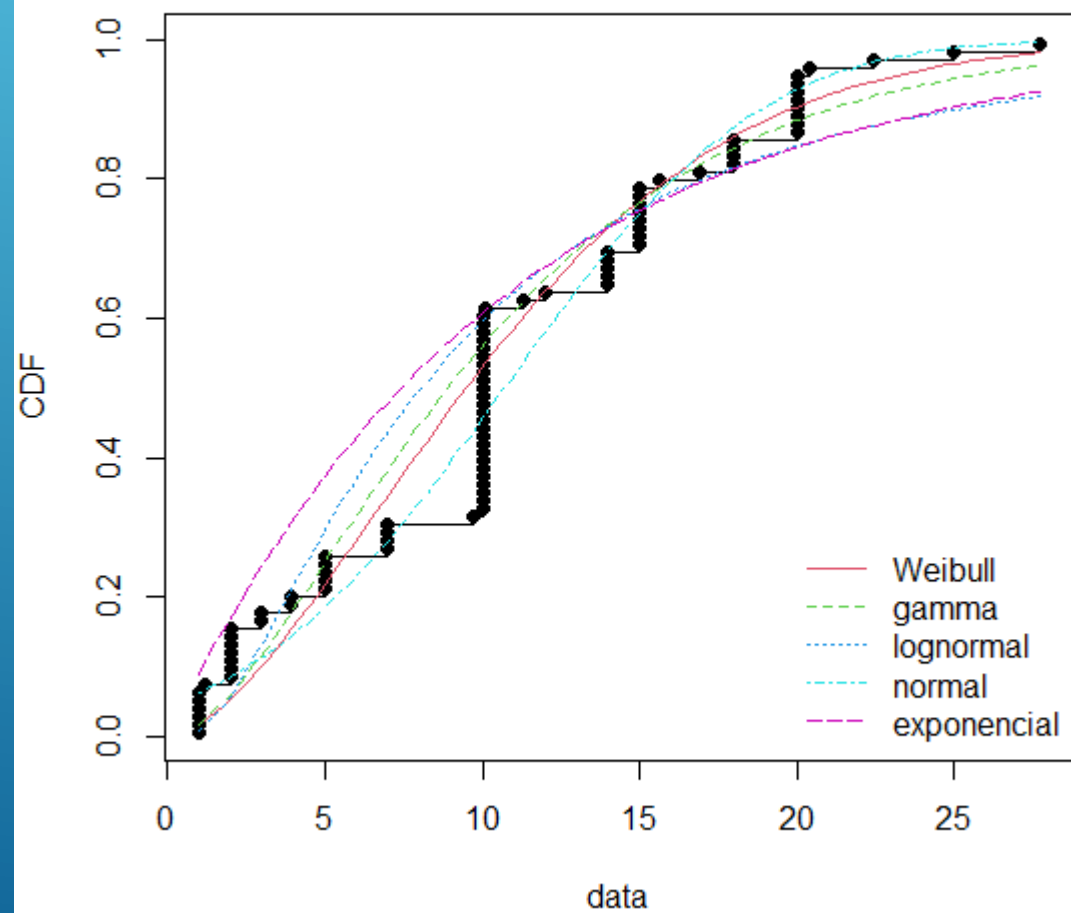
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.041705, p-value = 0.3274
alternative hypothesis: non-unimodal, i.e., at least bimodal

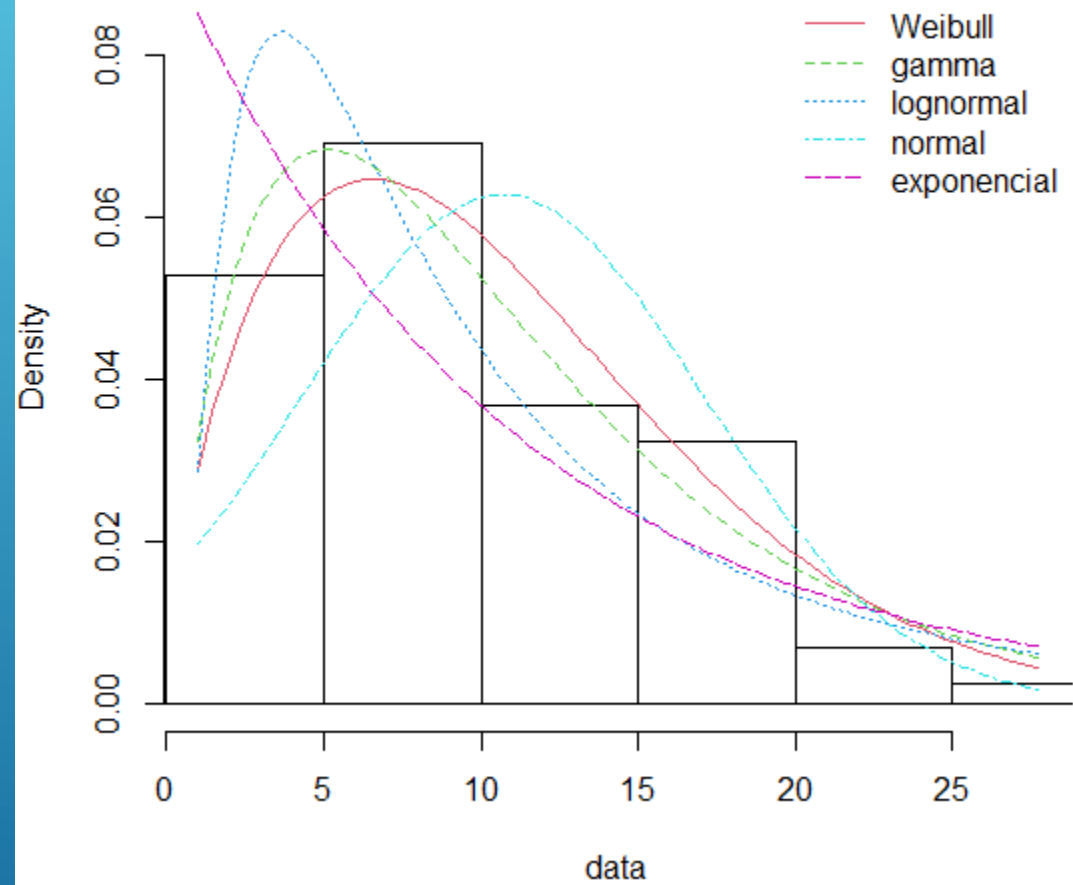
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6538175
```

Teor da fase ativa

