

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

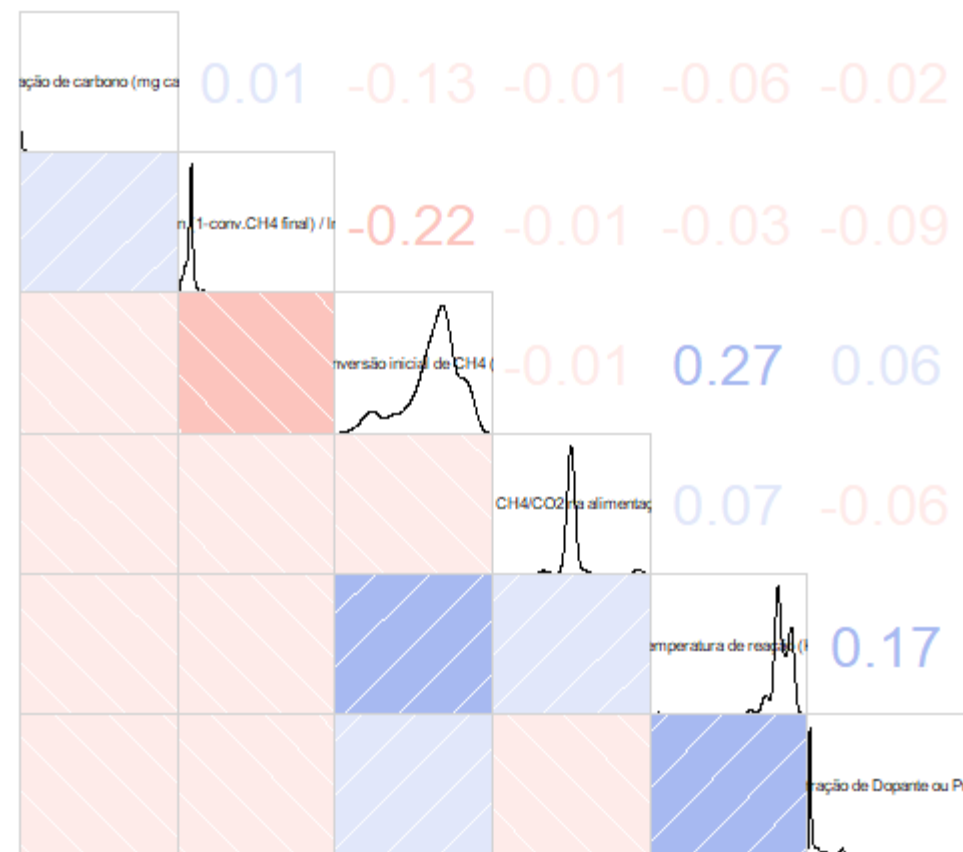
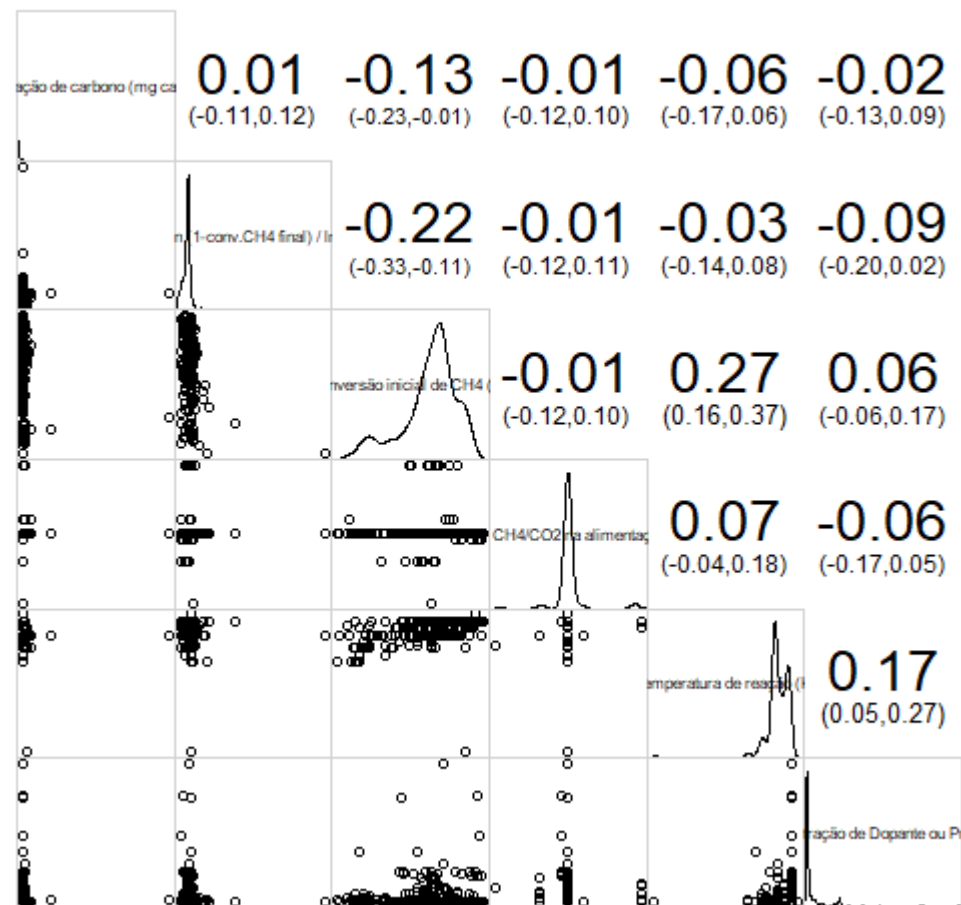
RESULTADOS ANÁLISE EXPLORATÓRIA DE DADOS DO PROCESSO DE REFORMA DO METANO

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ORIENTADORES: LISIANE VEIGA MATTOS
JOÃO FELIPE MITRE DE ARAUJO

Planilha os três do arquivo data_dt

▶ database

306 obs. of 19 variables



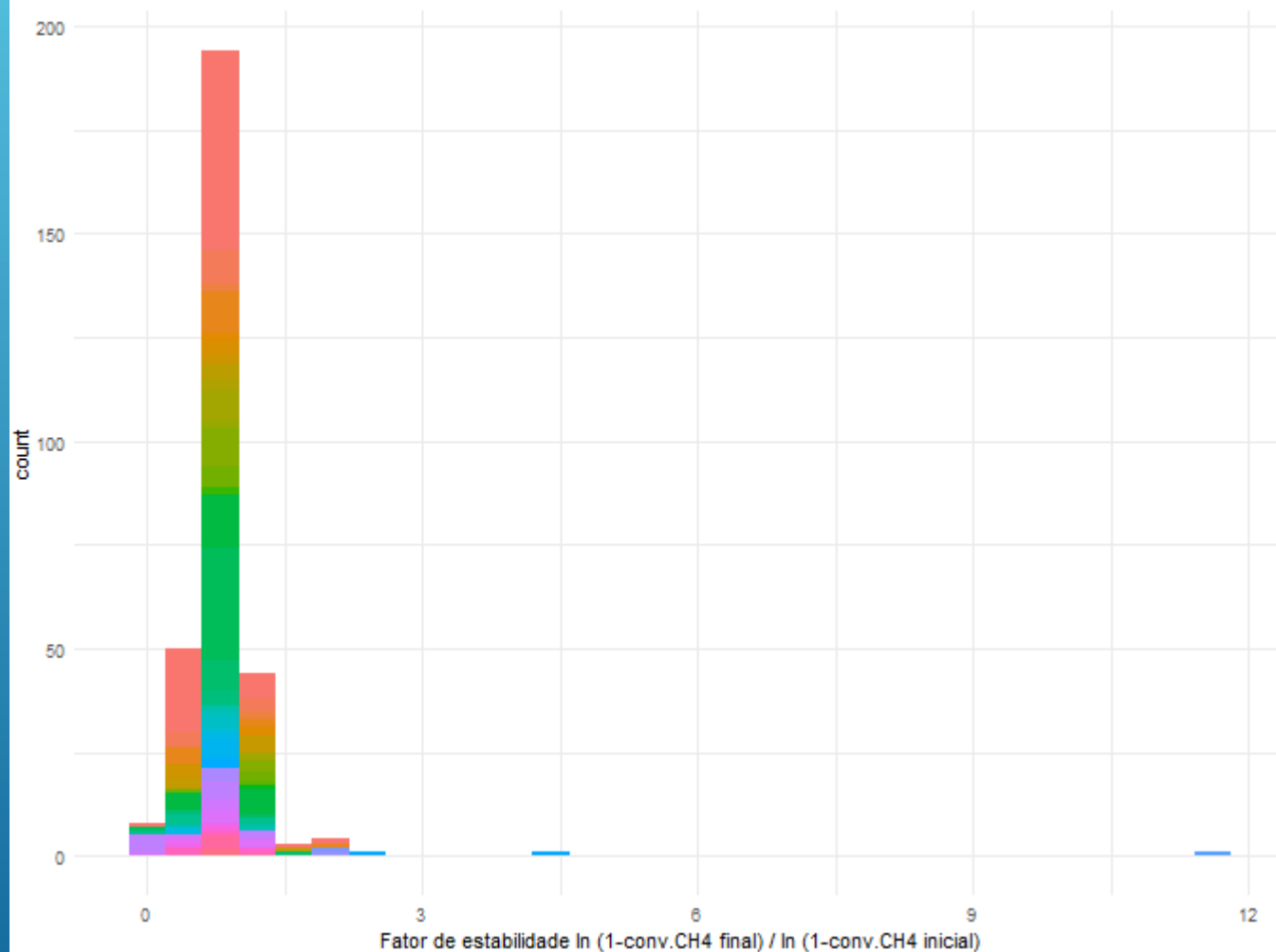
Crítérios de relevância

- R1 Taxa de formação de carbono - Superior à 100
- R2 Fator de estabilidade - Superior a 2
- R3 Conversão inferior à 6
- R4 Razão de alimentação Diferente de 1
- R5 razão inerte superior à 6
- R6 Temperaturas de reação inferiores à 300
- R7 Concentração de dopante ou Promotor 20

Lacunas

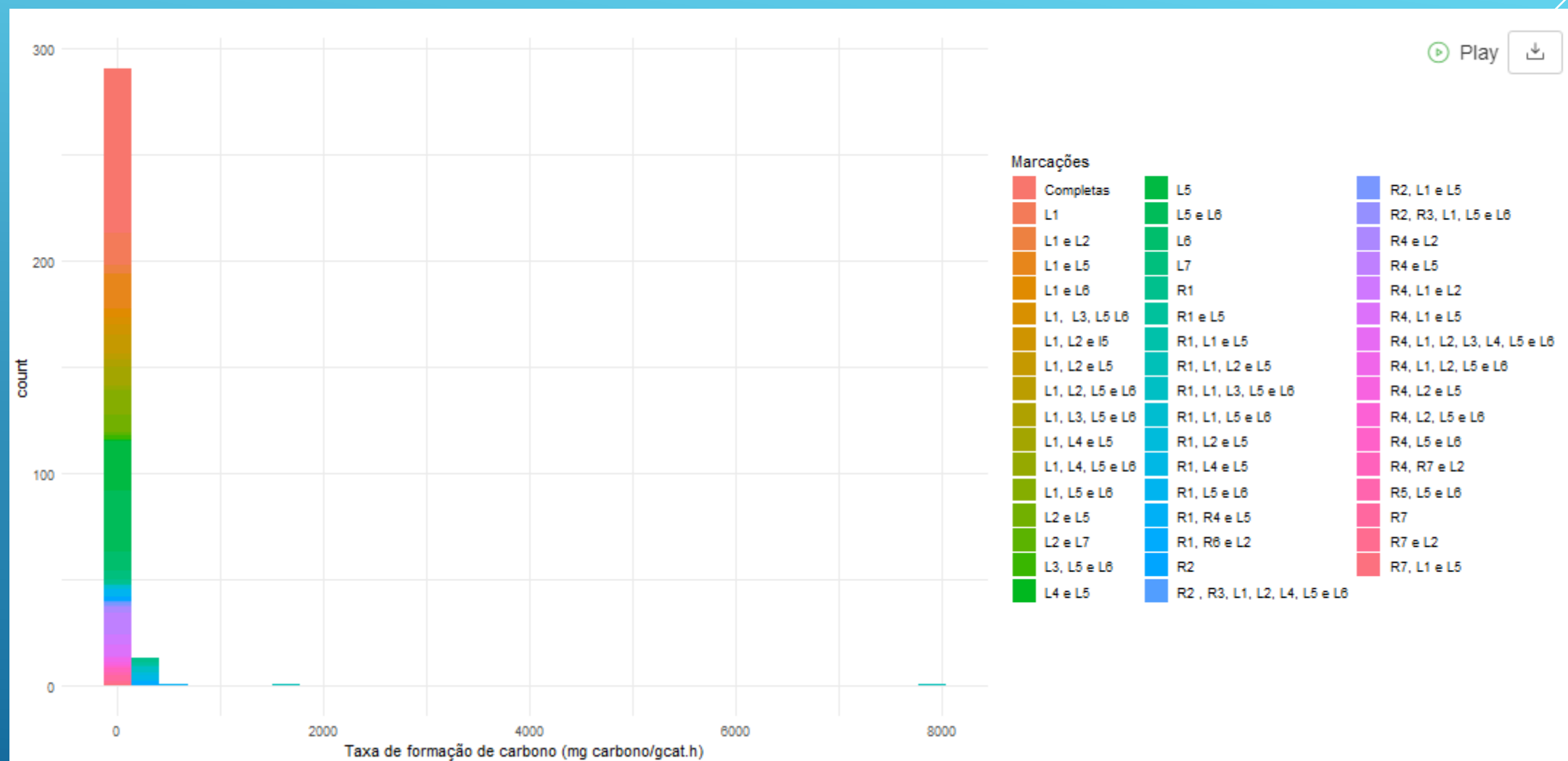
- L1 razão inerte/metano
- L2 WSHV
- L3 Temperatura de calcinação
- L4 Temperatura de redução
- L5 Tamanho de cristalito
- L6 Área específica do catalisador
- L7 Teor de fase ativa

Play

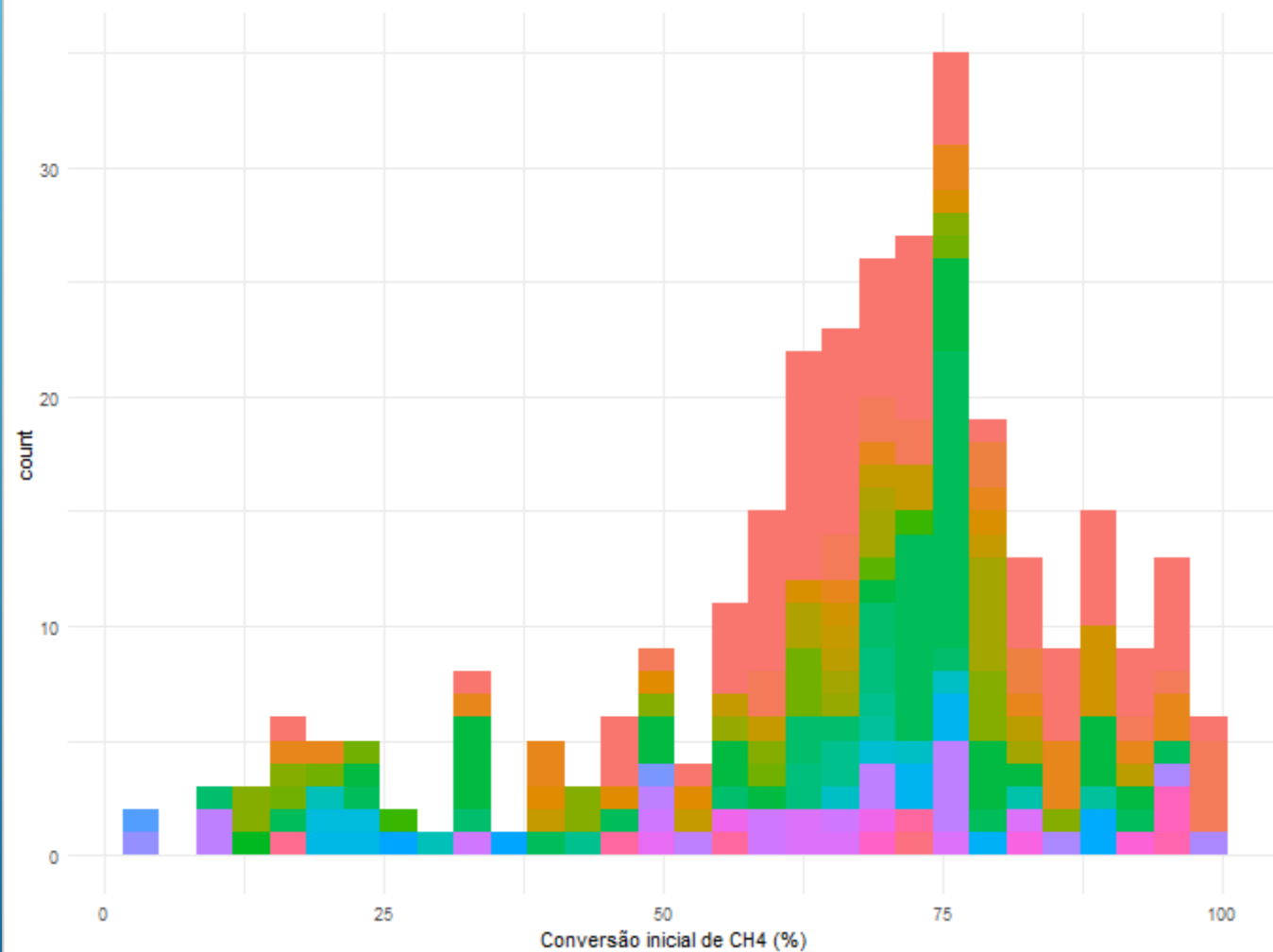


Marcações

- | | | |
|-----------------|-----------------------------|-----------------------------|
| Completas | L5 | R2, L1 e L5 |
| L1 | L5 e L6 | R2, R3, L1, L5 e L6 |
| L1 e L2 | L6 | R4 e L2 |
| L1 e L5 | L7 | R4 e L5 |
| L1 e L6 | R1 | R4, L1 e L2 |
| L1, L3, L5 e L6 | R1 e L5 | R4, L1 e L5 |
| L1, L2 e L5 | R1, L1 e L5 | R4, L1, L2, L3, L4, L5 e L6 |
| L1, L2 e L6 | R1, L1, L2 e L5 | R4, L1, L2, L5 e L6 |
| L1, L2, L5 e L6 | R1, L1, L3, L5 e L6 | R4, L2 e L5 |
| L1, L3, L5 e L6 | R1, L1, L5 e L6 | R4, L2, L5 e L6 |
| L1, L4 e L5 | R1, L2 e L5 | R4, L5 e L6 |
| L1, L4, L5 e L6 | R1, L4 e L5 | R4, R7 e L2 |
| L1, L5 e L6 | R1, L5 e L6 | R5, L5 e L6 |
| L2 e L5 | R1, R4 e L5 | R7 |
| L2 e L7 | R1, R6 e L2 | R7 e L2 |
| L3, L5 e L6 | R2 | R7, L1 e L5 |
| L4 e L5 | R2, R3, L1, L2, L4, L5 e L6 | |



Play



Marcações

Completas

L1

L1 e L2

L1 e L5

L1 e L6

L1, L3, L5 e L6

L1, L2 e L5

L1, L2 e L6

L1, L3, L5 e L6

L1, L4 e L5

L1, L4, L5 e L6

L1, L5 e L6

L2 e L5

L2 e L7

L3, L5 e L6

L4 e L5

L5

L5 e L6

L6

L7

R1

R1 e L5

R1, L1 e L5

R1, L1, L2 e L5

R1, L1, L3, L5 e L6

R1, L1, L5 e L6

R1, L2 e L5

R1, L4 e L5

R1, L5 e L6

R1, R4 e L5

R1, R6 e L2

R2

R2, R3, L1, L2, L4, L5 e L6

R2, L1 e L5

R2, R3, L1, L5 e L6

R4 e L2

R4 e L5

R4, L1 e L2

R4, L1 e L5

R4, L1, L2, L3, L4, L5 e L6

R4, L1, L2, L5 e L6

R4, L2 e L5

R4, L2, L5 e L6

R4, L5 e L6

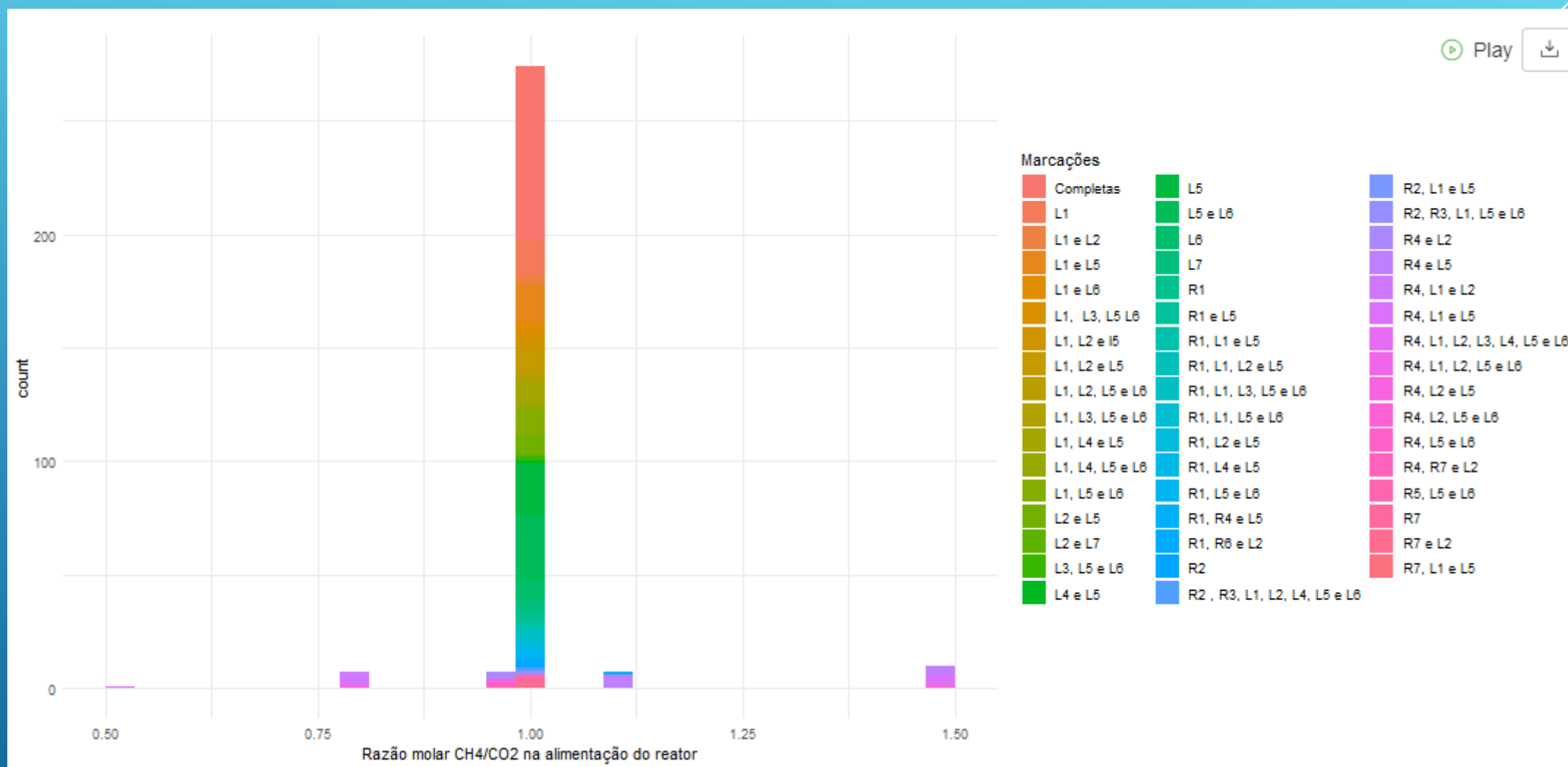
R4, R7 e L2

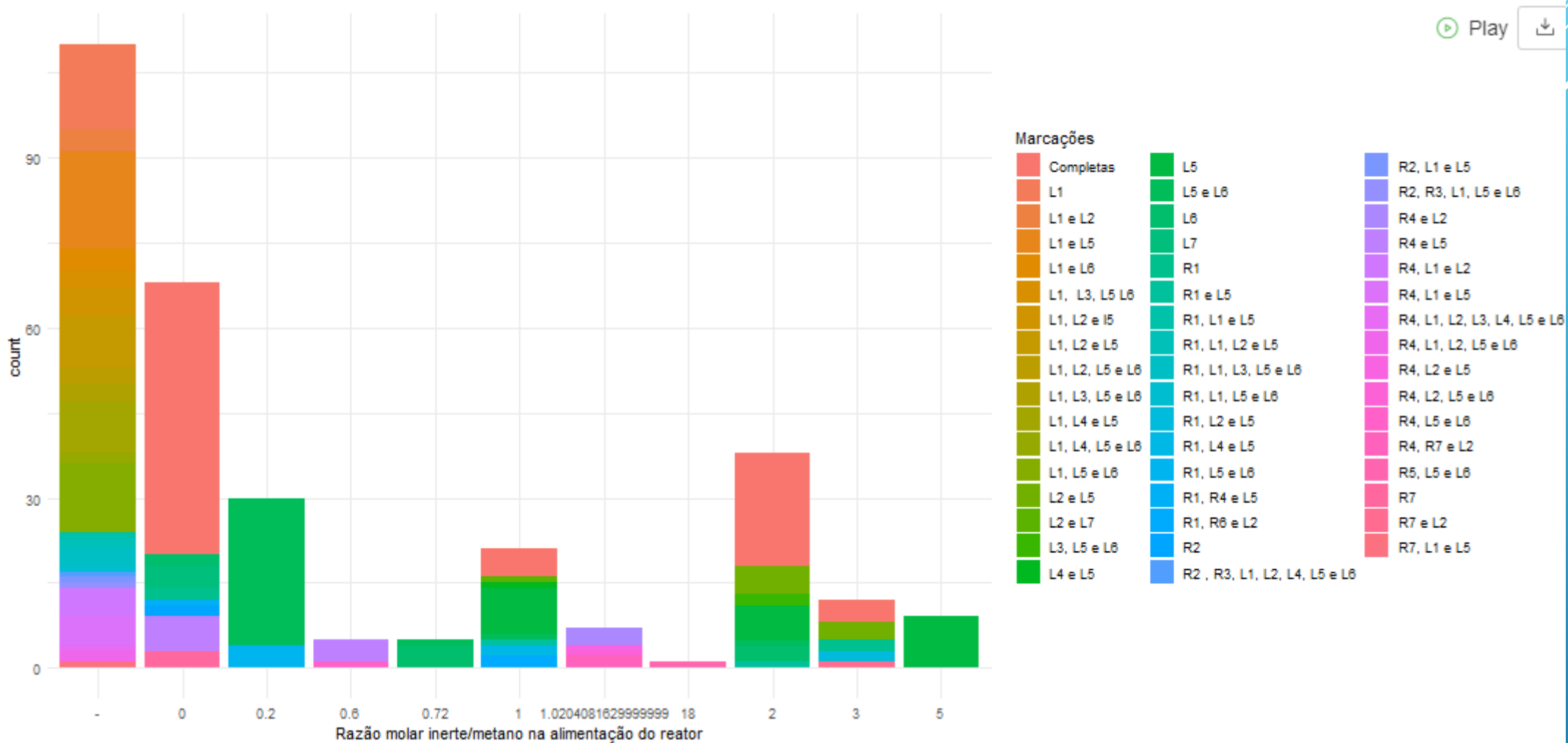
R5, L5 e L6

R7

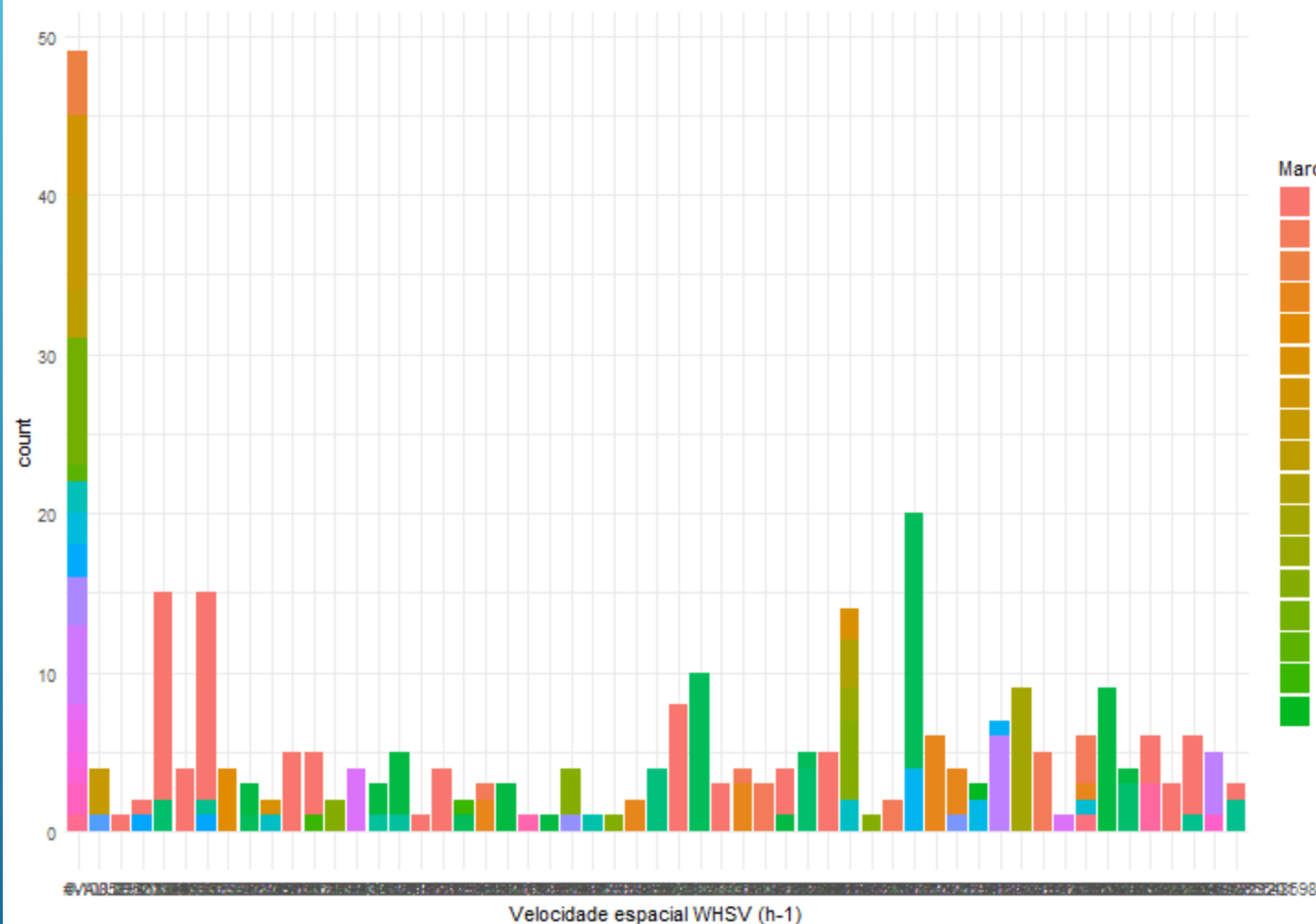
R7 e L2

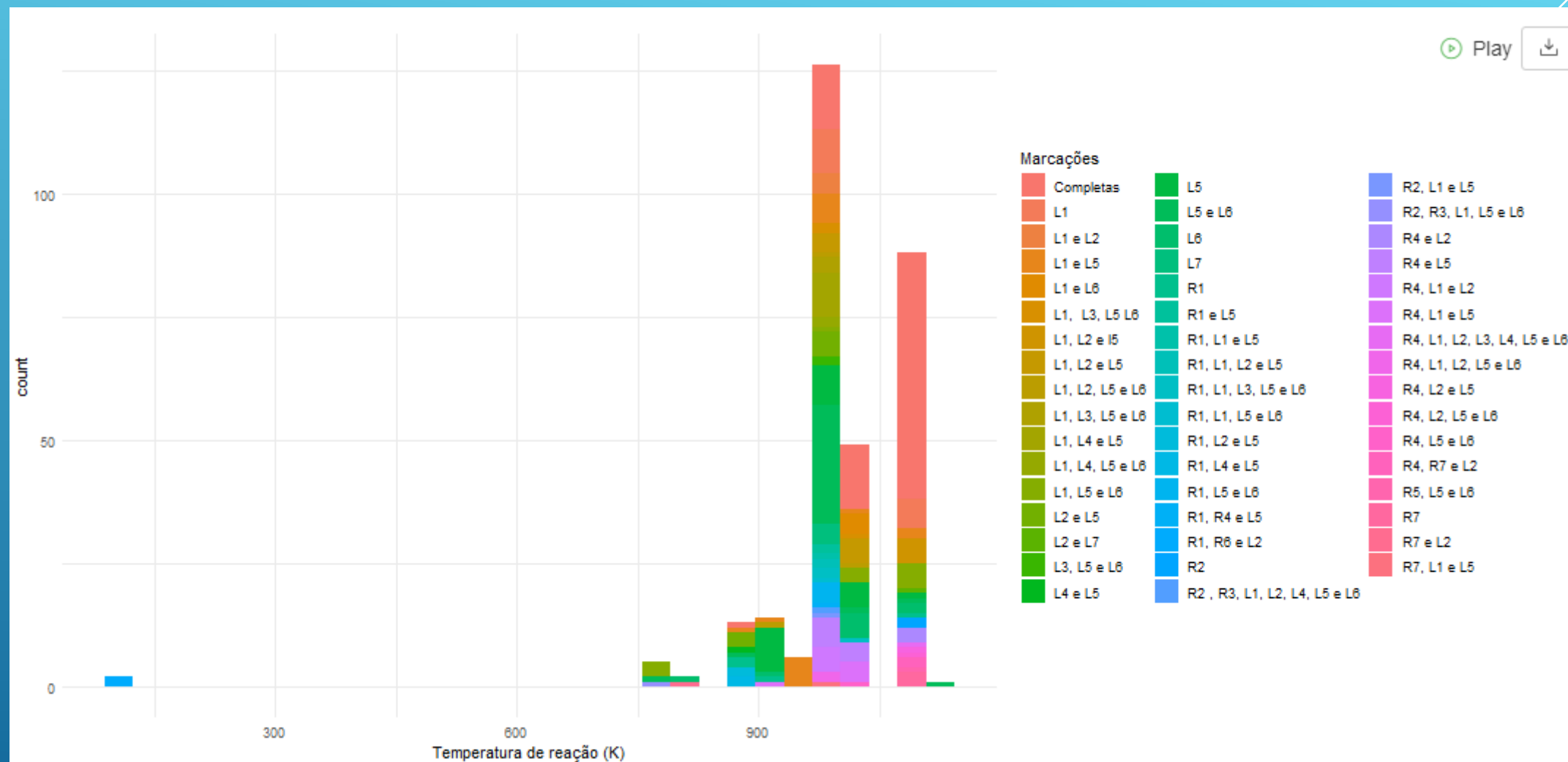
R7, L1 e L5

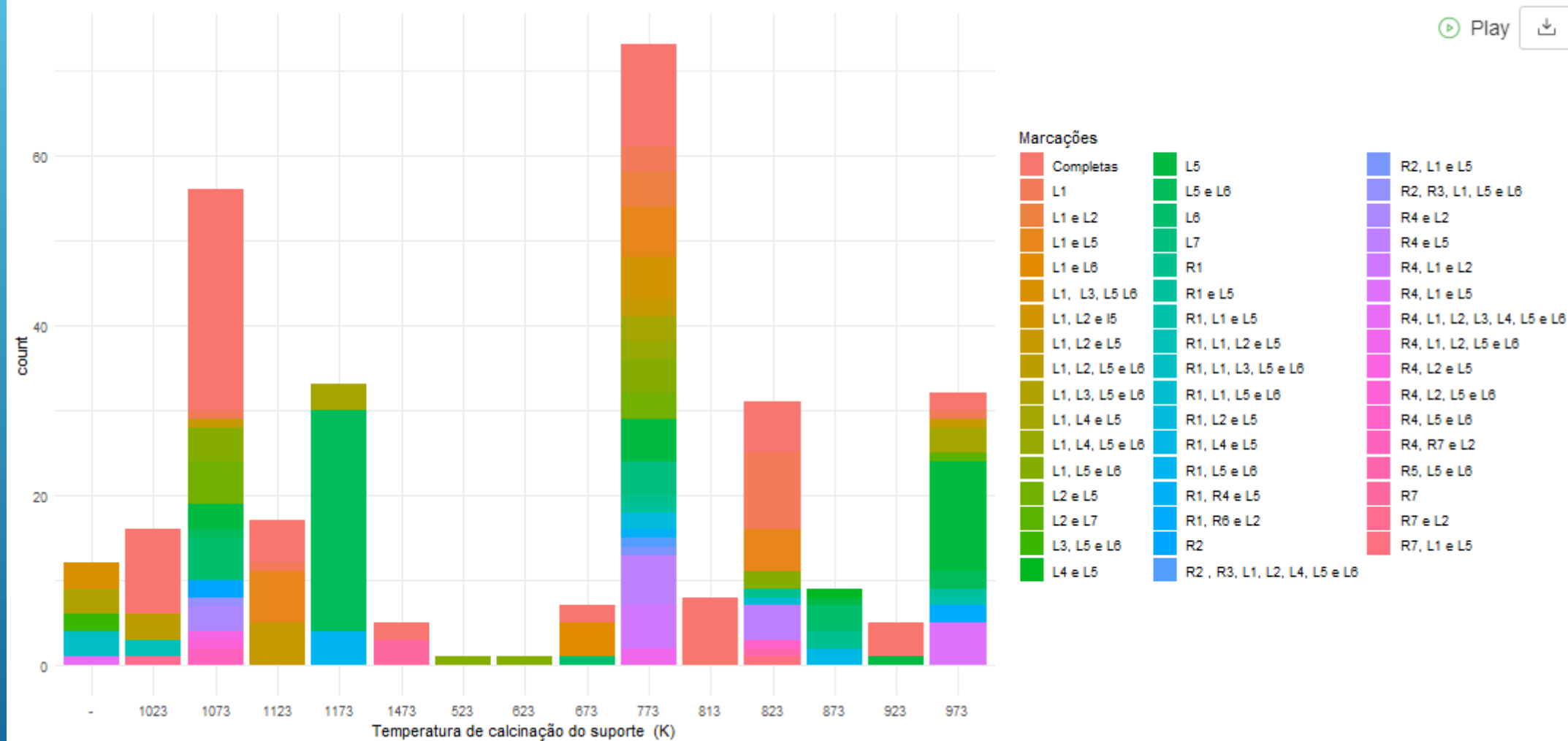




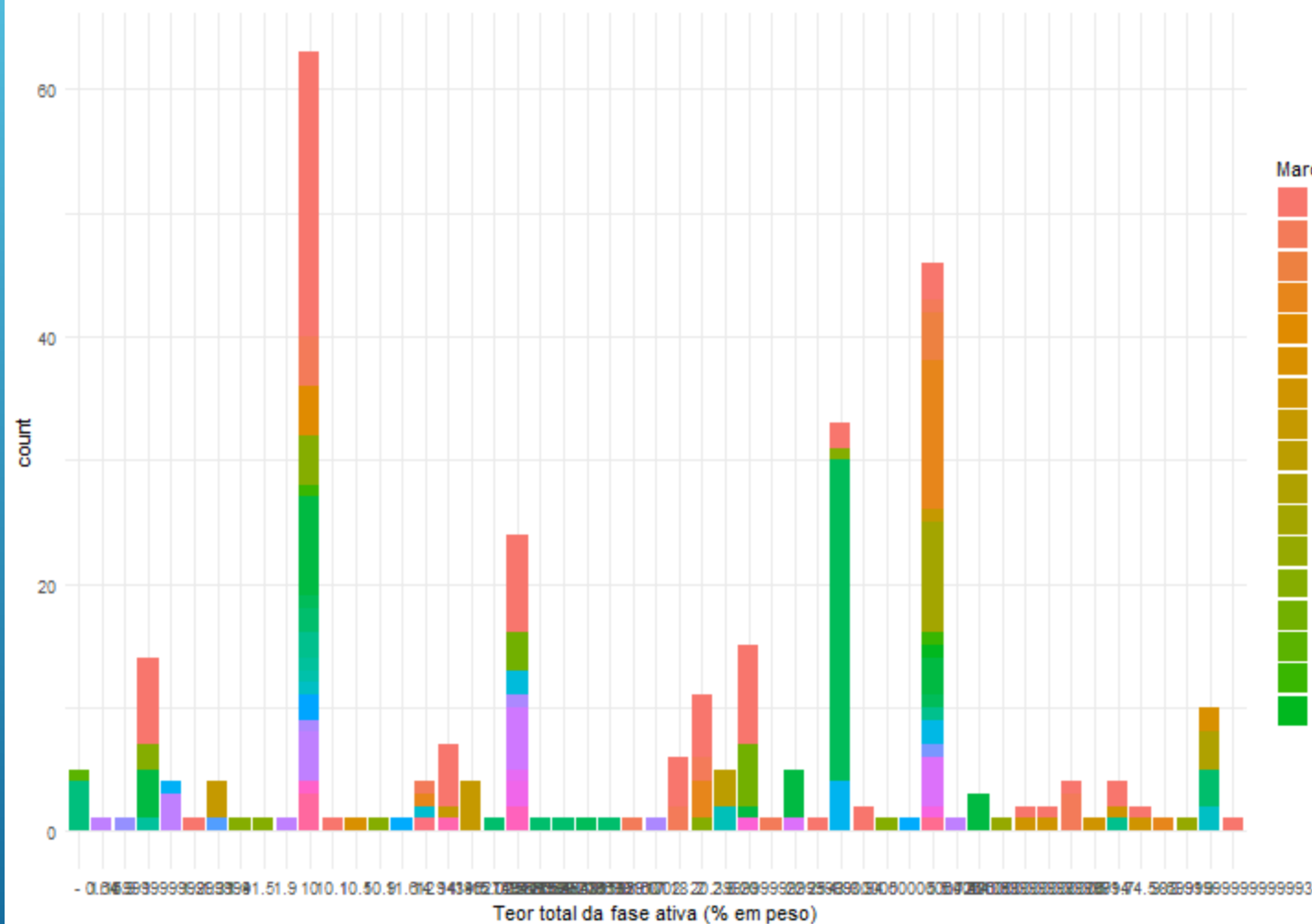
Play





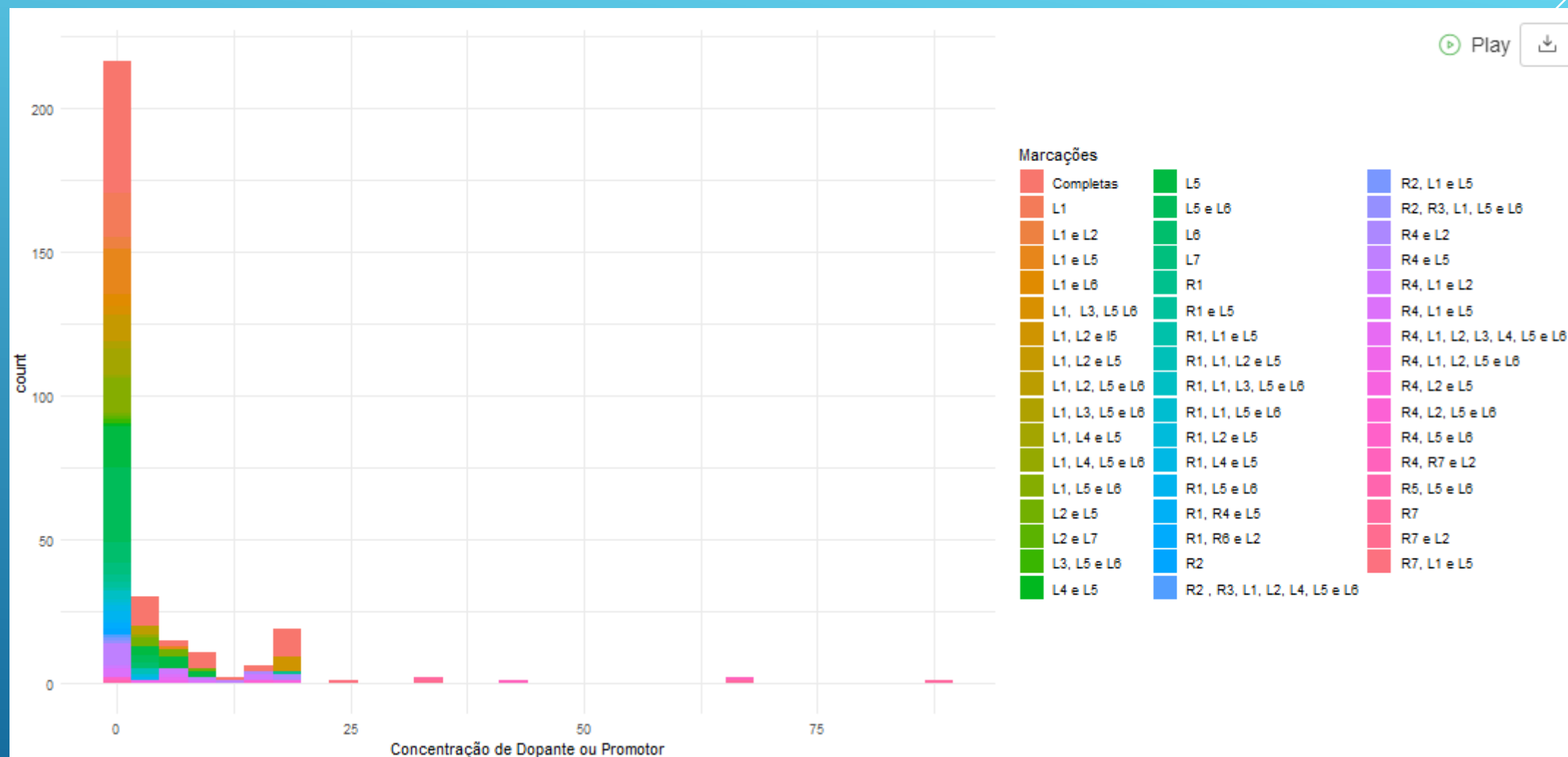


Play



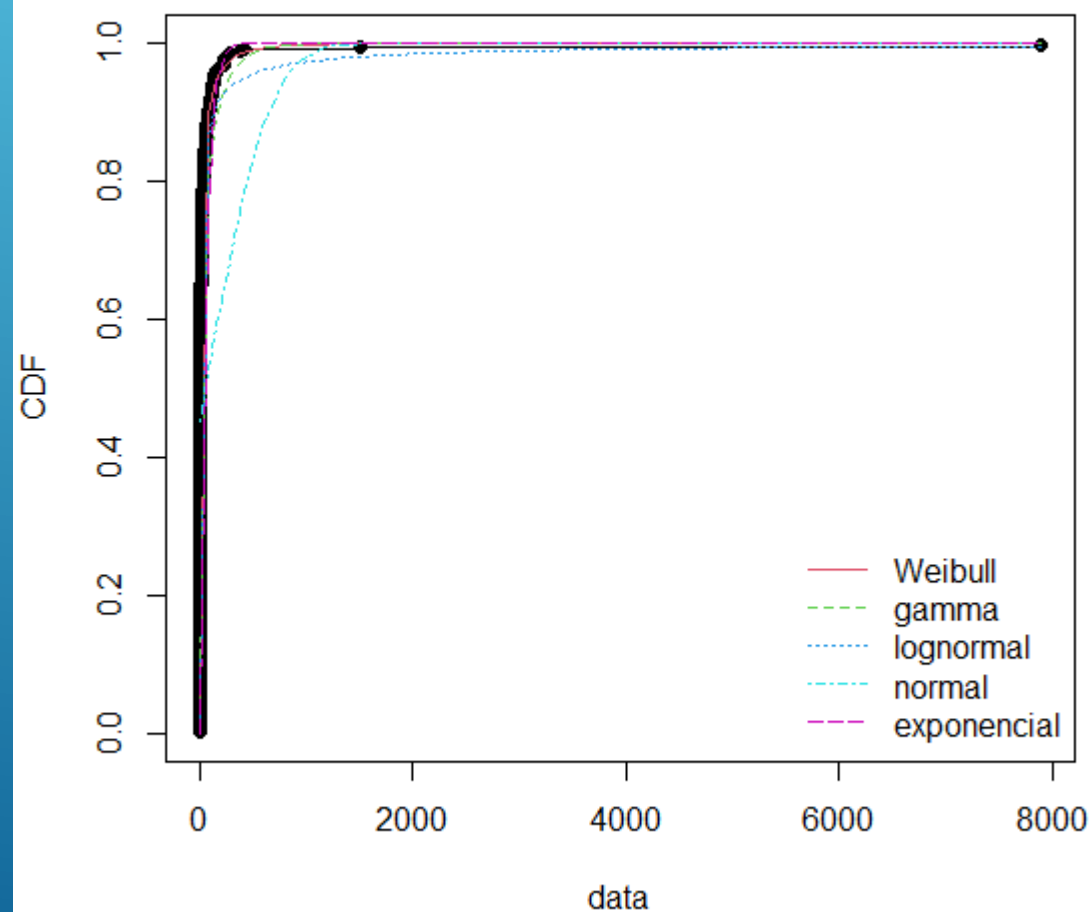
Marcações

- | | | |
|-----------------|-----------------------------|-----------------------------|
| Completas | L5 | R2, L1 e L5 |
| L1 | L5 e L6 | R2, R3, L1, L5 e L6 |
| L1 e L2 | L6 | R4 e L2 |
| L1 e L5 | L7 | R4 e L5 |
| L1 e L6 | R1 | R4, L1 e L2 |
| L1, L3, L5 e L6 | R1 e L5 | R4, L1 e L5 |
| L1, L2 e L5 | R1, L1 e L5 | R4, L1, L2, L3, L4, L5 e L6 |
| L1, L2 e L6 | R1, L1, L2 e L5 | R4, L1, L2, L5 e L6 |
| L1, L3, L5 e L6 | R1, L1, L3, L5 e L6 | R4, L2 e L5 |
| L1, L4 e L5 | R1, L1, L5 e L6 | R4, L2, L5 e L6 |
| L1, L4, L5 e L6 | R1, L2 e L5 | R4, L5 e L6 |
| L1, L5 e L6 | R1, L4 e L5 | R4, R7 e L2 |
| L2 e L5 | R1, L5 e L6 | R5, L5 e L6 |
| L2 e L7 | R1, R4 e L5 | R7 |
| L3, L5 e L6 | R1, R6 e L2 | R7 e L2 |
| L4 e L5 | R2 | R7, L1 e L5 |
| | R2, R3, L1, L2, L4, L5 e L6 | |

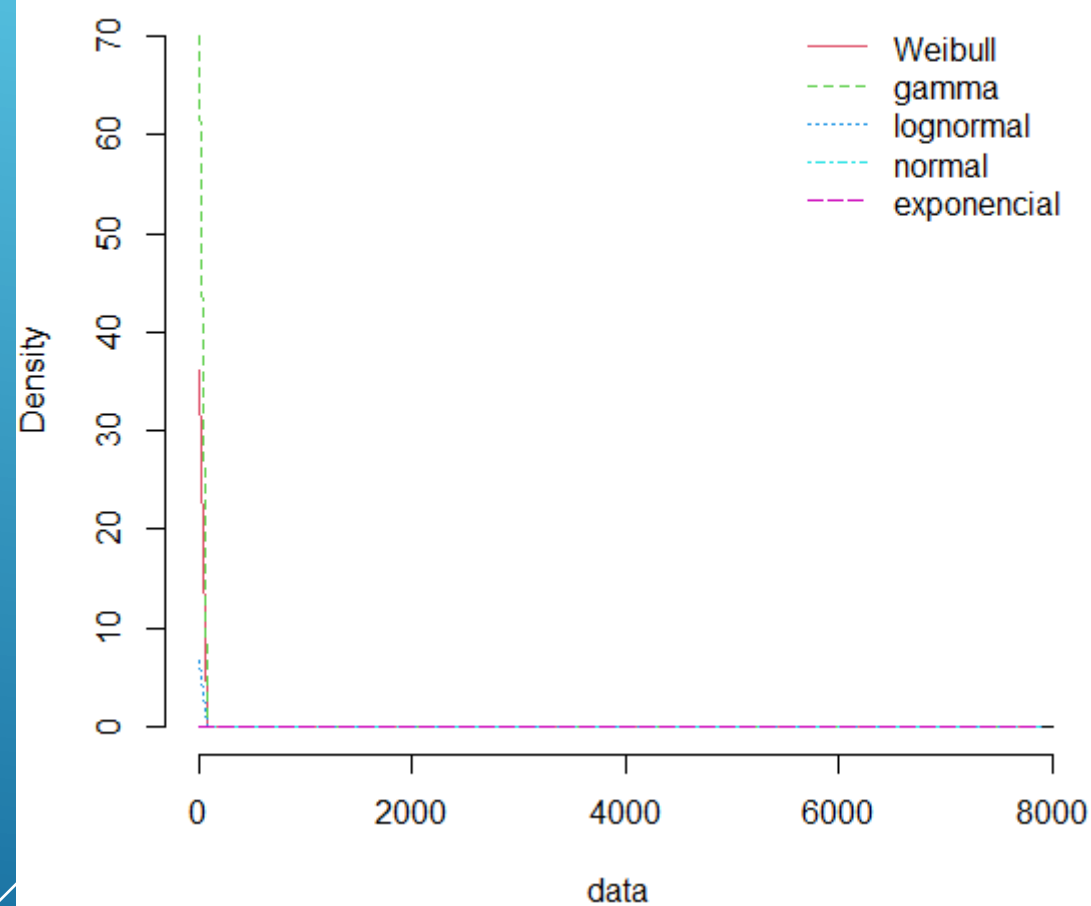


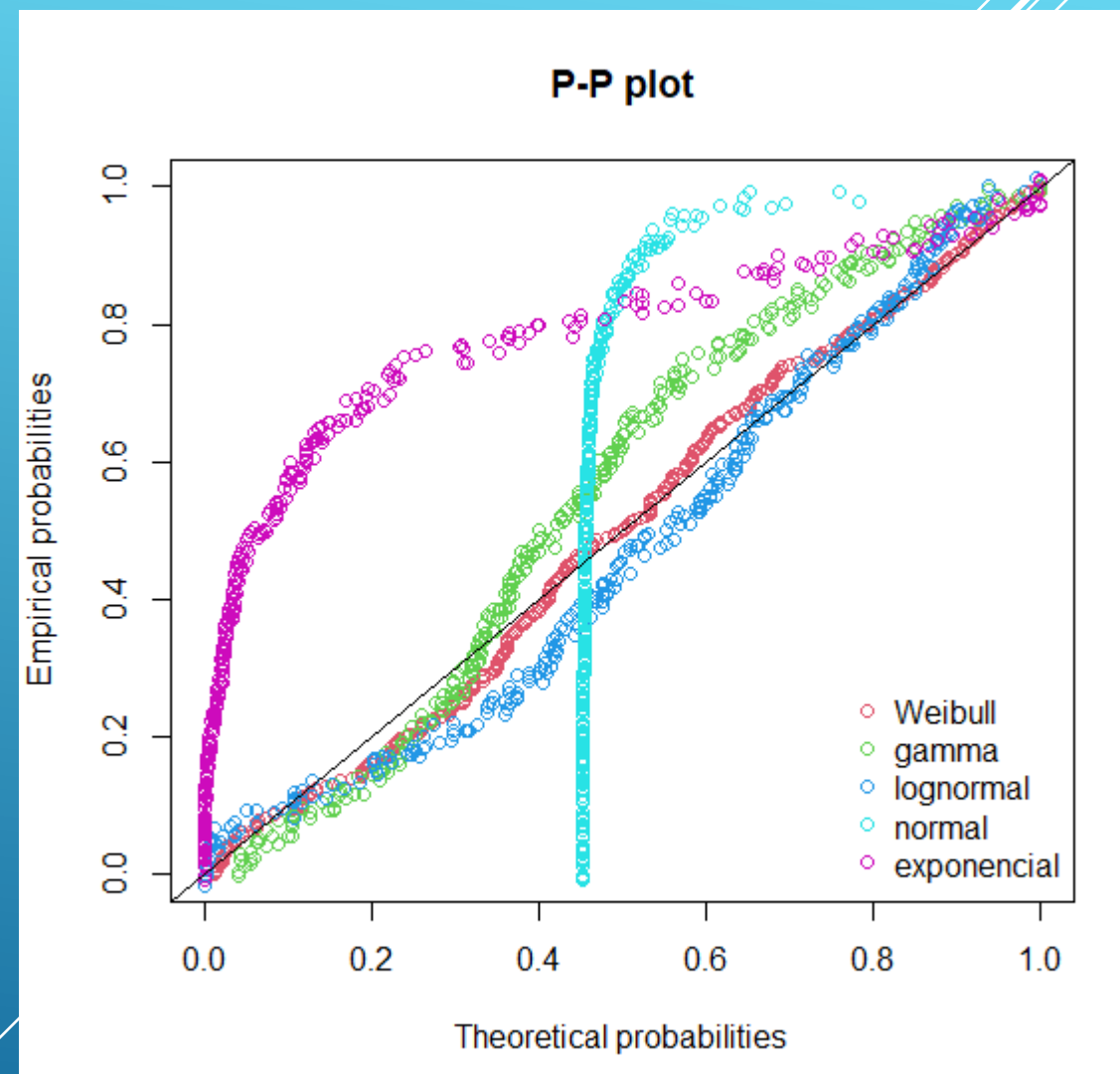
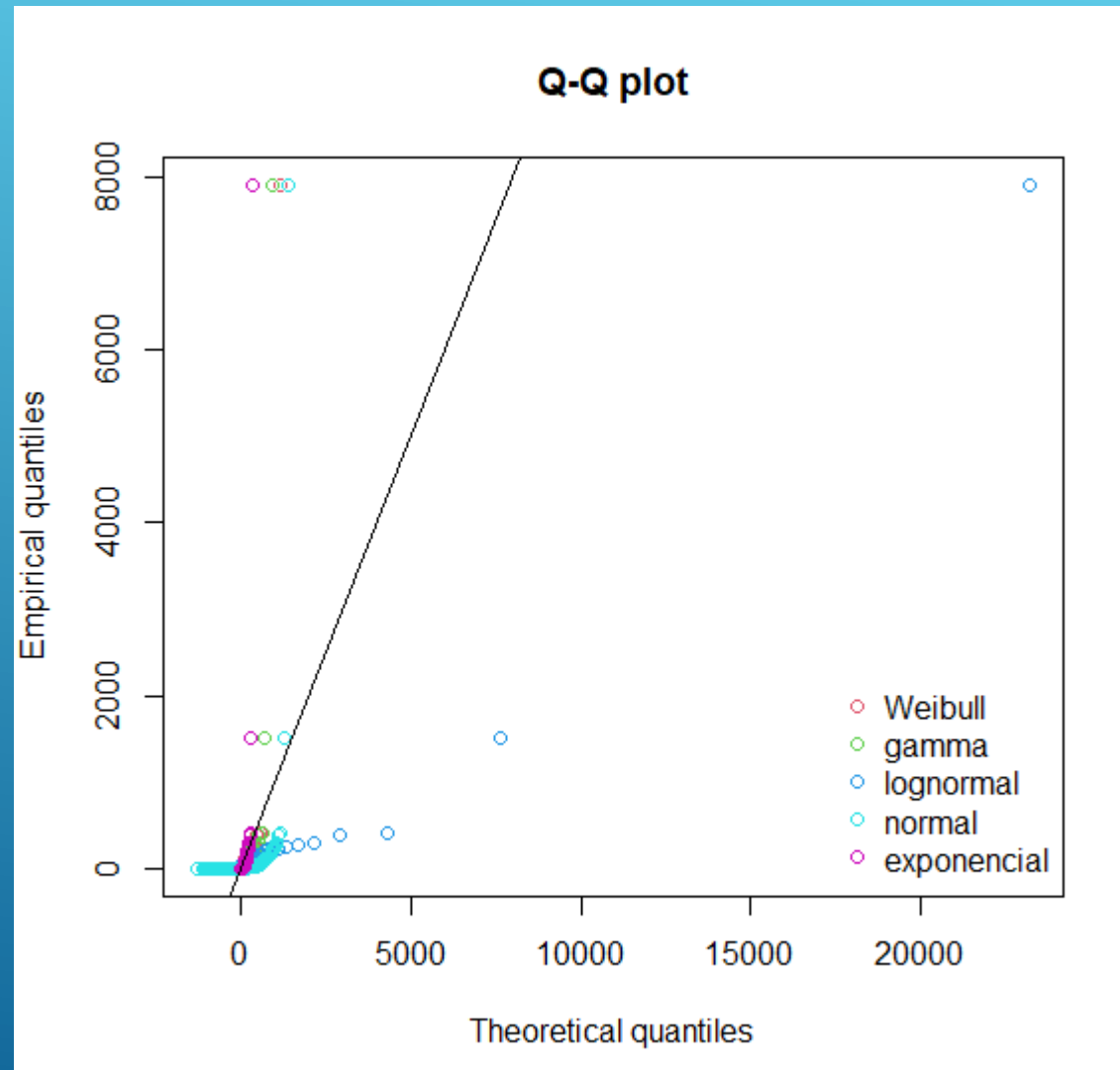
Fase Ativa	Contagem de Fase Ativa	Dopante ou Promotor	Contagem de Dopante ou Promotor	Suporte	Contagem de Suporte
Ni	241	none	176	Al ₂ O ₃	143
Ni Co	14	Zr	21	CeO ₂	42
Cu Ni	12	Gd	17	SiO ₂	16
Mo Ni	10	Ce	13	Hidrotalcita	15
Pt	8	Ca	11	Al ₂ O ₃ CeO ₂	13
Co	6	Pr	9	SBA-15	10
Pd	5	Ca Ce	8	MCM-41	8
Rh	4	V	8	HZSM-5	7
Ca Ni	1	Yb	8	MgO	7
K Ni	1	La	6	ZrO ₂	5
Mn Ni	1	Nb	5	BaTiO ₃ Al ₂ O ₃	4
Pt Ni	1	Mn Zr	4	La ₂ NiO ₄ γ-Al ₂ O ₃	4
Ru	1	K	3	TiO ₂	4
Sn Ni	1	Mn	3	Zeólita Silicalite	4
Total	306	Y	3	CeZrO ₂	3
		Ce Zr	2	MgO ZrO ₂	3
		Mg	2	TiO ₂ SiO ₂	3
		Sm	2	Zeólita-Y	3
		Sn	2	La _{0.8} Sr _{0.2} Ni _{0.8} Cu _{0.2} O ₃	2
		Co	1	ZSM	2
		Rh	1	γ-Al ₂ O ₃	2
		Rh La	1	AlSBA-15	1
		Total	306	BaTiO ₃	1
				CeSiO ₂ LaNiO ₃	1
				La _{0.8} Sr _{0.2} NiO ₃	1
				LaNiO ₃	1
				LaNiO ₃ Al ₂ O ₃	1
				Total	306

Empirical and theoretical CDFs



Histogram and theoretical densities





Taxa de formação de carbono (mg carbono/gcat.h)

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.06177092 0.1654709 0.1119505 0.4522119
Cramer-von Mises statistic 0.20396026 2.3608547 0.8445408 20.7823097
Anderson-Darling statistic 1.16311681 12.3812030 5.5486409      Inf

      exponencial
Kolmogorov-Smirnov statistic 0.5113819
Cramer-von Mises statistic 33.2031428
Anderson-Darling statistic      Inf

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 2073.013 2178.411 2112.983 4625.016
Bayesian Information Criterion 2080.460 2185.858 2120.431 4632.463

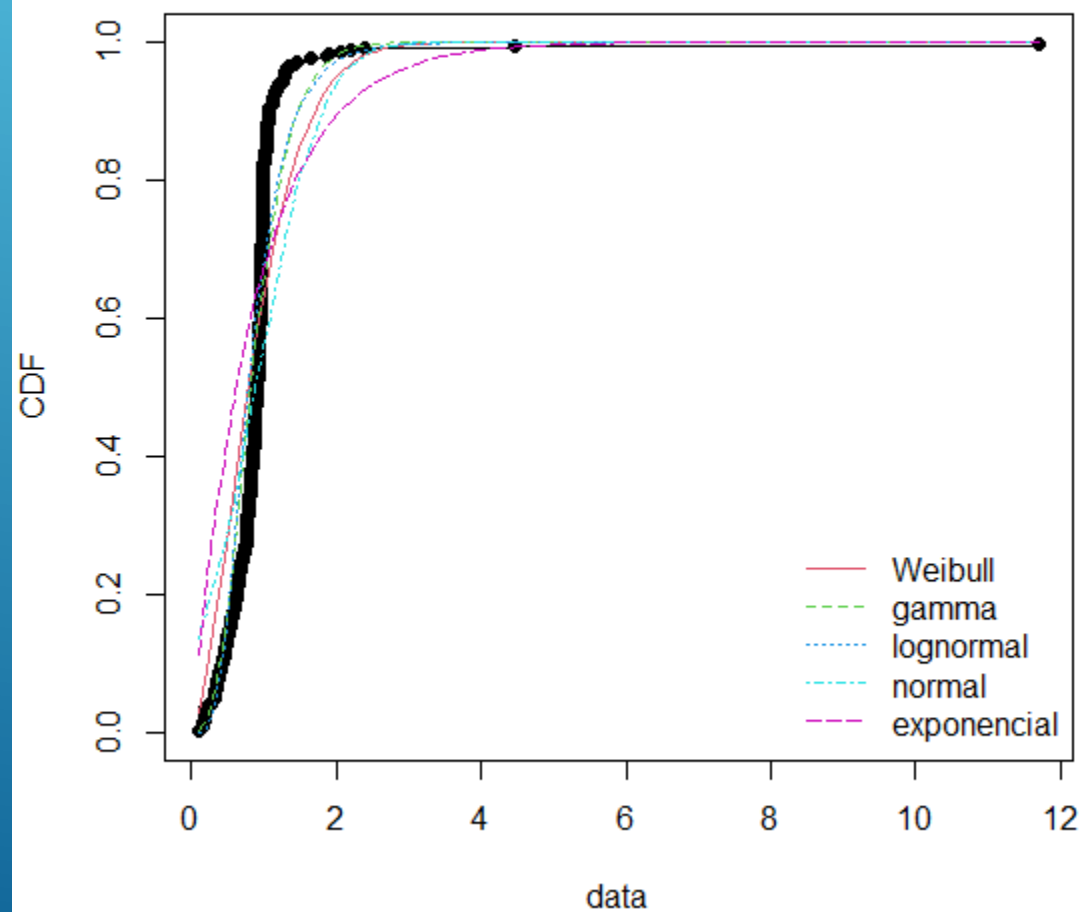
      exponencial
Akaike's Information Criterion 3069.408
Bayesian Information Criterion 3073.131
```

```
Hartigan's dip test for unimodality / multimodality

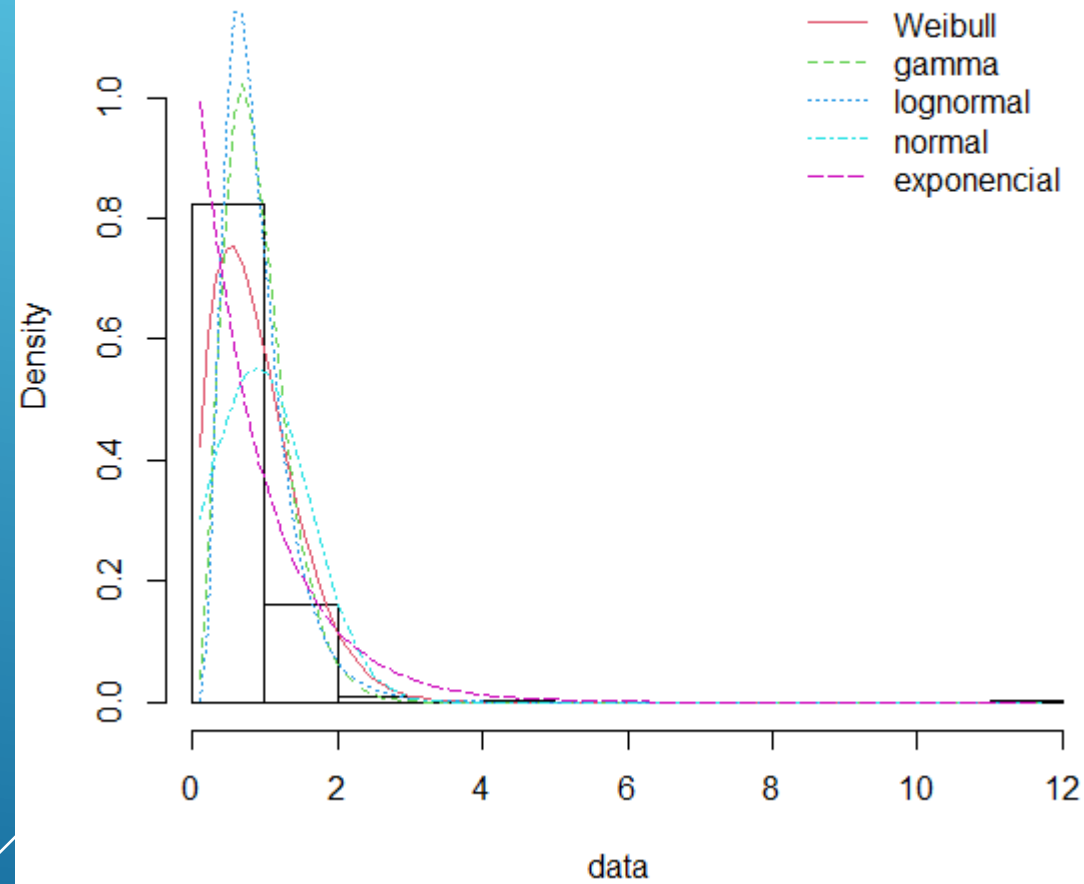
data: vari
D = 0.012353, p-value = 0.9926
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.9579104
```

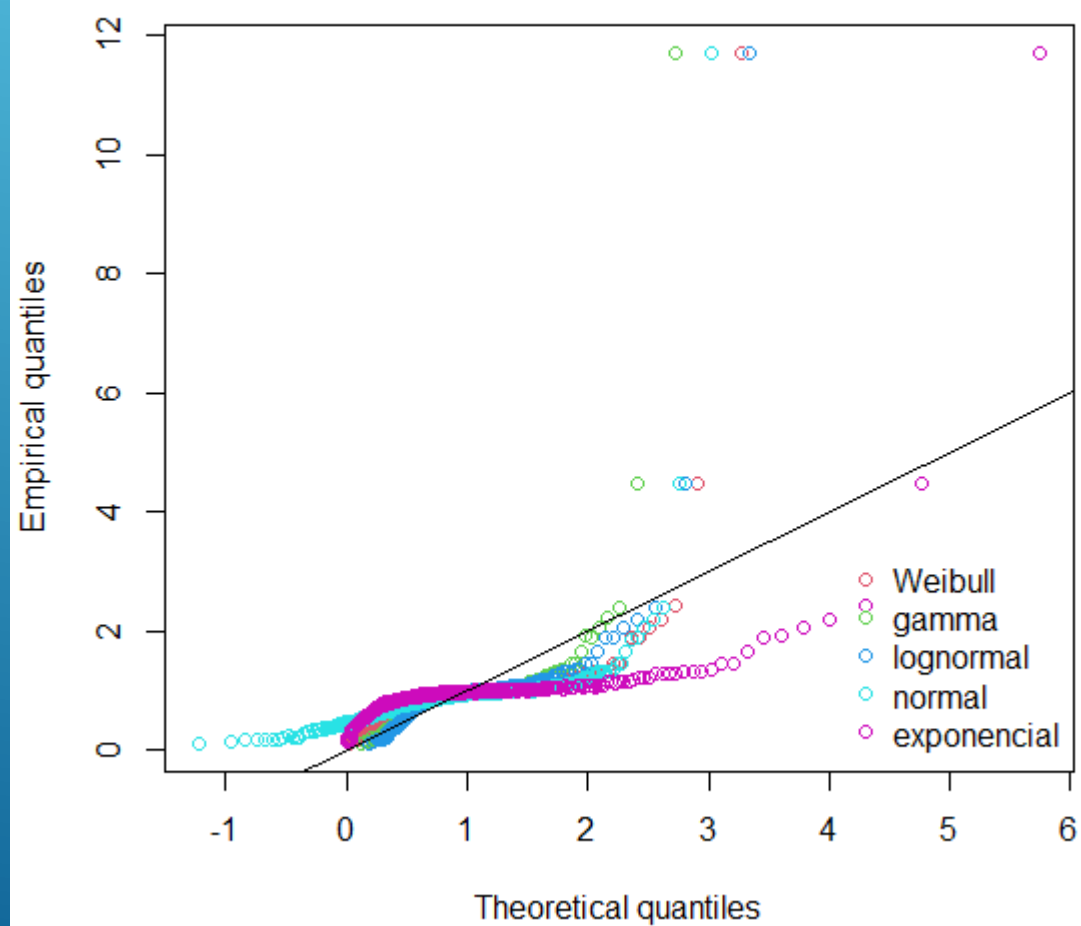
Empirical and theoretical CDFs



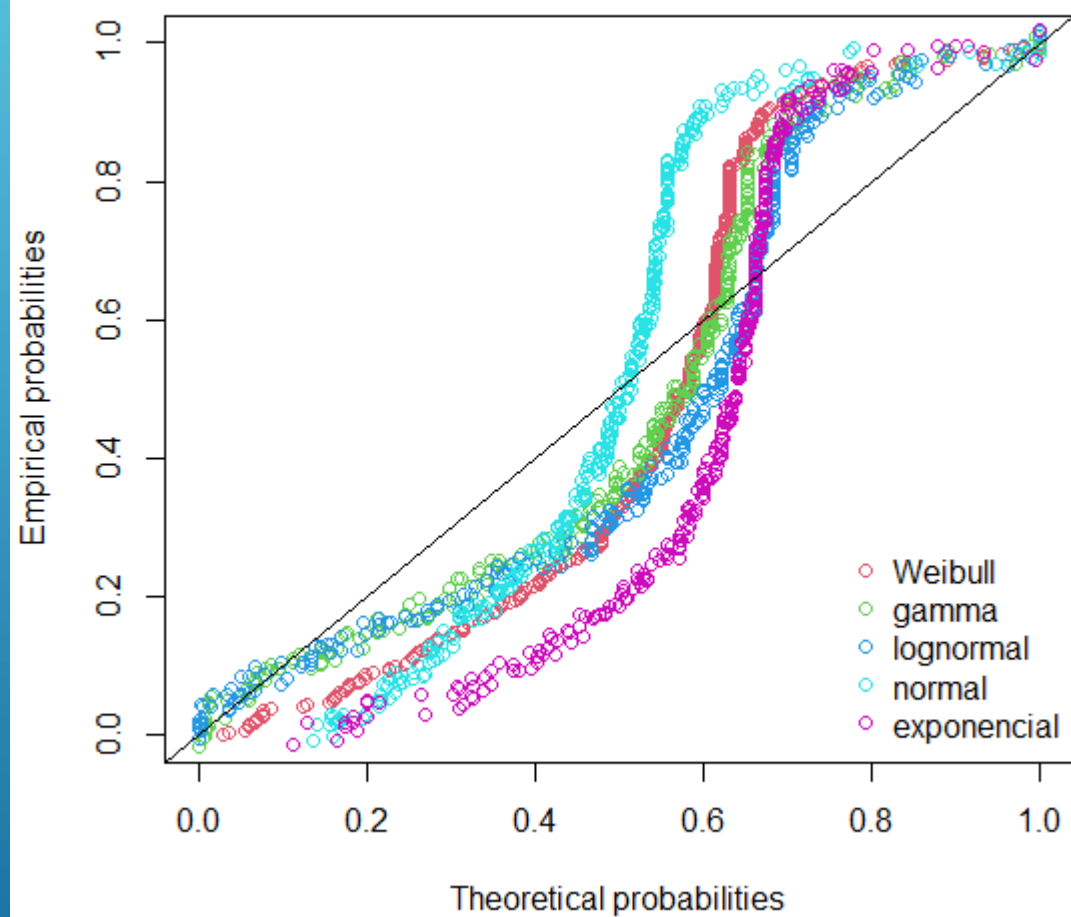
Histogram and theoretical densities



Q-Q plot



P-P plot



Fator de estabilidade

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2301158	0.195361	0.1916501	0.3049083
Cramer-von Mises statistic	5.9842909	3.378380	3.7592933	8.0476138
Anderson-Darling statistic	Inf	Inf	19.4677684	Inf

```
exponencial
```

Kolmogorov-Smirnov statistic	0.3066209
Cramer-von Mises statistic	11.9389112
Anderson-Darling statistic	58.7569583

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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	422.7155	313.0446	292.1210	671.7404
Bayesian Information Criterion	430.1627	320.4917	299.5682	679.1875

```
exponencial
```

Akaike's Information Criterion	546.7524
Bayesian Information Criterion	550.4760

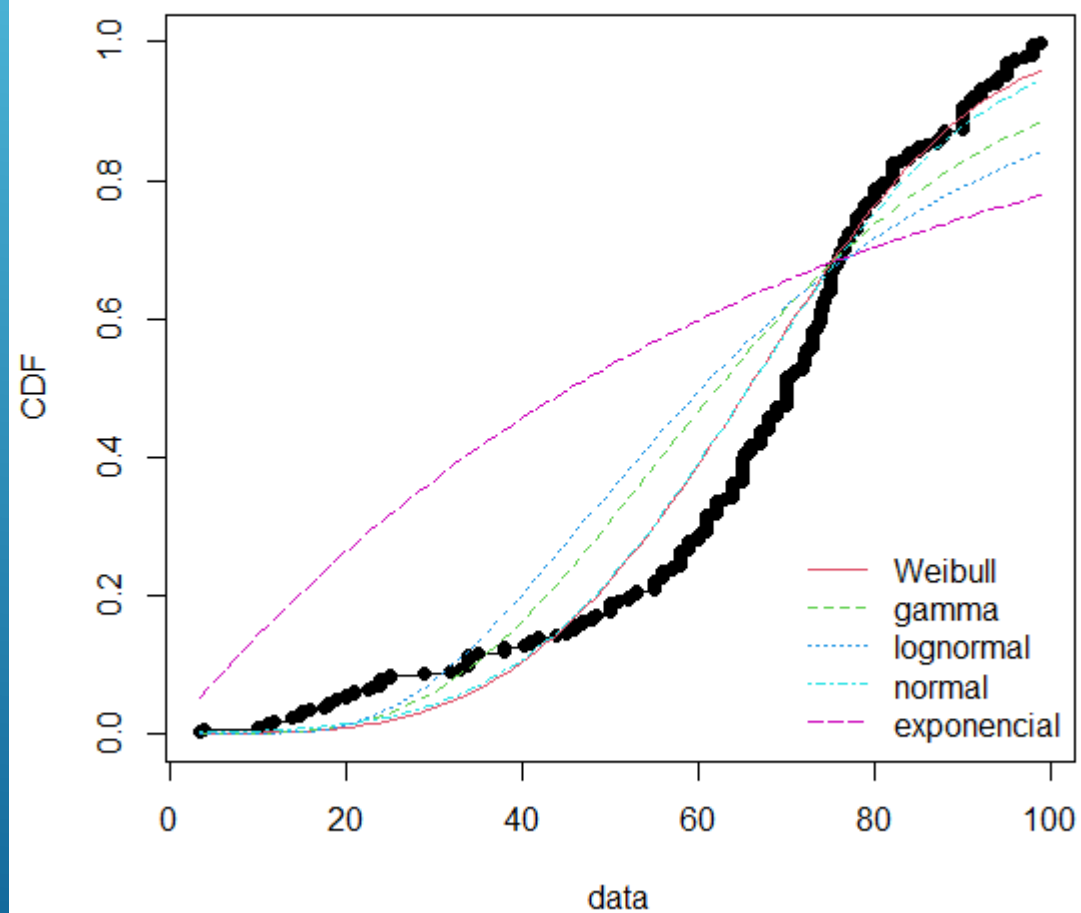
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.032704, p-value = 0.02062
alternative hypothesis: non-unimodal, i.e., at least bimodal

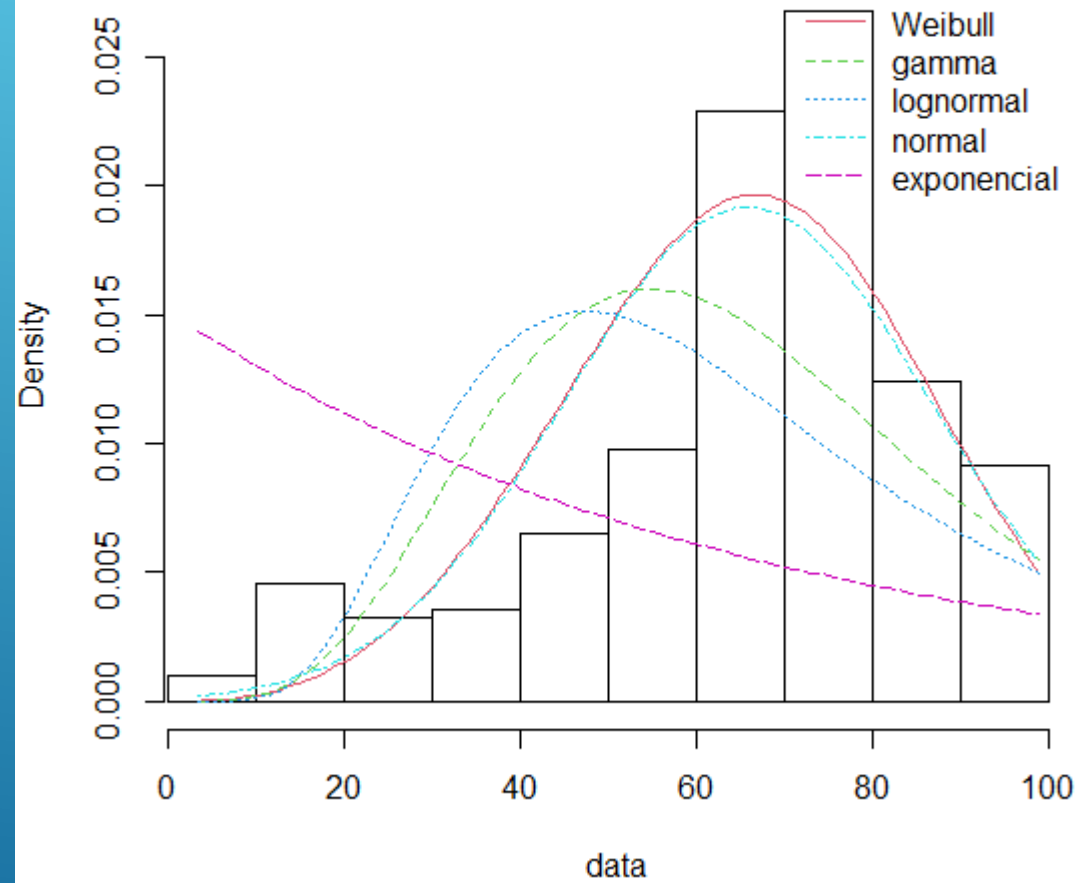
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.7827691
```

Conversão inicial de CH₄ (%)

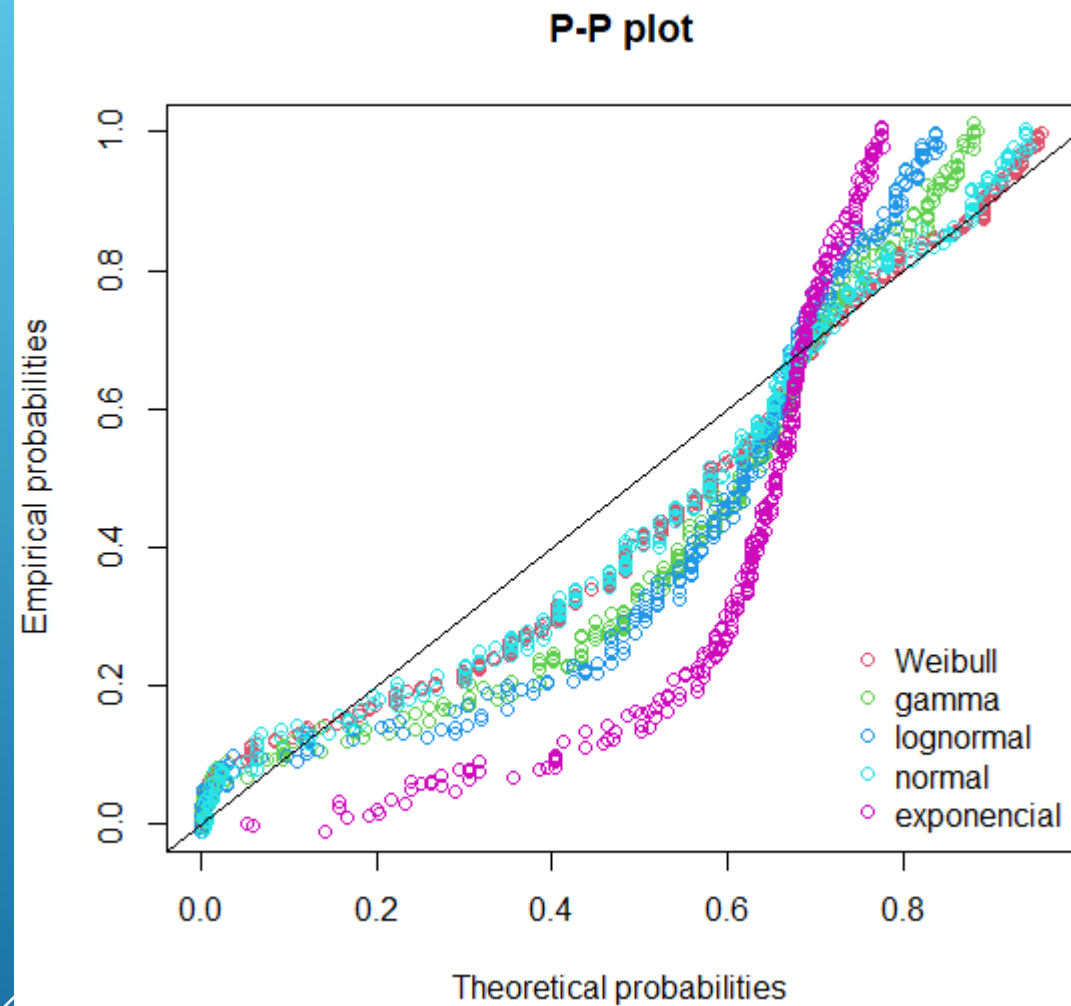
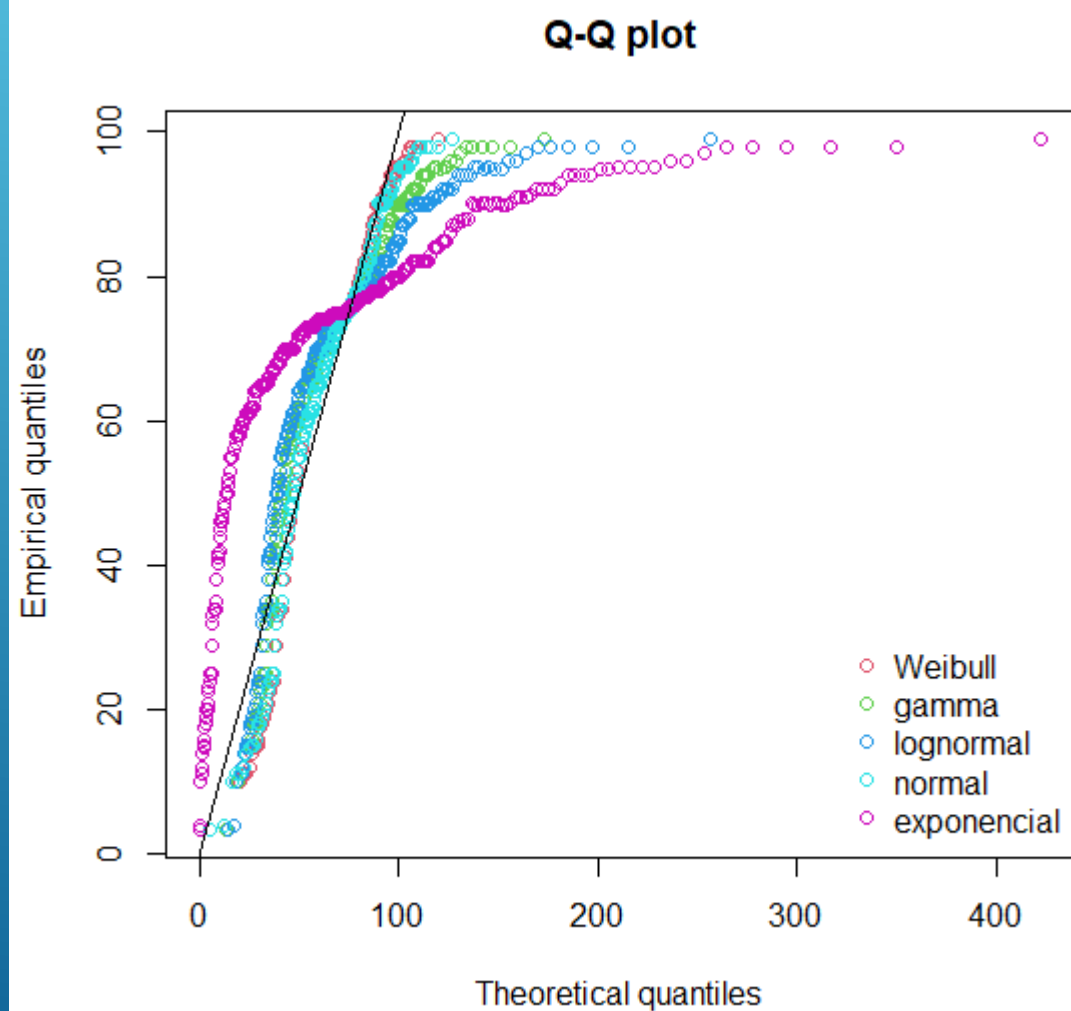
Empirical and theoretical CDFs



Histogram and theoretical densities



Conversão inicial de CH₄ (%)



Conversão inicial de CH4 (%)

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.1246077 0.1917663 0.2244336 0.1245776
Cramer-von Mises statistic  1.1959788 3.3834576 4.7612996 1.2007844
Anderson-Darling statistic  7.9511102 18.5756588 25.6212840 7.2497750

      exponencial
Kolmogorov-Smirnov statistic 0.3603149
Cramer-von Mises statistic  13.7234724
Anderson-Darling statistic  66.5167504

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 2738.411 2850.591 2948.493 2729.486
Bayesian Information Criterion 2745.858 2858.038 2955.940 2736.933

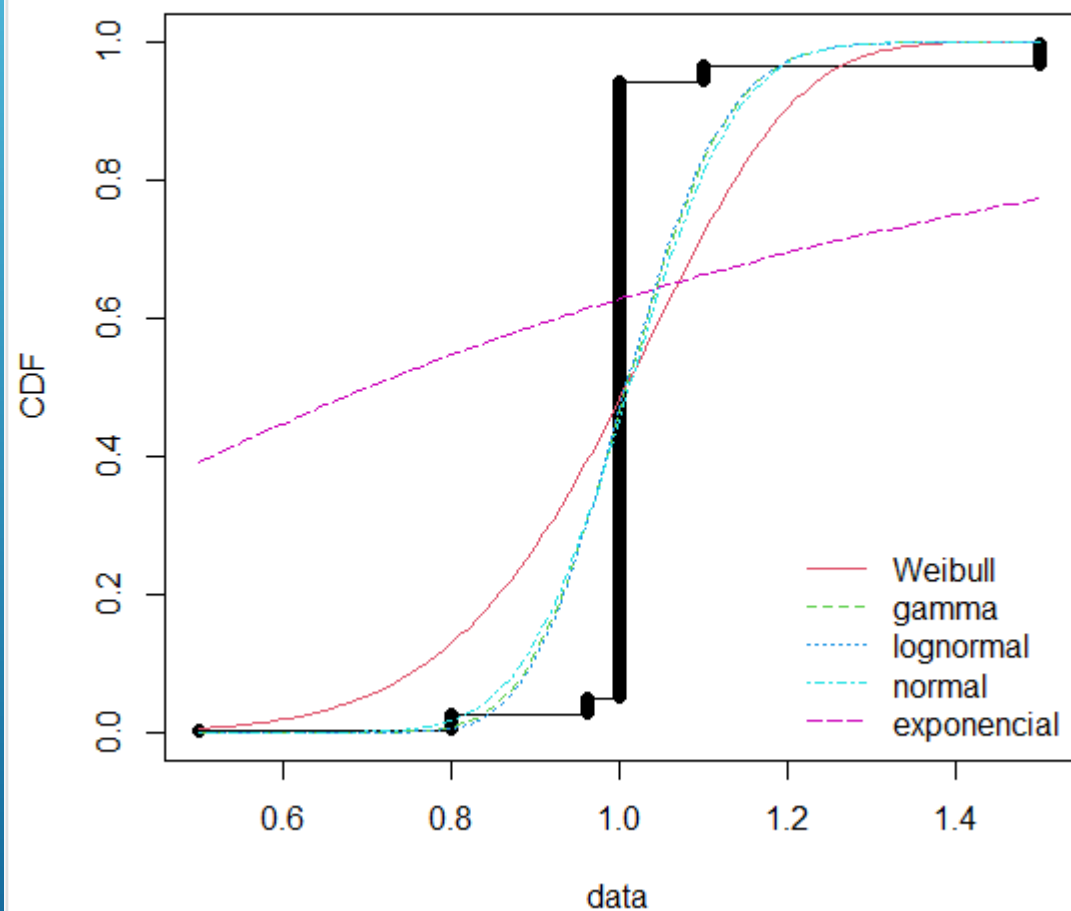
      exponencial
Akaike's Information Criterion 3176.725
Bayesian Information Criterion 3180.448
```

```
Hartigan's dip test for unimodality / multimodality

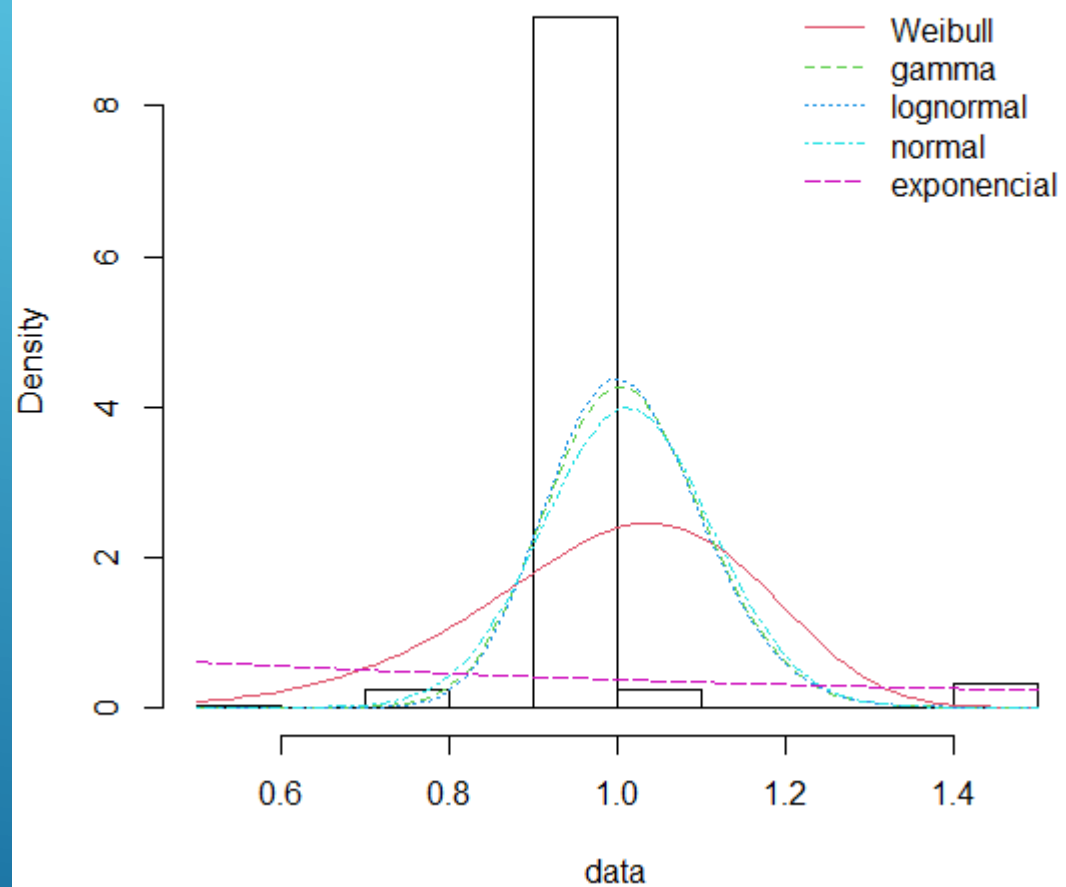
data: vari
D = 0.021368, p-value = 0.4522
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.5322984
```

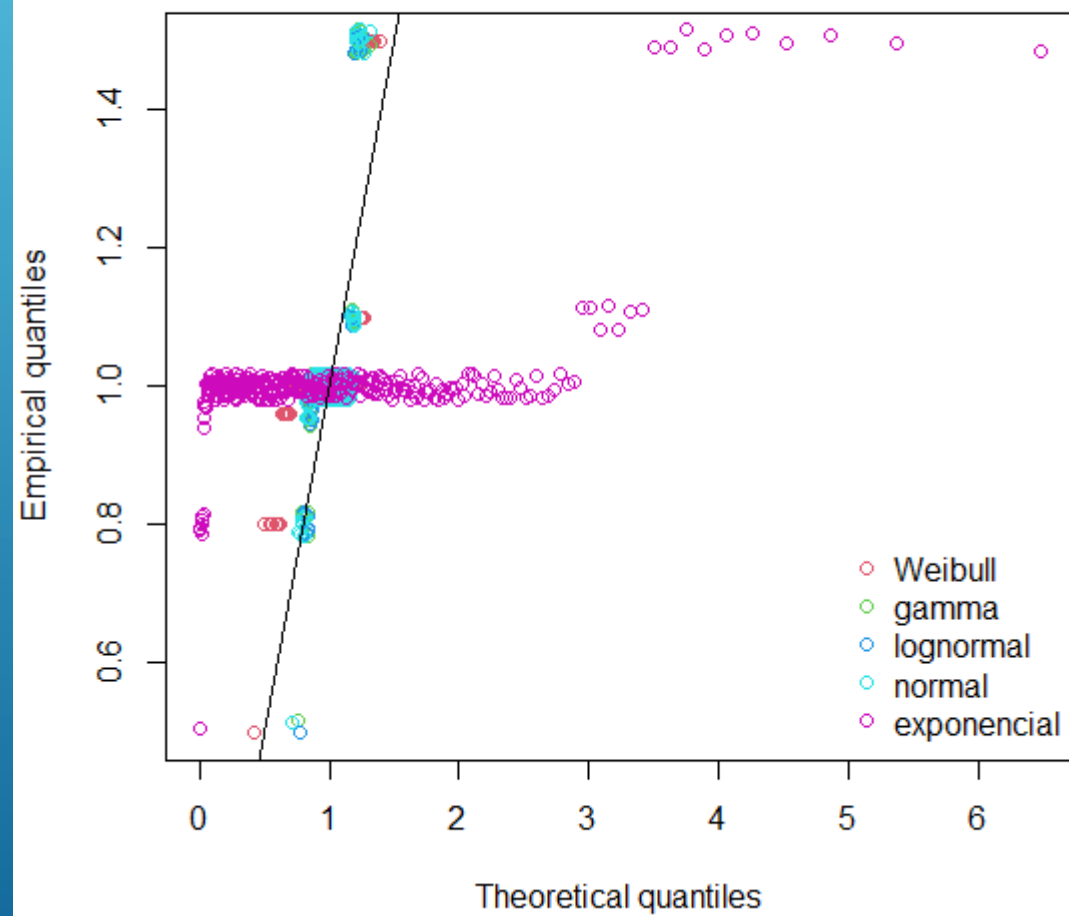
Empirical and theoretical CDFs



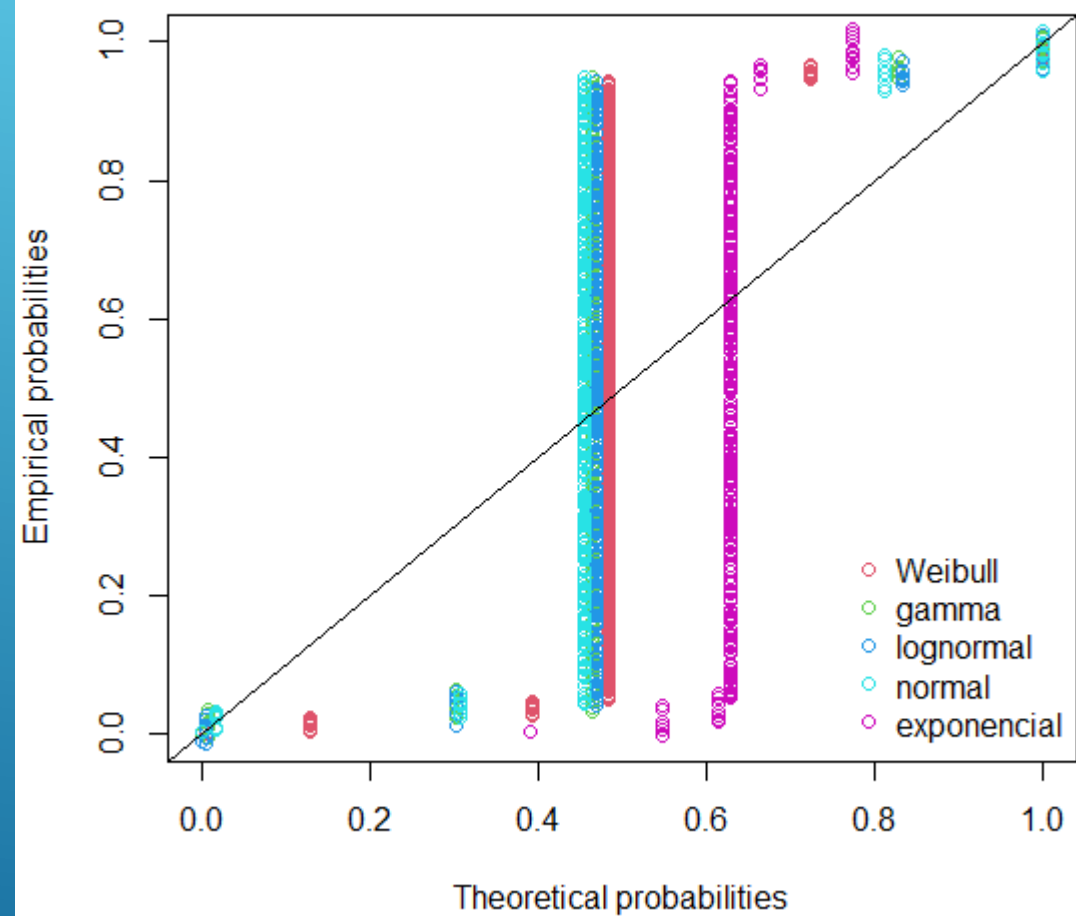
Histogram and theoretical densities



Q-Q plot



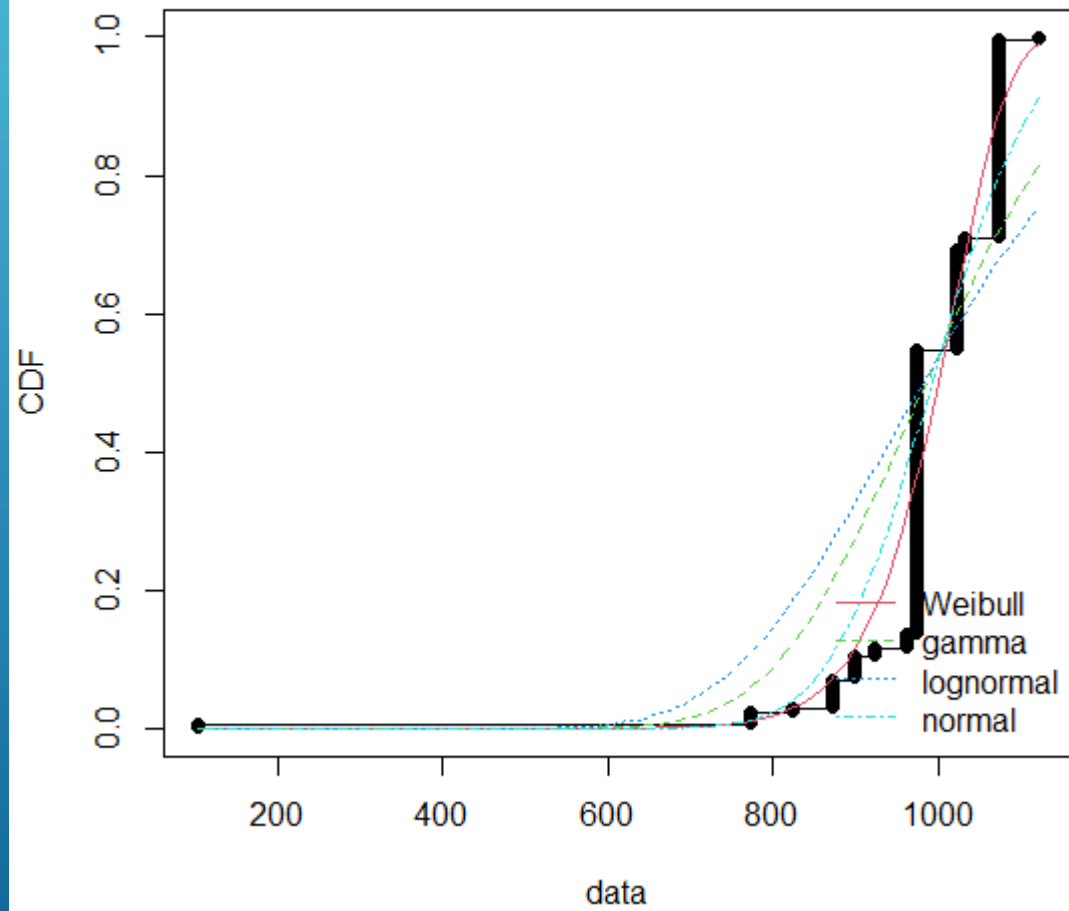
P-P plot



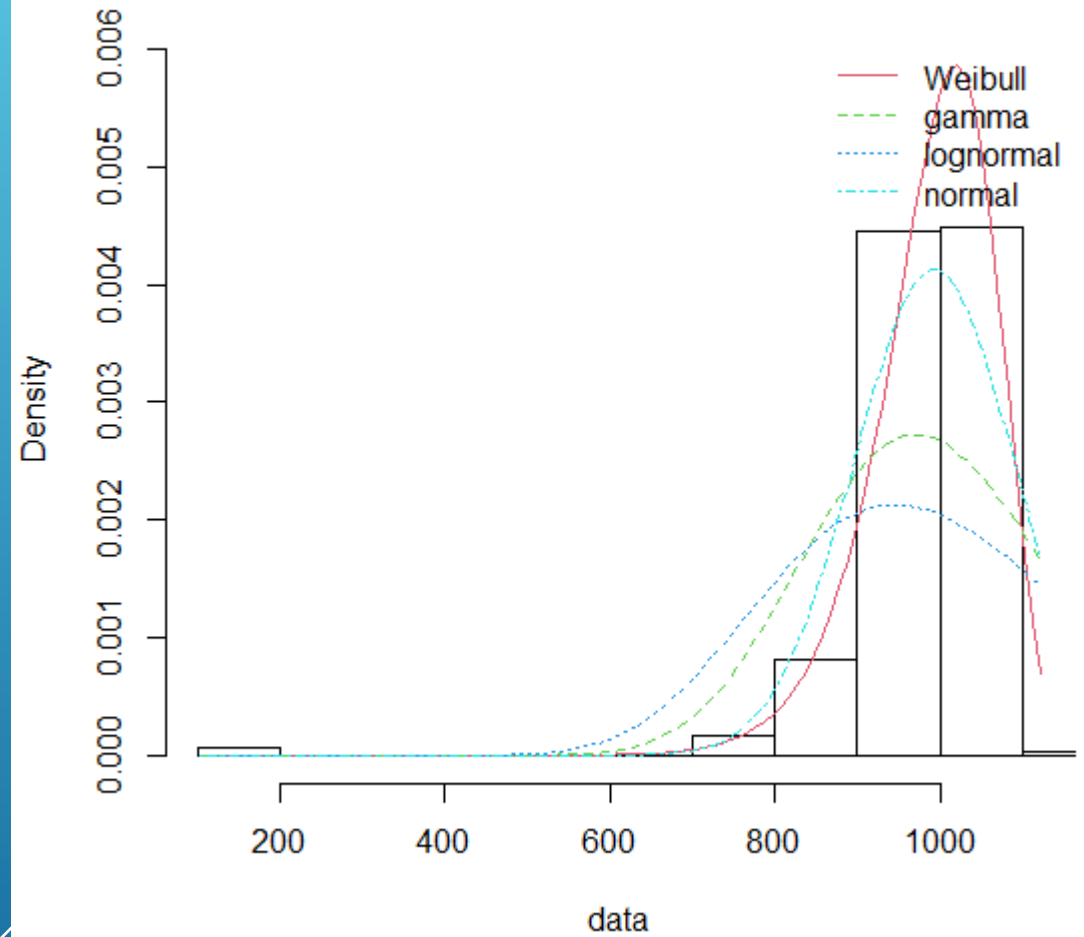
Razão molar CH₄/CO₂ na alimentação