Empirical and theoretical CDFs

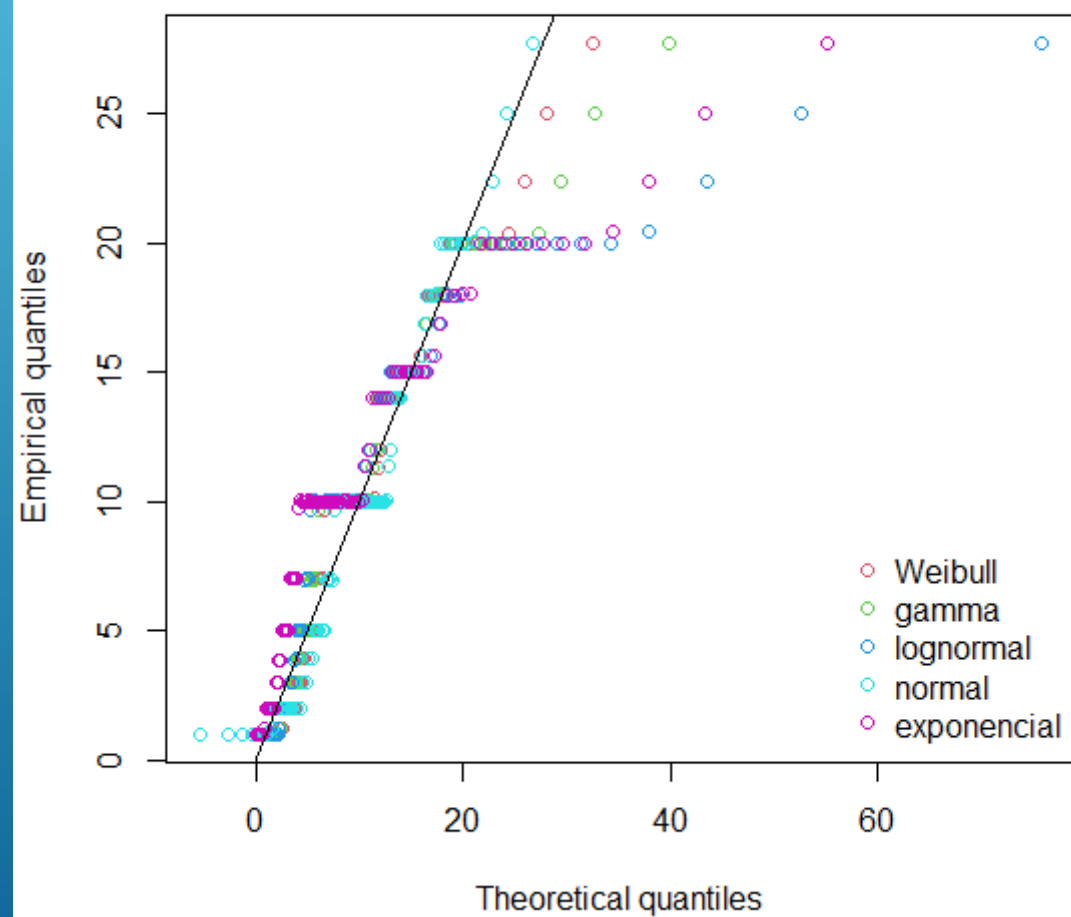


Histogram and theoretical densities

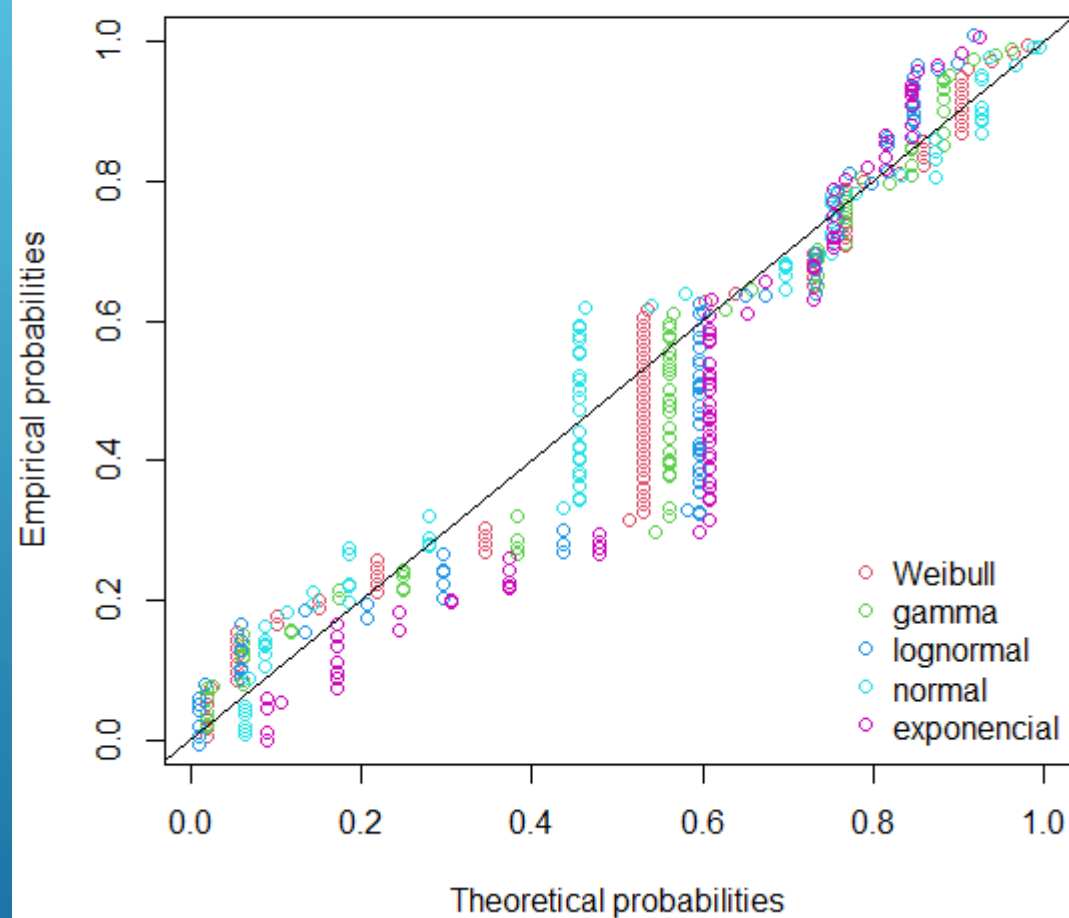


Teor da fase ativa

Q-Q plot



P-P plot



Teor da fase ativa

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2087663	0.2386853	0.2745549	0.1584176