```
Hartigans' dip test for unimodality / multimodality  
  
data: vari  
D = 0.01634, p-value = 0.8831  
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] 0.5122344
```

Empirical and theoretical CDFs

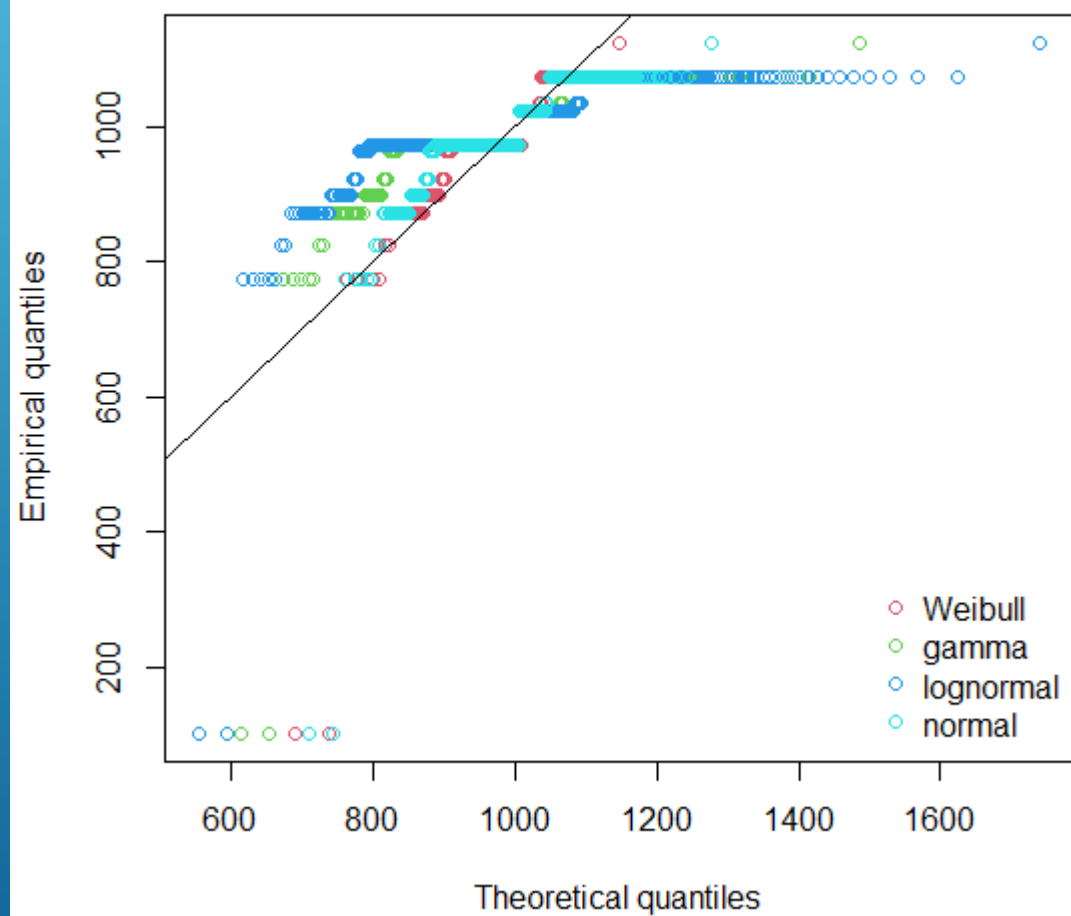


Histogram and theoretical densities

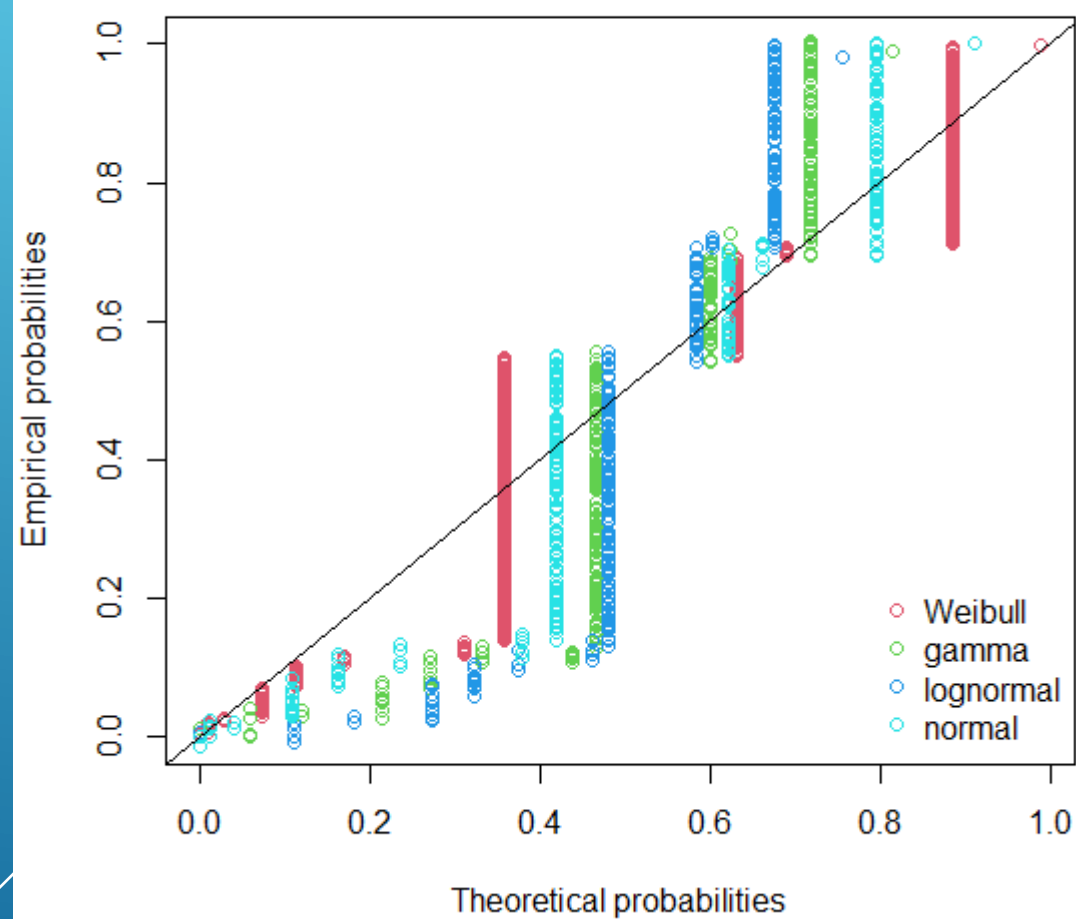


Temperatura de reação (K)

Q-Q plot



P-P plot



Temperatura de reação (K)

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.219364	0.3287802	0.344039	0.2811269
Cramer-von Mises statistic	2.817238	7.5347235	10.038840	4.0185285
Anderson-Darling statistic	16.757915	41.2495911	53.324703	22.8882532

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	3534.821	3926.071	4087.402	3670.557
Bayesian Information Criterion	3542.268	3933.519	4094.849	3678.004

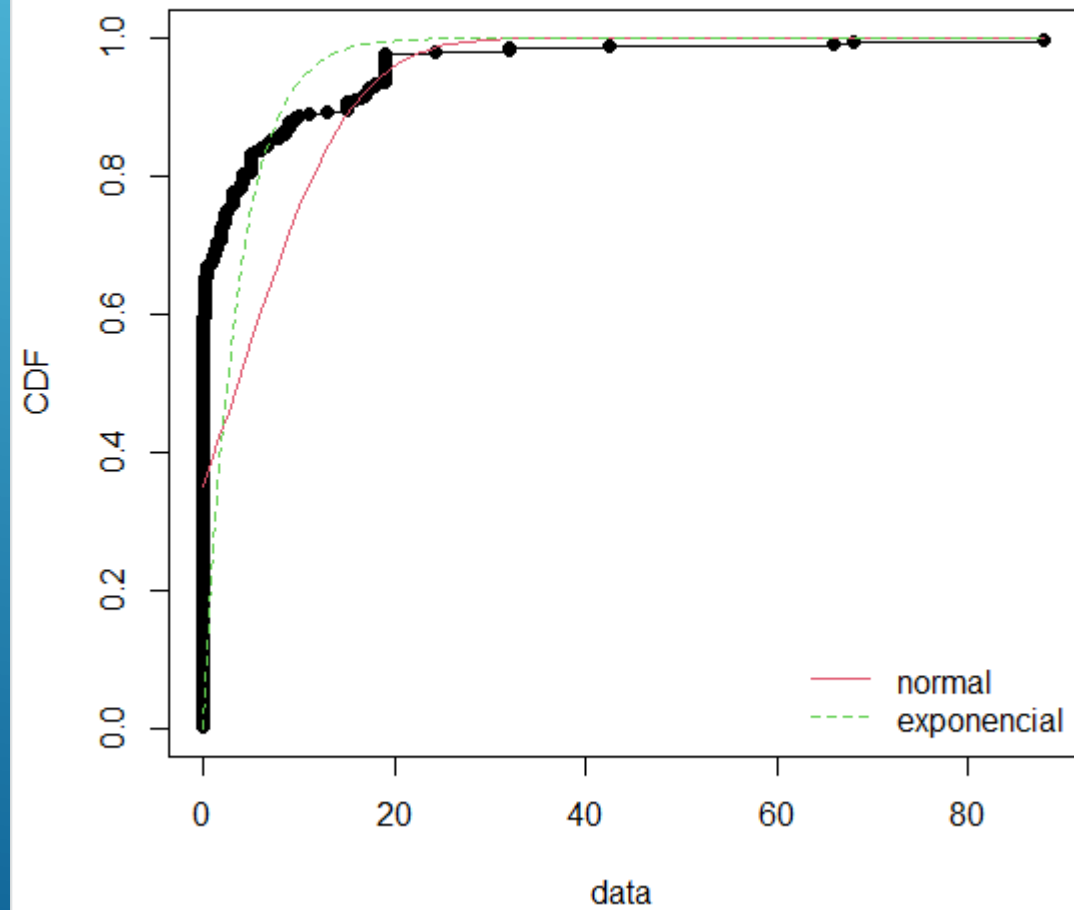
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.14379, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

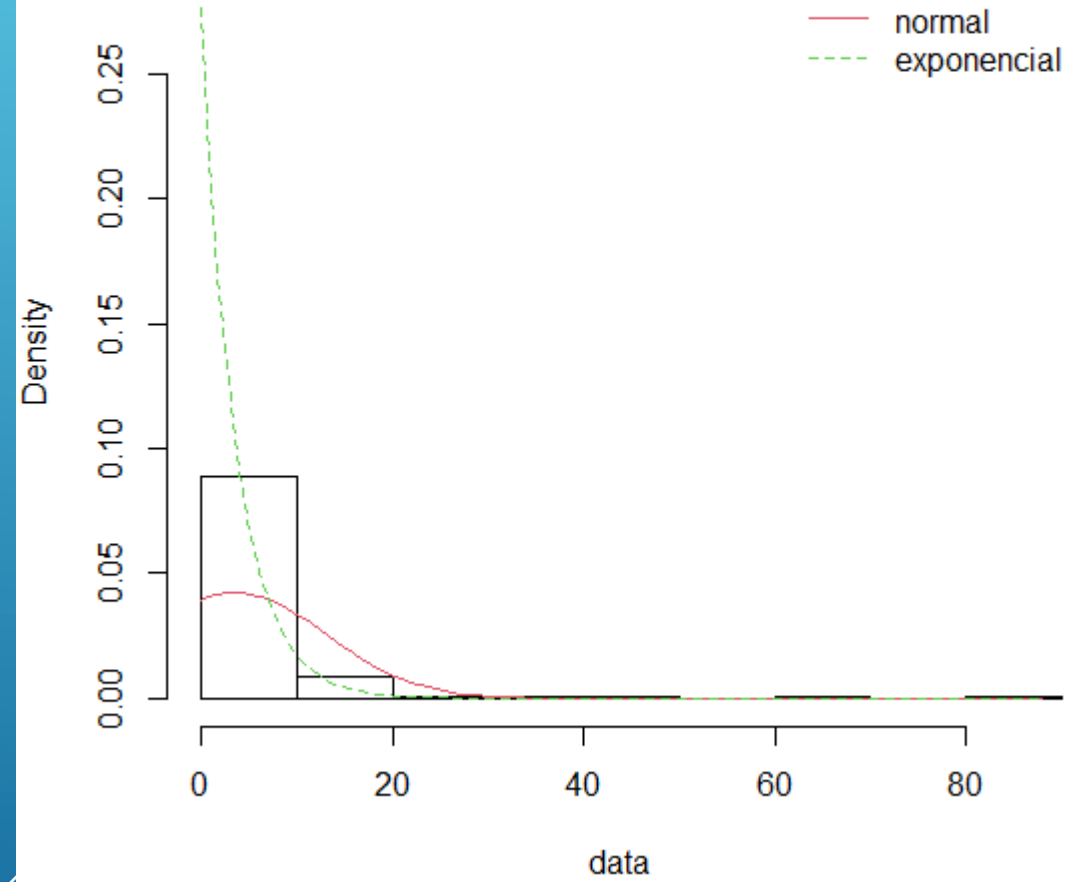
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.5981386
```

Concentração de Dopante ou Promotor

Empirical and theoretical CDFs

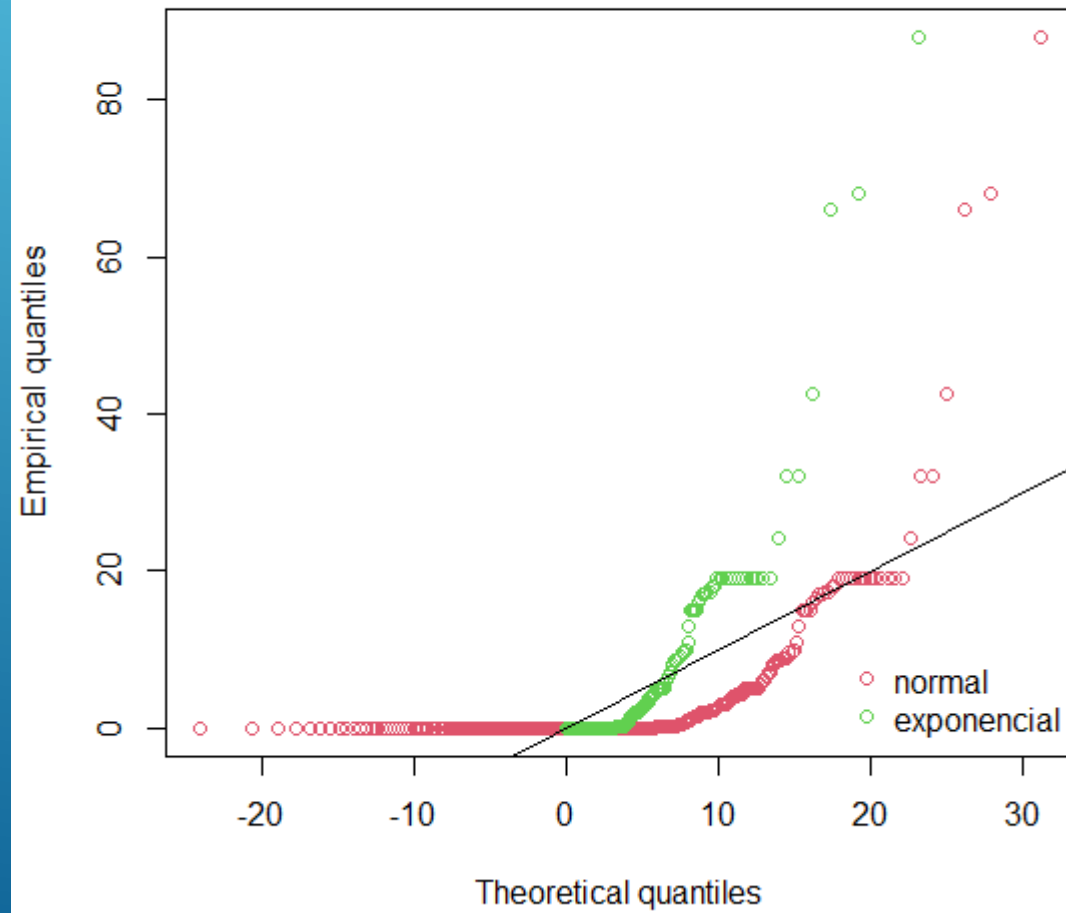


Histogram and theoretical densities

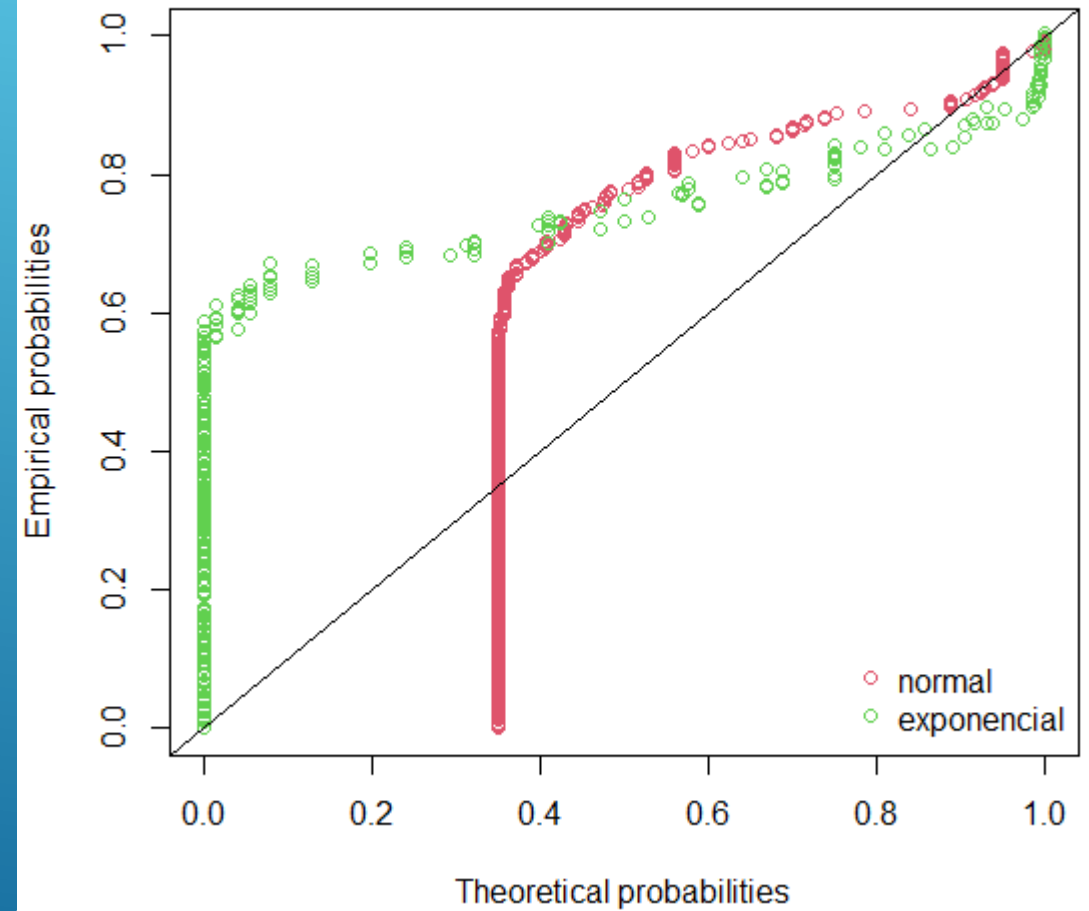


Concentração de Dopante ou Promotor

Q-Q plot



P-P plot



Concentração de Dopante ou Promotor

```
Goodness-of-fit statistics
              normal  exponencial
Kolmogorov-Smirnov statistic  0.3500228  0.5810569
Cramer-von Mises statistic   12.1781102  32.2205465
Anderson-Darling statistic      Inf      Inf

Goodness-of-fit criteria
              normal  exponencial
Akaike's Information Criterion 2243.589  1401.449
Bayesian Information Criterion 2251.037  1405.173
```

```
Hartigans' dip test for unimodality / multimodality

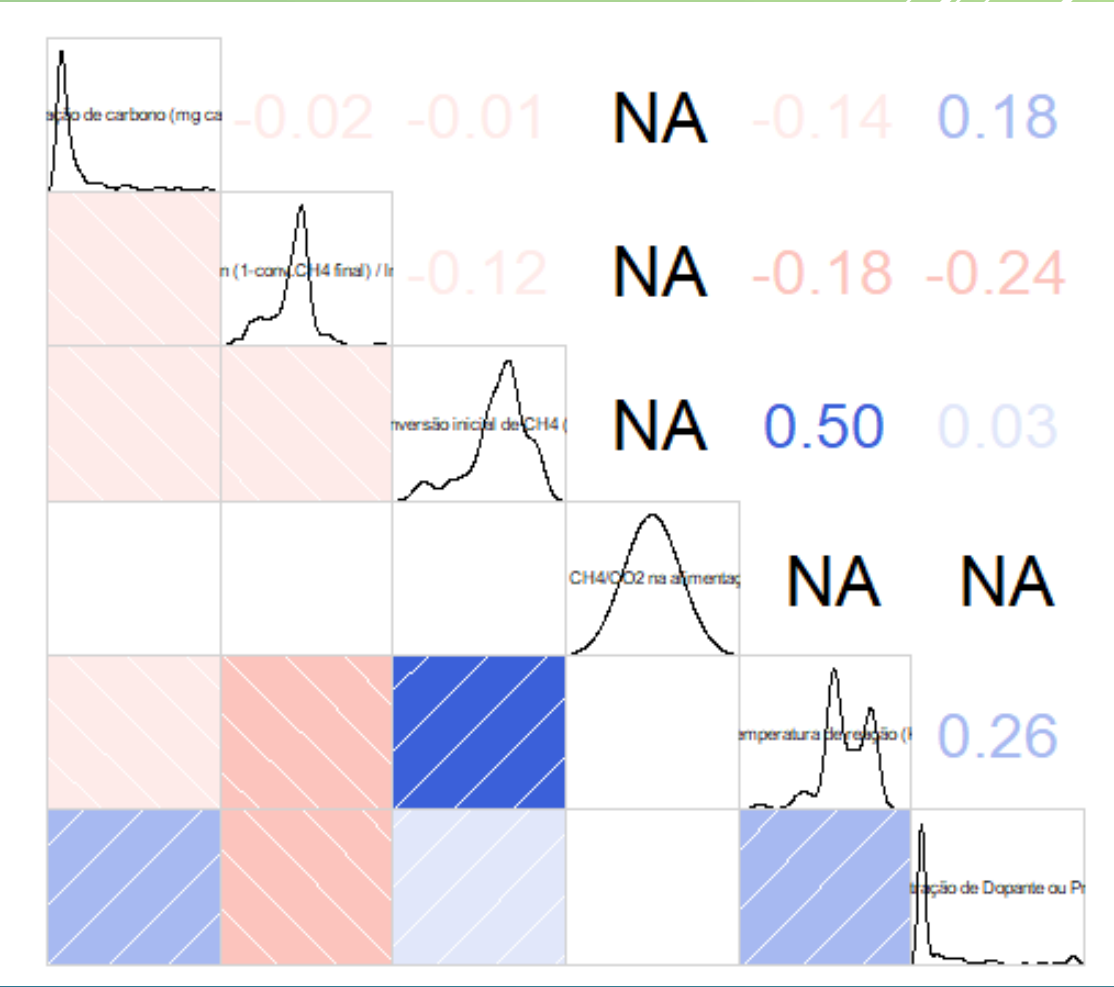
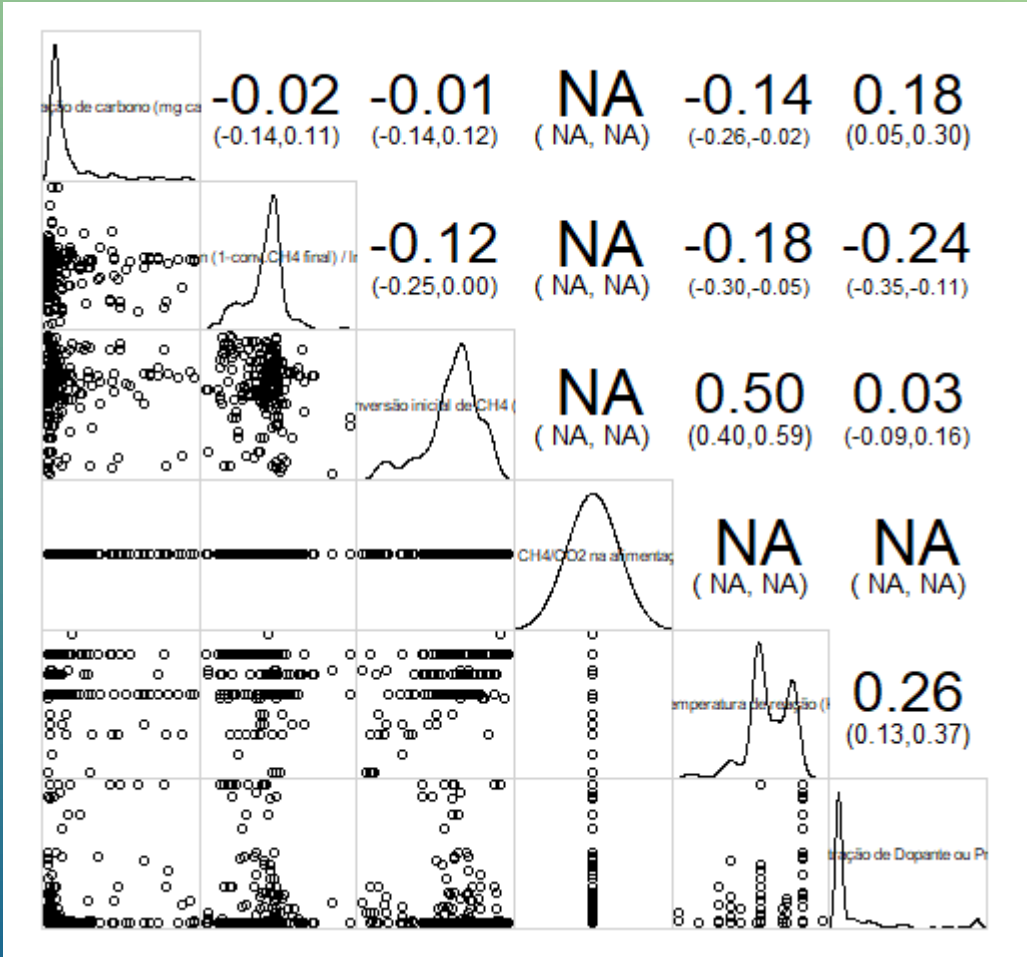
data: vari
D = 0.021381, p-value = 0.451
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.7227334
```

Retirando os dados pouco relevantes

▶ database

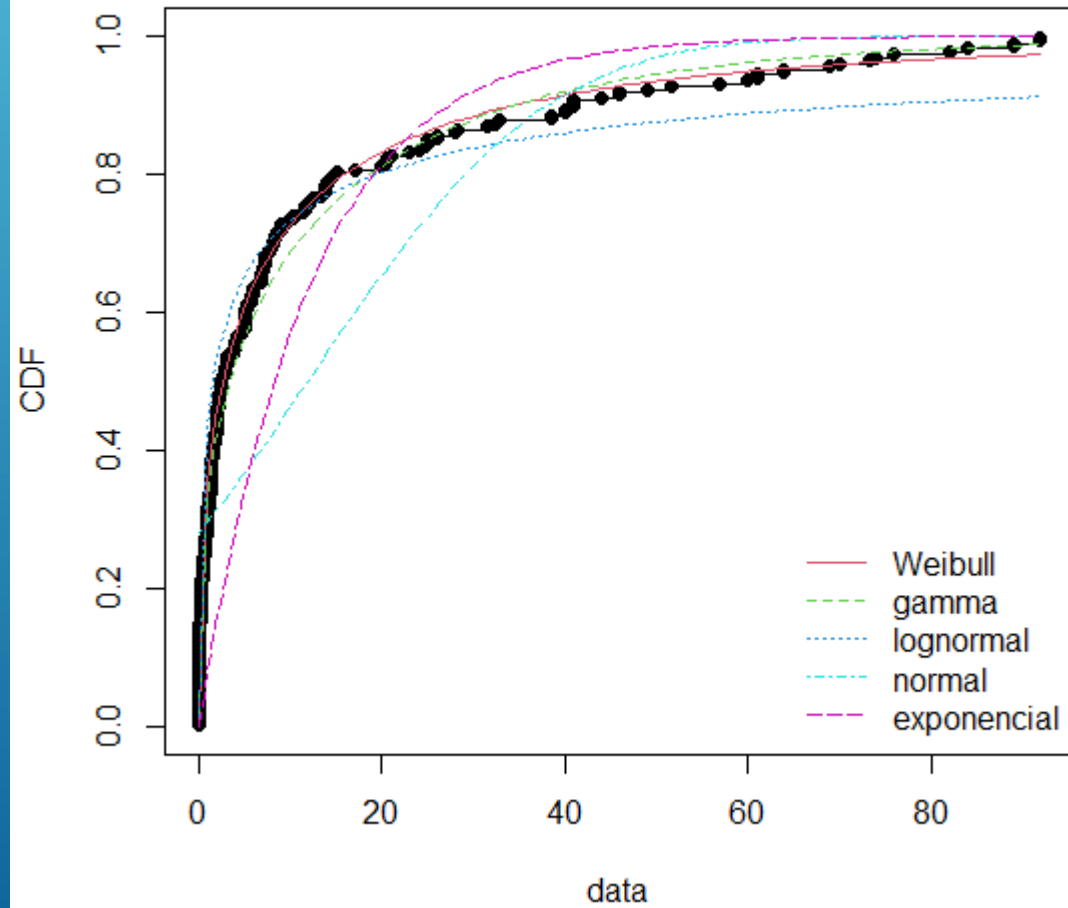
240 obs. of 20 variables



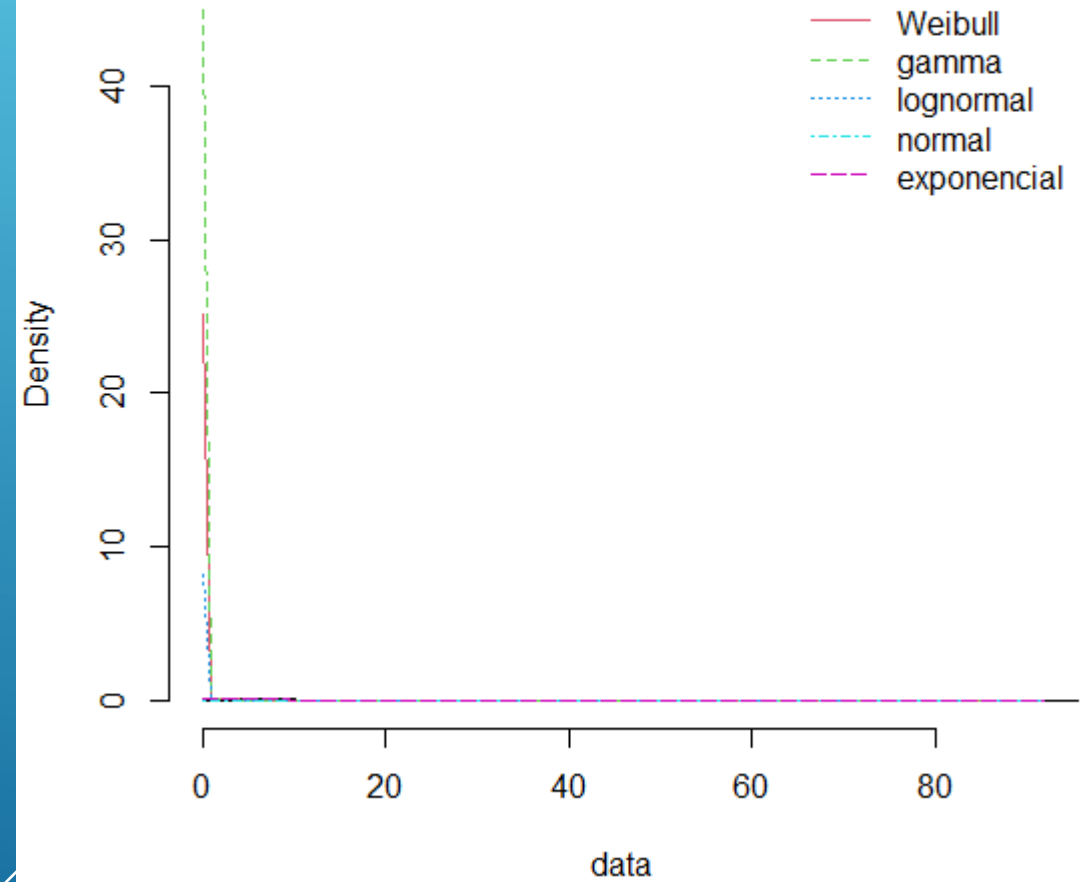
Fase Ativa	Contagem de Fase Ativa	Dopante ou Promotor	Contagem de Dopante ou Promotor	Suporte	Contagem de Suporte
Ni	189	none	145	Al ₂ O ₃	115
Ni Co	11	Gd	16	CeO ₂	30
Cu Ni	9	Ca	10	Al ₂ O ₃ CeO ₂	13
Pt	8	Ca Ce	8	SiO ₂	9
Co	5	Ce	8	Hidrotalcita	8
Mo Ni	4	Yb	8	MCM-41	8
Pd	4	V	7	SBA-15	8
Rh	4	Zr	7	HZSM-5	7
Ca Ni	1	Nb	5	MgO	7
K Ni	1	Pr	5	BaTiO ₃ Al ₂ O ₃	4
Mn Ni	1	K	3	TiO ₂	4
Pt Ni	1	La	3	CeZrO ₂	3
Ru	1	Mn	3	La ₂ NiO ₄ γ-Al ₂ O ₃	3
Sn Ni	1	Mn Zr	3	MgO ZrO ₂	3
Total	240	Y	3	TiO ₂ SiO ₂	3
		Sm	2	Zeólita Silicalite	3
		Sn	2	Zeólita-Y	3
		Co	1	ZrO ₂	2
		Mg	1	ZSM	2
		Total	240	AlSBA-15	1
				BaTiO ₃	1
				CeSiO ₂ LaNiO ₃	1
				La _{0.8} Sr _{0.2} NiO ₃	1
				γ-Al ₂ O ₃	1
				Total	240

Taxa de formação de carbono

Empirical and theoretical CDFs

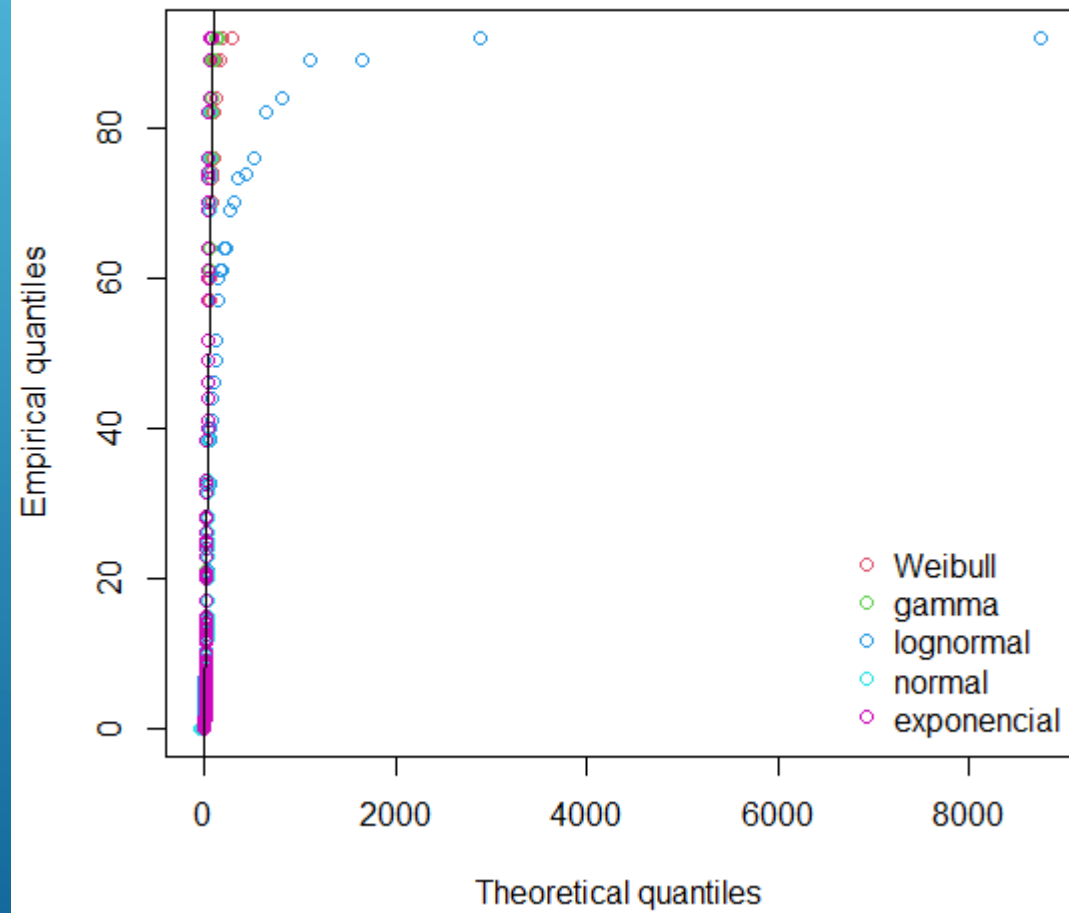


Histogram and theoretical densities

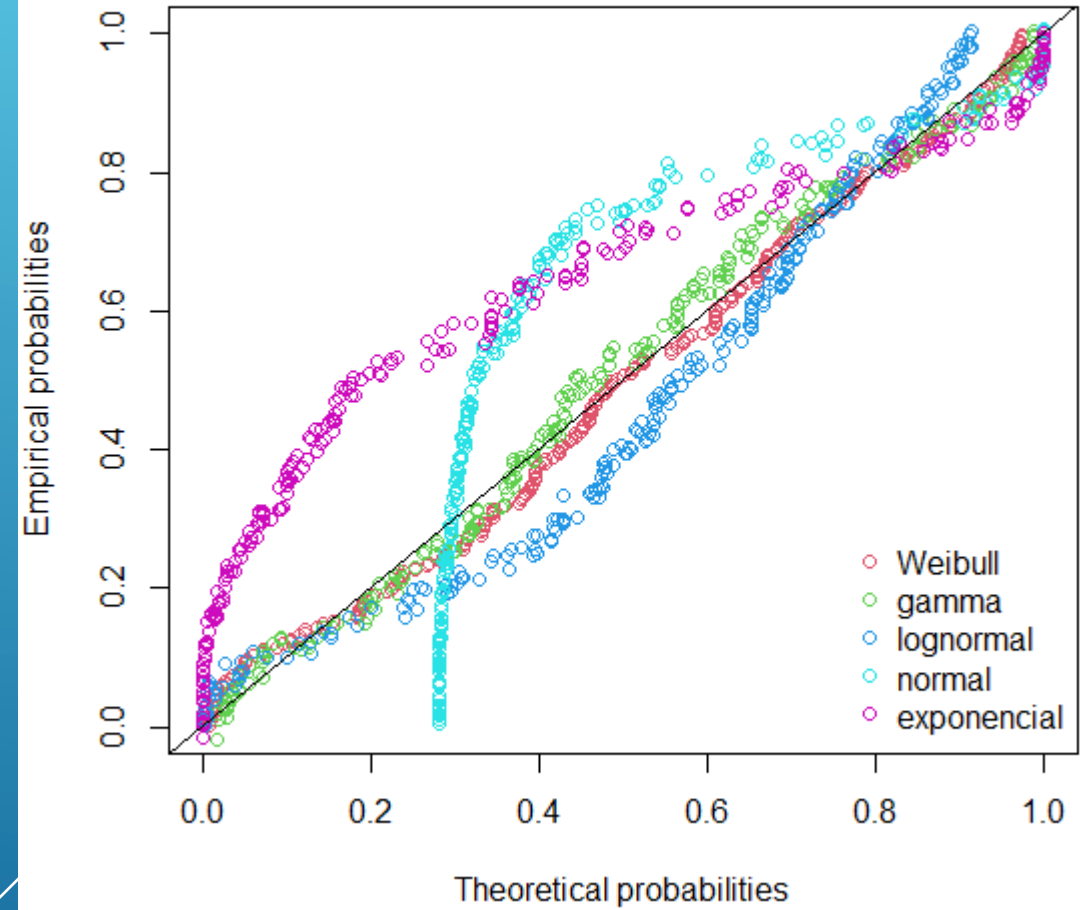


Taxa de formação de carbono

Q-Q plot



P-P plot



Taxa de formação de carbono

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.0563756	0.06437021	0.1396731	0.2872047
Cramer-von Mises statistic	0.1295387	0.19772120	1.1963083	6.8286766
Anderson-Darling statistic	1.2576023	1.17193942	7.5193942	35.2827118

	exponencial
Kolmogorov-Smirnov statistic	0.3188731
Cramer-von Mises statistic	8.9020293
Anderson-Darling statistic	78.9131966

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1351.644	1345.627	1420.620	2133.674
Bayesian Information Criterion	1358.605	1352.588	1427.582	2140.635

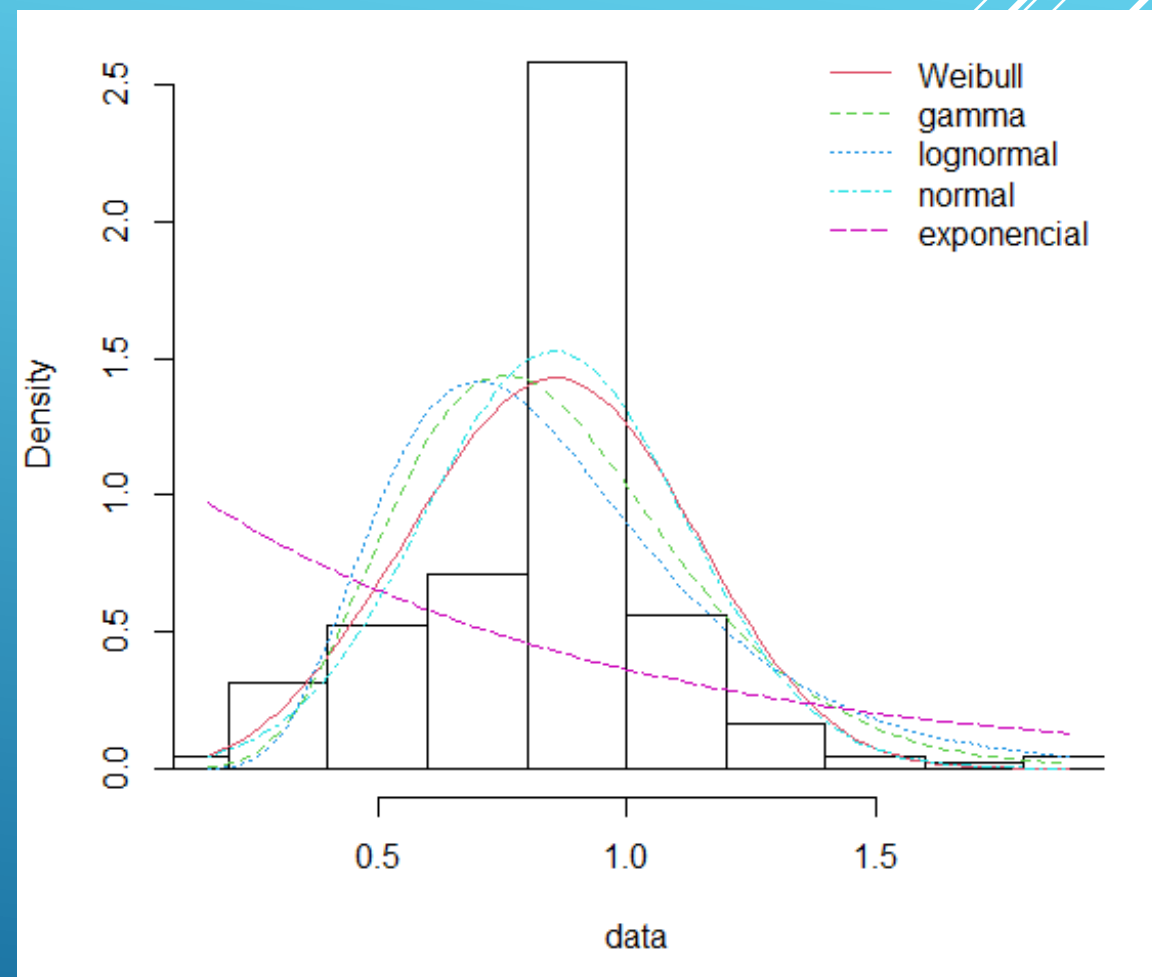
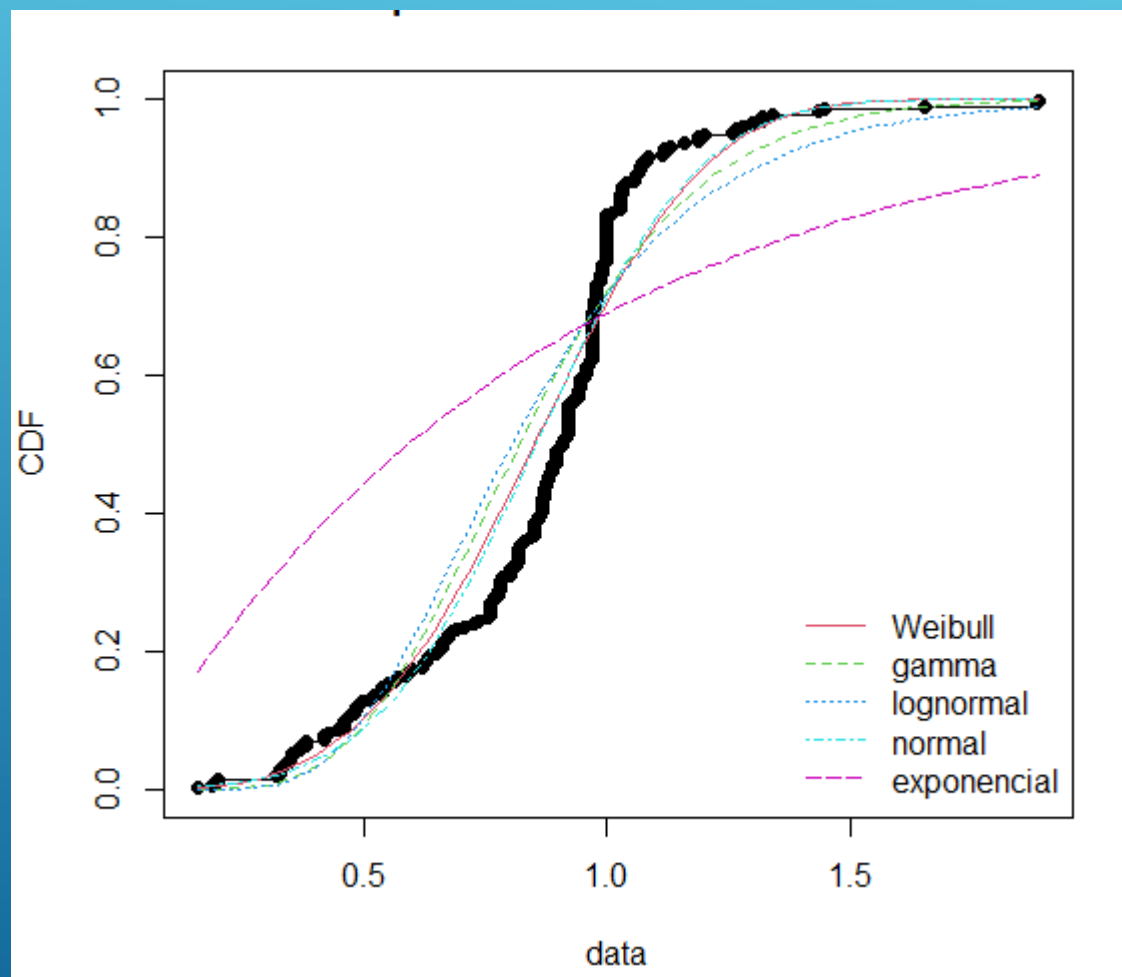
	exponencial
Akaike's Information Criterion	1670.146
Bayesian Information Criterion	1673.627

Hartigans' dip test for unimodality / multimodality

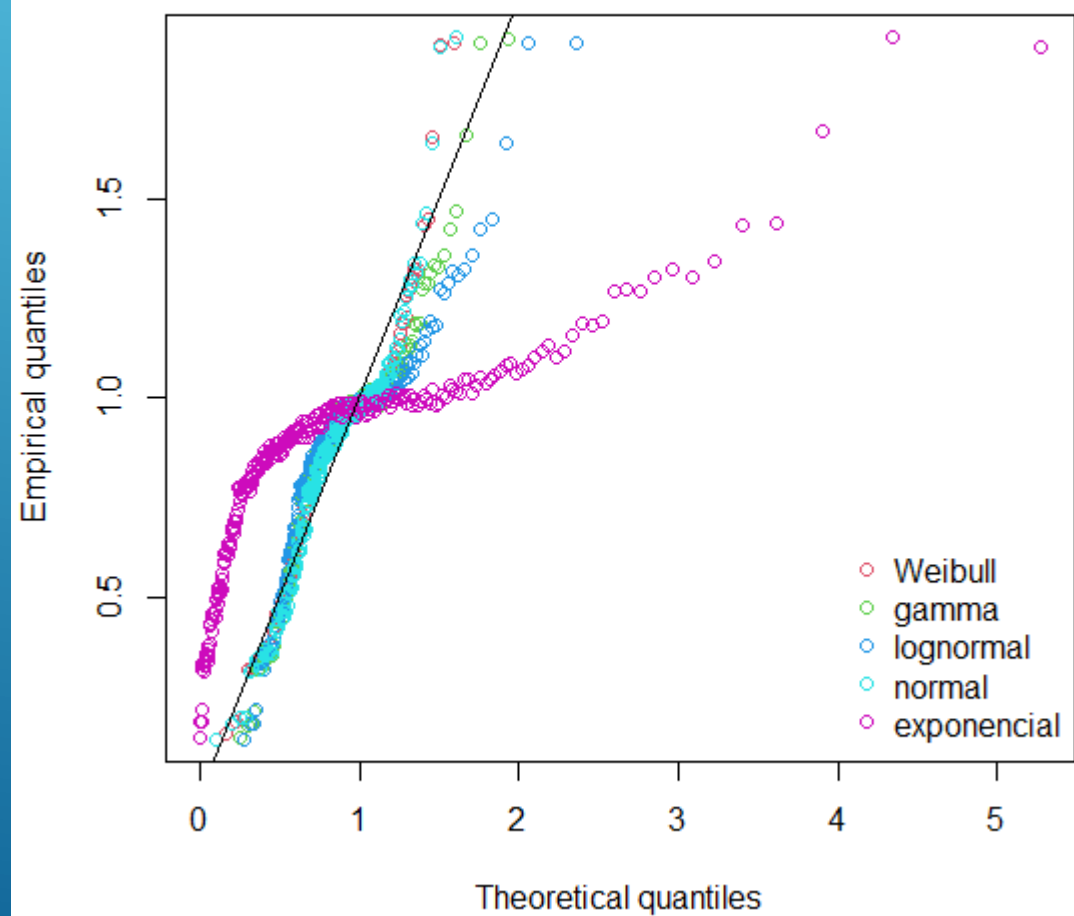
```
data: vari
D = 0.015069, p-value = 0.9901
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> 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] 0.8183553
```

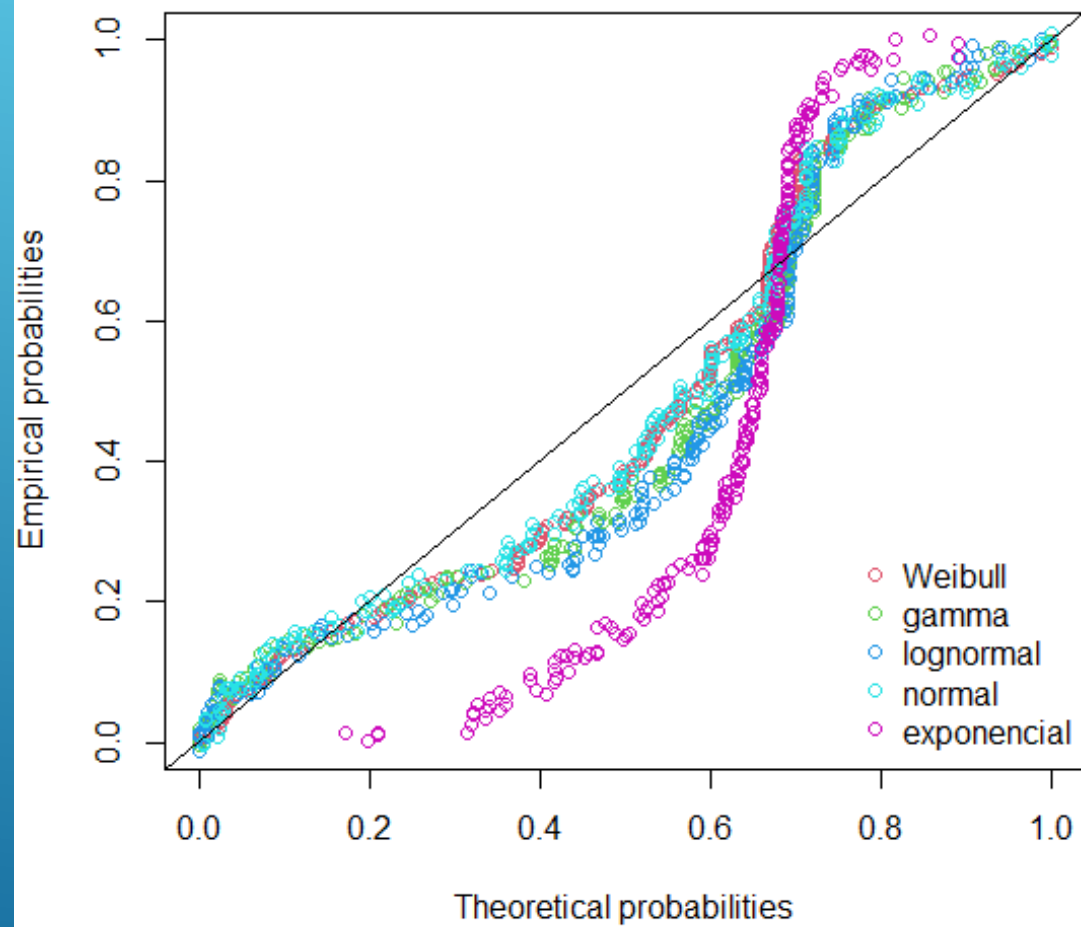
Fator de estabilidade



Q-Q plot



P-P plot



Fator de estabilidade

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1314673	0.1725521	0.1905401	0.126338
Cramer-von Mises statistic	1.3585529	2.1275627	2.7095471	1.205905
Anderson-Darling statistic	7.0005170	10.8170411	13.8030011	6.366164


```
exponencial
```

Kolmogorov-Smirnov statistic	0.3415319
Cramer-von Mises statistic	11.5076013
Anderson-Darling statistic	56.0194618


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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	47.54910	74.78645	111.3911	41.03506
Bayesian Information Criterion	54.51037	81.74773	118.3523	47.99633


```
exponencial
```

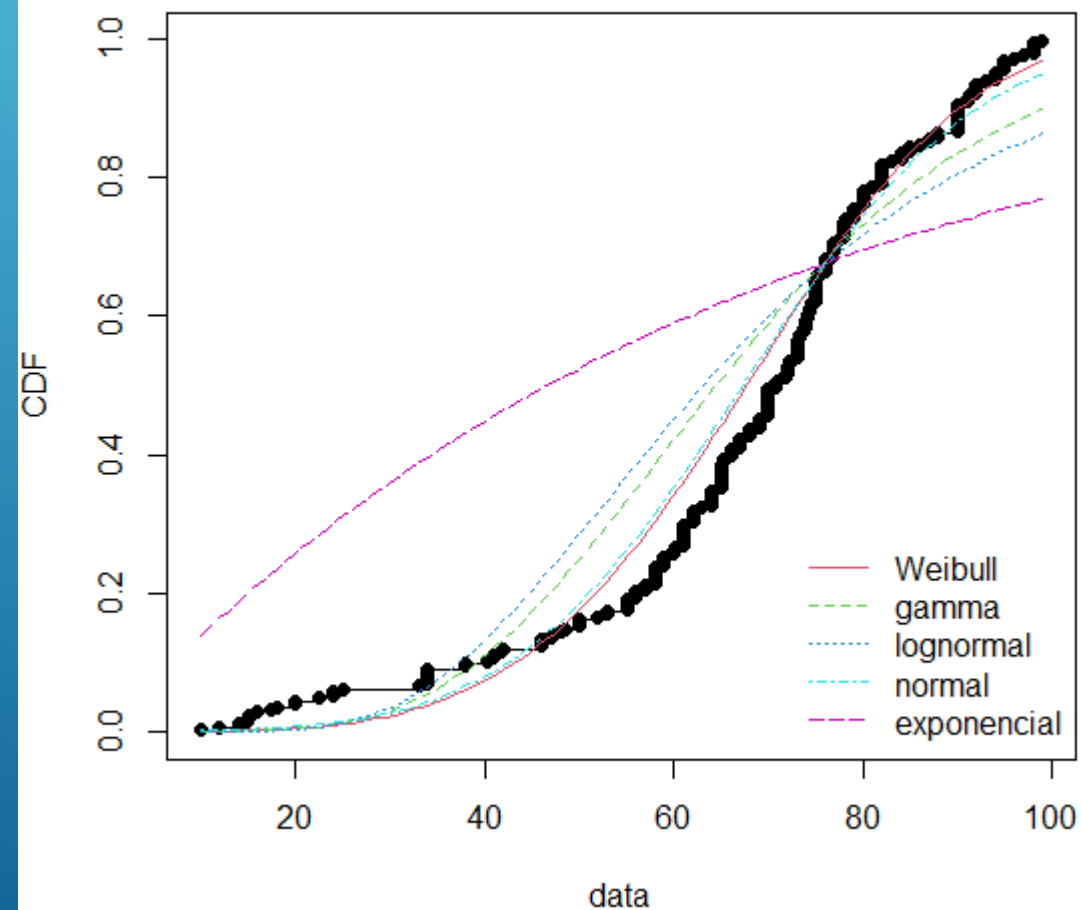
Akaike's Information Criterion	406.5723
Bayesian Information Criterion	410.0529

```
Hartigans' dip test for unimodality / multimodality

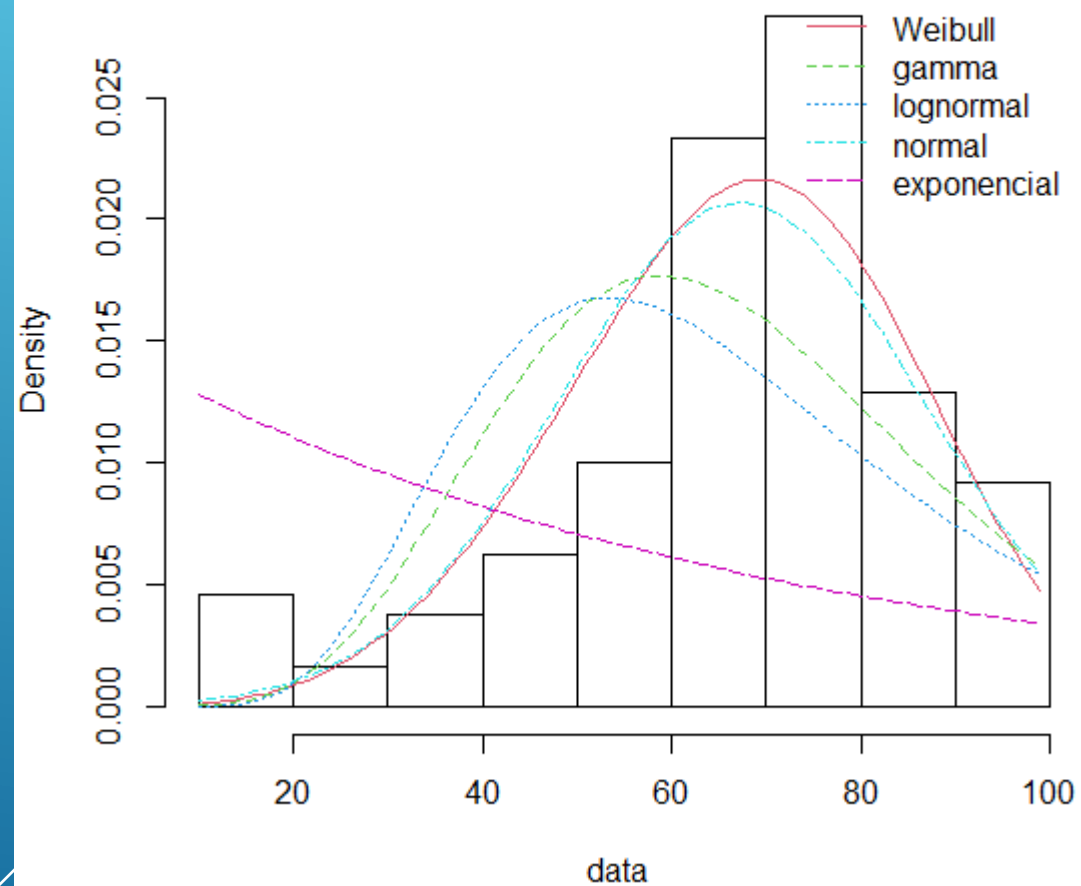
data: vari
D = 0.035417, p-value = 0.03372
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.2026127
```

Empirical and theoretical CDFs

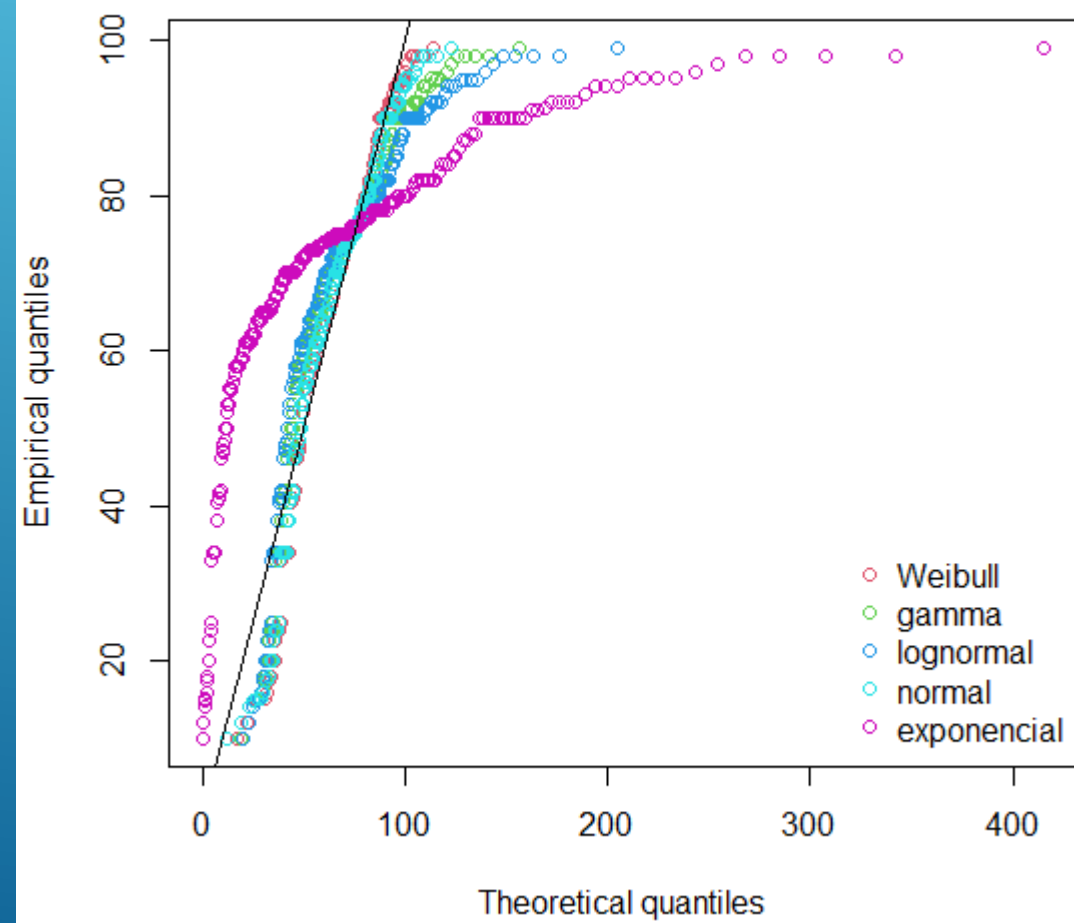


Histogram and theoretical densities

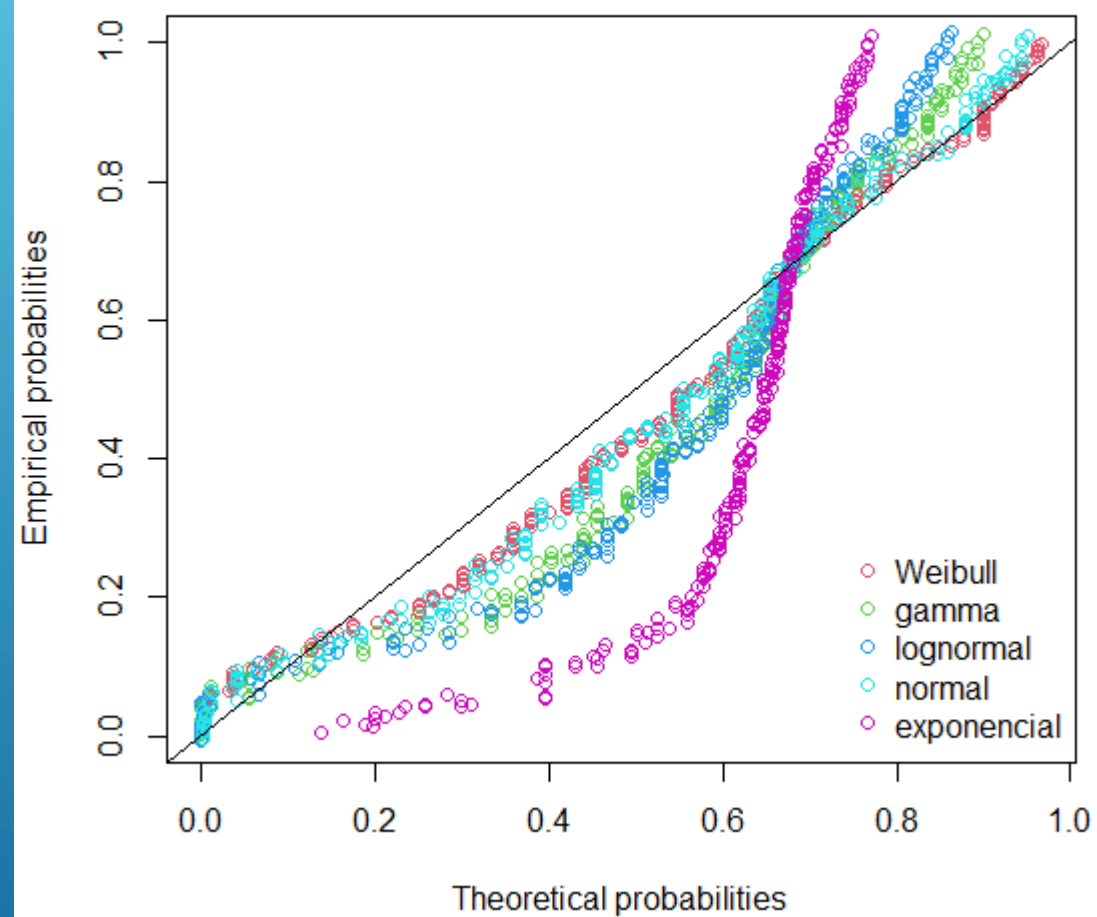


Conversão inicial de CH4

Q-Q plot



P-P plot



Conversão inicial de CH4

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.0953625	0.1733098	0.2055342	0.1068256
Cramer-von Mises statistic	0.5825196	2.1524275	3.0652044	0.7522124
Anderson-Darling statistic	4.2745847	12.4460547	17.3732702	4.7445617

	exponencial
Kolmogorov-Smirnov statistic	0.383269
Cramer-von Mises statistic	11.795895
Anderson-Darling statistic	56.965890

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	2101.695	2186.879	2246.902	2106.035
Bayesian Information Criterion	2108.656	2193.840	2253.863	2112.996

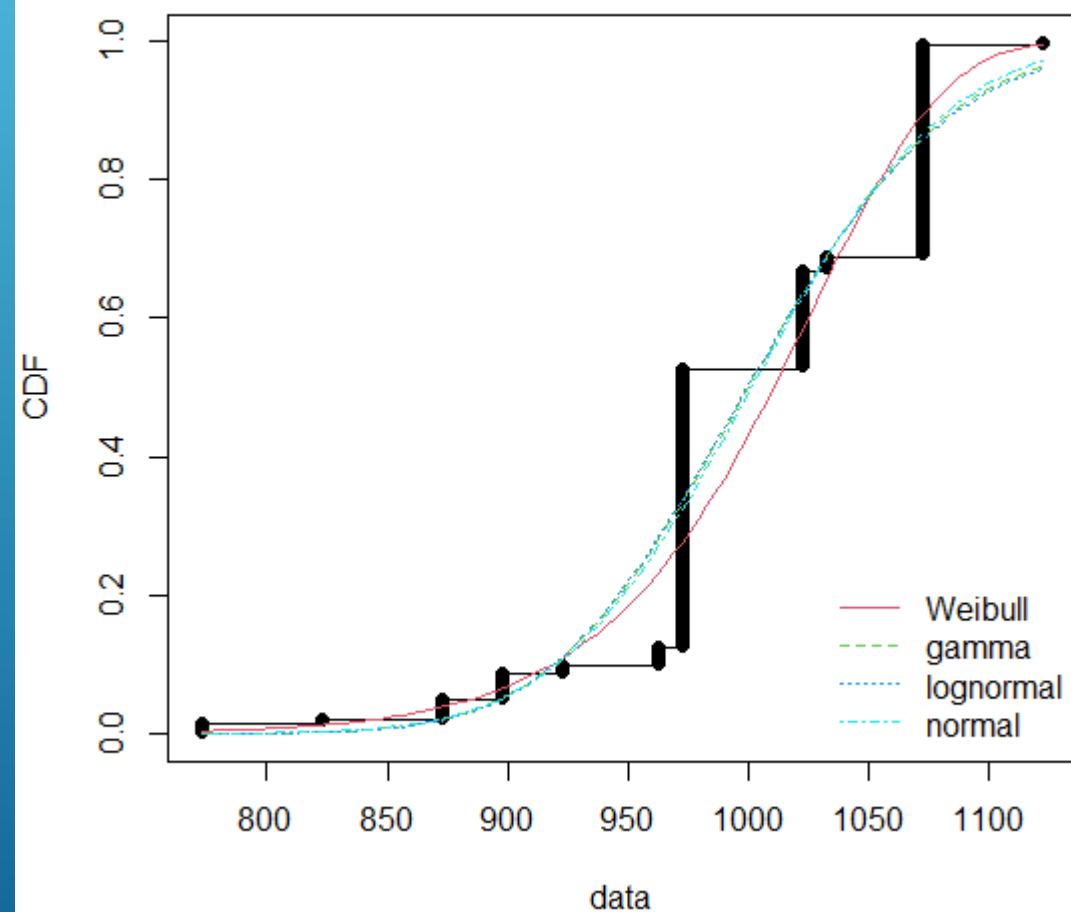
	exponencial
Akaike's Information Criterion	2502.504
Bayesian Information Criterion	2505.985

Hartigans' dip test for unimodality / multimodality

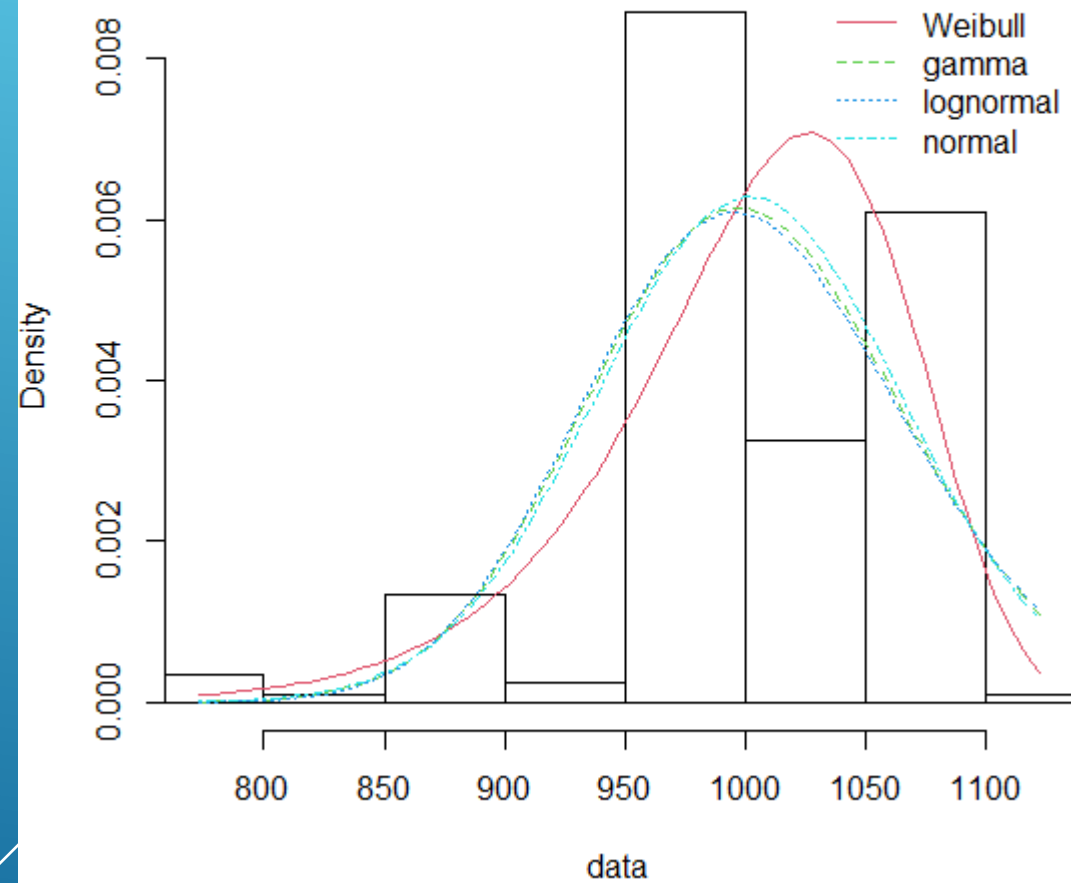
```
data: vari
D = 0.02375, p-value = 0.474
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> 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] 0.4990005
```

Empirical and theoretical CDFs

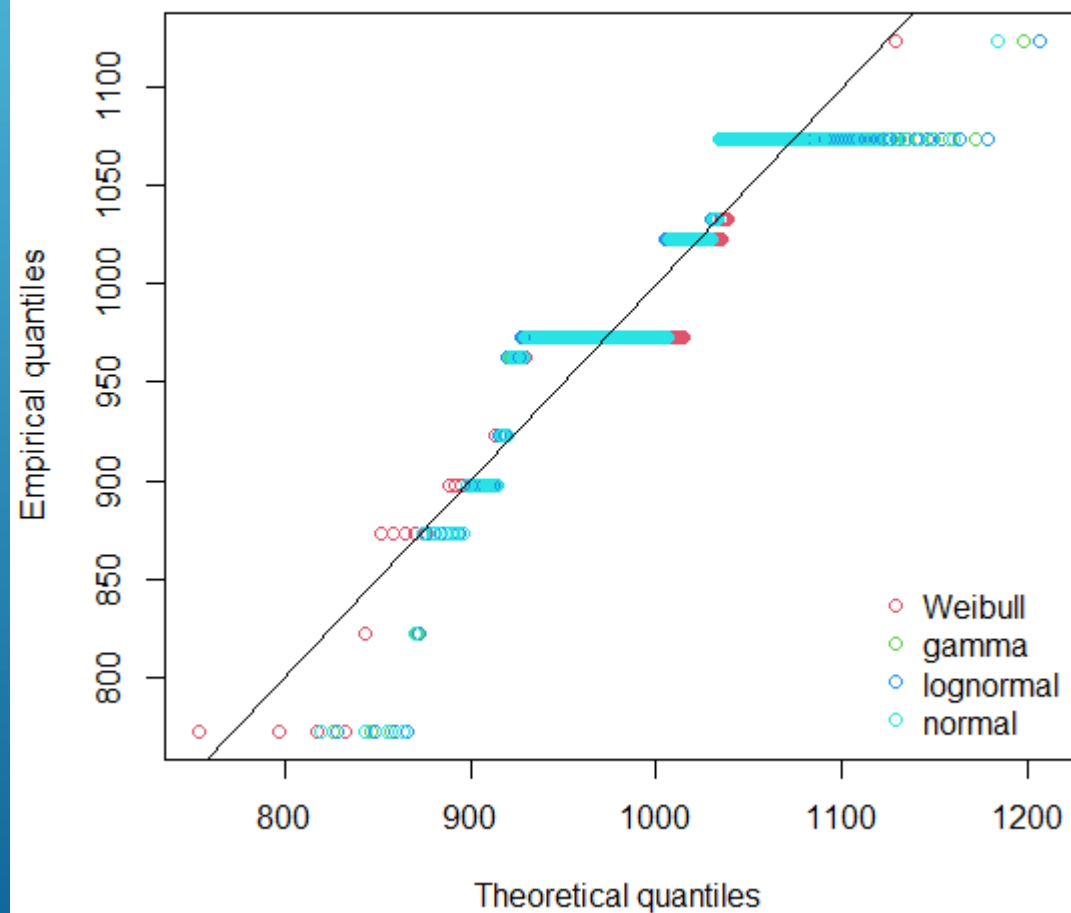


Histogram and theoretical densities

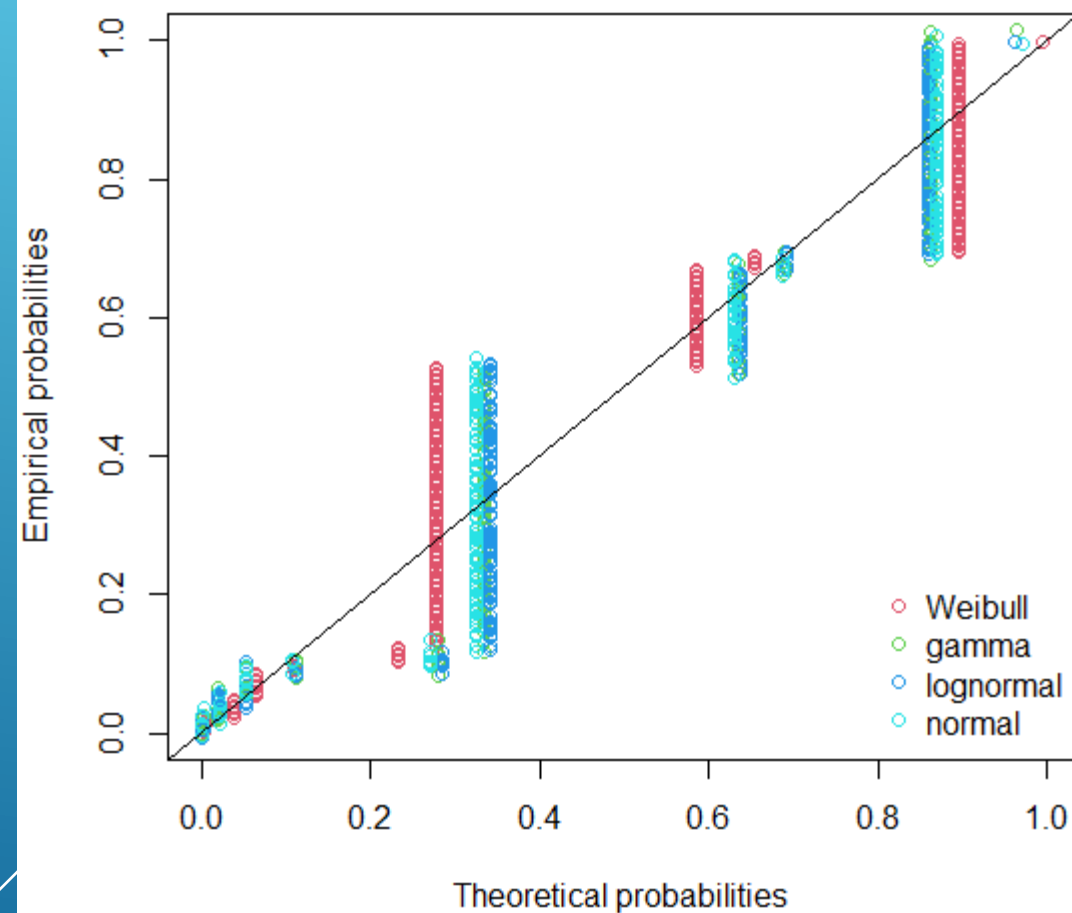


Temperatura de reação

Q-Q plot



P-P plot



Temperatura de reação

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2512244	0.2100661	0.2150877	0.2041801
Cramer-von Mises statistic	2.4715075	2.1921345	2.2084429	2.1769538
Anderson-Darling statistic	14.8905290	13.1763621	13.2644187	13.0953215


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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	2647.842	2687.857	2693.708	2677.527
Bayesian Information Criterion	2654.803	2694.818	2700.669	2684.488

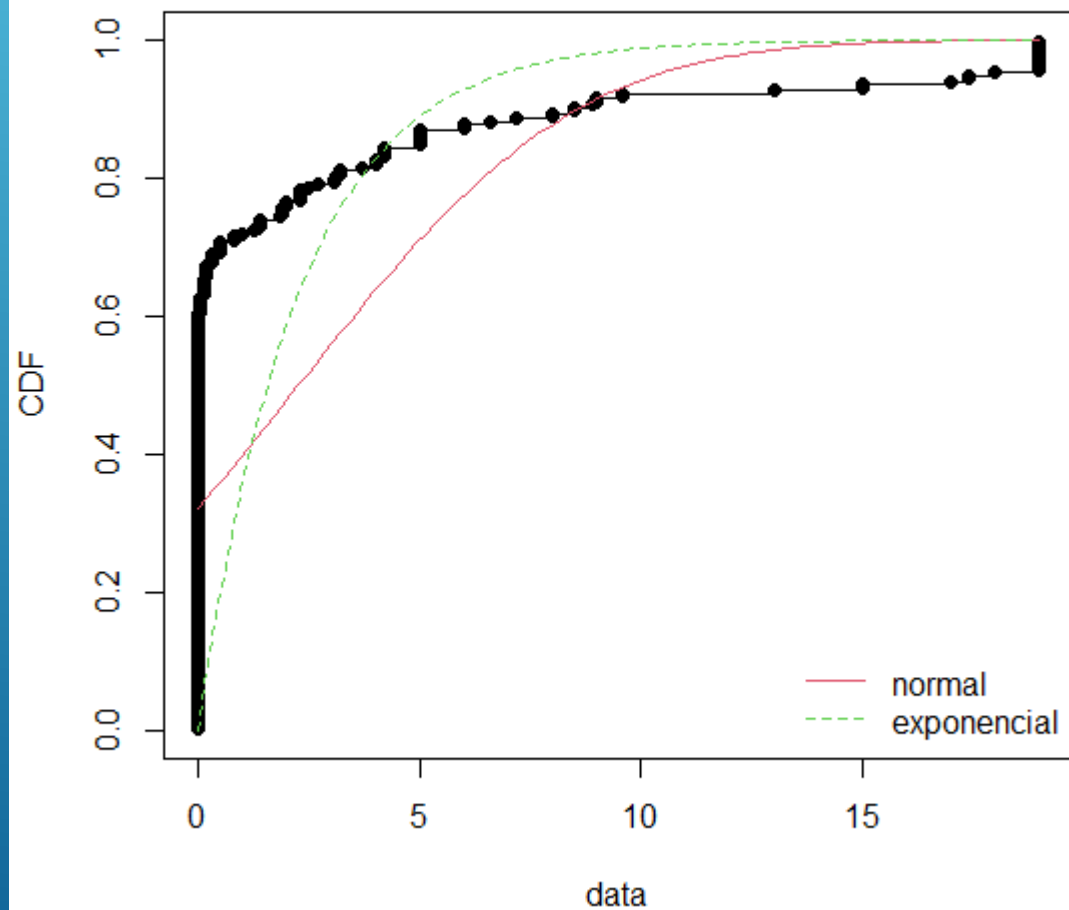
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.15208, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

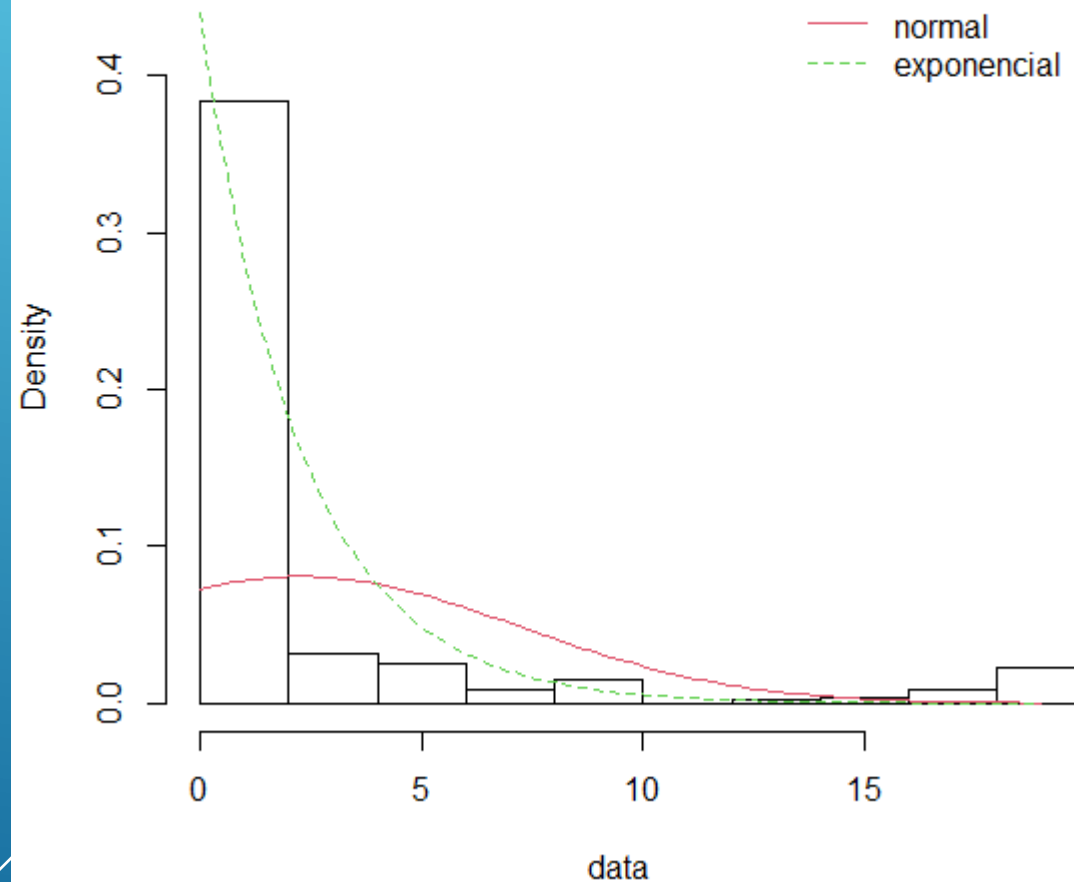
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.395898
```


Concentração de Dopante ou Promotor

Empirical and theoretical CDFs

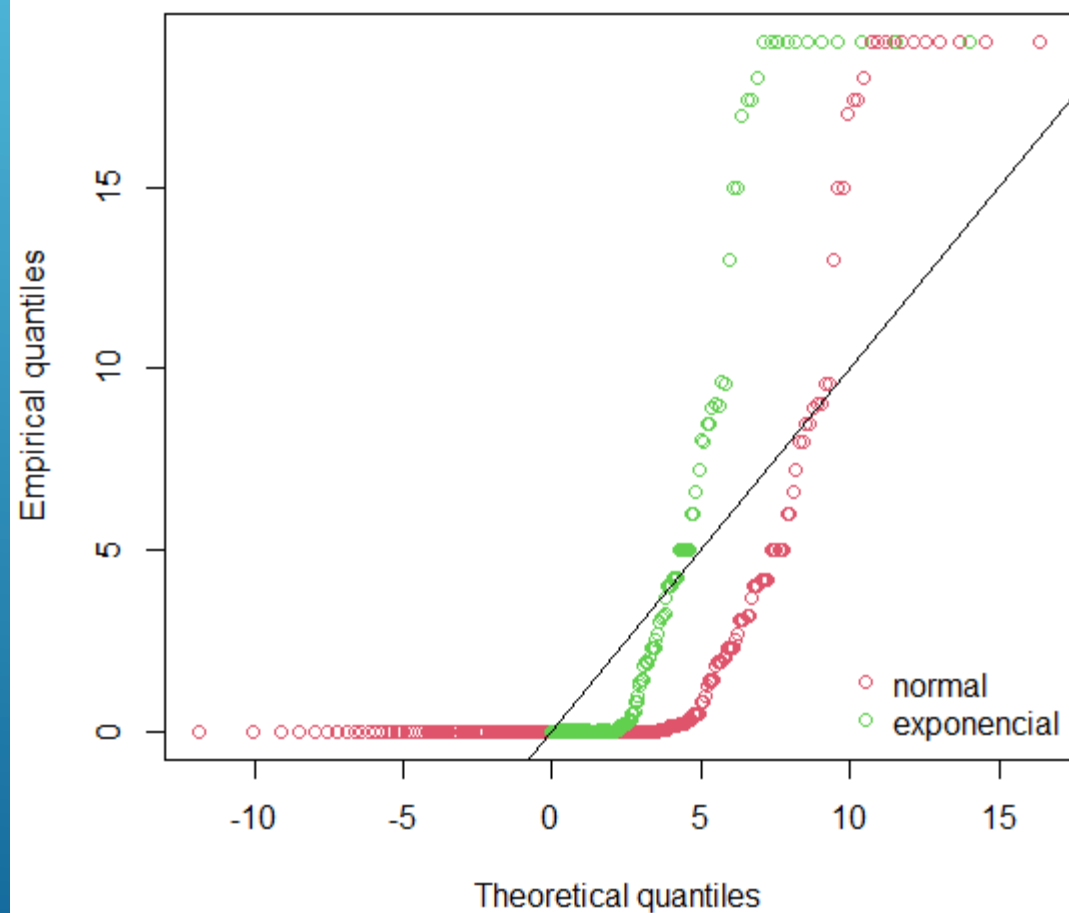


Histogram and theoretical densities

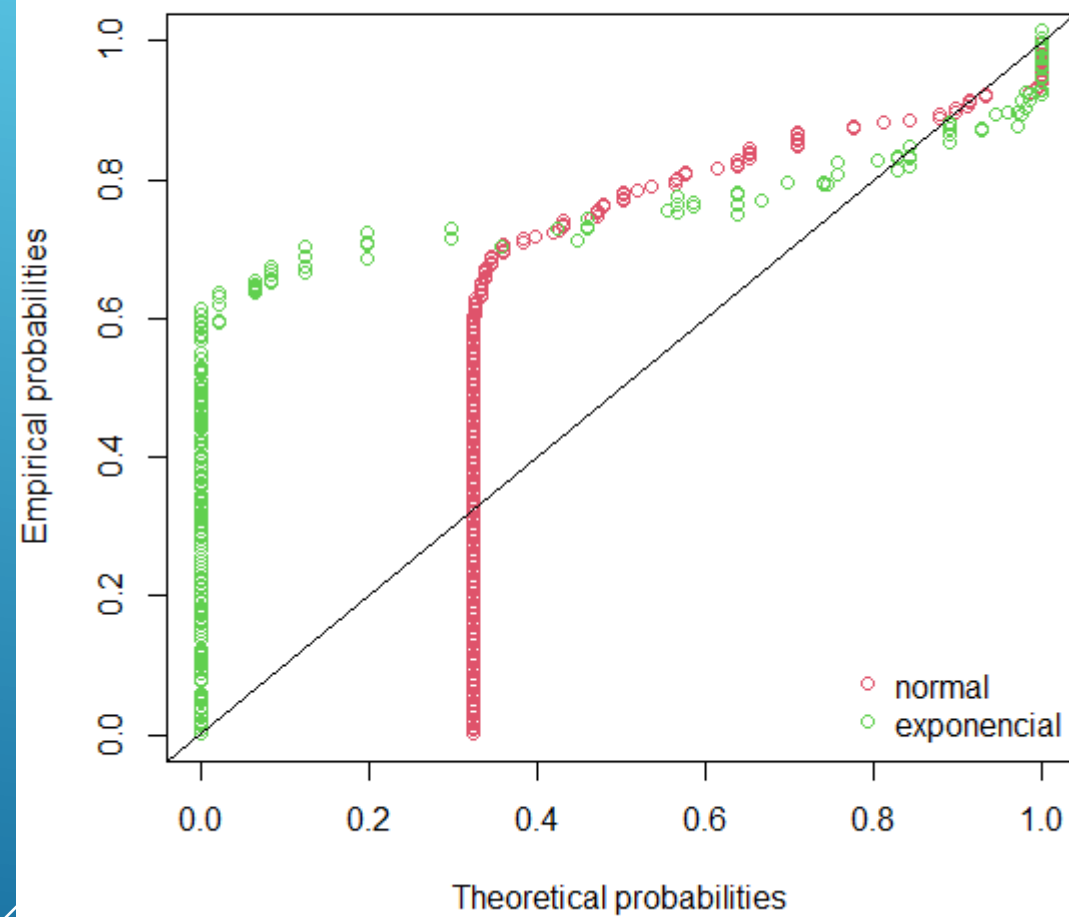


Concentração de Dopante ou Promotor

Q-Q plot



P-P plot



Concentração de Dopante ou Promotor

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

	normal	exponencial
Kolmogorov-Smirnov statistic	0.3487613	0.6074107
Cramer-von Mises statistic	9.4504742	27.0093207
Anderson-Darling statistic	48.3594037	Inf

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

	normal	exponencial
Akaike's Information Criterion	1450.929	876.1544
Bayesian Information Criterion	1457.891	879.6351

```
>
```

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

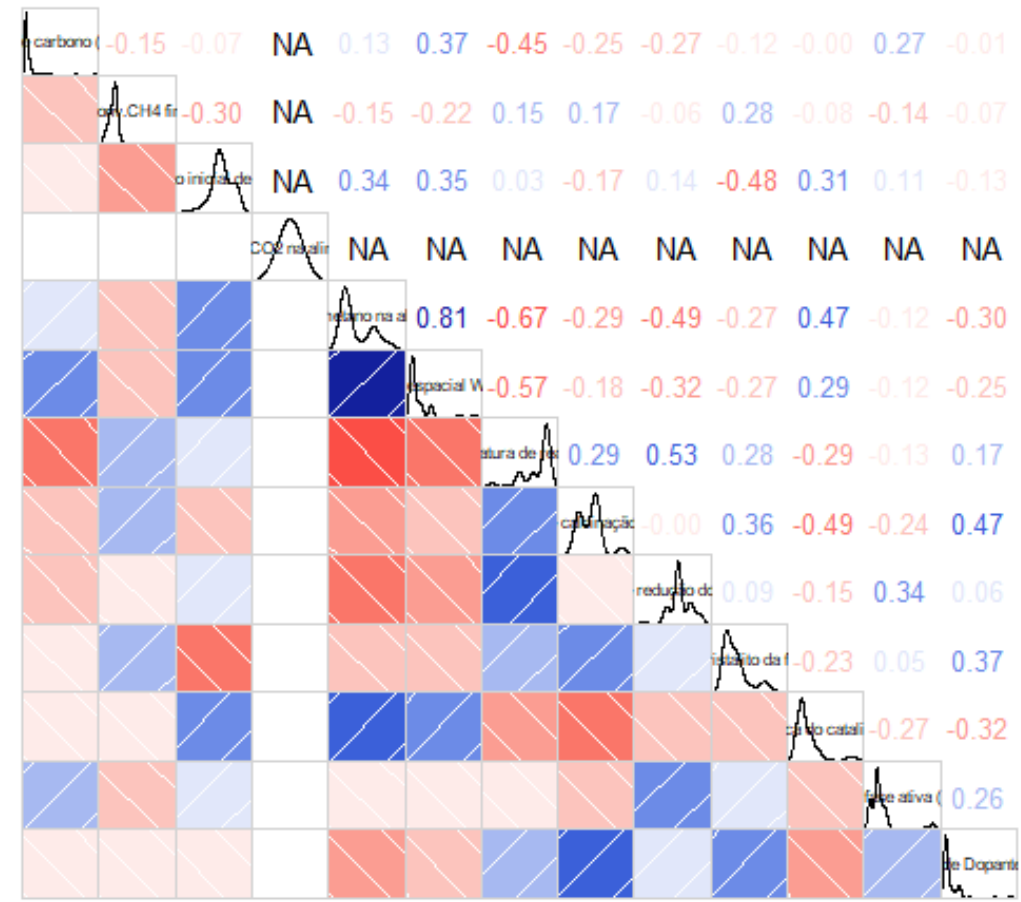
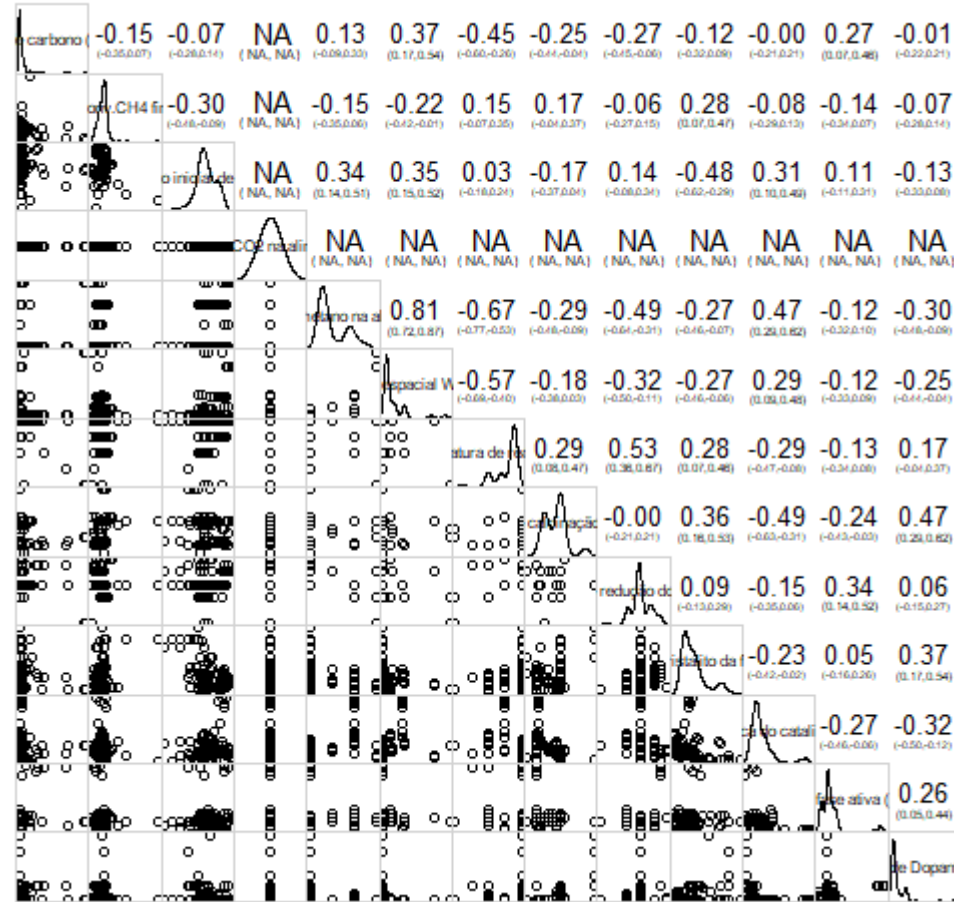
data: vari
D = 0.023271, p-value = 0.5111
alternative hypothesis: non-unimodal, i.e., at least bimodal