Cramer-von Mises statistic	0.4365717	0.5868458	0.9266869	0.2973325
Anderson-Darling statistic	2.5618586	3.1508513	5.0775045	1.6576541

	exponencial
Kolmogorov-Smirnov statistic	0.2856422
Cramer-von Mises statistic	1.1733475
Anderson-Darling statistic	5.8185327

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	566.2038	572.6567	593.1731	572.9142
Bayesian Information Criterion	571.1356	577.5885	598.1049	577.8461

	exponencial
Akaike's Information Criterion	588.4673
Bayesian Information Criterion	590.9332

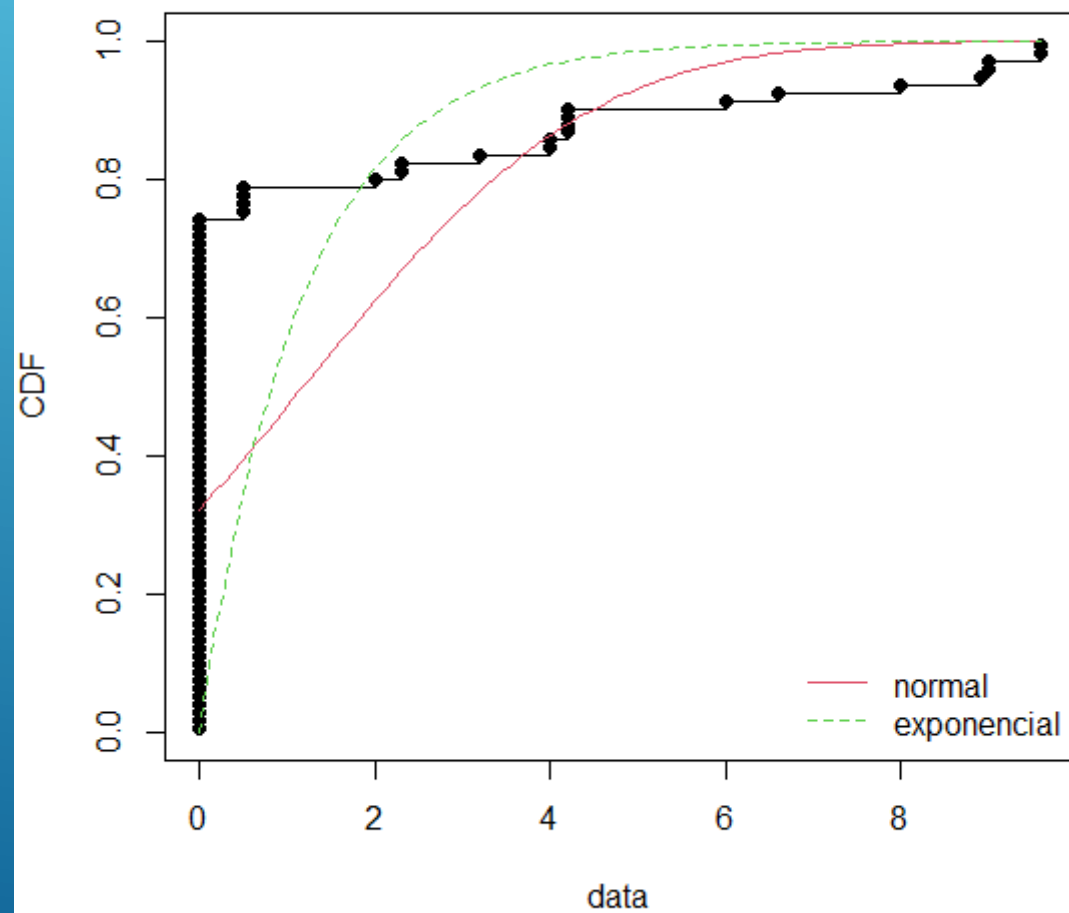
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.062624, p-value = 0.01061
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