```
> 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] 0.8756487
```

Retirando as lacunas

database

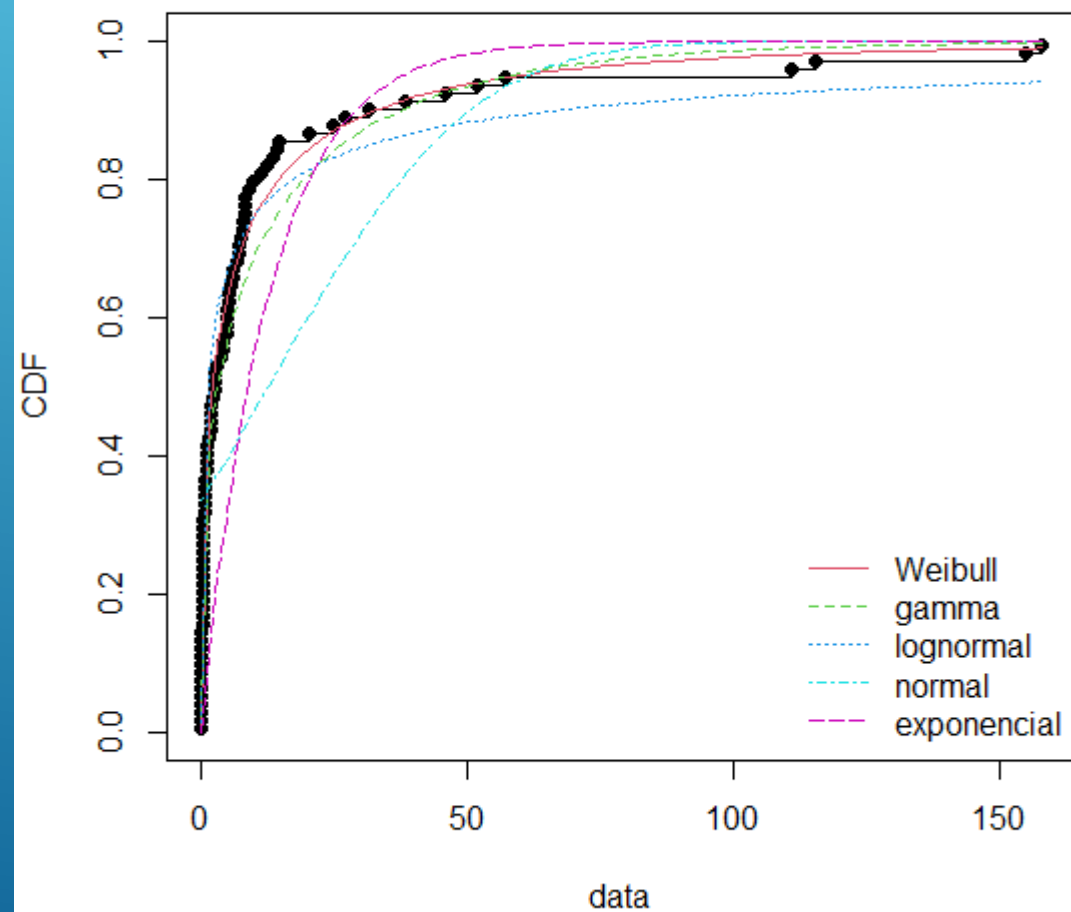
86 obs. of 20 variables



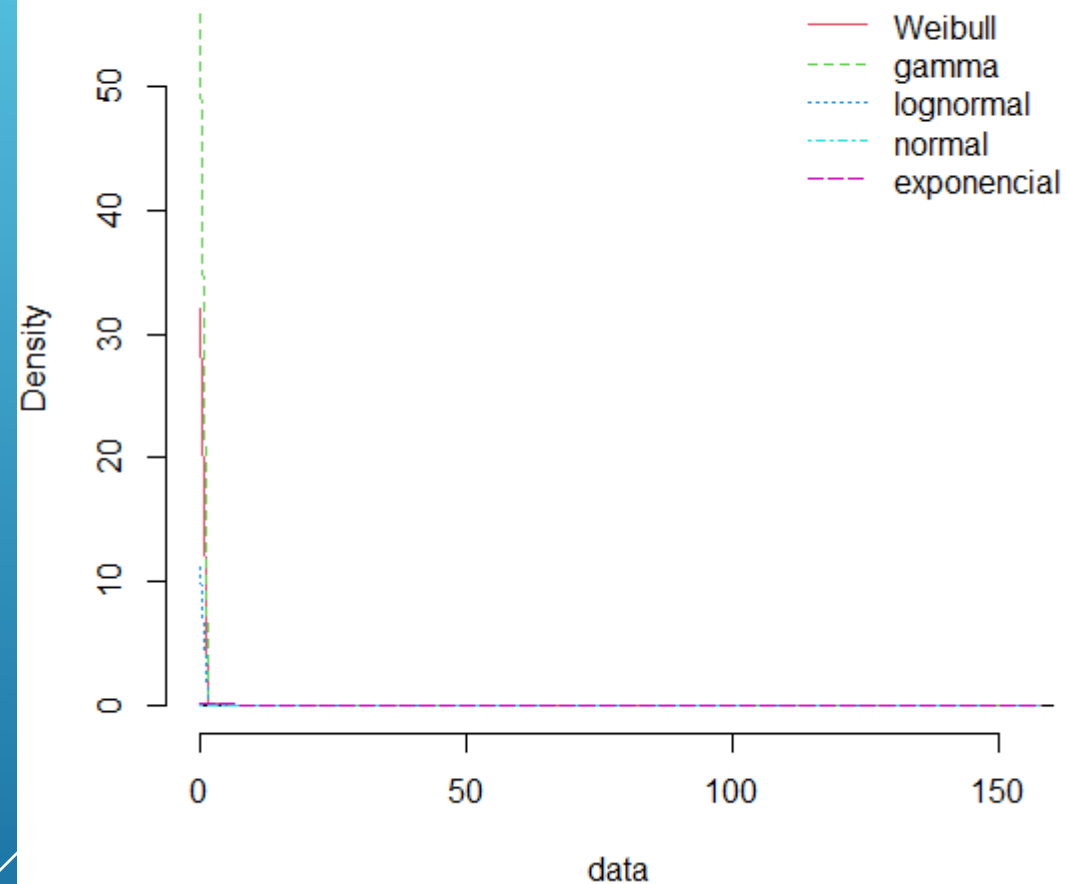
Fase Ativa	Contagem de Fase Ativa	Dopante ou Promotor	Contagem de Dopante ou Promotor	Suporte	Contagem de Suporte
Ni	73	none	47	Al2O3	23
Pt	7	Gd	12	CeO2	23
Cu Ni	6	Pr	8	Al2O3 CeO2	13
Total	86	Nb	5	MCM-41	8
		Yb	4	Hidrotalcita	6
		Sm	2	HZSM-5	4
		Y	2	CeZrO2	3
		Zr	2	SiO2	3
		Ca	1	CeSiO2 LaNiO3	1
		K	1	LaNiO3	1
		Mn	1	LaNiO3 Al2O3	1
		Sn	1	Total	86
		Total	86		

Taxa de formação de carbono

Empirical and theoretical CDFs

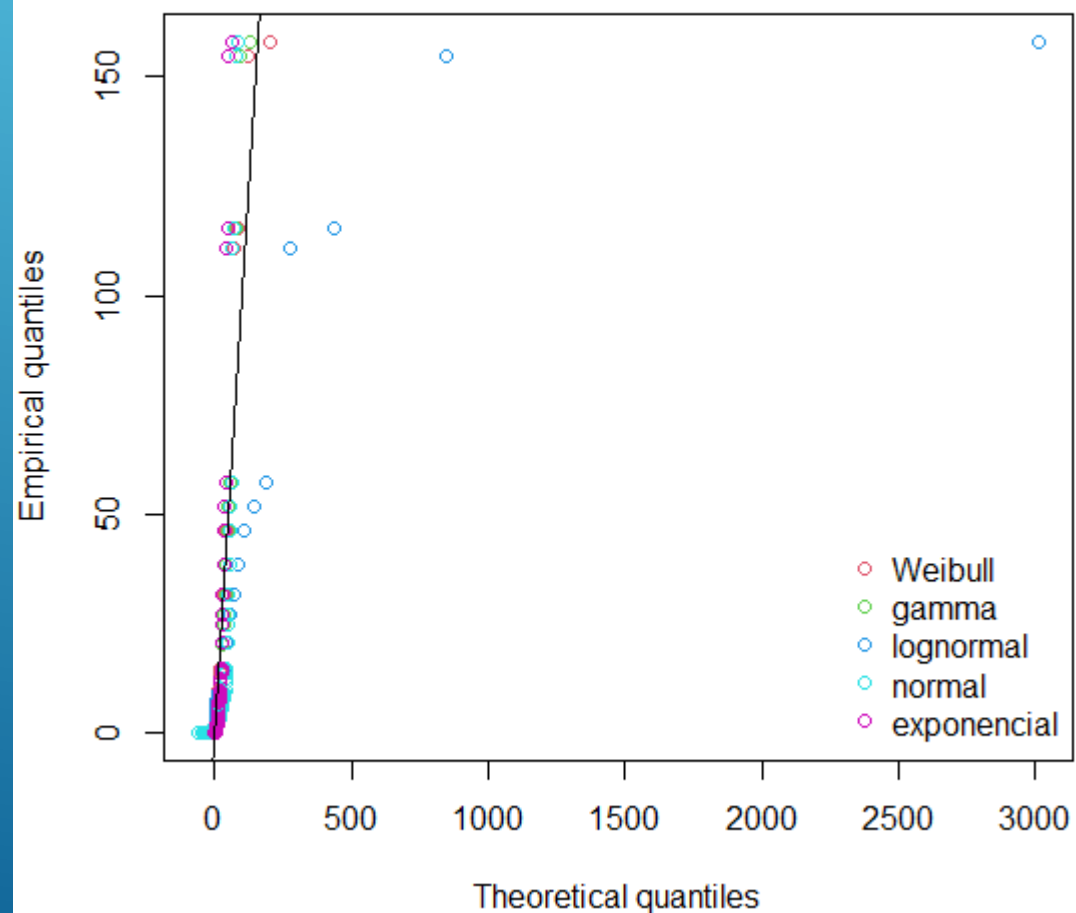


Histogram and theoretical densities

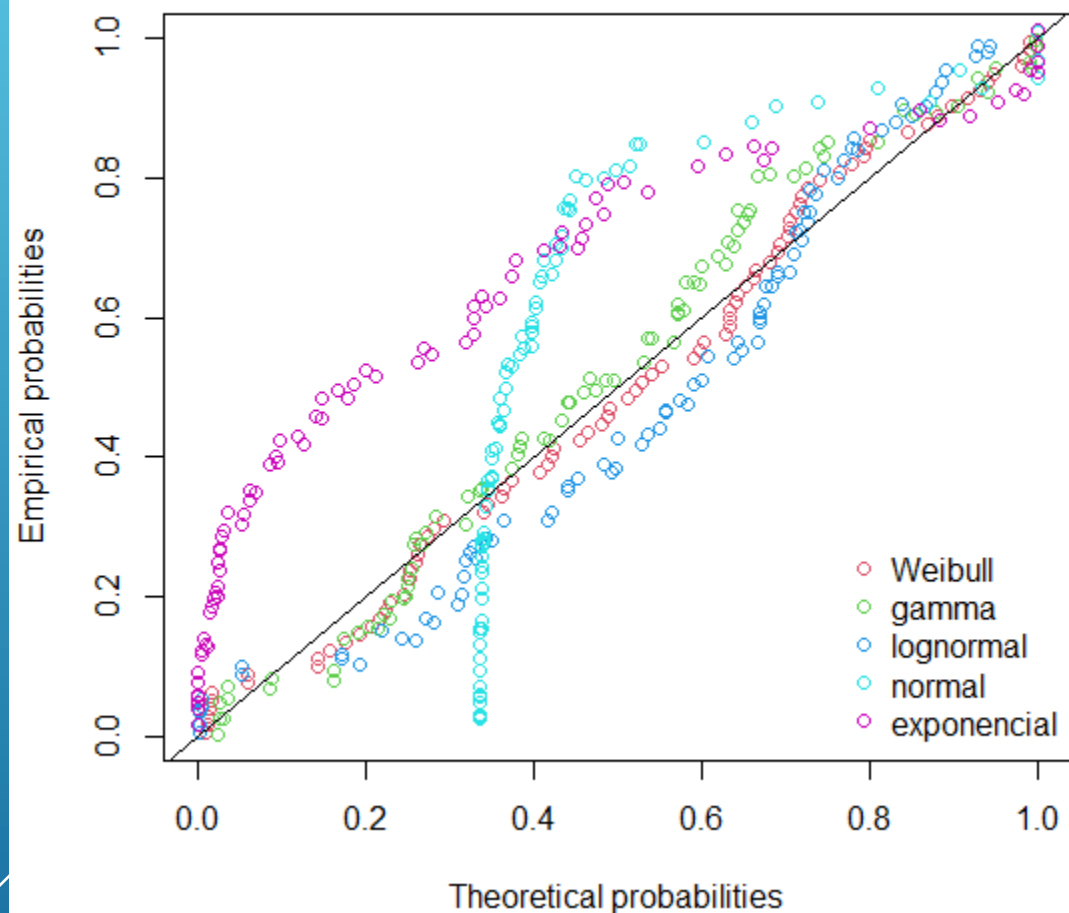


Taxa de formação de carbono

Q-Q plot



P-P plot



Taxa de formação de carbono

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.06473635	0.1248808	0.1109915	0.3416766
Cramer-von Mises statistic	0.07782060	0.2164181	0.4114701	3.4883131
Anderson-Darling statistic	0.62915867	1.2975572	2.8198336	17.5462970

	exponencial
Kolmogorov-Smirnov statistic	0.3281493
Cramer-von Mises statistic	4.4224128
Anderson-Darling statistic	37.0882163

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	463.4125	468.5207	486.0837	830.4401
Bayesian Information Criterion	468.3211	473.4294	490.9924	835.3488

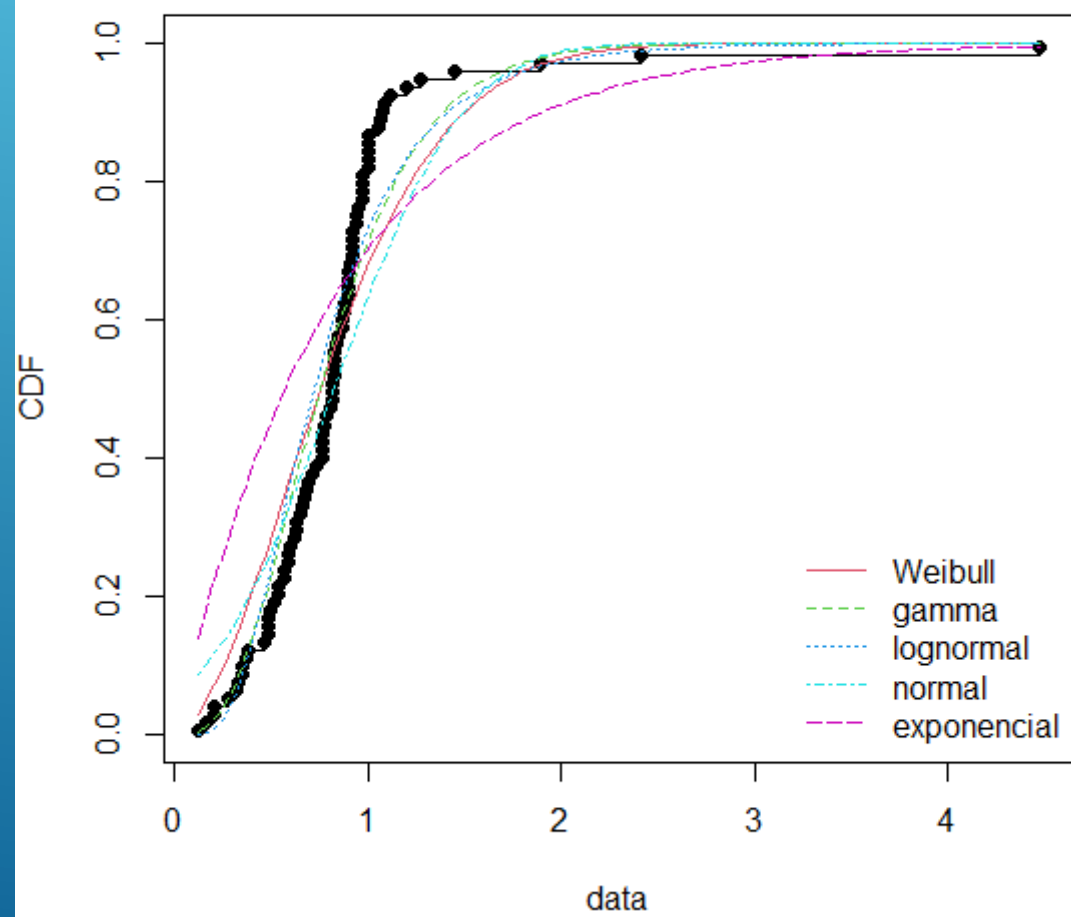
	exponencial
Akaike's Information Criterion	610.0565
Bayesian Information Criterion	612.5108

Hartigans' dip test for unimodality / multimodality

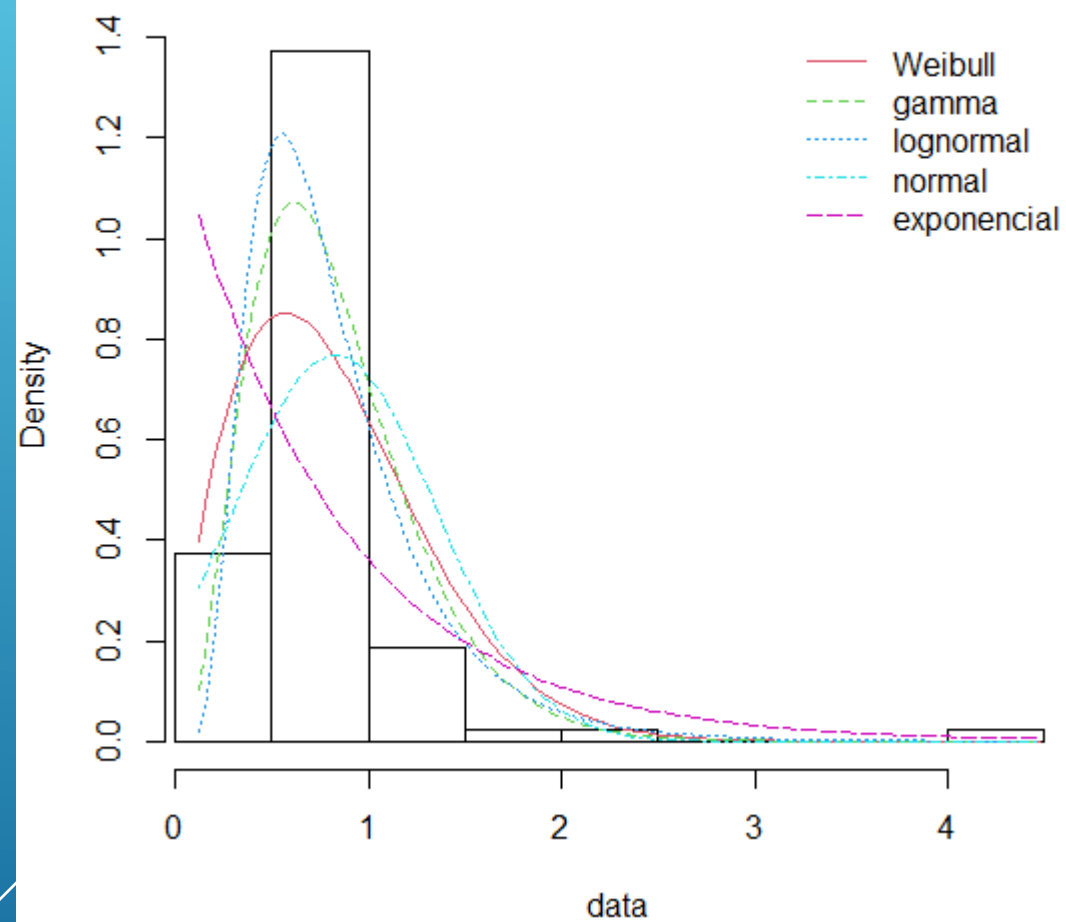
```
data: vari
D = 0.025349, p-value = 0.982
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.8582702
```

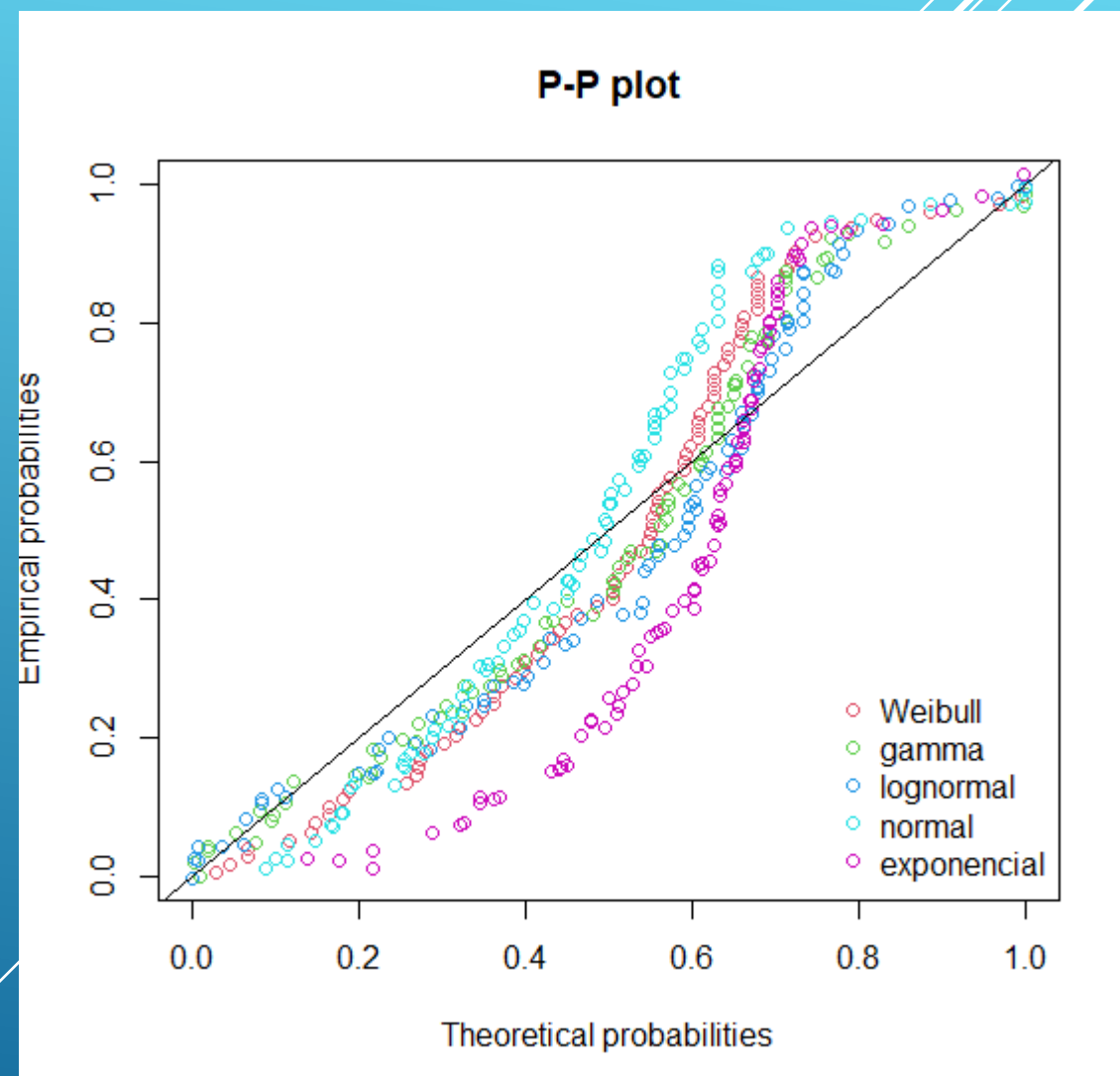
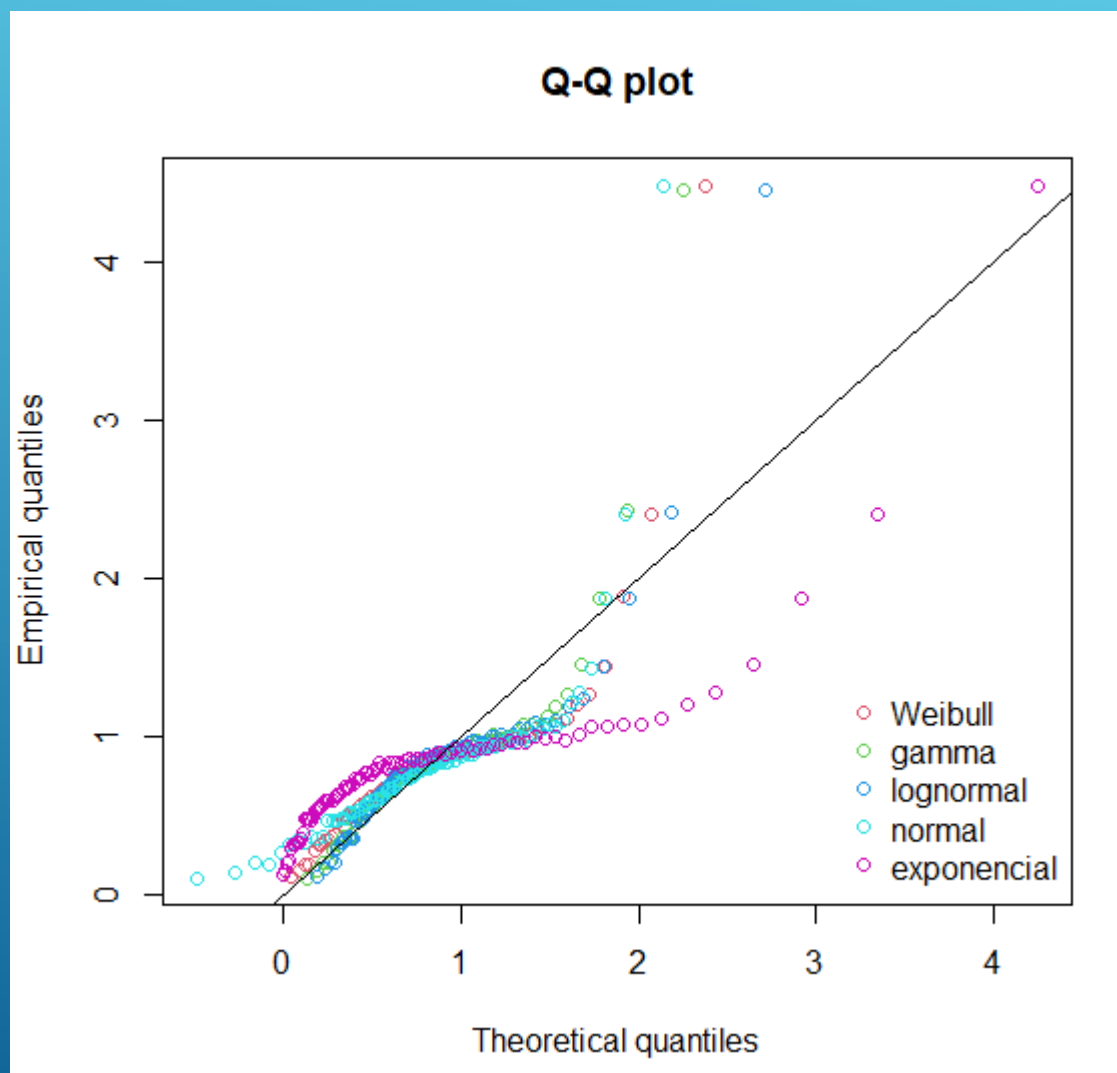

Empirical and theoretical CDFs



Histogram and theoretical densities



Fator de estabilidade



Fator de estabilidade

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1937080	0.1610159	0.1435175	0.240851
Cramer-von Mises statistic	0.8173042	0.4534239	0.5444952	1.075179
Anderson-Darling statistic	4.6660397	2.6507712	3.0316510	6.302960

```
exponencial
```

Kolmogorov-Smirnov statistic	0.302401
Cramer-von Mises statistic	2.688220
Anderson-Darling statistic	13.444949

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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	100.0381	82.82359	81.25269	135.3994
Bayesian Information Criterion	104.9468	87.73229	86.16138	140.3081

```
exponencial
```

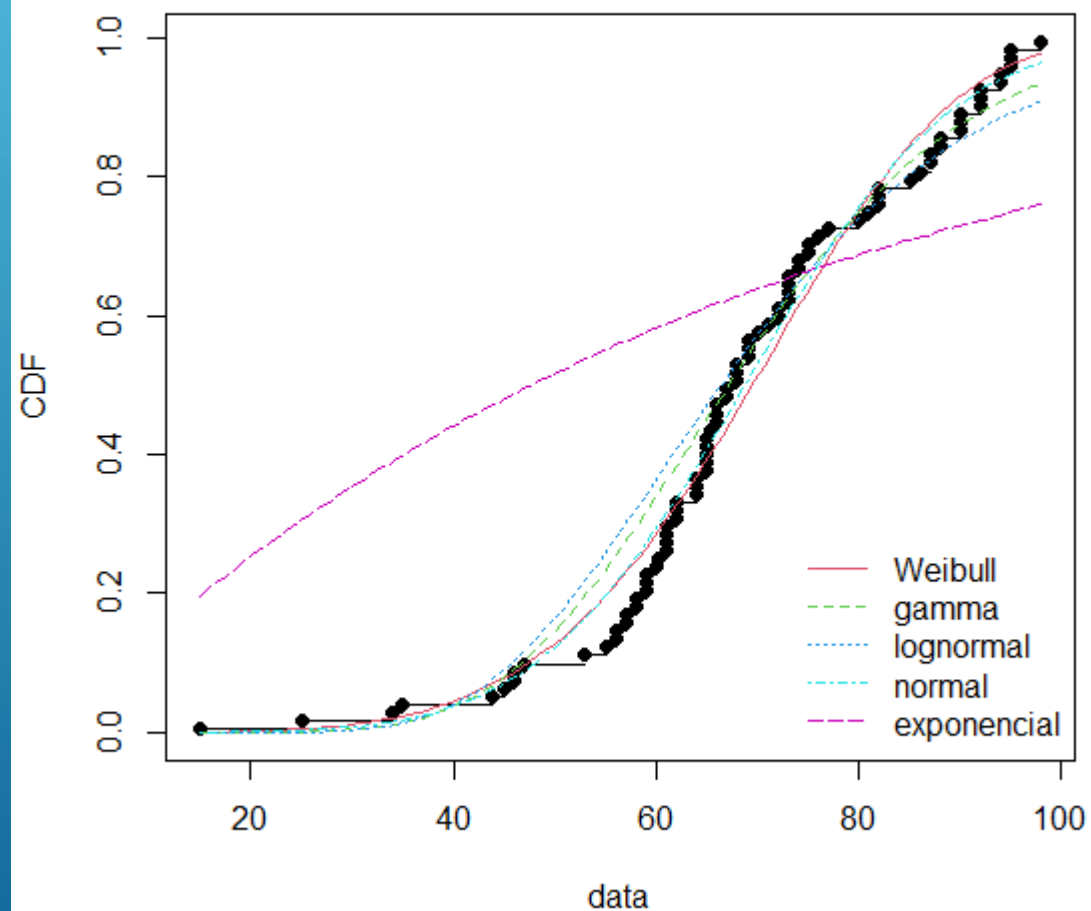
Akaike's Information Criterion	141.1016
Bayesian Information Criterion	143.5559

Hartigan's dip test for unimodality / multimodality

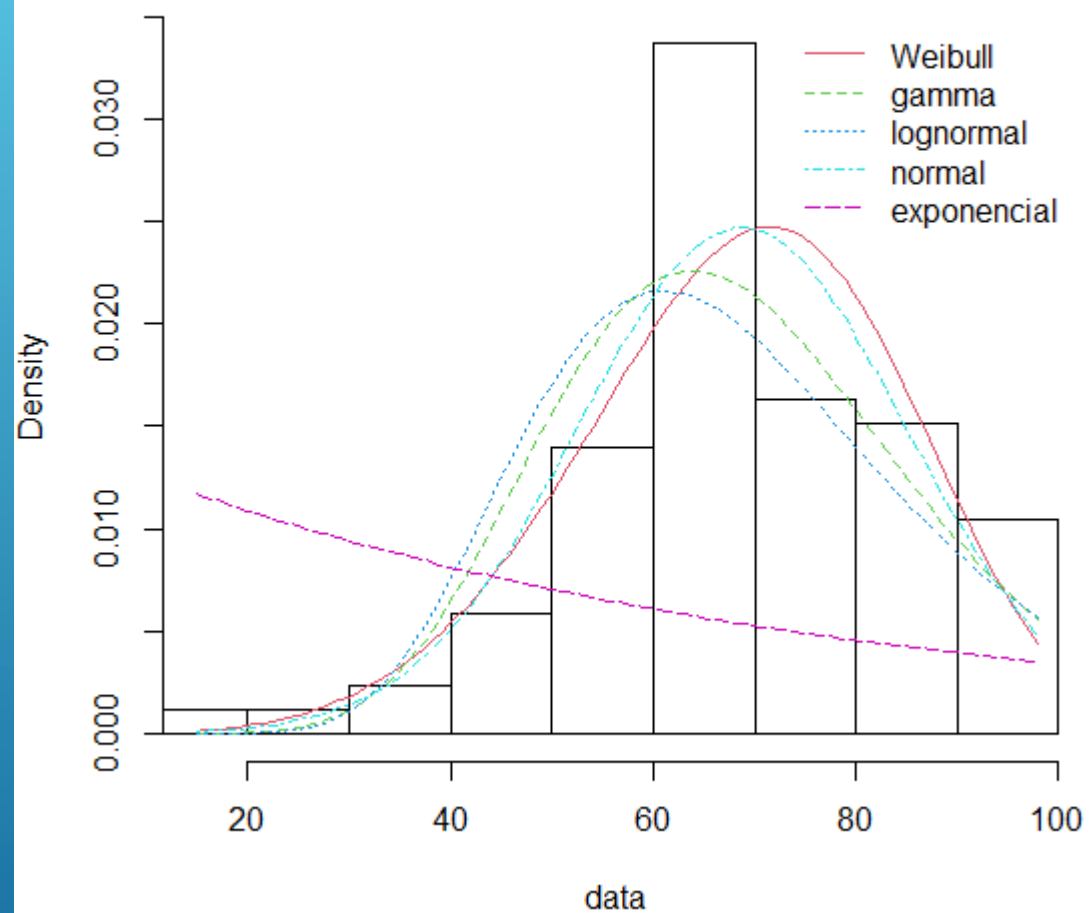
```
data: vari
D = 0.02907, p-value = 0.9069
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.6422572
>
```

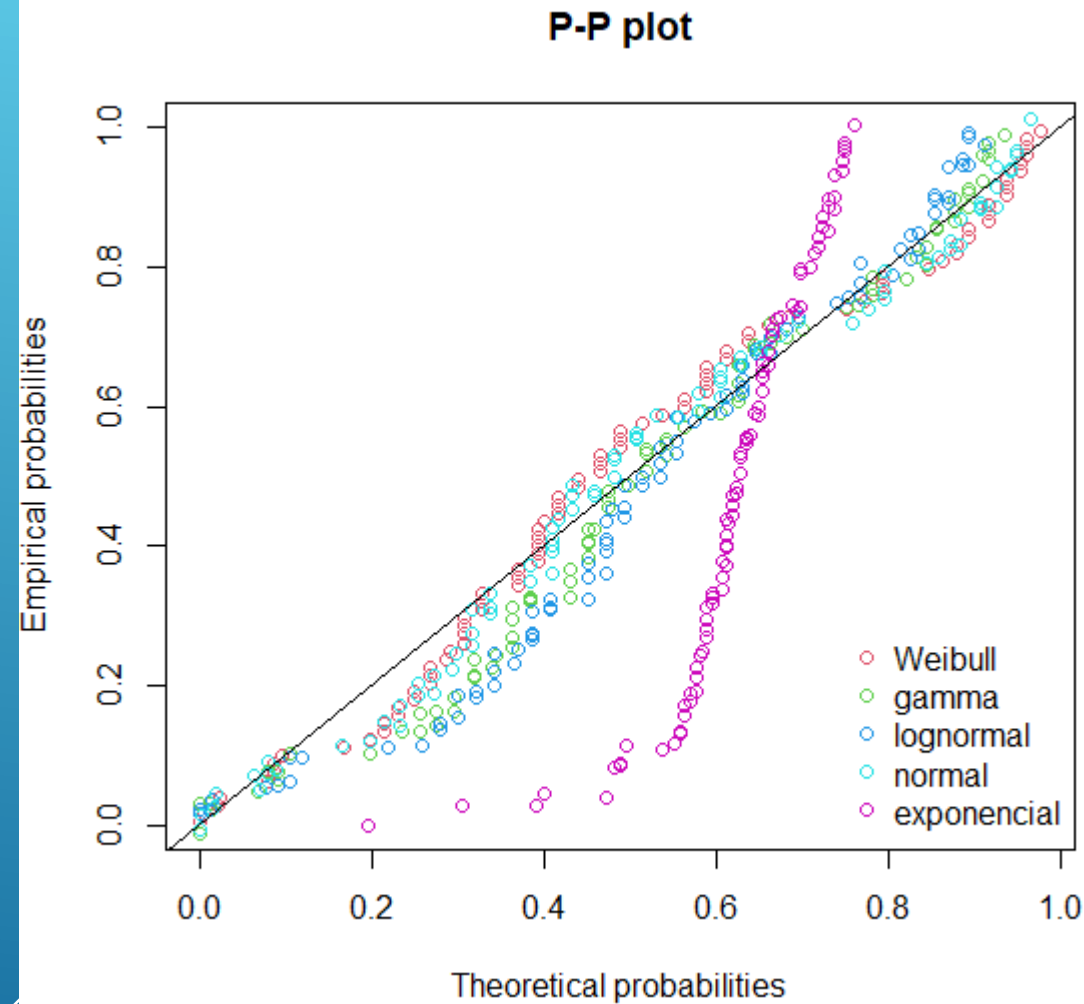
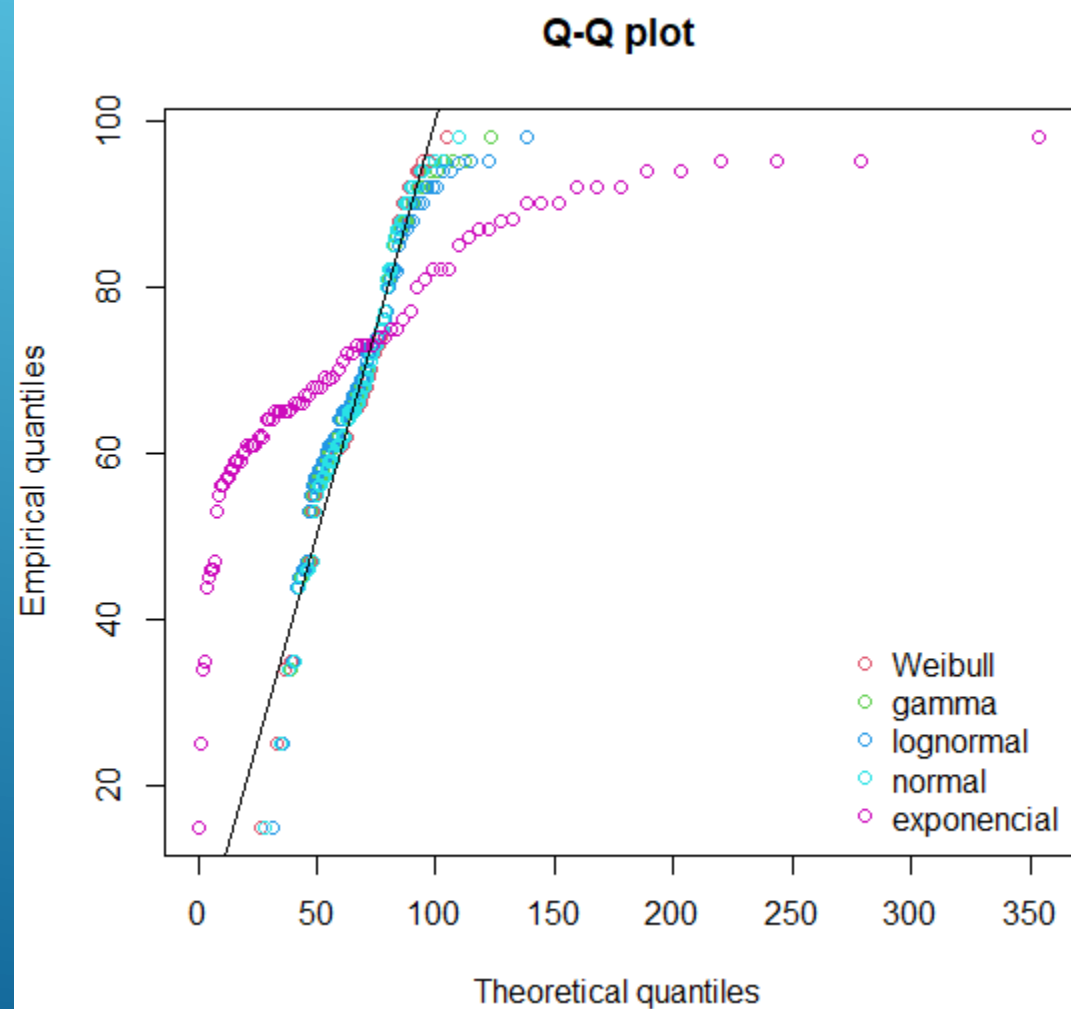
Empirical and theoretical CDFs



Histogram and theoretical densities



Conversão inicial de CH4



Conversão inicial de CH4

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.08496481 0.1265612 0.1514440 0.08688236
Cramer-von Mises statistic  0.15741190 0.2517058 0.4090172 0.12601719
Anderson-Darling statistic  0.98498822 1.7258420 2.6650799 0.86883398

      exponencial
Kolmogorov-Smirnov statistic  0.434398
Cramer-von Mises statistic    4.942853
Anderson-Darling statistic    23.538099

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 725.2493 742.8121 756.8639 726.4363
Bayesian Information Criterion 730.1580 747.7208 761.7726 731.3450

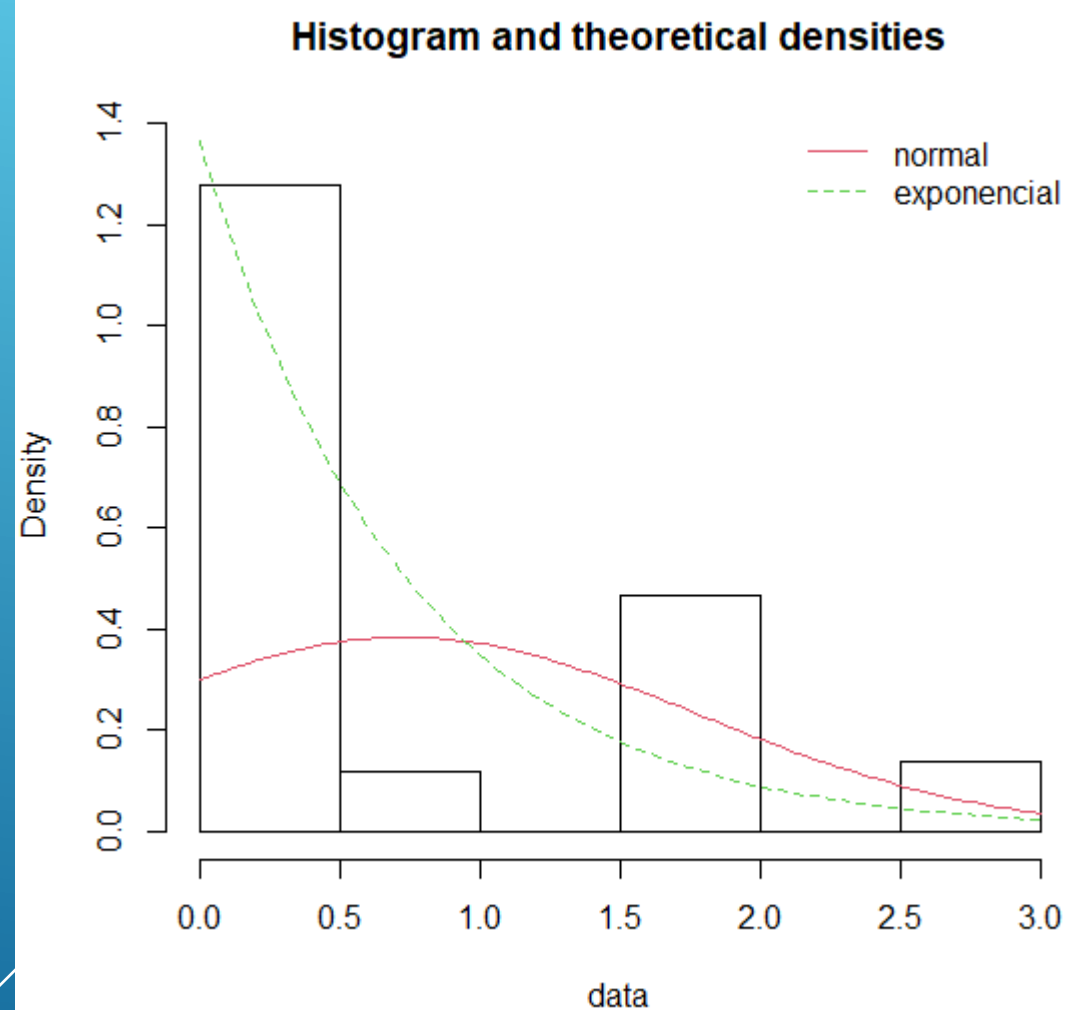
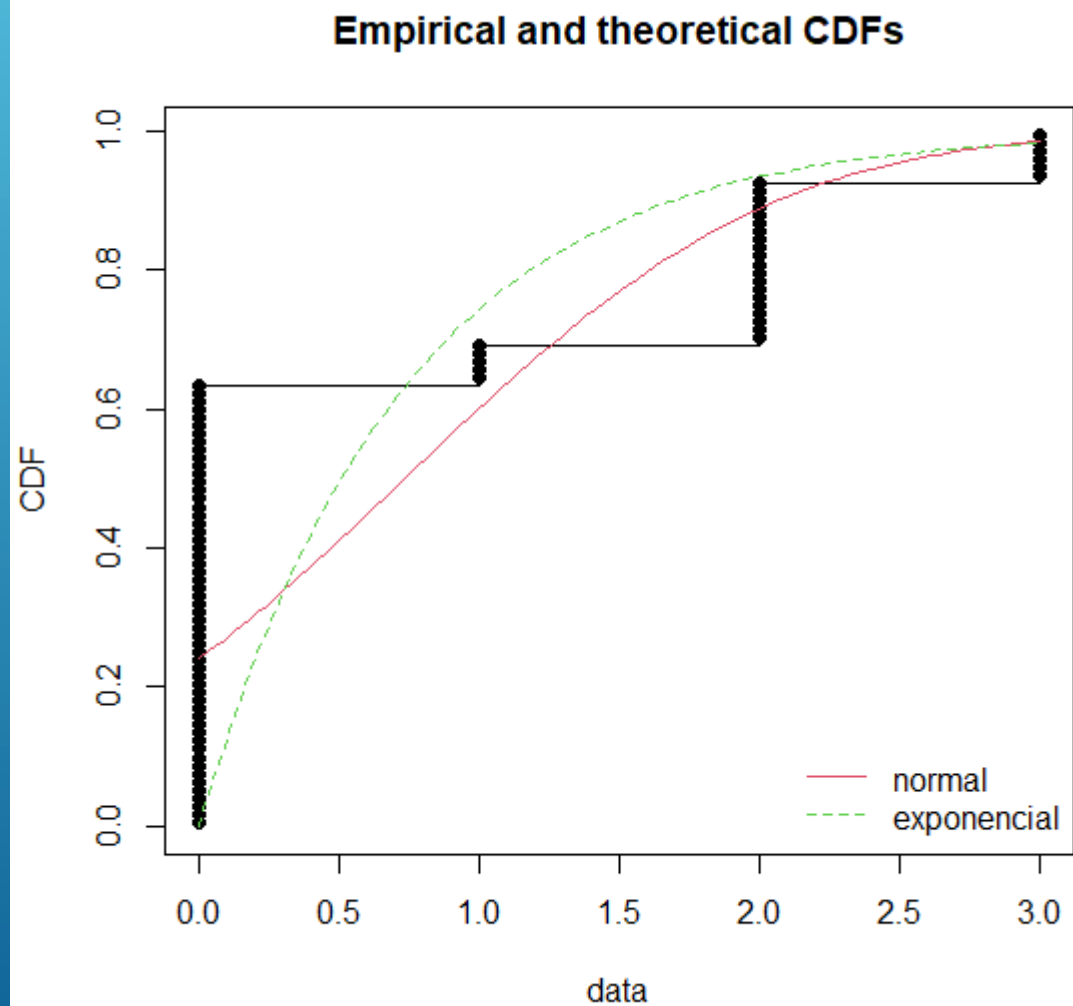
      exponencial
Akaike's Information Criterion  901.6391
Bayesian Information Criterion  904.0934
```

Hartigans' dip test for unimodality / multimodality

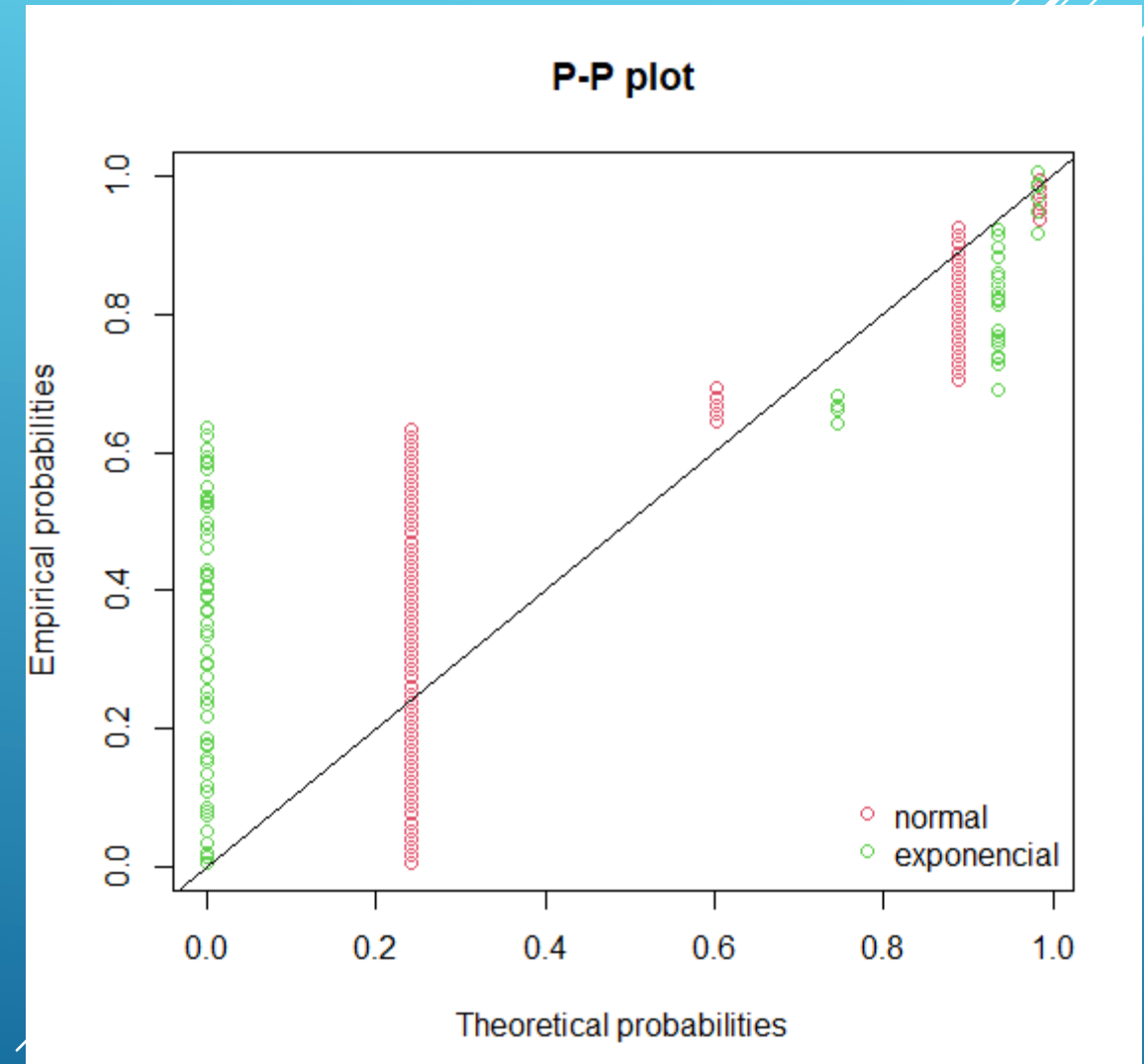
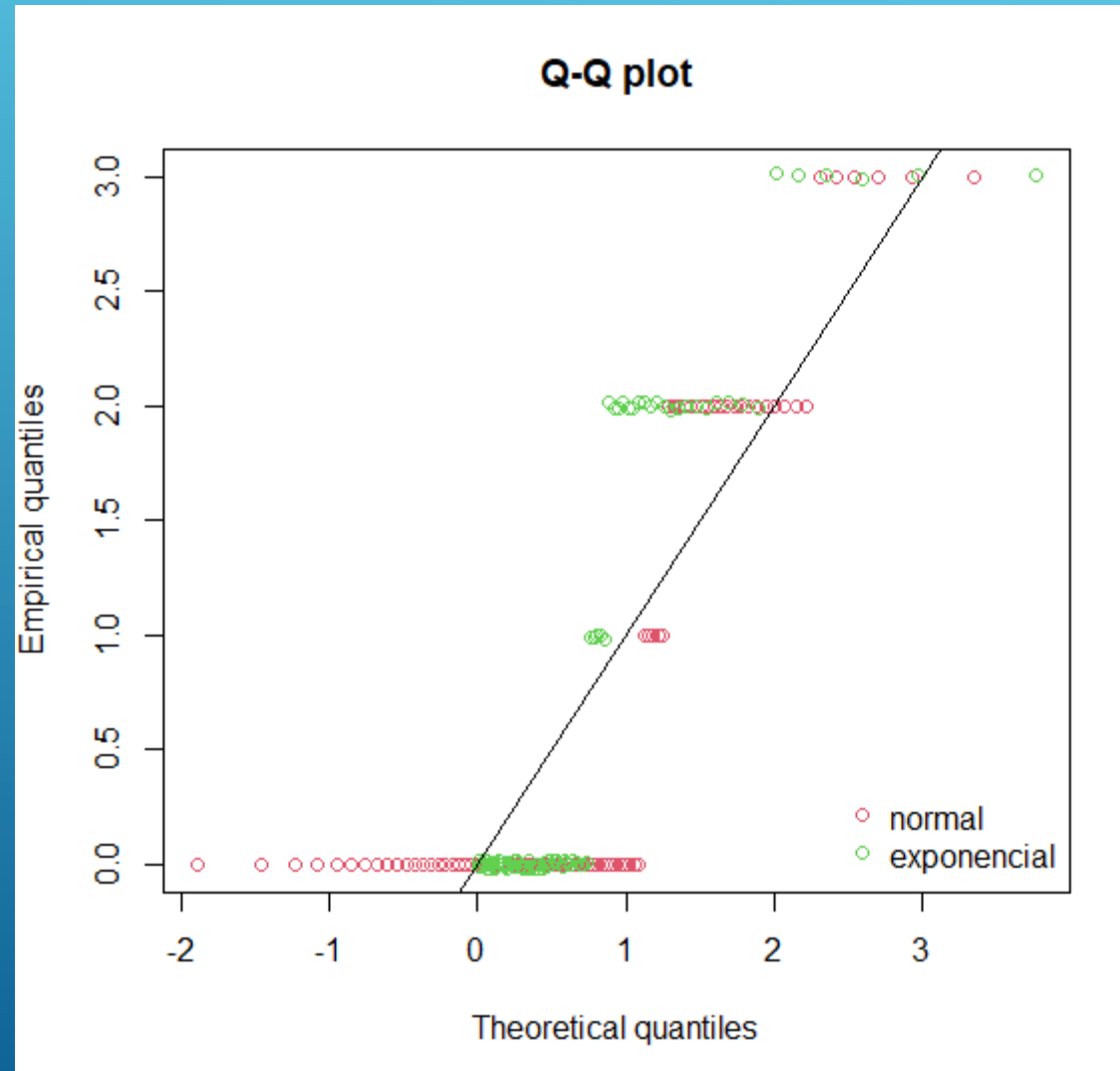
```
data: vari
D = 0.031395, p-value = 0.82
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.3175631
```

Razão molar inerte/metano na alimentação do reator



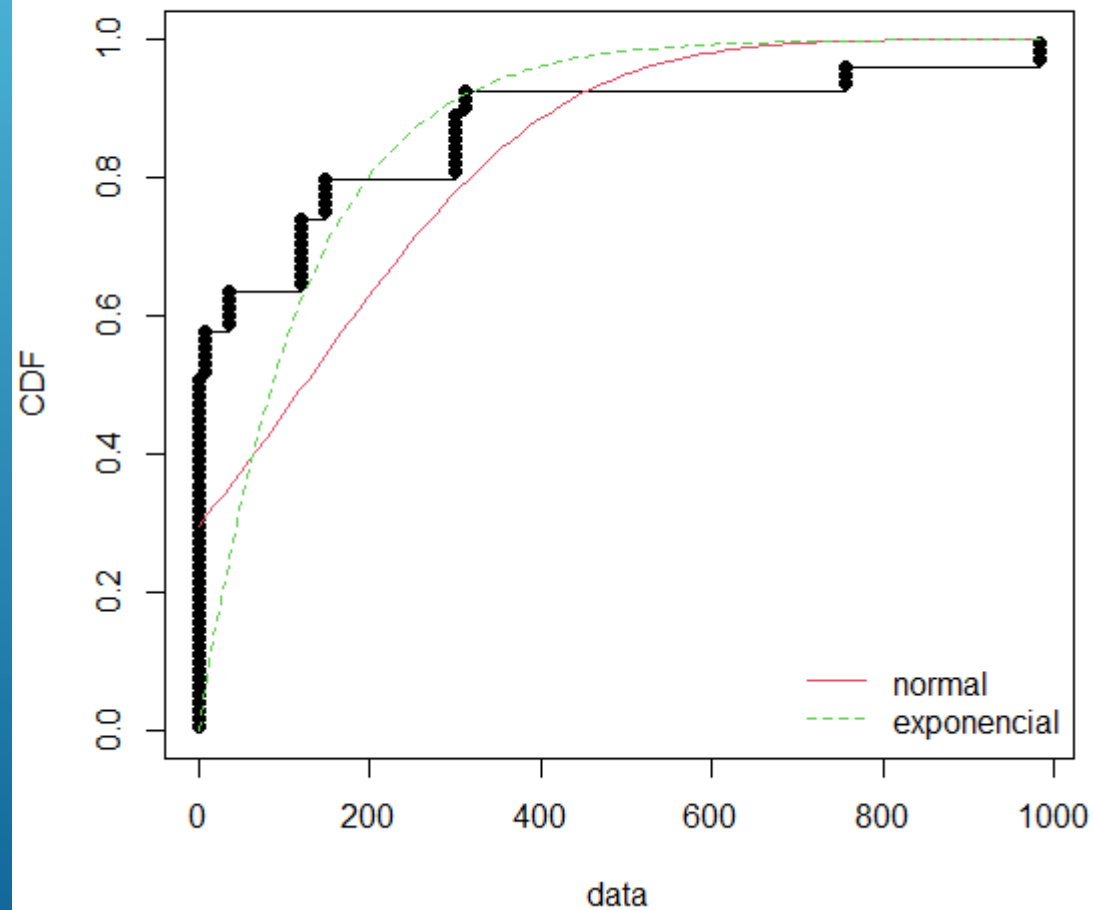
Razão molar inerte/metano na alimentação do reator



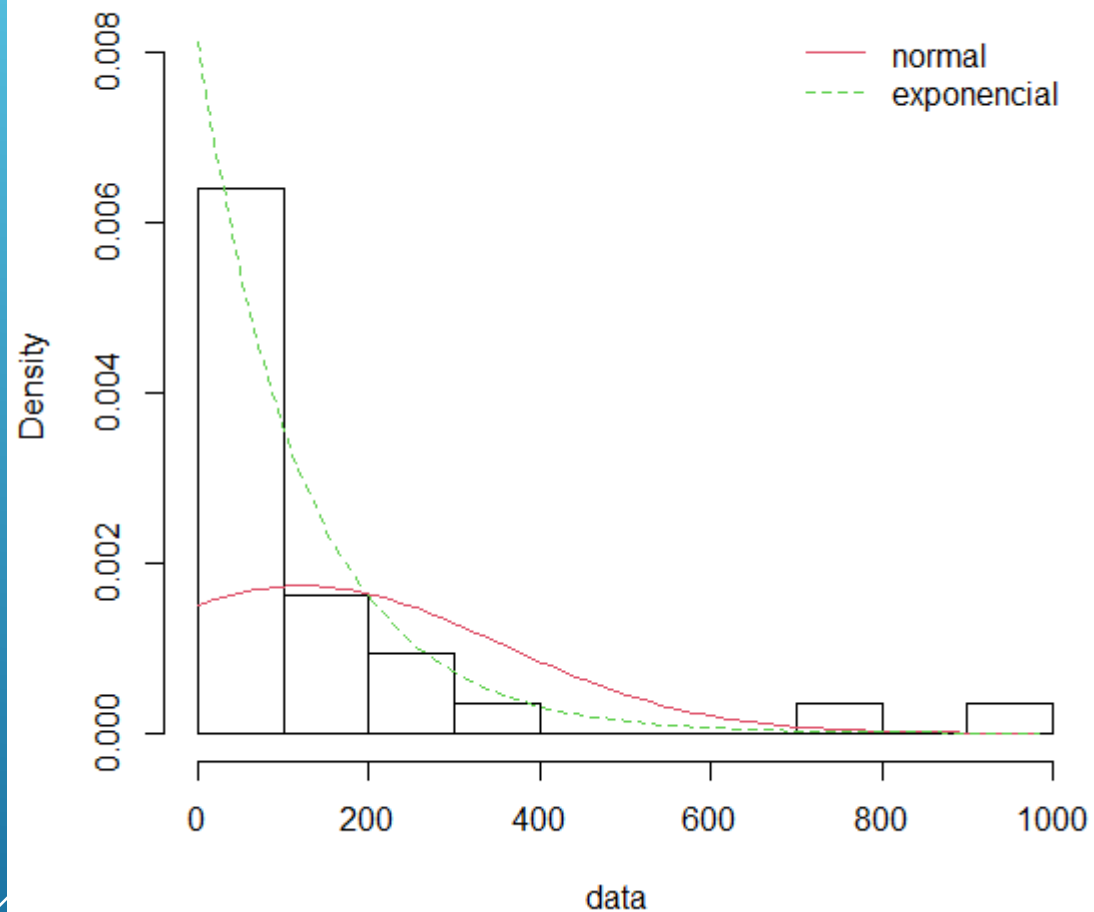
Razão molar inerte/metano na alimentação do reator

```
Hartigans' dip test for unimodality / multimodality  
data: vari  
D = 0.11628, 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] 0.7877888
```

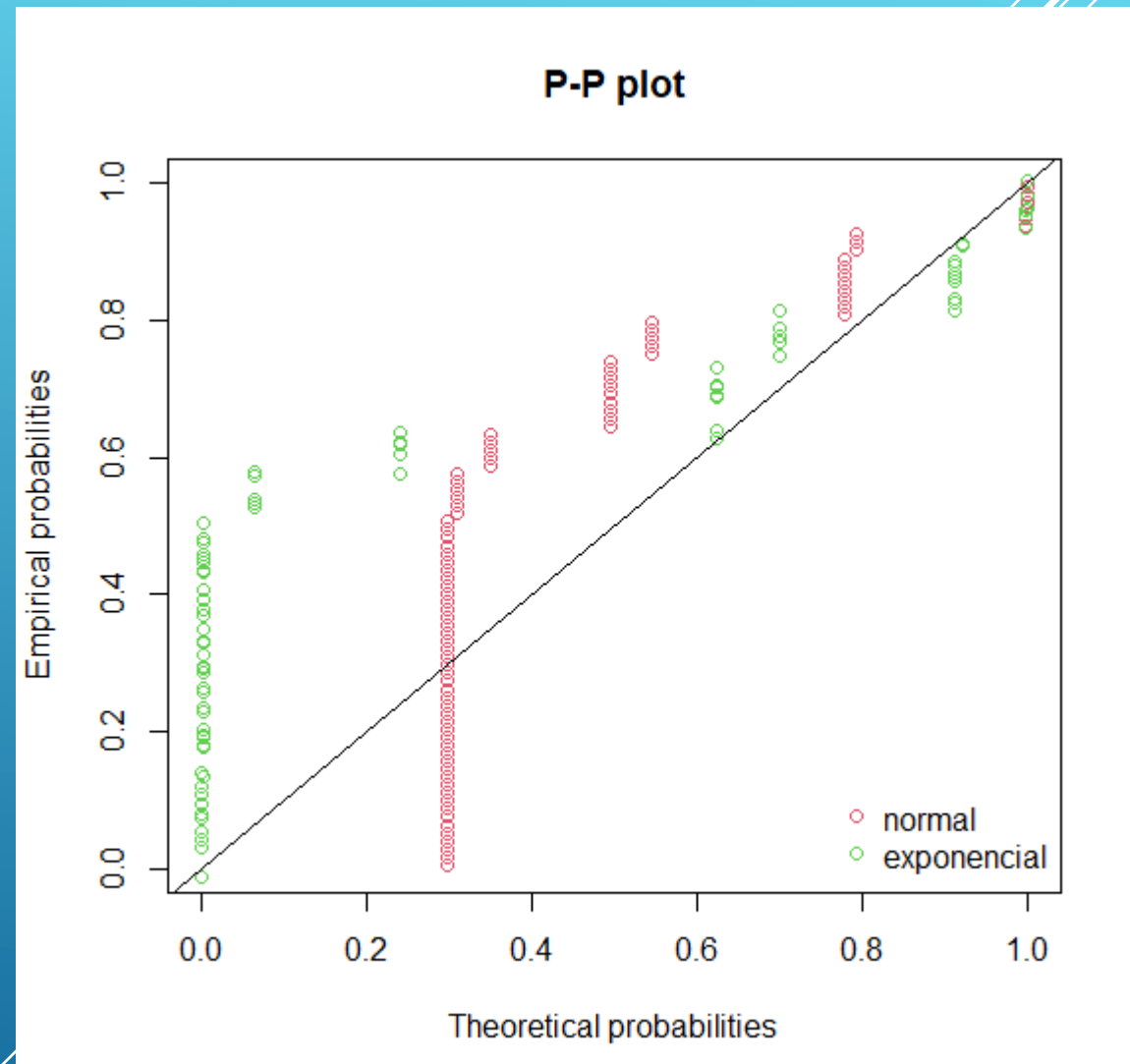
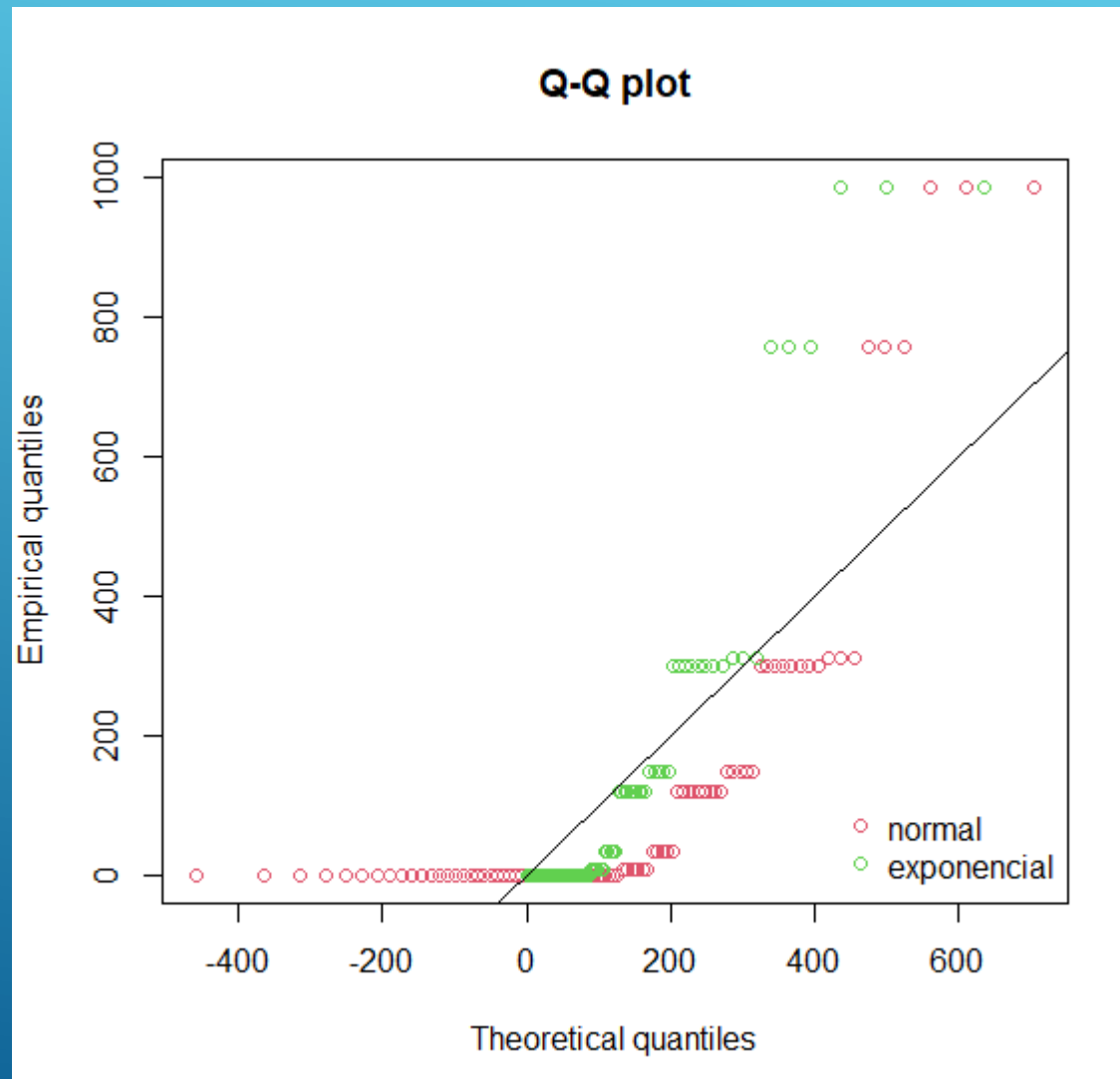
Empirical and theoretical CDFs



Histogram and theoretical densities



Velocidade espacial WHSV (h-1)



Velocidade espacial WHSV (h-1)

Goodness-of-fit statistics

	normal	exponencial
Kolmogorov-Smirnov statistic	0.2963685	0.5178212
Cramer-von Mises statistic	2.4381675	5.9974007
Anderson-Darling statistic	13.2077760	Inf

Goodness-of-fit criteria

	normal	exponencial
Akaike's Information Criterion	1183.753	1002.071
Bayesian Information Criterion	1188.661	1004.525

Hartigans' dip test for unimodality / multimodality

data: vari

D = 0.075581, p-value = 0.0005553

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)
```

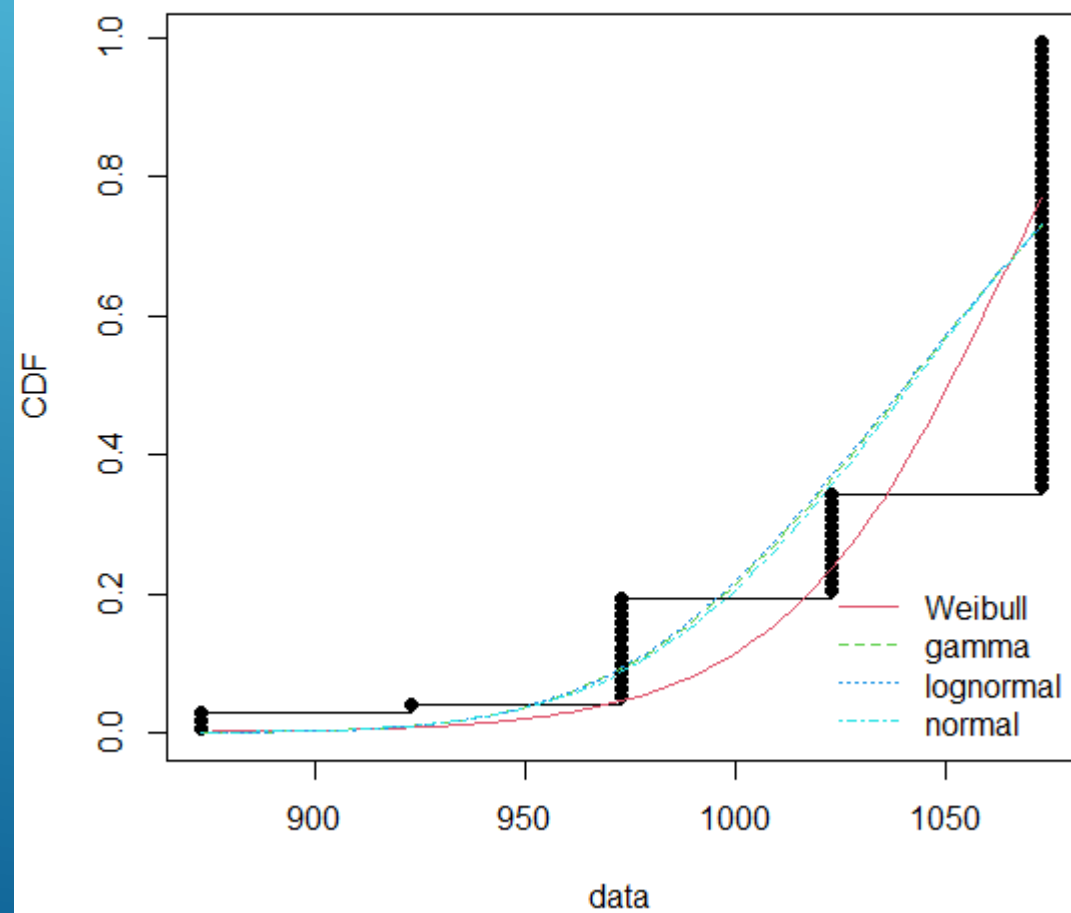
```
[1] FALSE
```

```
> bimodality_coefficient(vari)
```

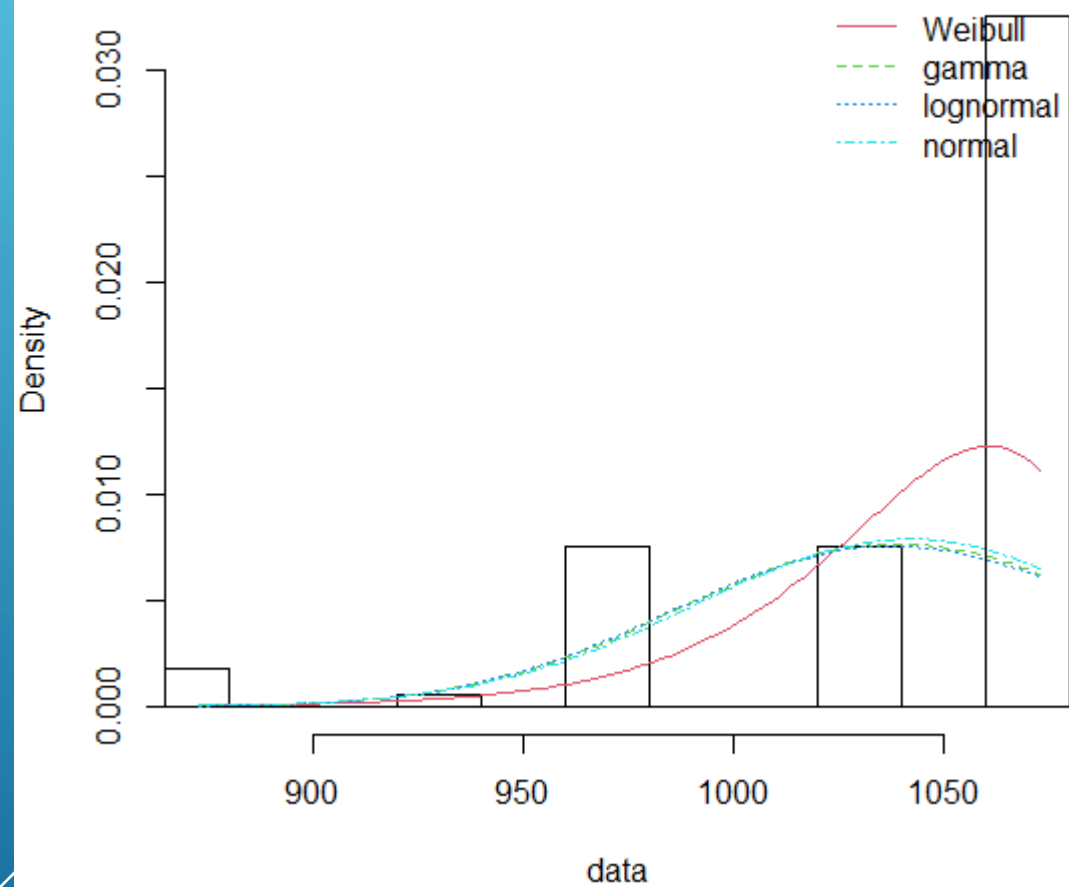
```
[1] 0.8005614
```

Temperatura de reação

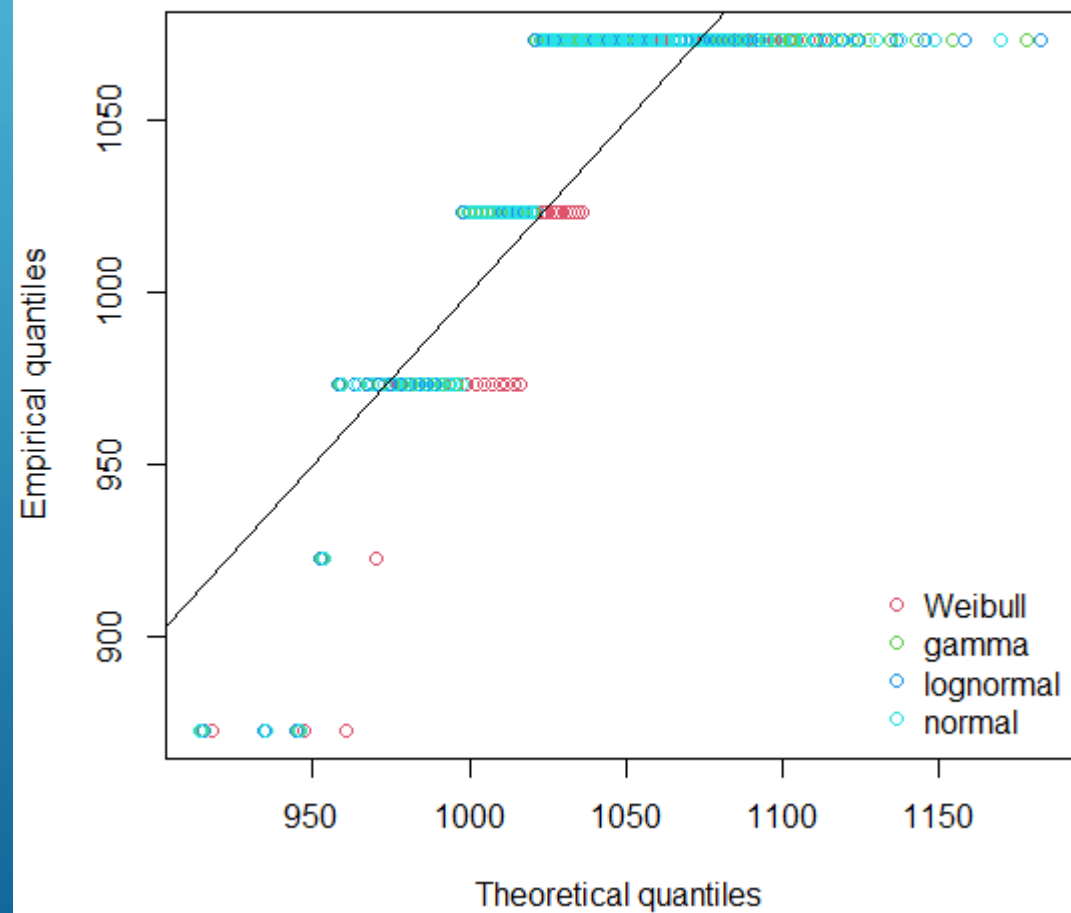
Empirical and theoretical CDFs



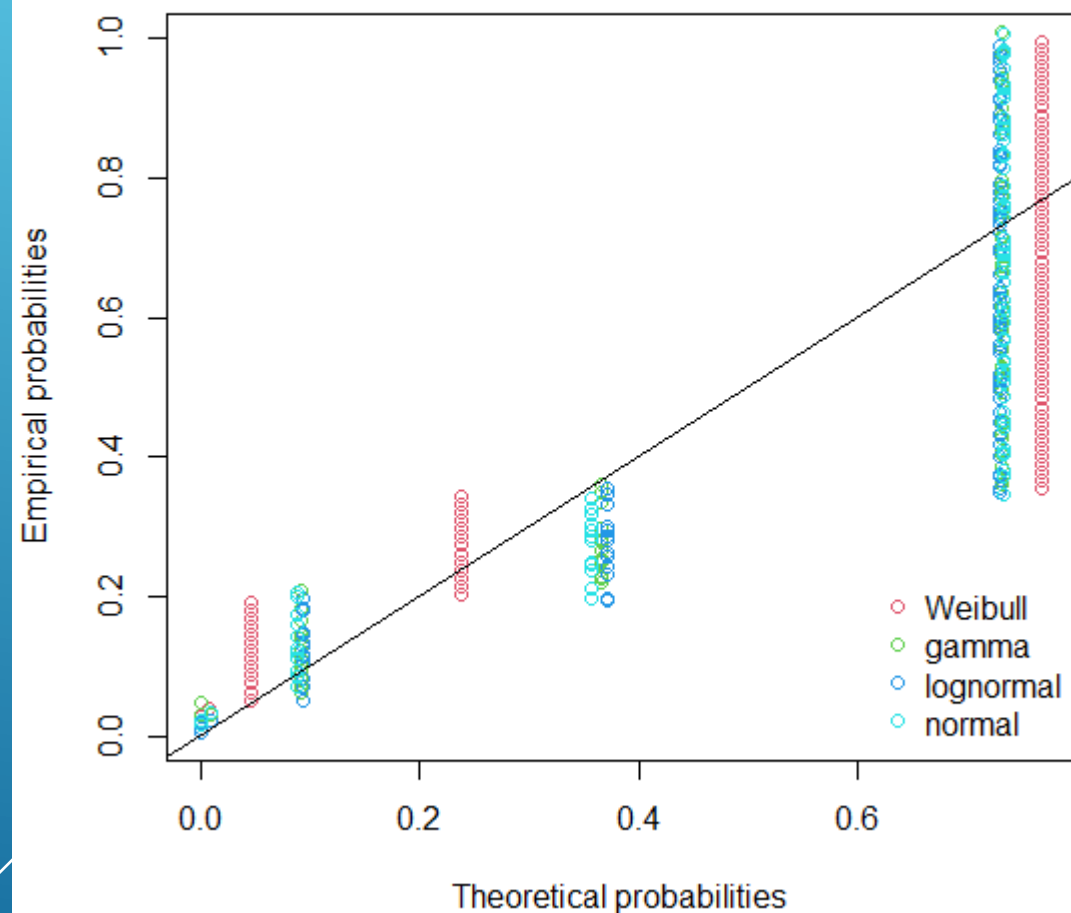
Histogram and theoretical densities



Q-Q plot



P-P plot



Temperatura de reação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.4193293	0.381311	0.3799533	0.3836665
Cramer-von Mises statistic	2.6169616	2.328227	2.3295695	2.3250290
Anderson-Darling statistic	14.6051582	12.293661	12.2960879	12.2886319

Goodness-of-fit criteria

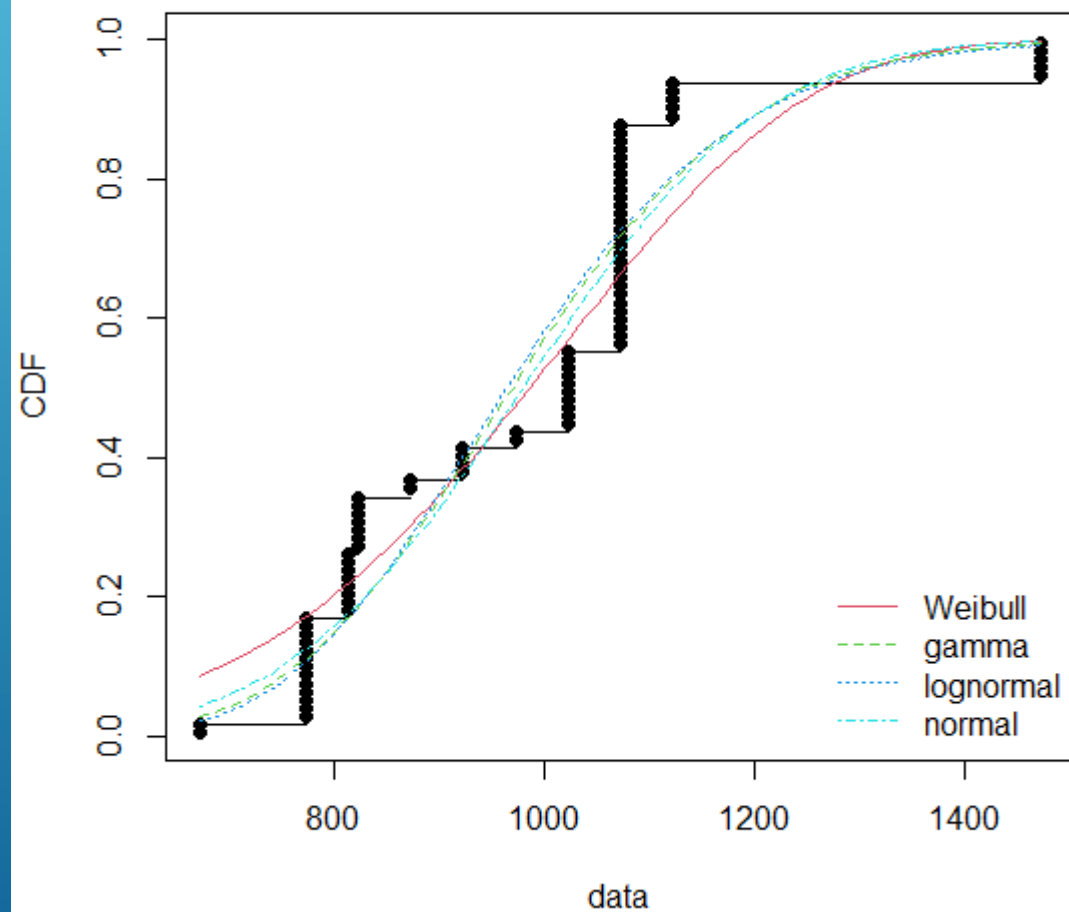
	weibull	gamma	lognormal	normal
Akaike's Information Criterion	880.5405	927.9128	930.4680	922.9933
Bayesian Information Criterion	885.4492	932.8215	935.3767	927.9020

Hartigans' dip test for unimodality / multimodality

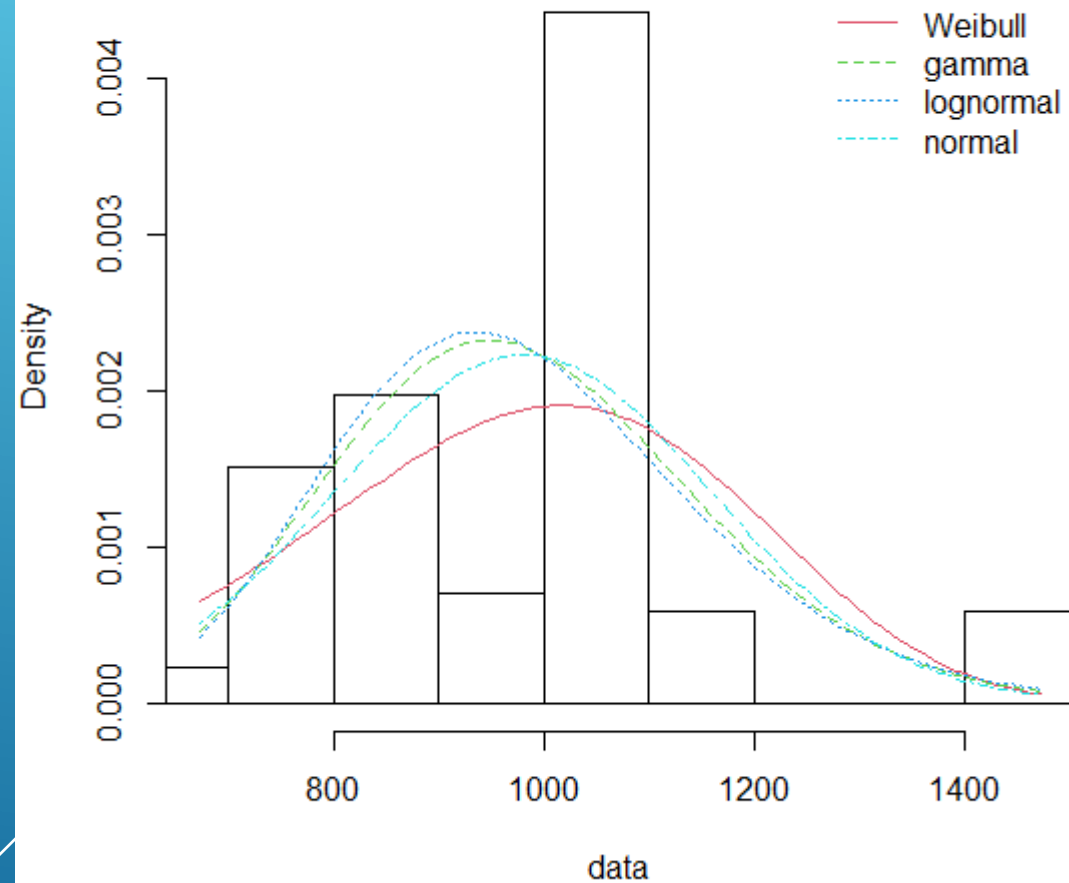
```
data: vari
D = 0.075581, p-value = 0.0005553
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> 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] 0.6963064
```

Empirical and theoretical CDFs

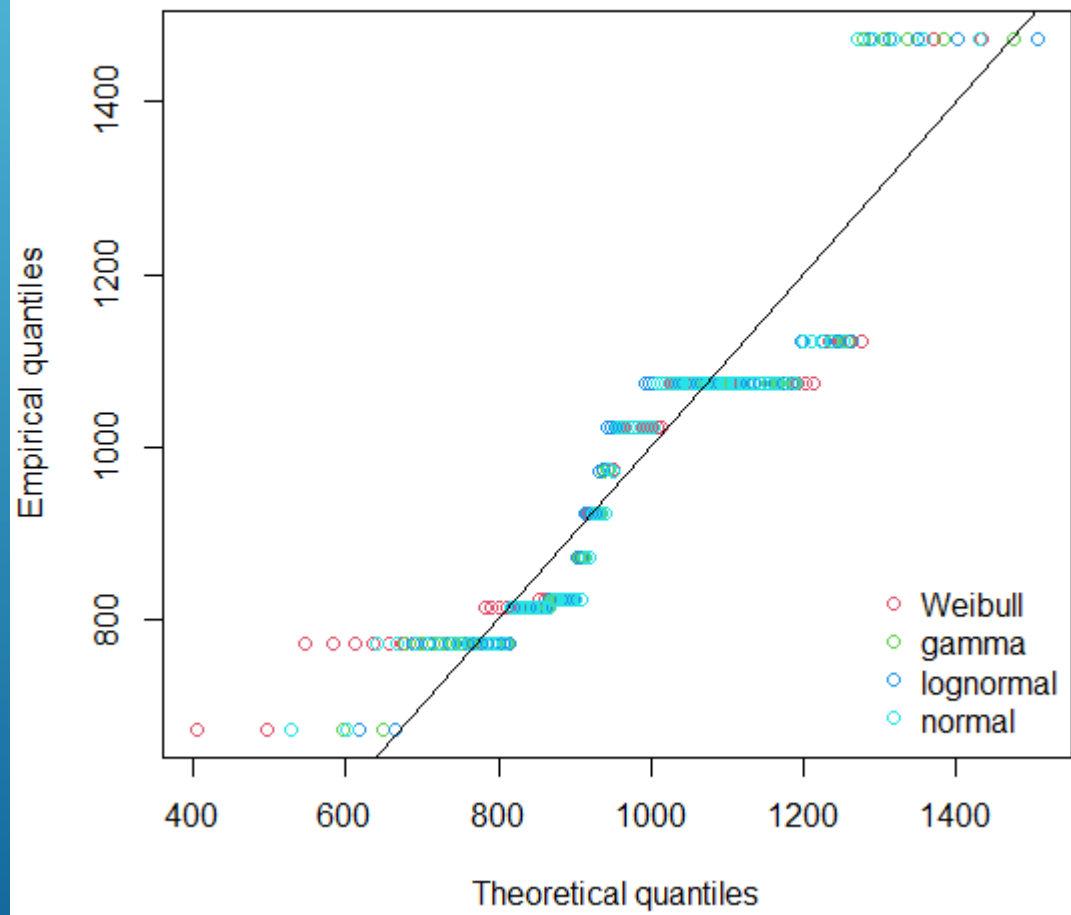


Histogram and theoretical densities

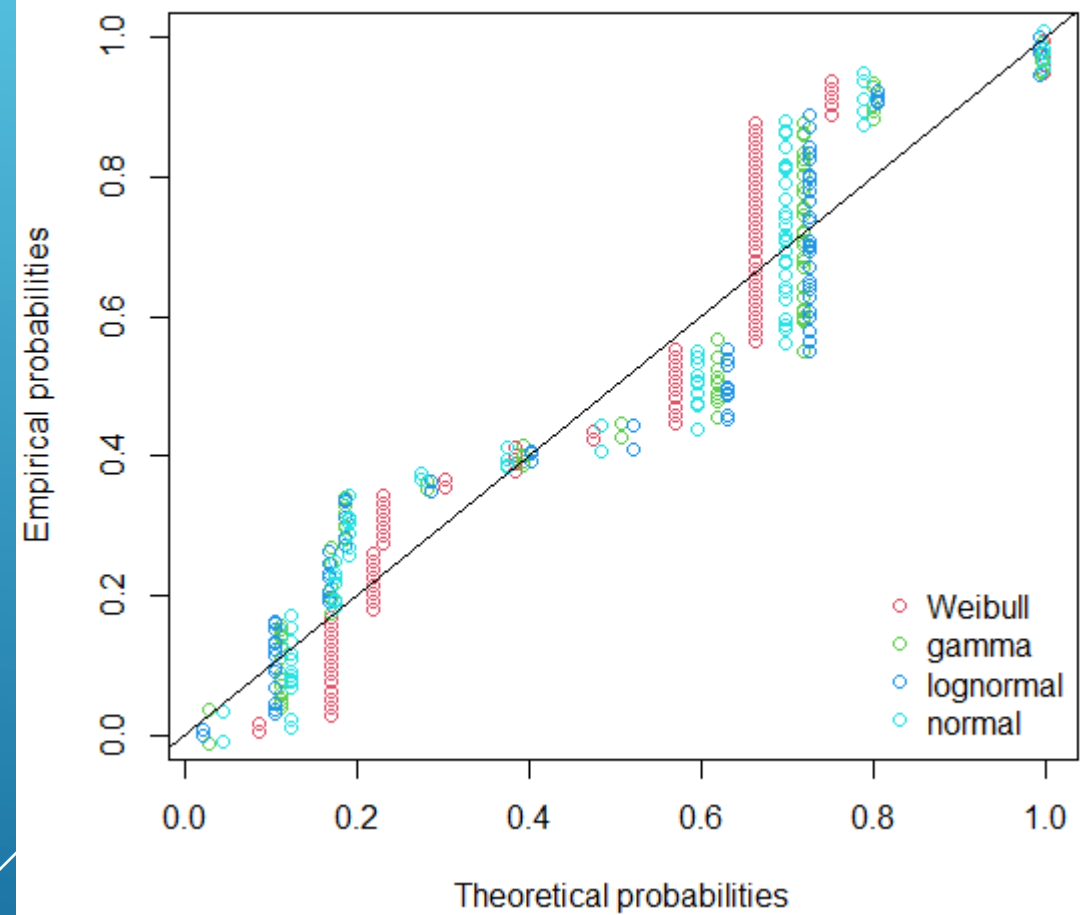


Temperatura de calcinação

Q-Q plot



P-P plot



Temperatura de calcinação

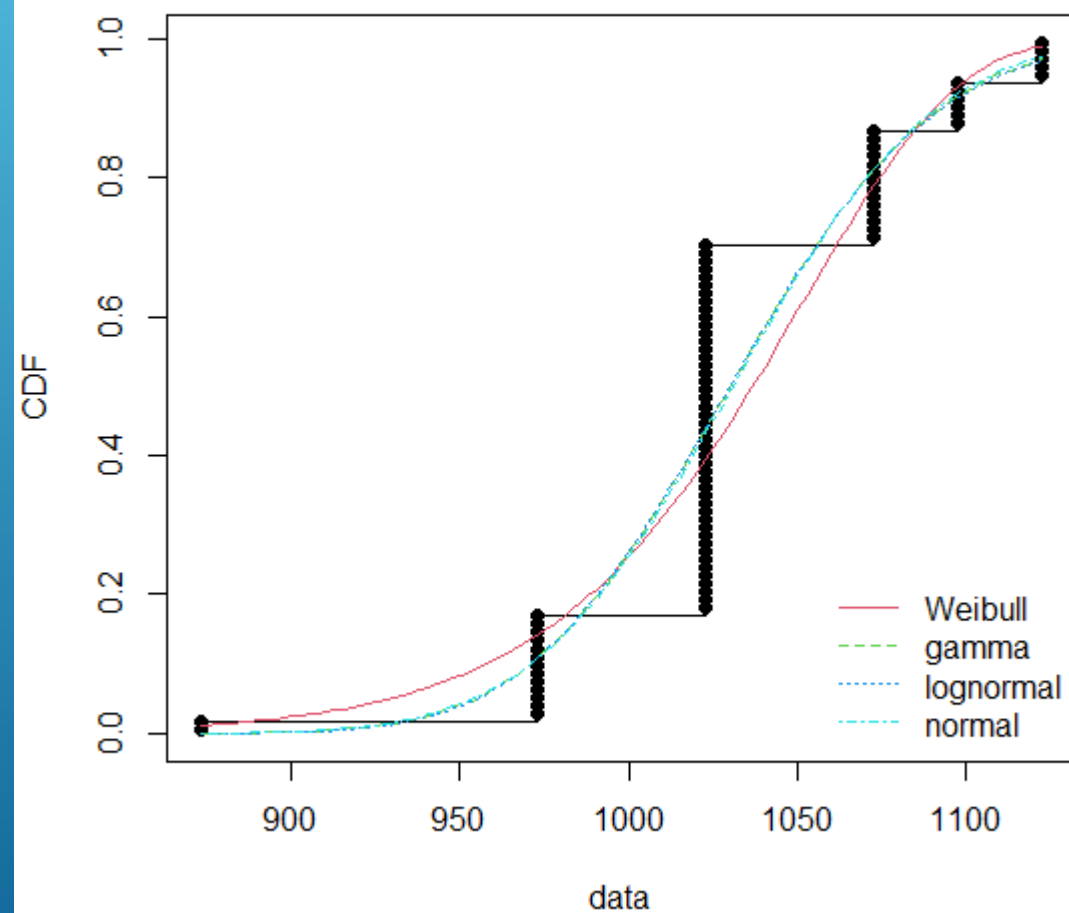
```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.2204979 0.1763522 0.1878734 0.1858098
Cramer-von Mises statistic  0.7042386 0.6569248 0.6839264 0.6295931
Anderson-Darling statistic  4.7091381 3.9342196 3.9530594 4.0735462