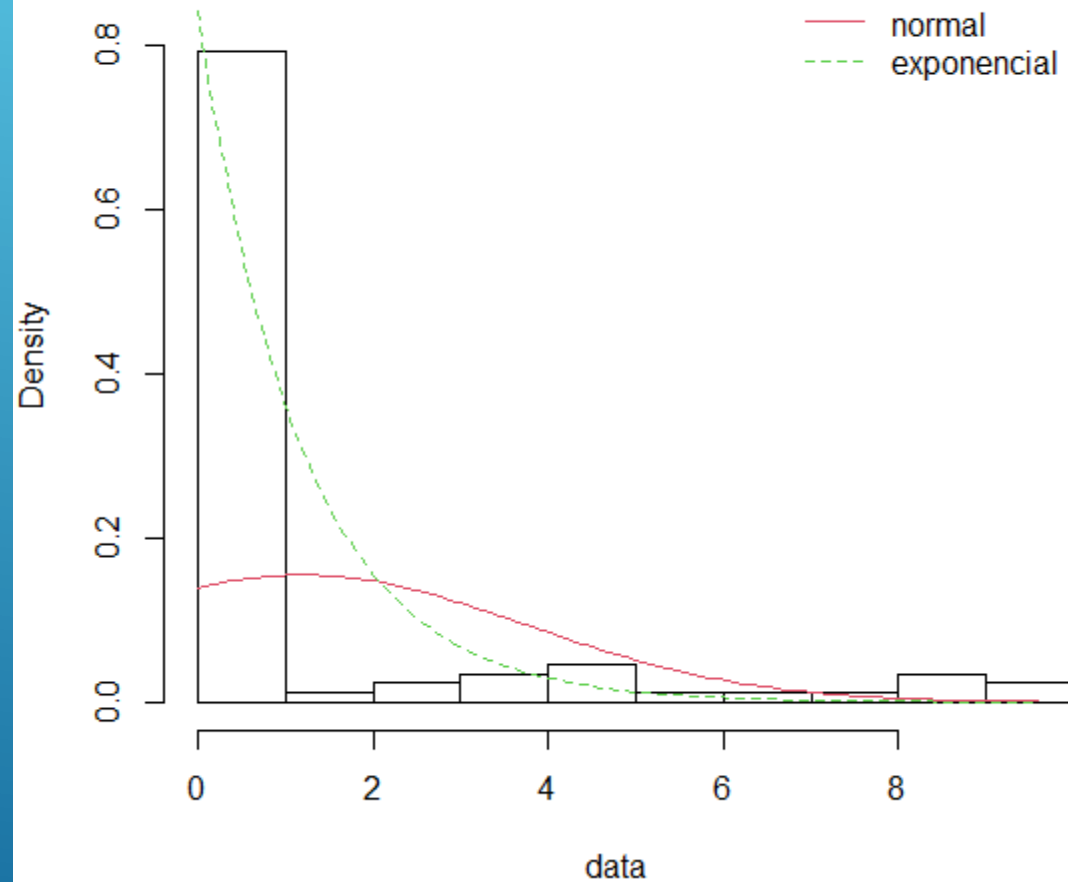
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.4136737
>
```


Concentração de dopante

Empirical and theoretical CDFs

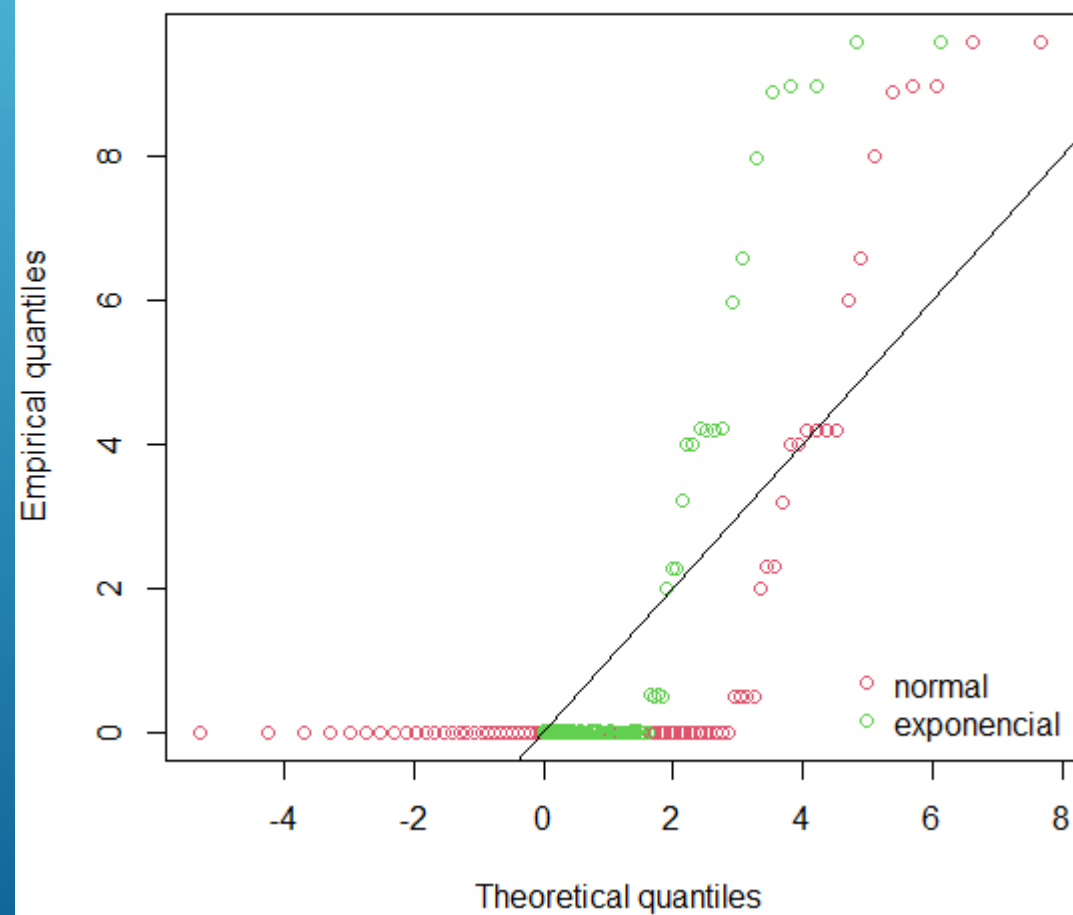


Histogram and theoretical densities

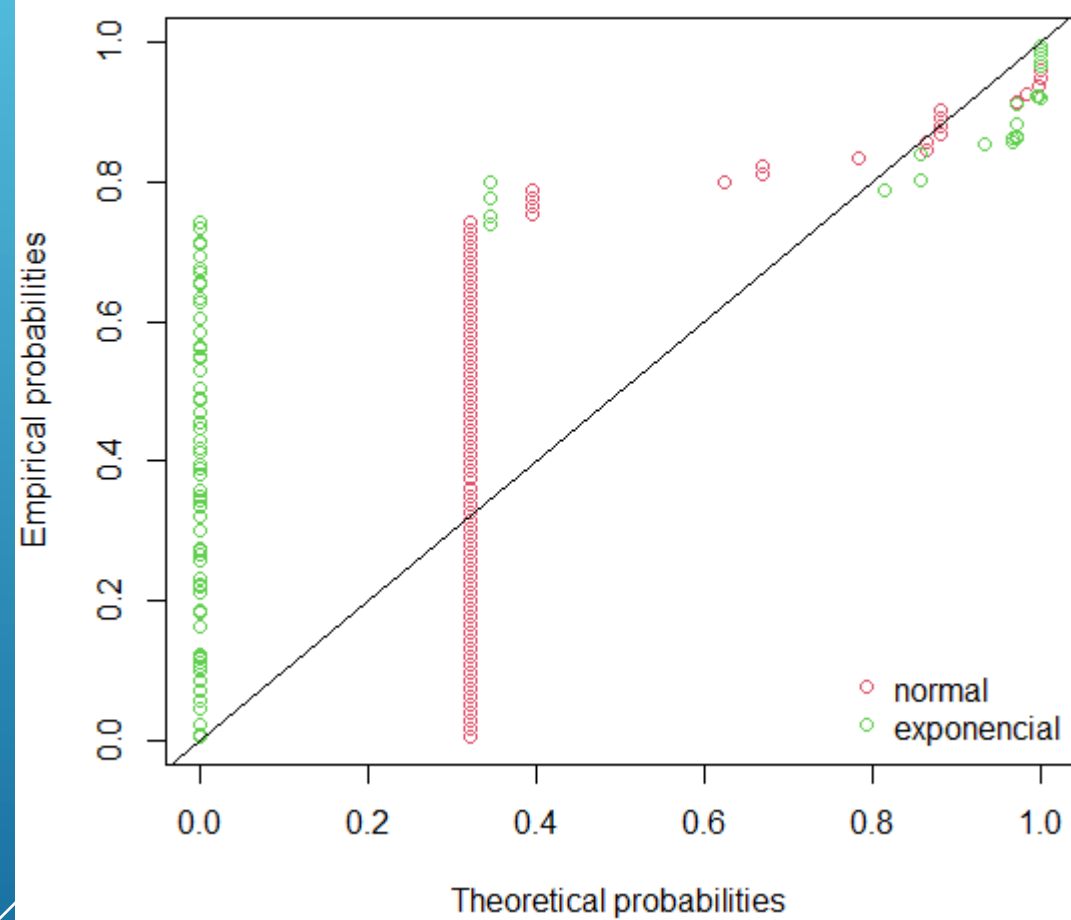


Concentração de dopante

Q-Q plot



P-P plot



Concentração de dopante

```
Goodness-of-fit statistics
               normal exponencial
Kolmogorov-Smirnov statistic  0.4250607  0.7471264
Cramer-von Mises statistic   3.8544497 12.9130905
Anderson-Darling statistic  19.0355356      Inf

Goodness-of-fit criteria
               normal exponencial
Akaike's Information Criterion 415.1637  205.8809
Bayesian Information Criterion 420.0955  208.3468
```

Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.031376, p-value = 0.8144
alternative hypothesis: non-unimodal, i.e., at least bimodal

> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8536255
>
```