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 1152.603 1134.083 1132.313 1140.282
Bayesian Information Criterion 1157.511 1138.992 1137.221 1145.190
```

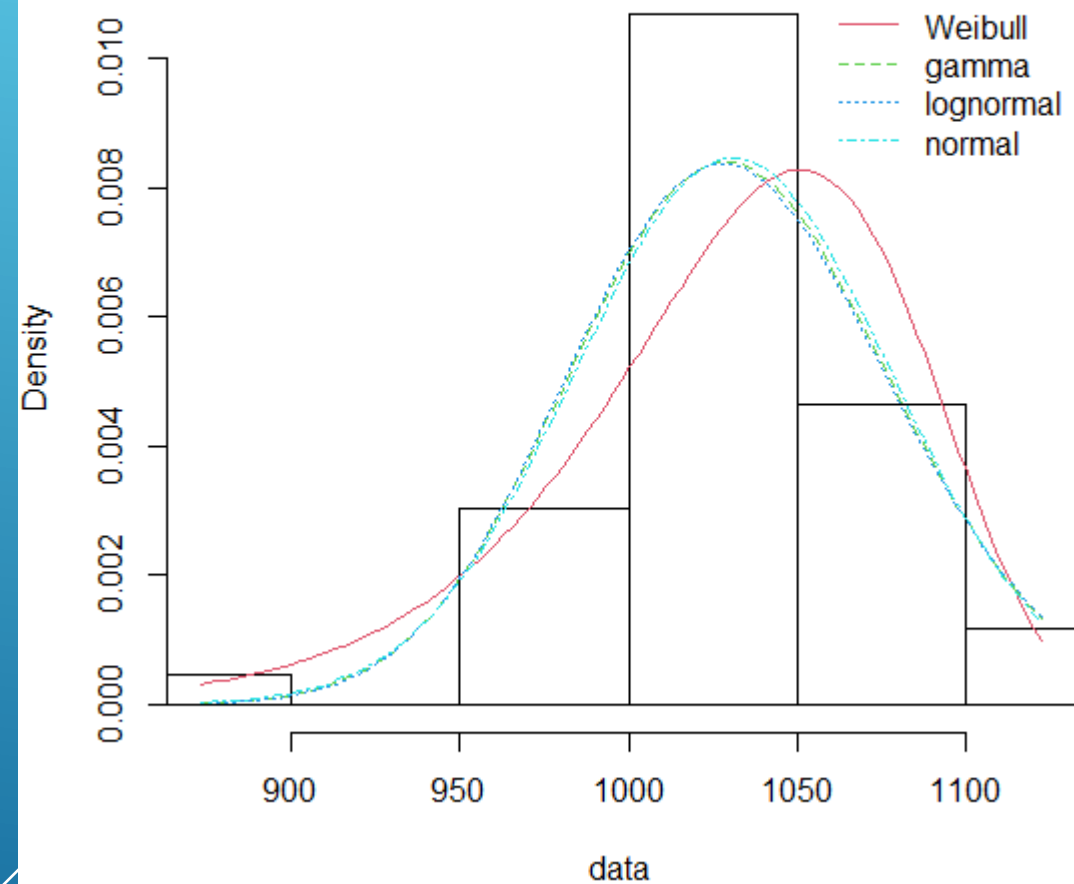
```
Hartigans' dip test for unimodality / multimodality
data: vari
D = 0.12093, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.3936323
```

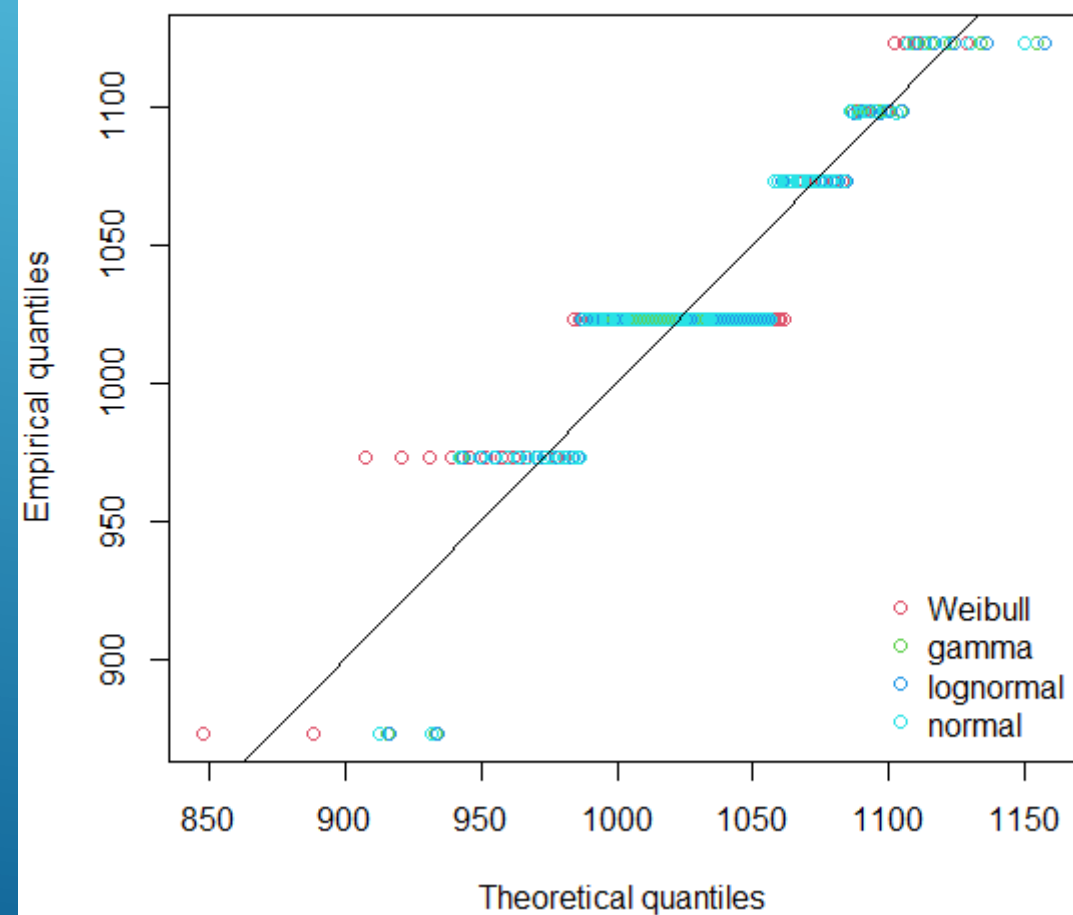
Empirical and theoretical CDFs



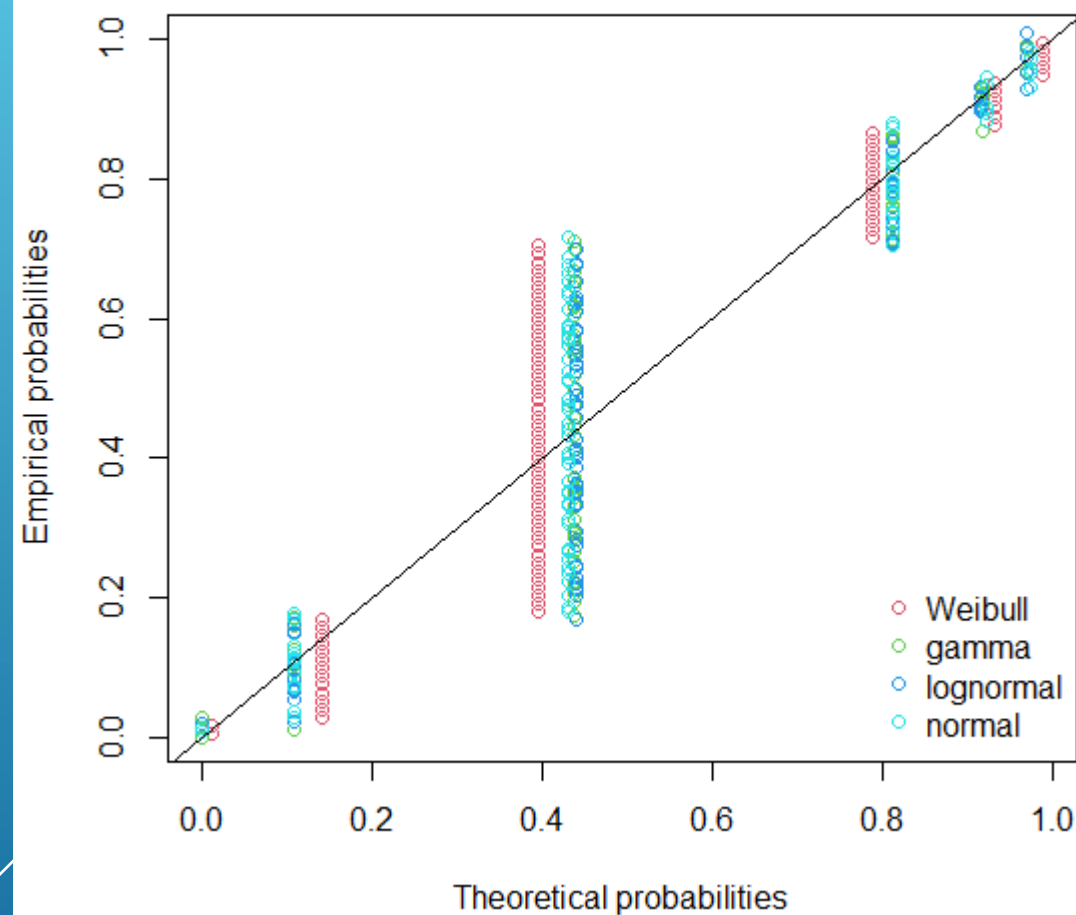
Histogram and theoretical densities



Q-Q plot



P-P plot



Temperatura de redução

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.314254	0.2714153	0.2682453	0.2779446
Cramer-von Mises statistic	1.286986	1.1658083	1.1644653	1.1713129
Anderson-Darling statistic	5.986728	5.3834339	5.3876609	5.3908085

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	915.0773	911.9248	912.7569	910.5442
Bayesian Information Criterion	919.9860	916.8335	917.6656	915.4529

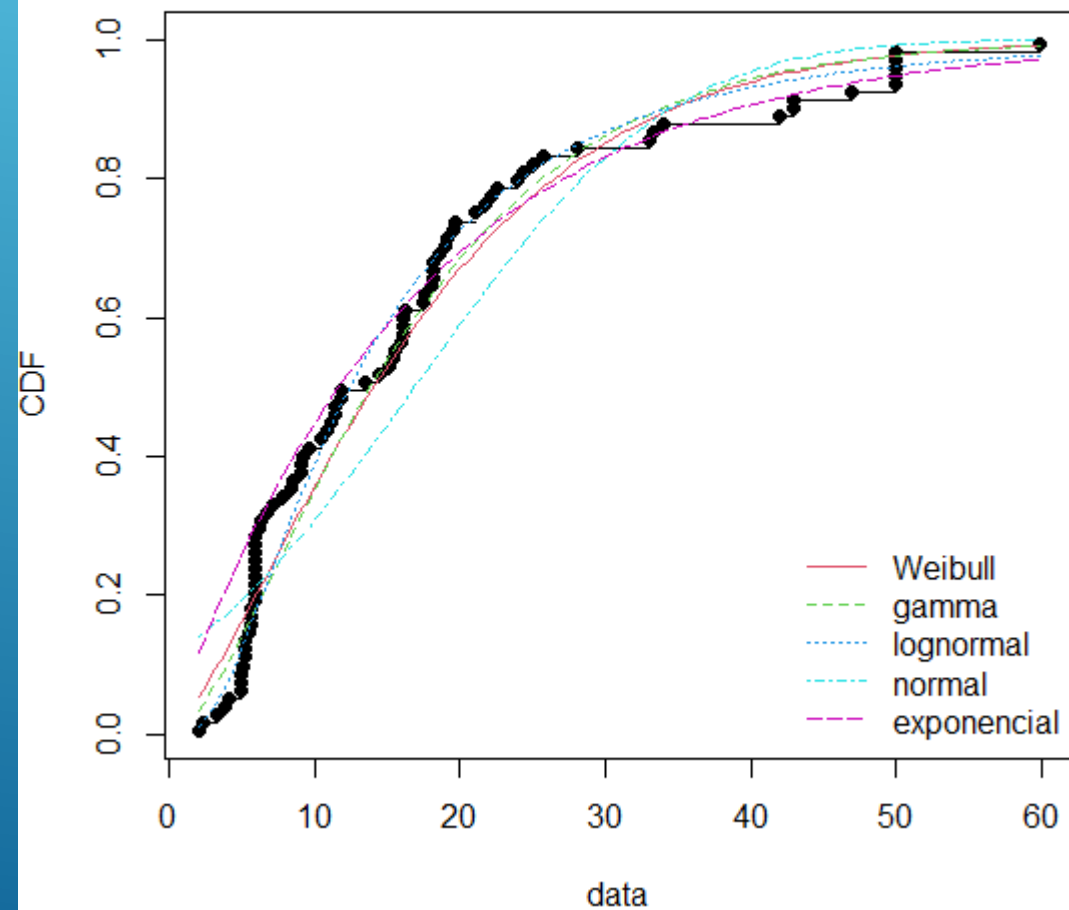
Hartigan's dip test for unimodality / multimodality

```
data: vari
D = 0.081395, p-value = 0.0001074
alternative hypothesis: non-unimodal, i.e., at least bimodal

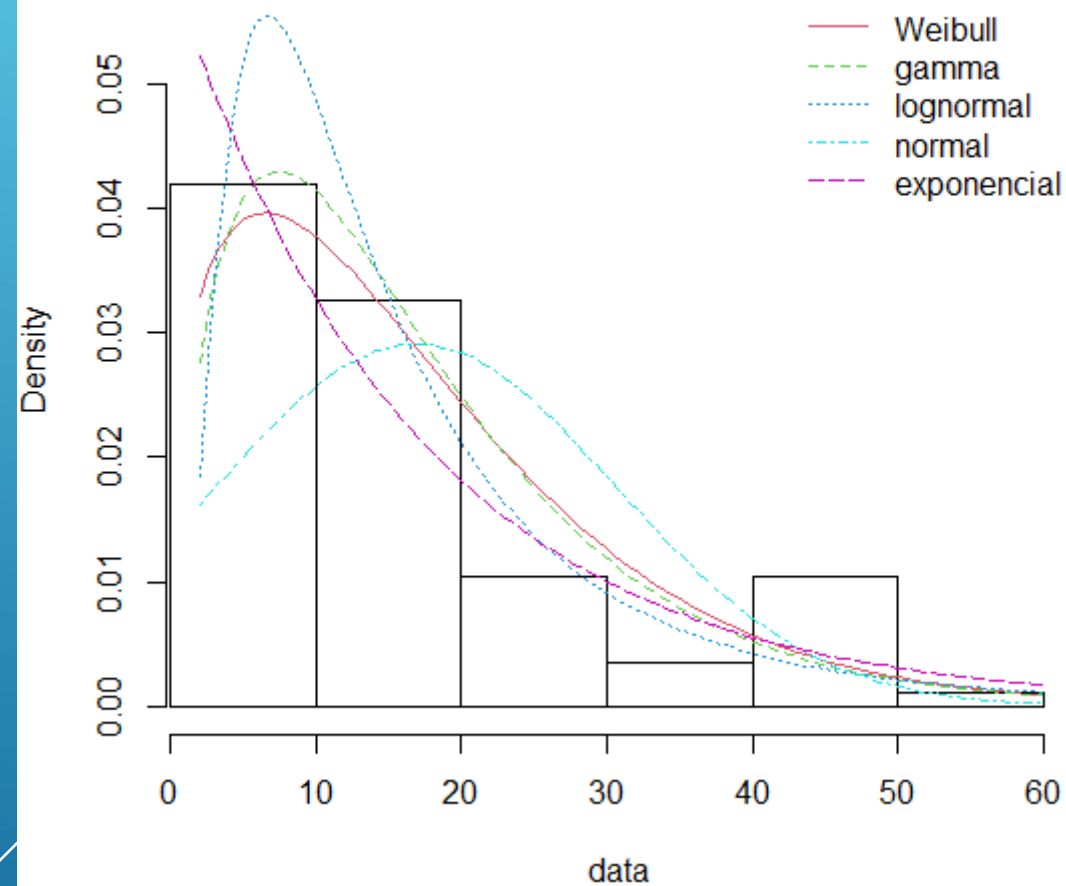
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] TRUE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.2459312
```

Tamanho de cristalito da fase ativa

Empirical and theoretical CDFs

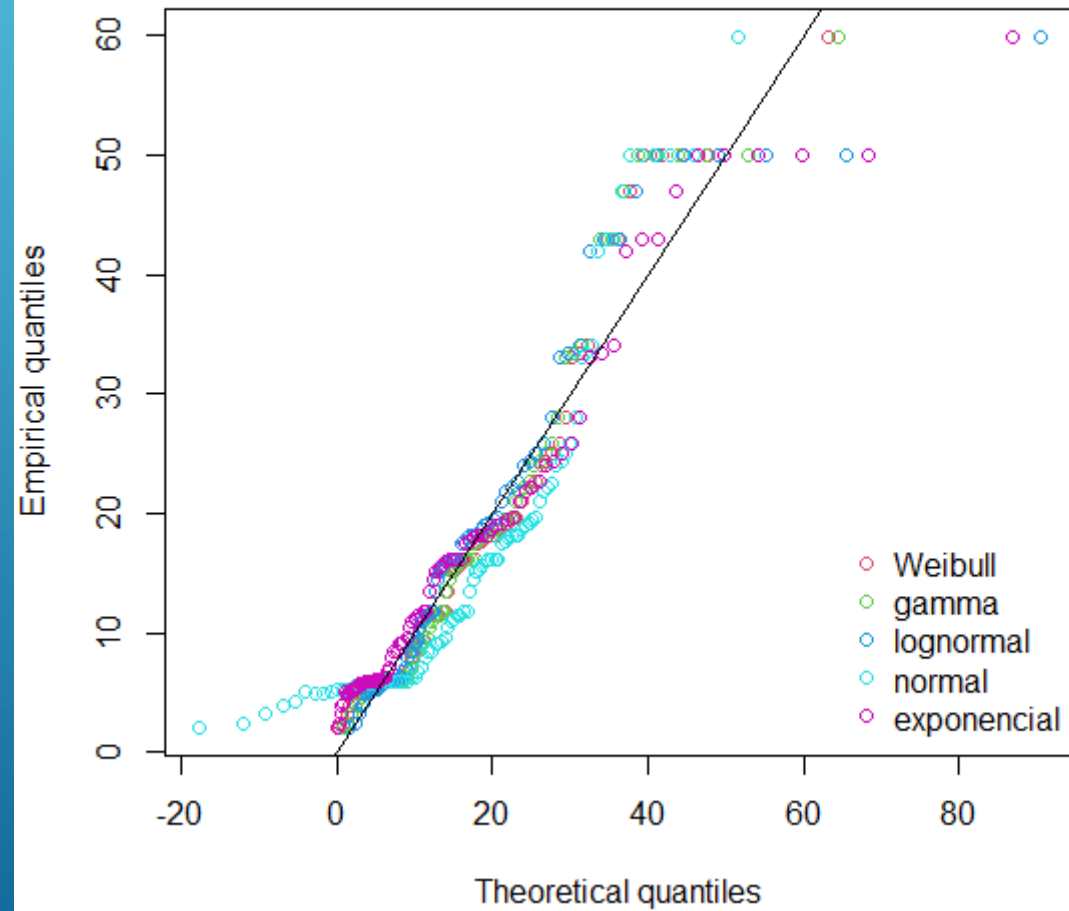


Histogram and theoretical densities

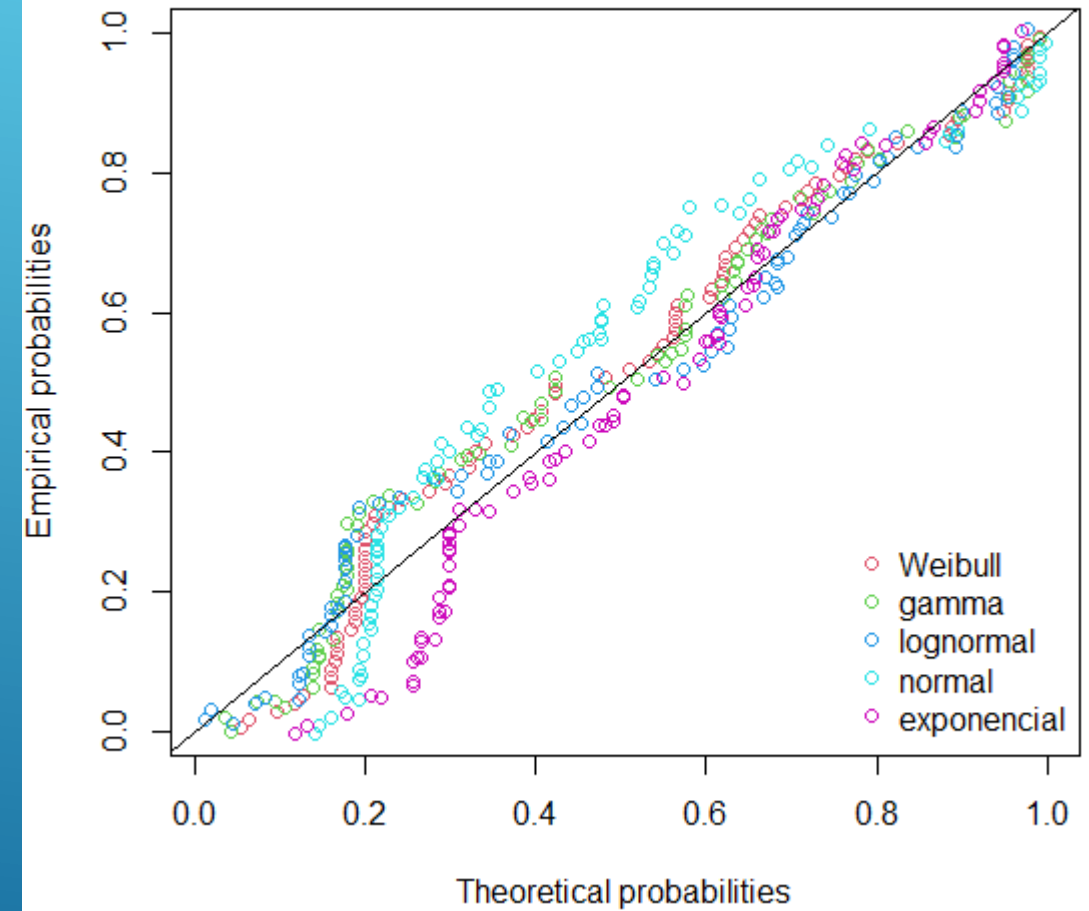


Tamanho de cristalito da fase ativa

Q-Q plot



P-P plot



Tamanho de cristalito da fase ativa

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.1033734 0.1223945 0.1221967 0.1636675
Cramer-von Mises statistic  0.2355436 0.2266585 0.1601407 0.8053937
Anderson-Darling statistic  1.7315142 1.6155516 1.0492111 5.1155980

      exponencial
Kolmogorov-Smirnov statistic 0.1979942
Cramer-von Mises statistic  0.4502269
Anderson-Darling statistic  3.1380408

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 651.2990 647.4417 640.6607 698.4337
Bayesian Information Criterion 656.2077 652.3504 645.5694 703.3424

      exponencial
Akaike's Information Criterion 660.2770
Bayesian Information Criterion 662.7313
```

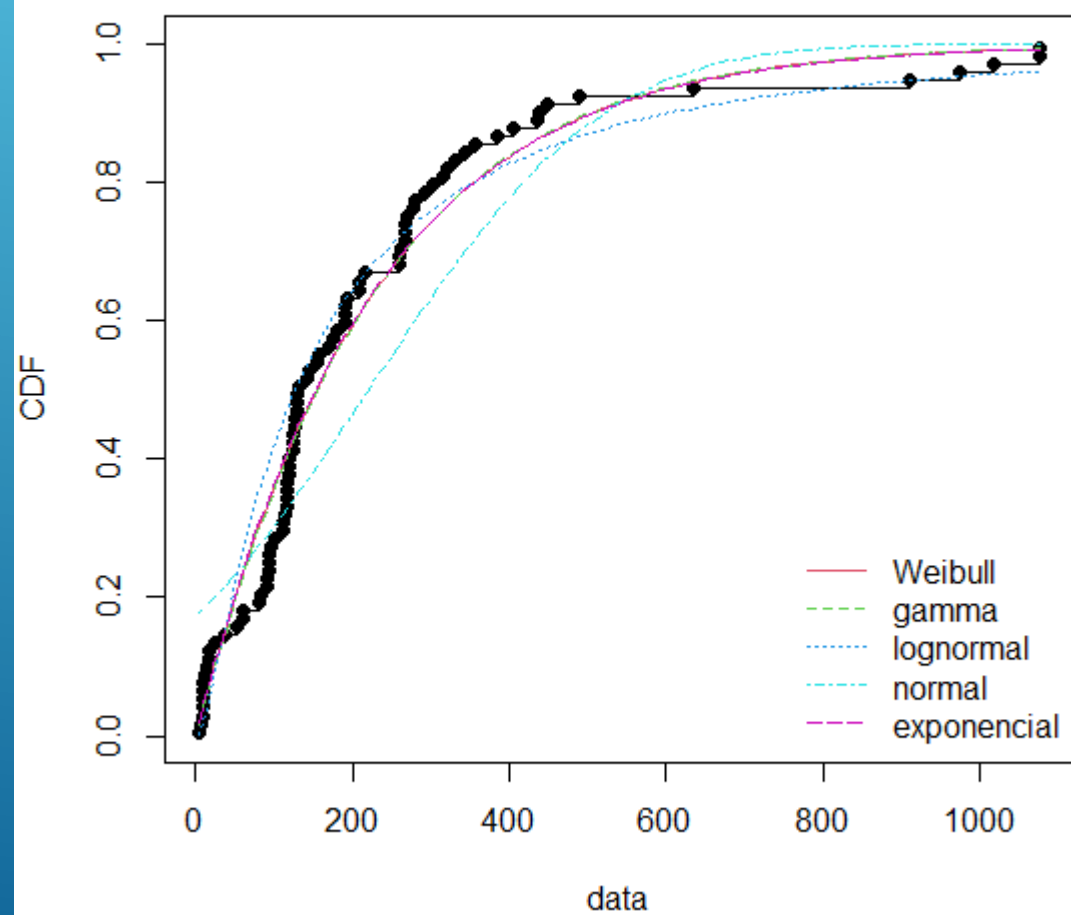
```
Hartigans' dip test for unimodality / multimodality

data: vari
D = 0.039559, p-value = 0.426
alternative hypothesis: non-unimodal, i.e., at least bimodal

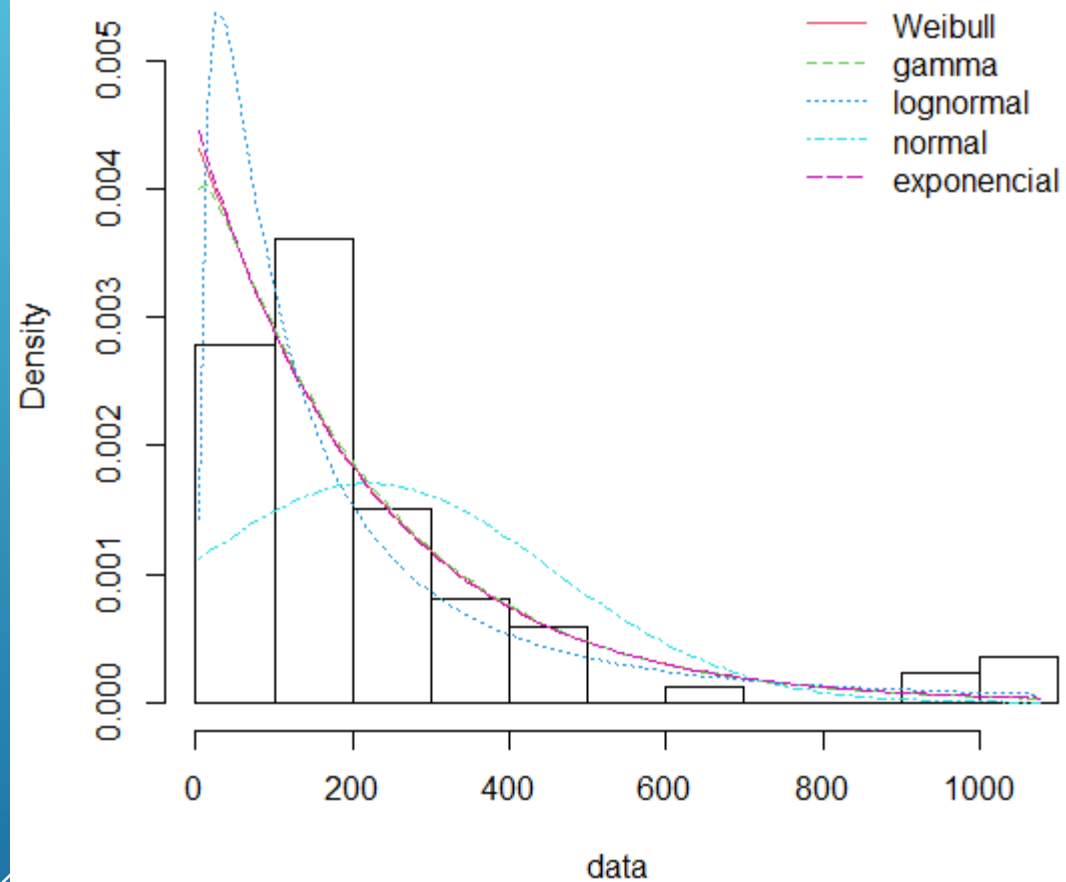
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6850521
```


Área específica do catalisador

Empirical and theoretical CDFs

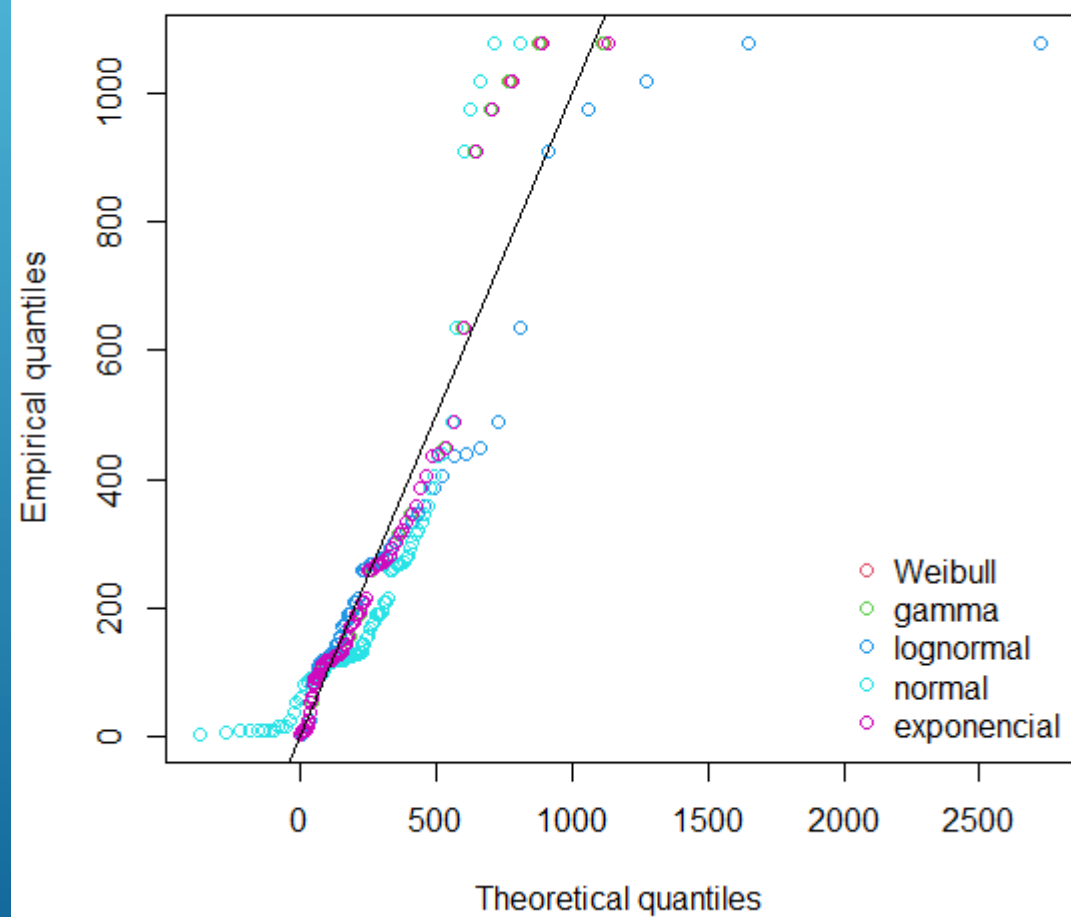


Histogram and theoretical densities

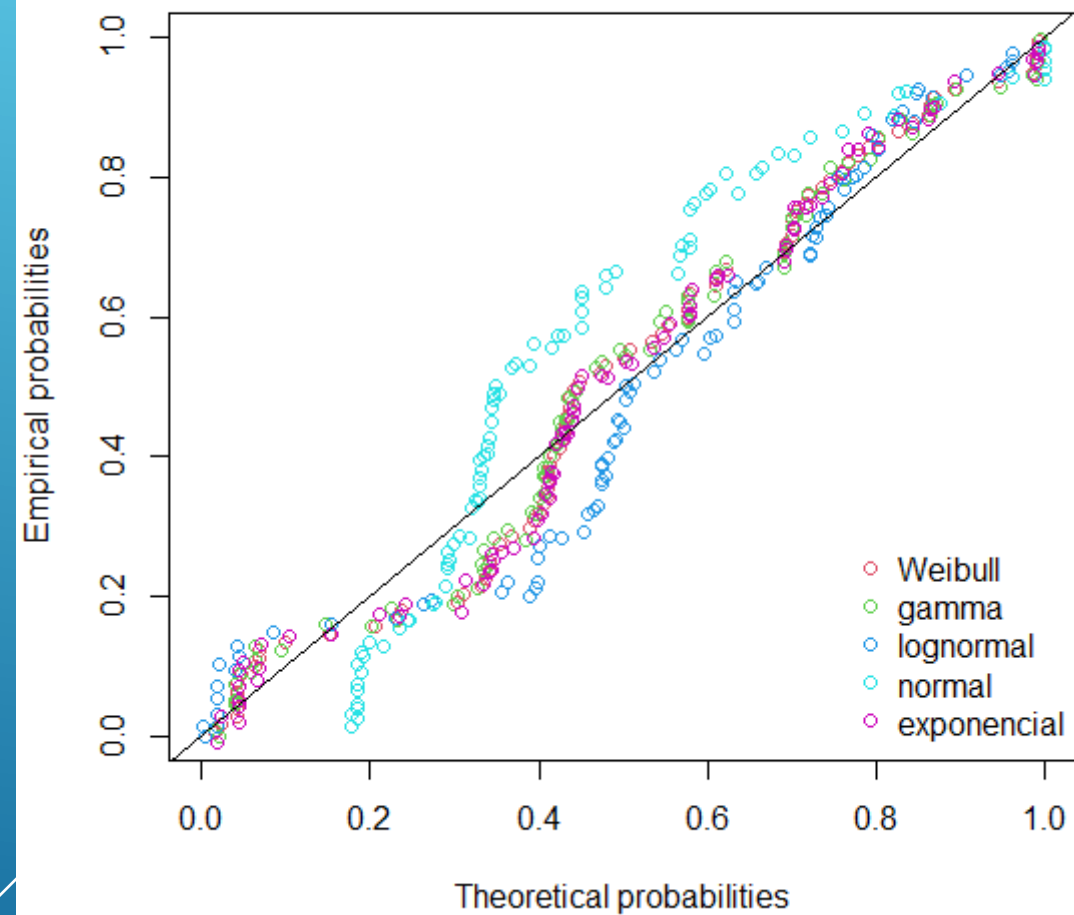


Área específica do catalisador

Q-Q plot



P-P plot



Área específica do catalisador

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1222402	0.1171019	0.1787064	0.1881667
Cramer-von Mises statistic	0.2216011	0.2117921	0.4848420	1.1341050
Anderson-Darling statistic	1.3466202	1.3302355	2.8457021	6.8747087

exponencial

Kolmogorov-Smirnov statistic	0.1257301
Cramer-von Mises statistic	0.2280770
Anderson-Darling statistic	1.3601766

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1104.142	1104.060	1114.983	1186.271
Bayesian Information Criterion	1109.051	1108.969	1119.892	1191.179

exponencial

Akaike's Information Criterion	1102.156
Bayesian Information Criterion	1104.610

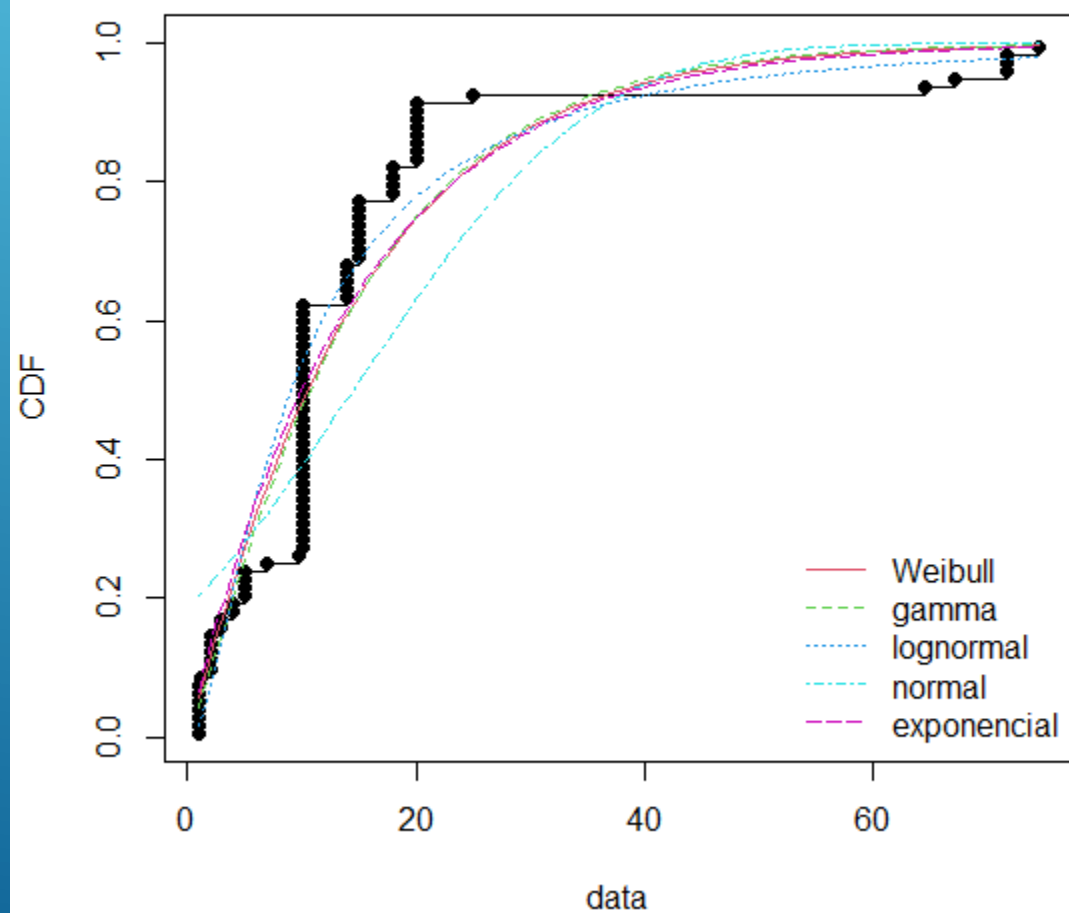
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.049456, p-value = 0.1214
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

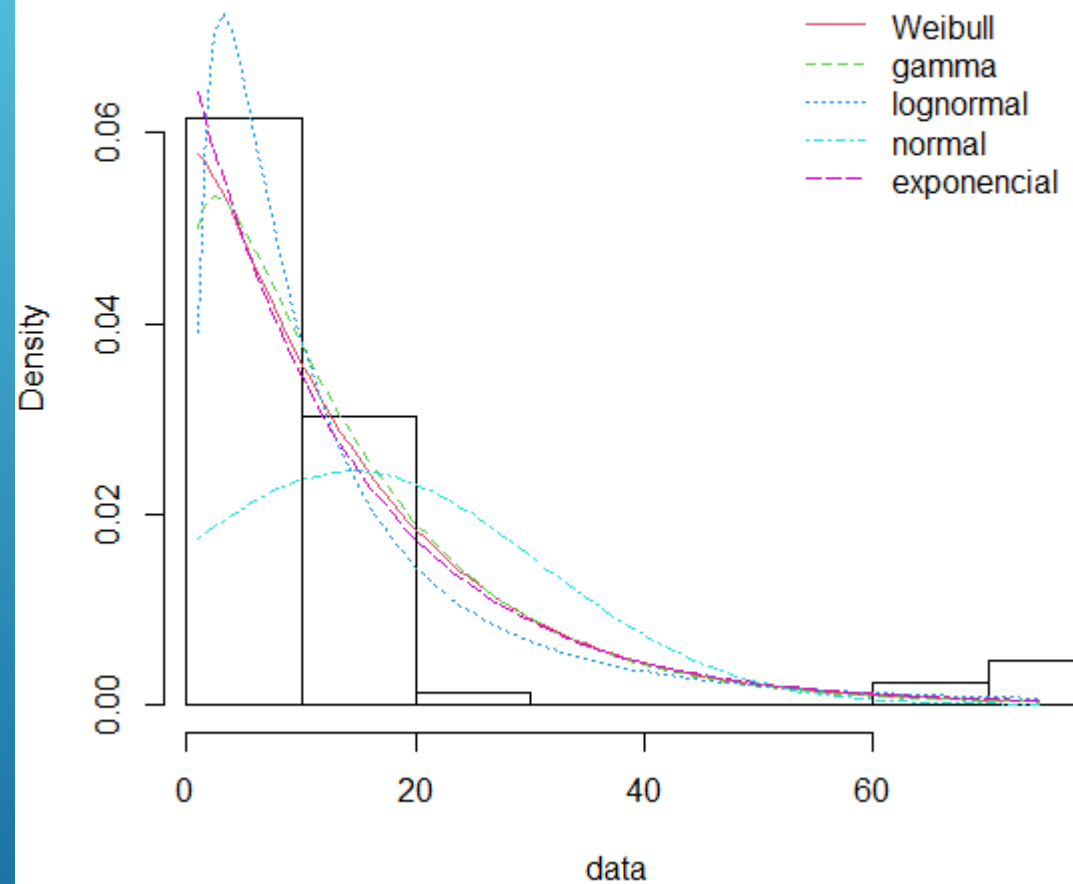
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.7292146
```

Teor total da fase ativa

Empirical and theoretical CDFs

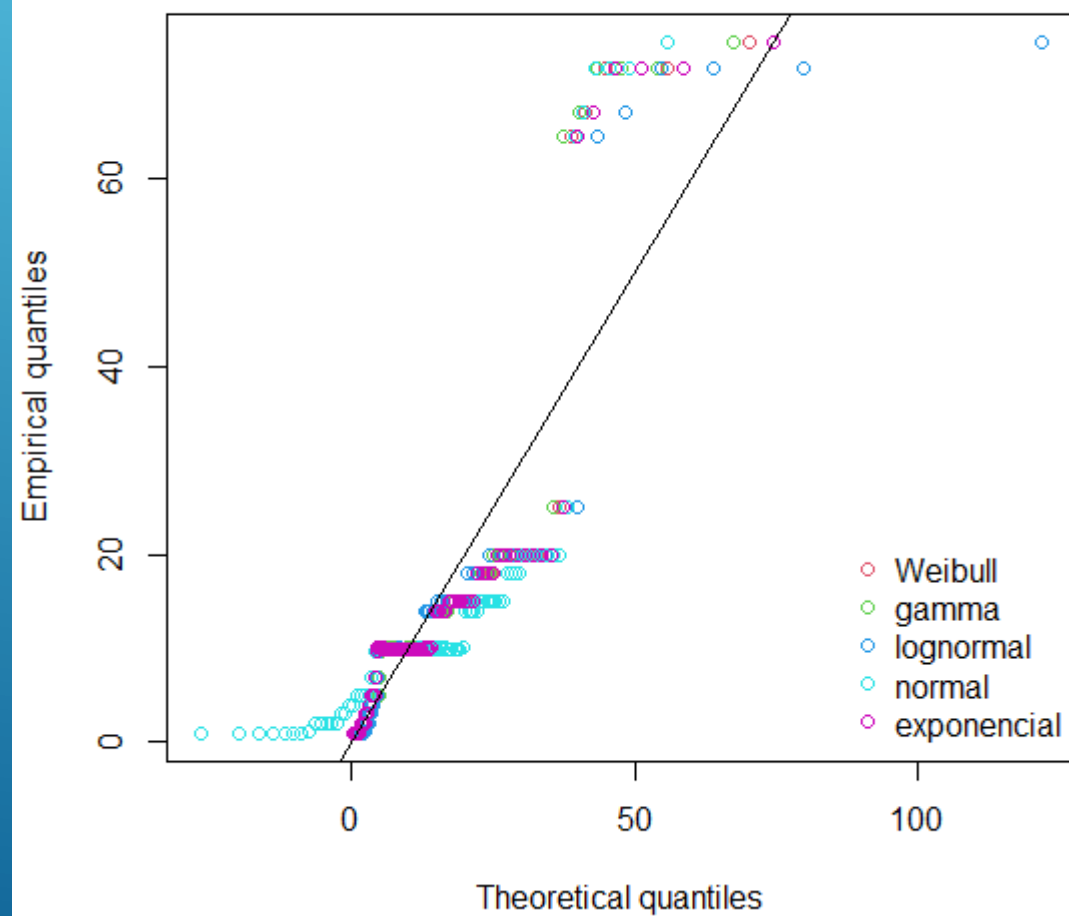


Histogram and theoretical densities

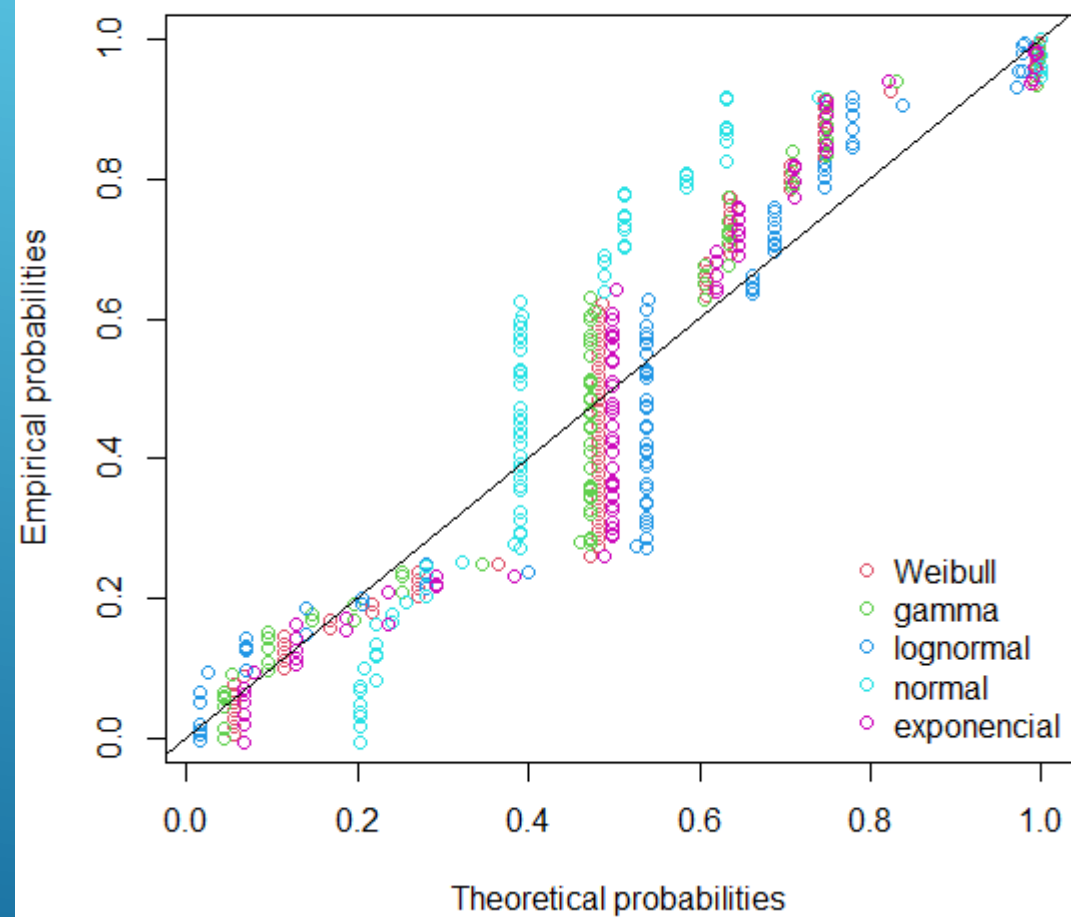


Teor total da fase ativa

Q-Q plot



P-P plot



Teor total da fase ativa

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2157307	0.2048017	0.2699101	0.2865259
Cramer-von Mises statistic	0.7319186	0.6932918	0.8434536	1.9846273
Anderson-Darling statistic	3.9838257	3.8810874	4.2955741	11.4168461

```
exponencial
```

Kolmogorov-Smirnov statistic	0.2319753
Cramer-von Mises statistic	0.7758935
Anderson-Darling statistic	4.1038544

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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	635.4737	634.1226	632.5383	728.2045
Bayesian Information Criterion	640.3824	639.0313	637.4470	733.1132

```
exponencial
```

Akaike's Information Criterion	633.9398
Bayesian Information Criterion	636.3941

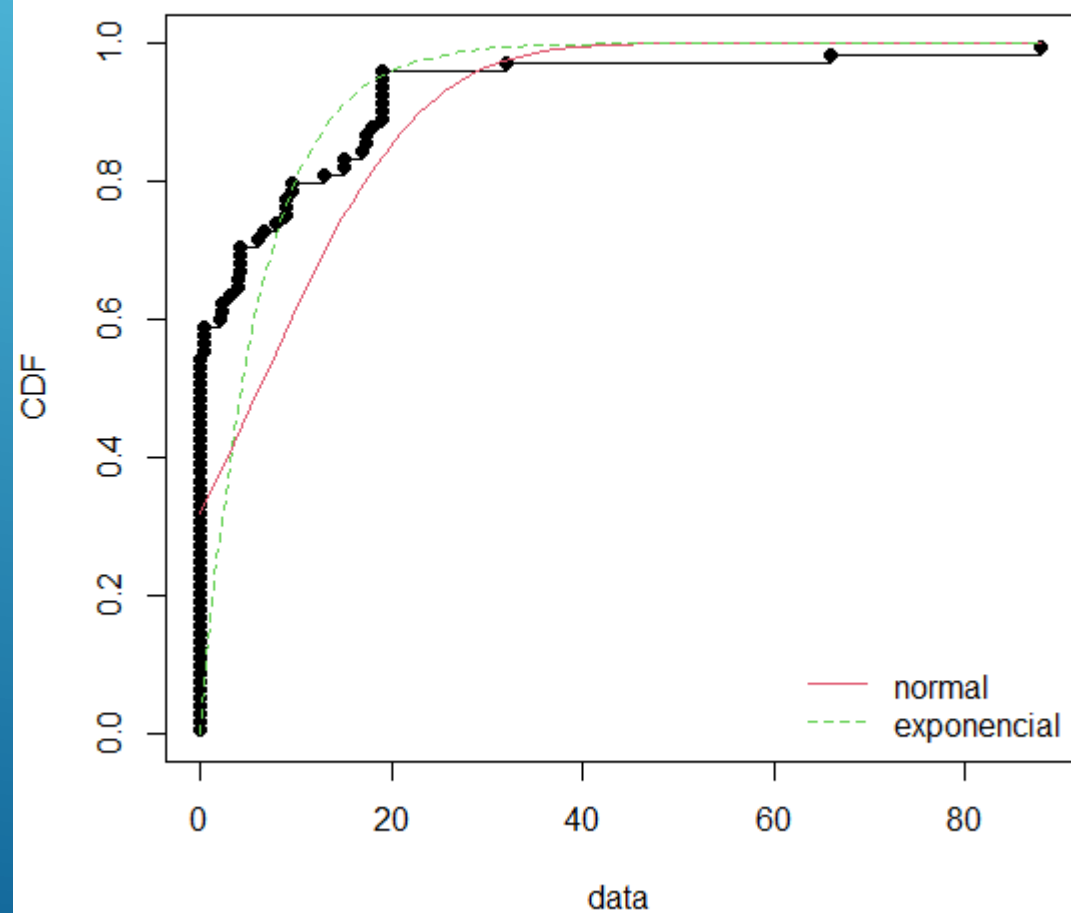
Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.063285, p-value = 0.009809
alternative hypothesis: non-unimodal, i.e., at least bimodal

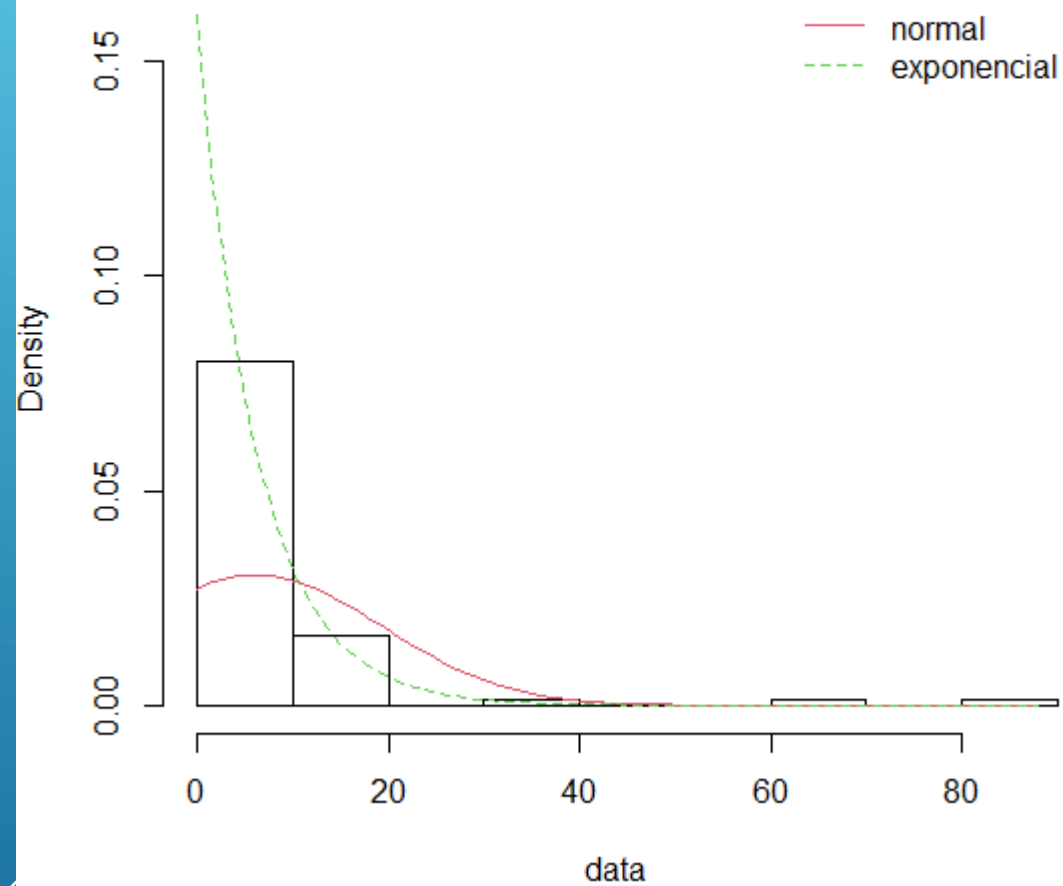
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] FALSE
> is.bimodal(vari)
[1] TRUE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.8270689
```

Concentração de Dopante ou Promotor

Empirical and theoretical CDFs

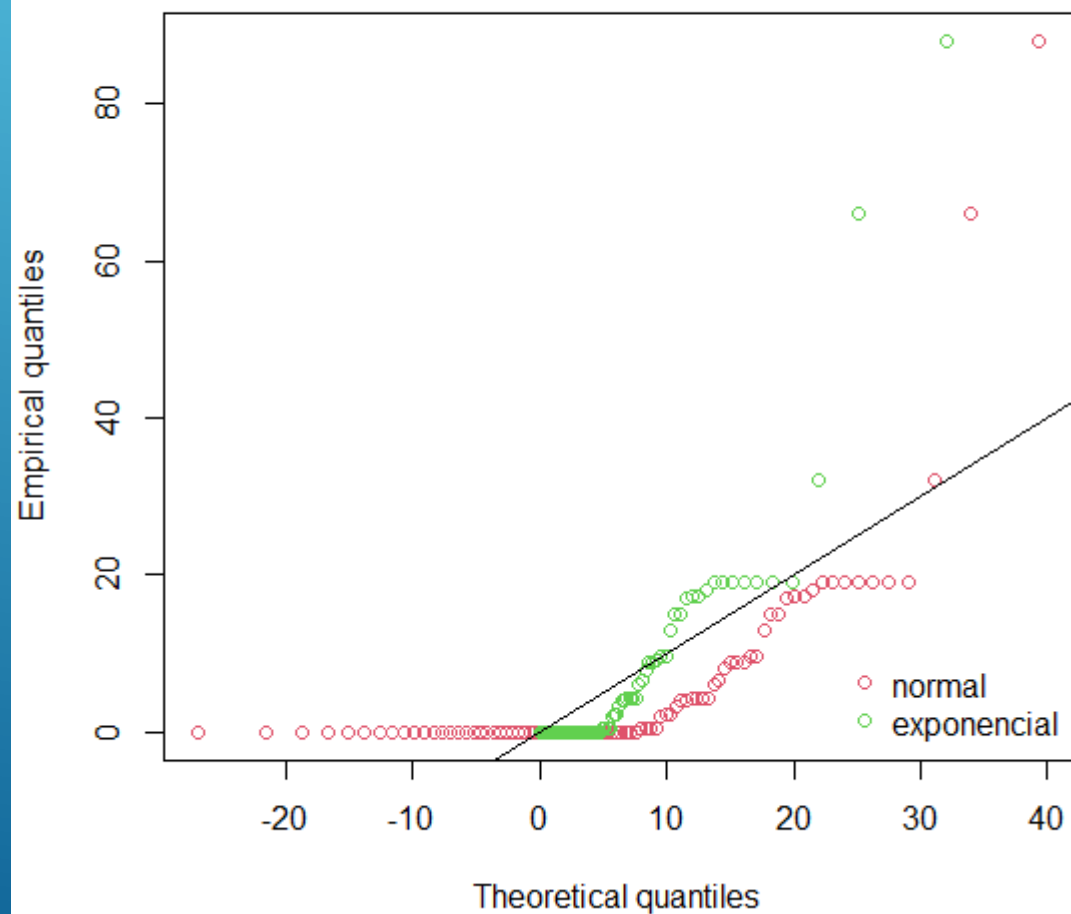


Histogram and theoretical densities

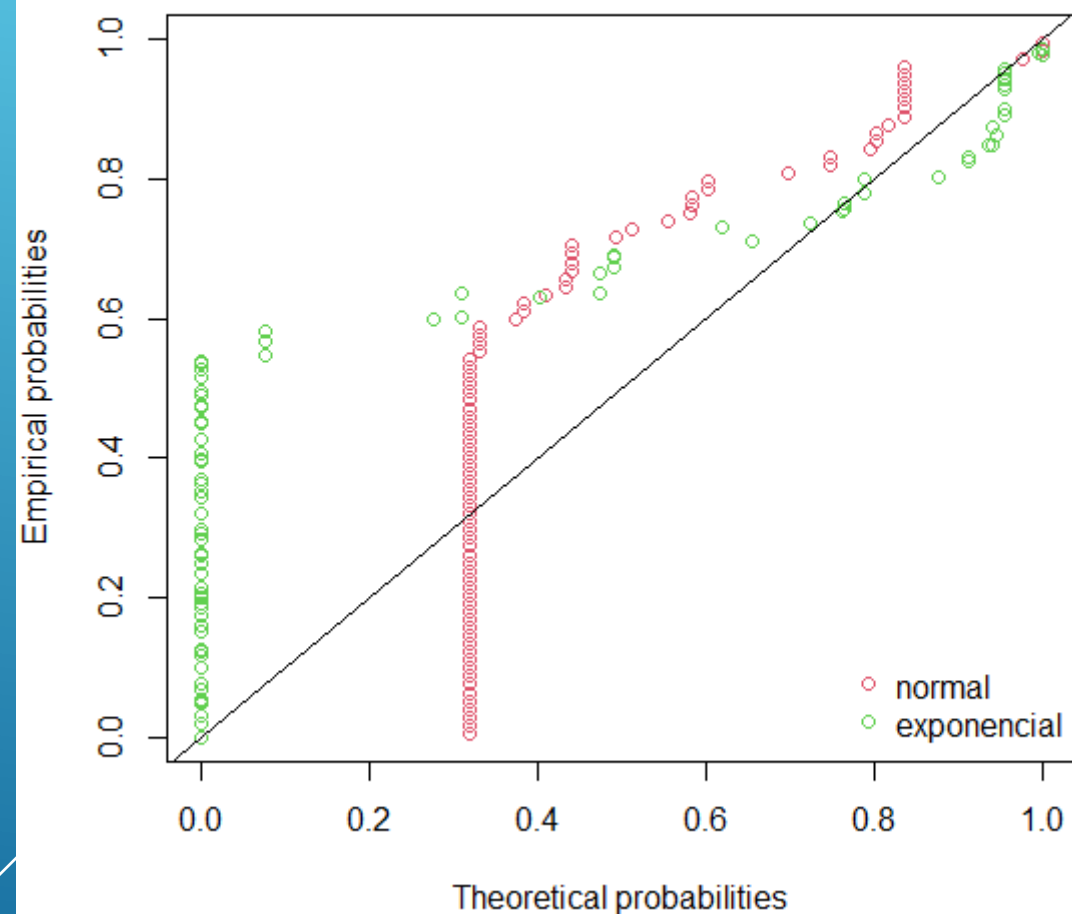


Concentração de Dopante ou Promotor

Q-Q plot



P-P plot



Concentração de Dopante ou Promotor

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

	normal	exponencial
Kolmogorov-Smirnov statistic	0.3179645	0.5465116
Cramer-von Mises statistic	2.4383050	6.2838034
Anderson-Darling statistic	12.7637876	Inf


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

	normal	exponencial
Akaike's Information Criterion	691.1164	488.4343
Bayesian Information Criterion	696.0251	490.8886

Hartigans' dip test for unimodality / multimodality

```
data: vari
D = 0.046669, p-value = 0.1802
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] 0.7409494
```

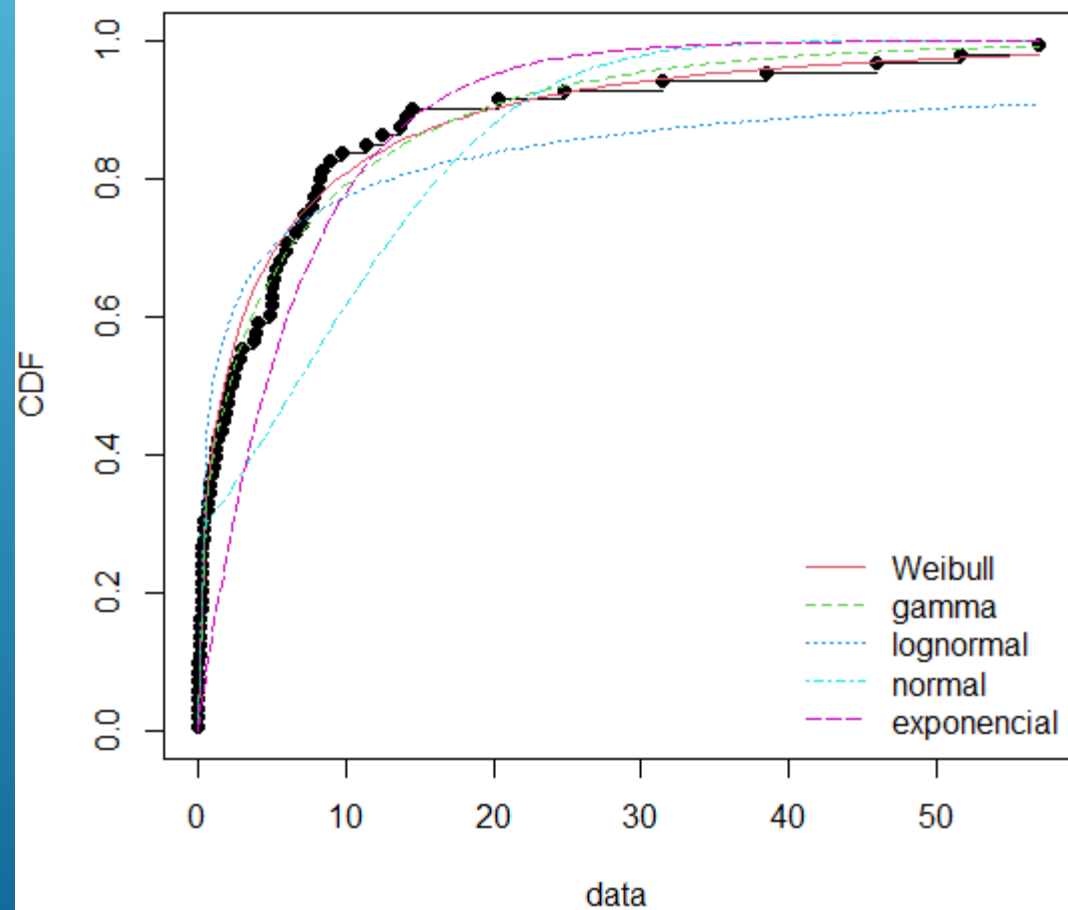
▶ database	77 obs. of 20 variables
------------	-------------------------



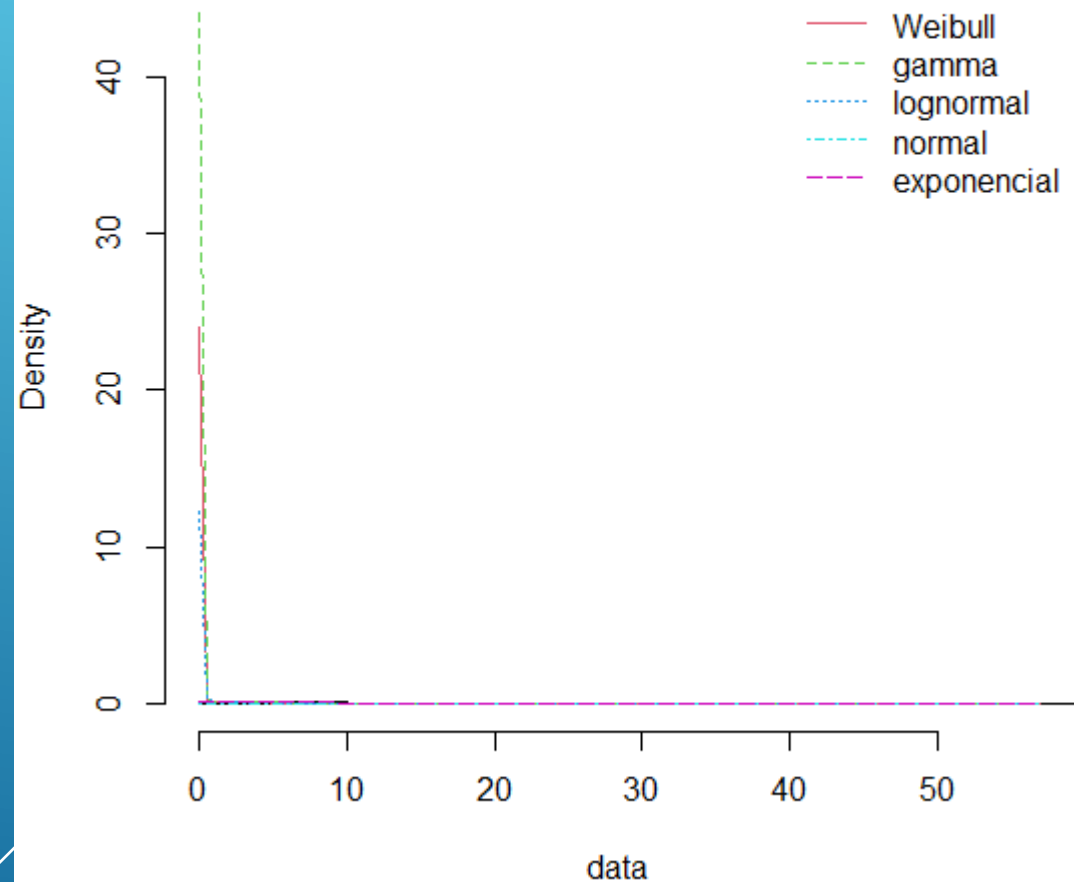
Fase Ativa	Contagem de Fase Ativa	Dopante ou Promotor	Contagem de Dopante ou Promotor	Suporte	Contagem de Suporte
Ni	65	none	42	Al ₂ O ₃	23
Pt	7	Gd	11	CeO ₂	19
Cu Ni	5	Nb	5	Al ₂ O ₃ CeO ₂	13
Total	77	Pr	5	MCM-41	8
		Yb	4	Hidrotalcita	5
		Sm	2	HZSM-5	4
		Y	2	CeZrO ₂	3
		Zr	2	CeSiO ₂ LaNiO ₃	1
		Ca	1	SiO ₂	1
		K	1	Total	77
		Mn	1		
		Sn	1		
		Total	77		

Taxa de formação de carbono

Empirical and theoretical CDFs

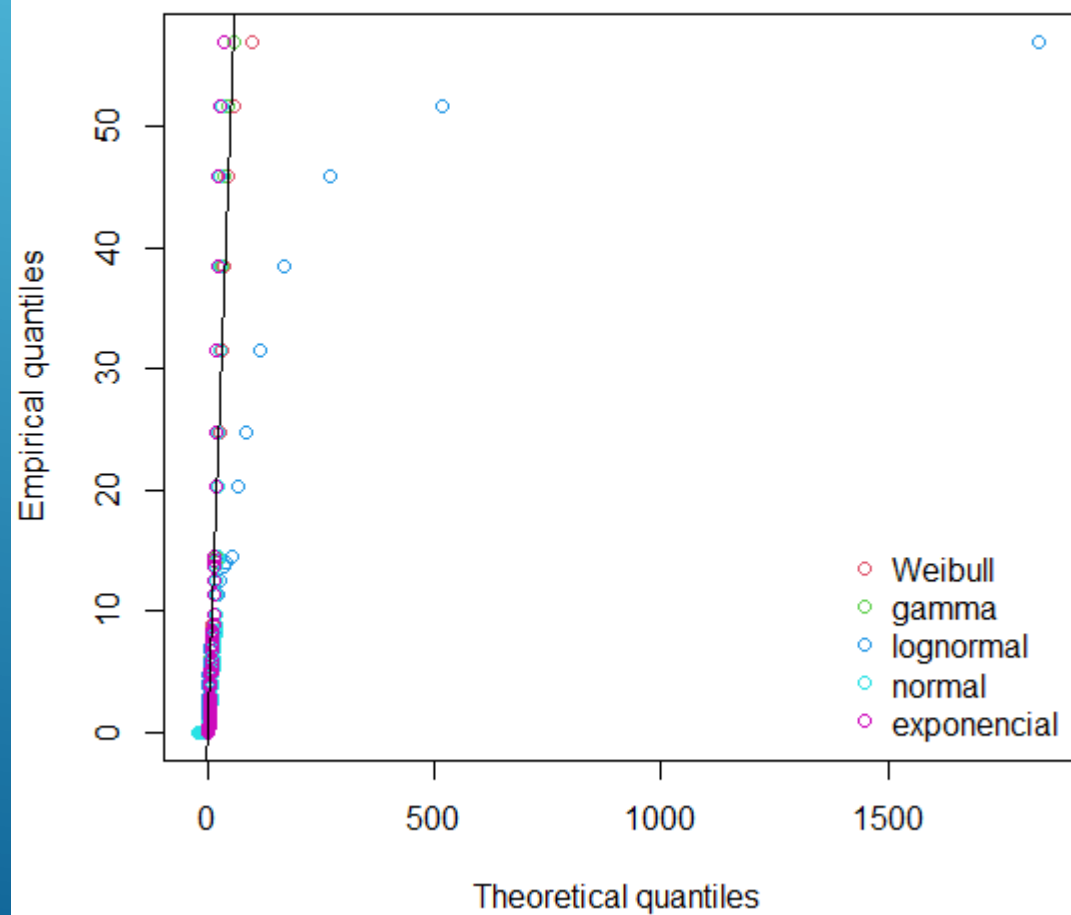


Histogram and theoretical densities

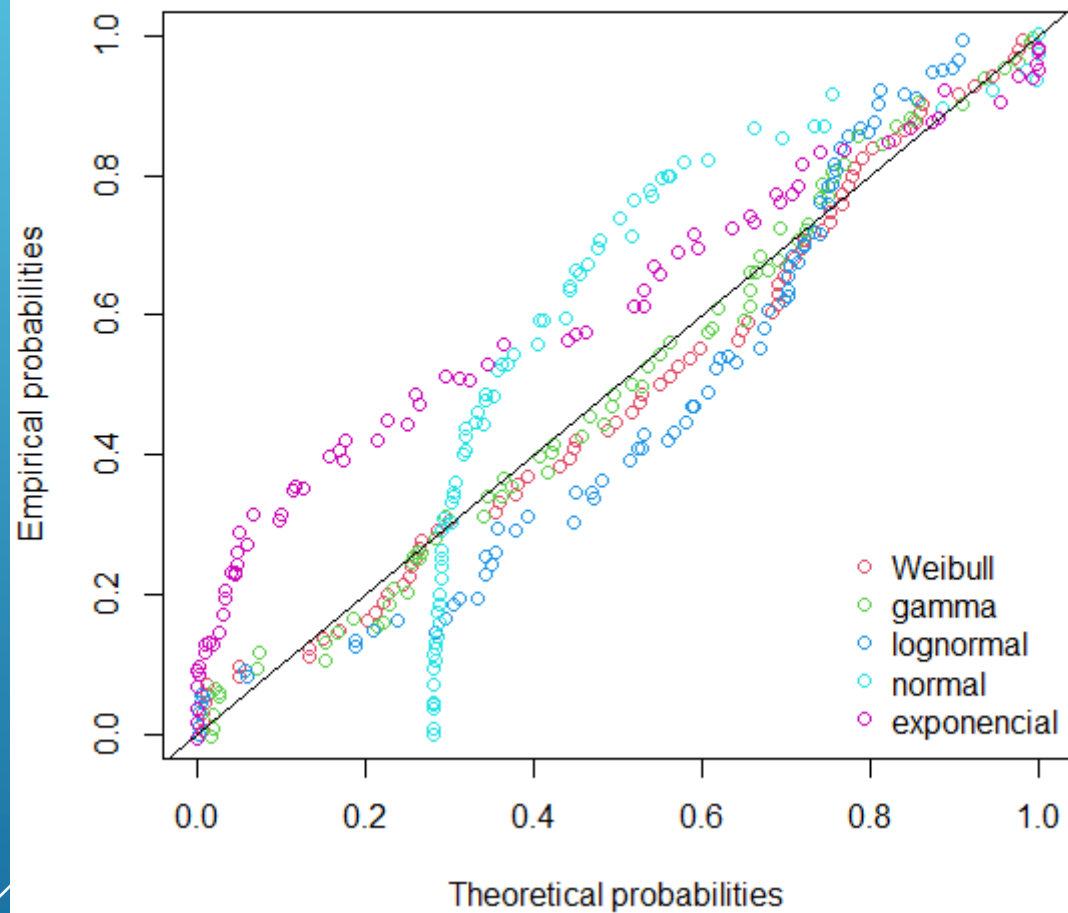


Taxa de formação de carbono

Q-Q plot



P-P plot



Taxa de formação de carbono

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.08632389 0.06319907 0.1377468 0.280710
Cramer-von Mises statistic 0.10024992 0.05563548 0.5517714 1.960888
Anderson-Darling statistic 0.85880420 0.47621373 3.6393274 10.625937
      exponencial
Kolmogorov-Smirnov statistic 0.2525659
Cramer-von Mises statistic 1.6869469
Anderson-Darling statistic 17.5667455

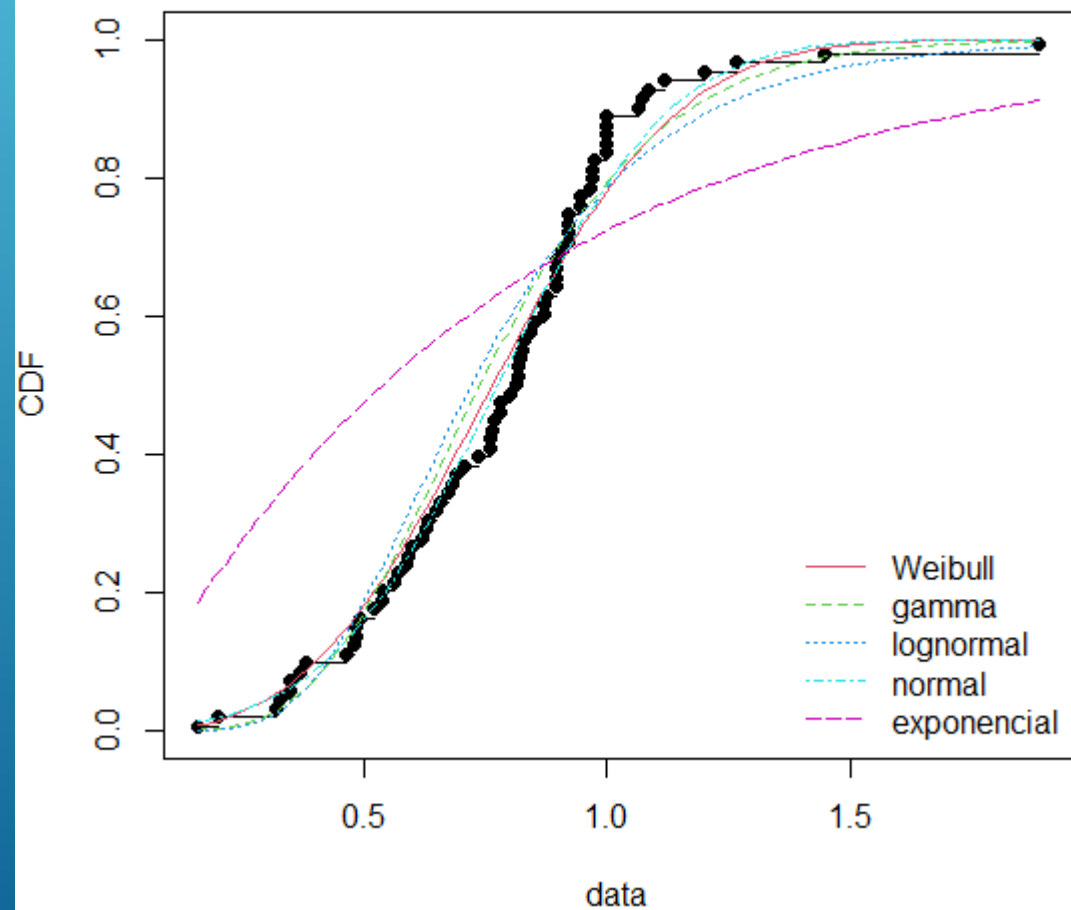
Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 366.6586 362.5951 395.9668 597.5725
Bayesian Information Criterion 371.3462 367.2827 400.6544 602.2601
      exponencial
Akaike's Information Criterion 447.3657
Bayesian Information Criterion 449.7095
```

```
Hartigans' dip test for unimodality / multimodality

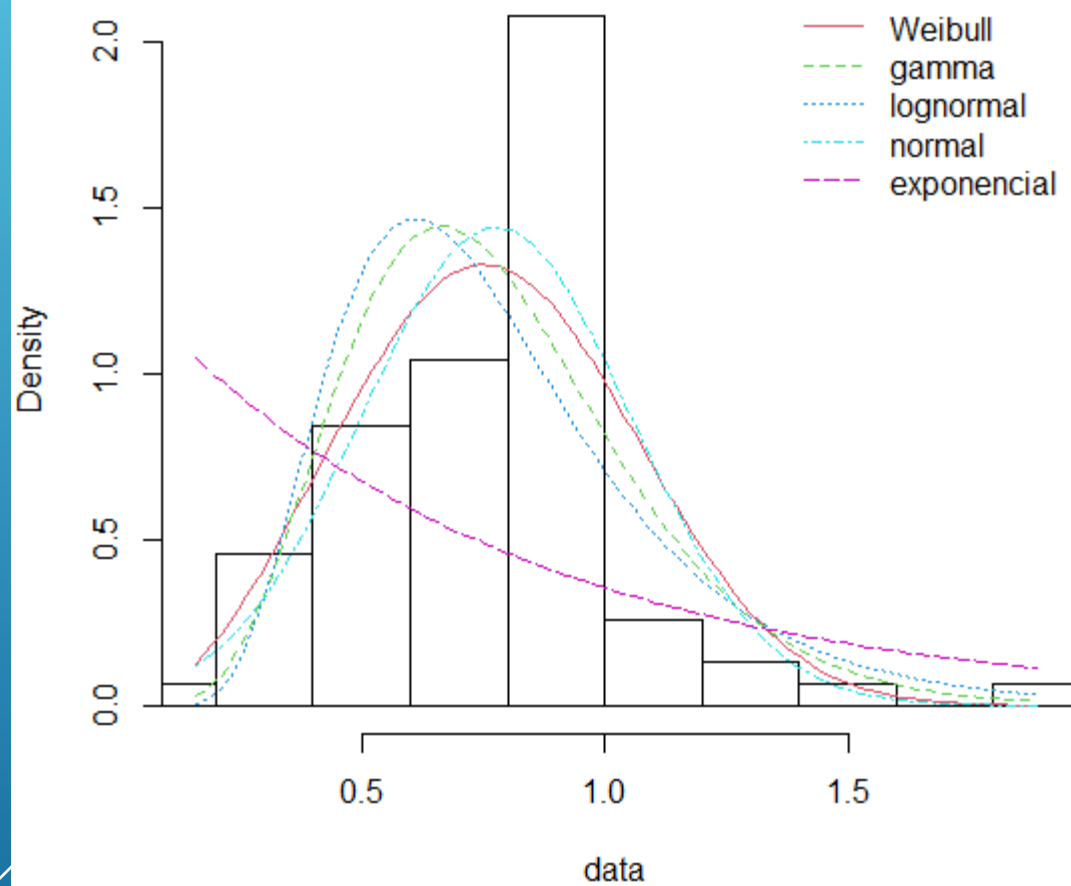
data: vari
D = 0.028312, p-value = 0.9585
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.8041463
```

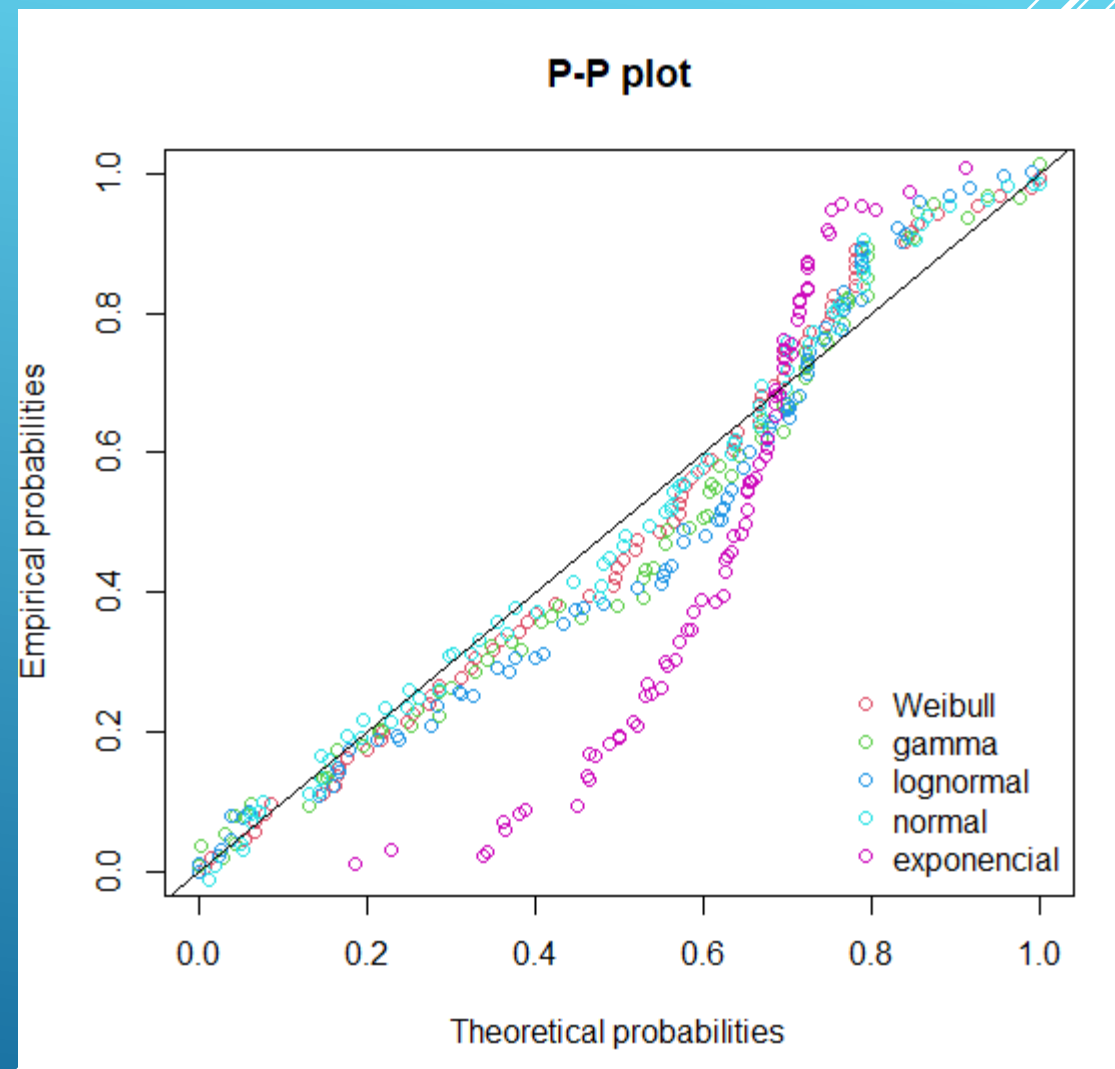
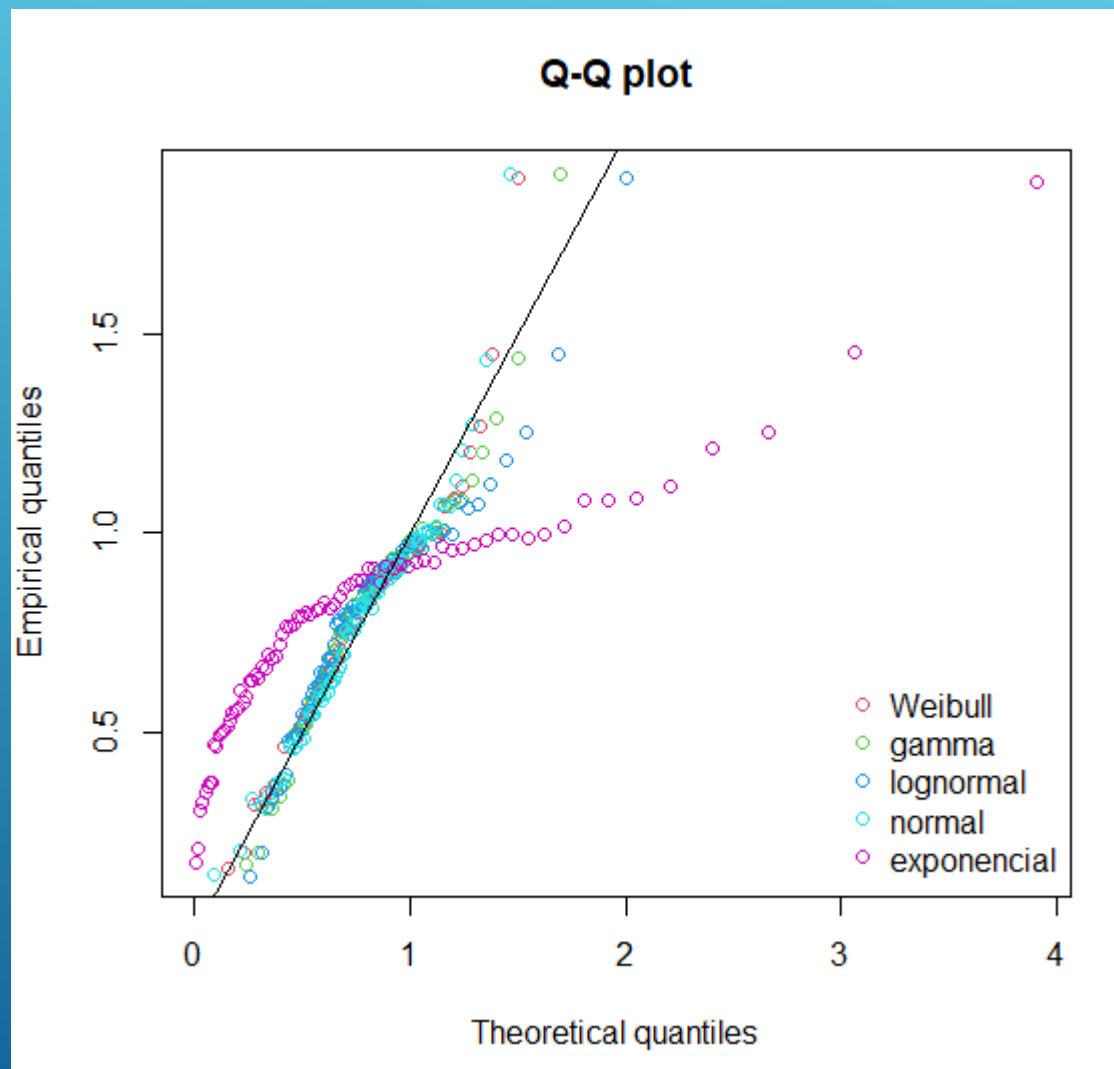
Empirical and theoretical CDFs



Histogram and theoretical densities



Fator de estabilidade



Fator de estabilidade

```
Goodness-of-fit statistics
      weibull      gamma lognormal      normal
Kolmogorov-Smirnov statistic 0.1158405 0.1248490 0.1472258 0.10647147
Cramer-von Mises statistic  0.1449718 0.2309842 0.3645225 0.09066551
Anderson-Darling statistic  0.9303805 1.3130845 2.0582574 0.64994667

      exponencial
Kolmogorov-Smirnov statistic 0.3462407
Cramer-von Mises statistic  3.1011798
Anderson-Darling statistic  15.3311019

Goodness-of-fit criteria
      weibull      gamma lognormal      normal
Akaike's Information Criterion 25.28734 26.57389 35.21476 24.81098
Bayesian Information Criterion 29.97495 31.26150 39.90238 29.49859

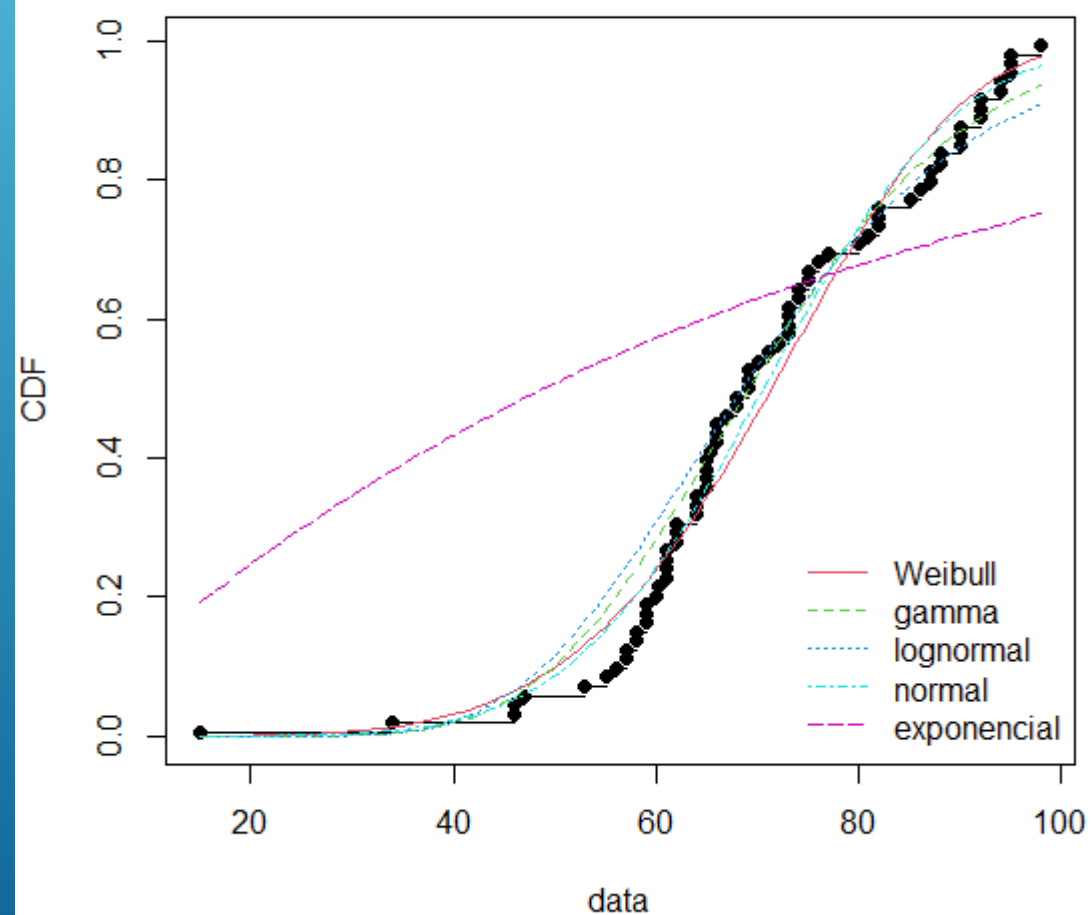
      exponencial
Akaike's Information Criterion 117.1413
Bayesian Information Criterion 119.4851
```

```
Hartigans' dip test for unimodality / multimodality

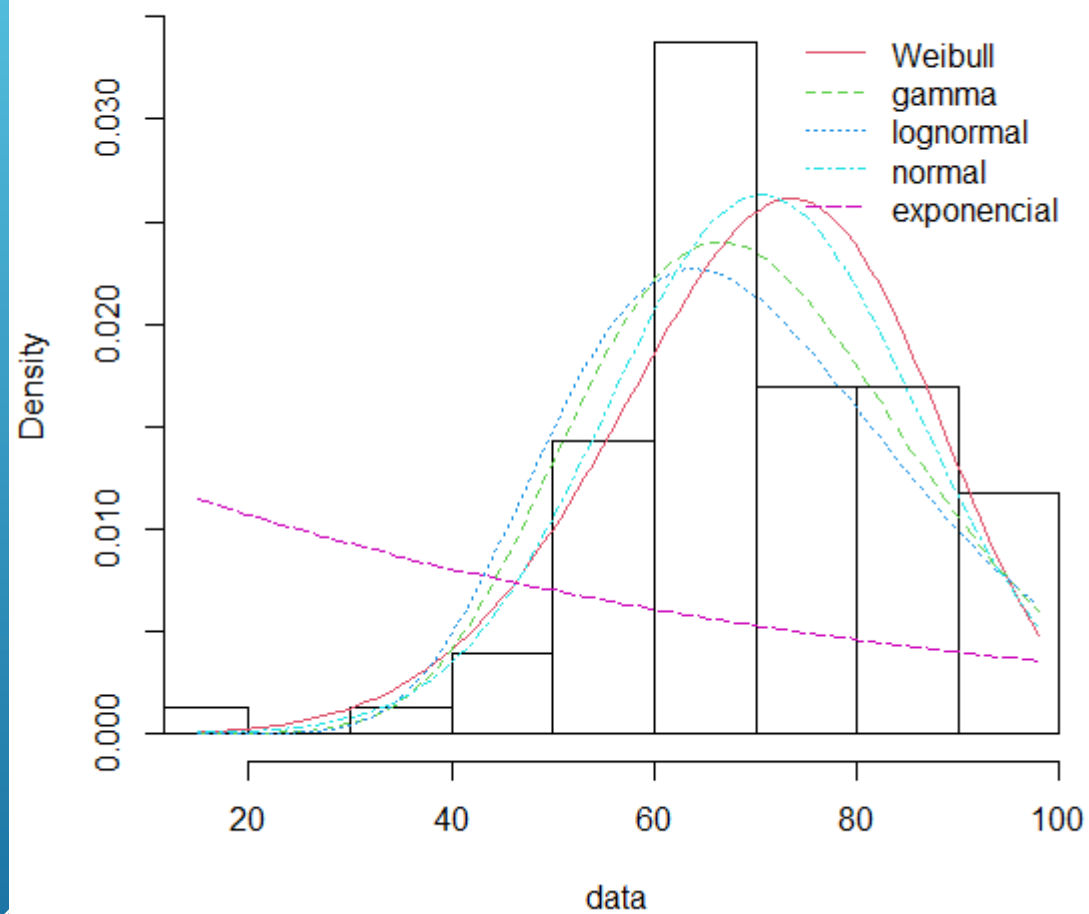
data: vari
D = 0.032468, p-value = 0.8404
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.2438425
```

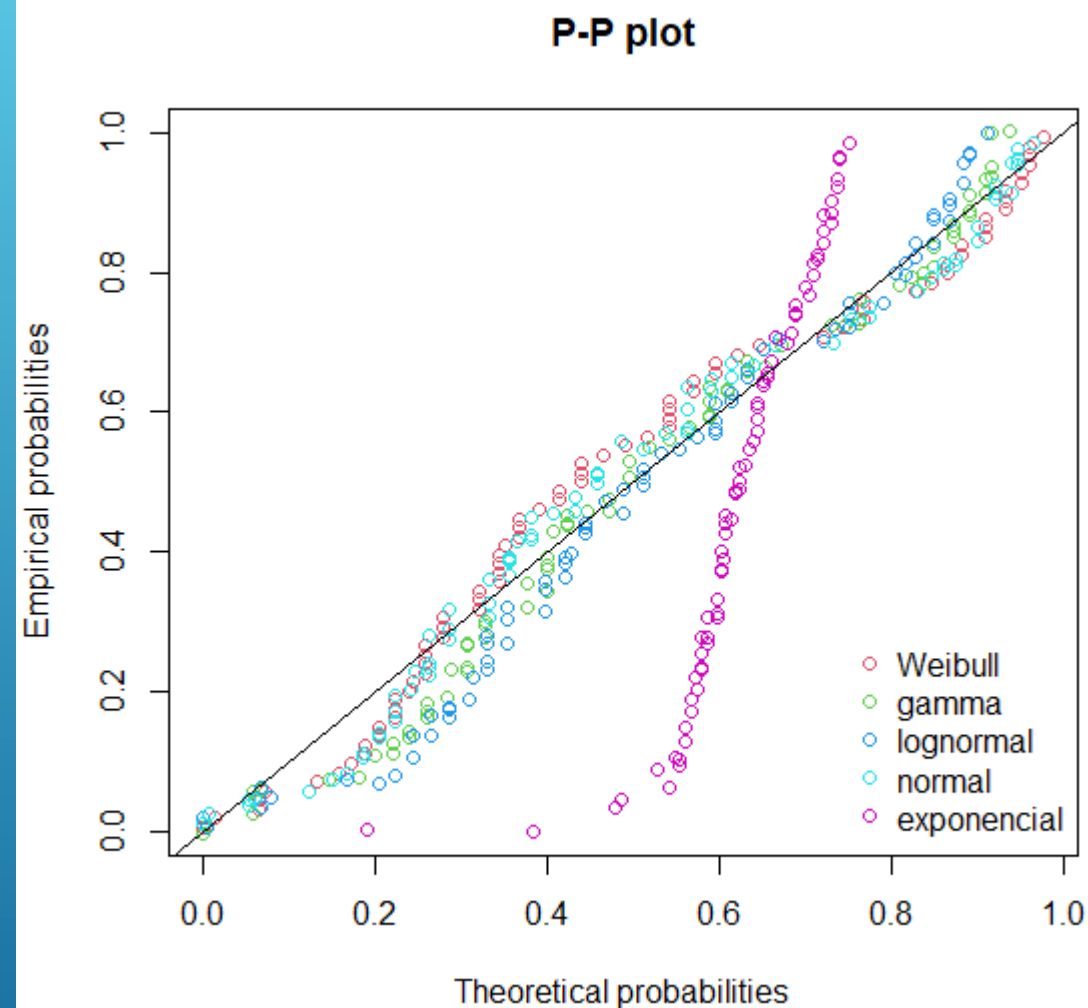
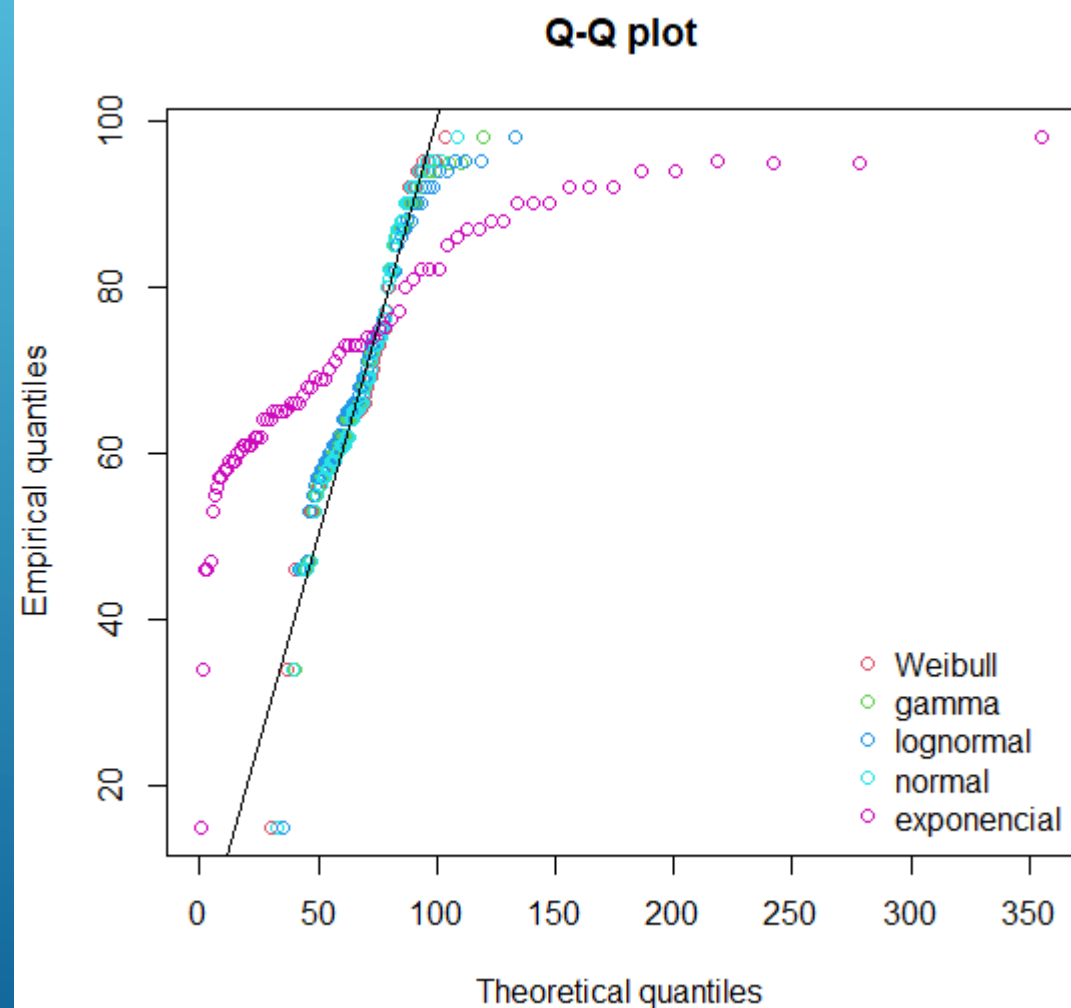
Empirical and theoretical CDFs



Histogram and theoretical densities



Conversão inicial de CH₄



Conversão inicial de CH4

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.09339147	0.1158239	0.1401084	0.0812235
Cramer-von Mises statistic	0.18244789	0.1623274	0.2715659	0.1261789
Anderson-Darling statistic	1.13997291	1.3267367	2.0729128	0.8870530

```
exponencial
```

Kolmogorov-Smirnov statistic	0.4632762
Cramer-von Mises statistic	4.7042544
Anderson-Darling statistic	22.2384842

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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	641.0833	656.2004	669.5689	641.2714
Bayesian Information Criterion	645.7709	660.8880	674.2565	645.9590

```
exponencial
```

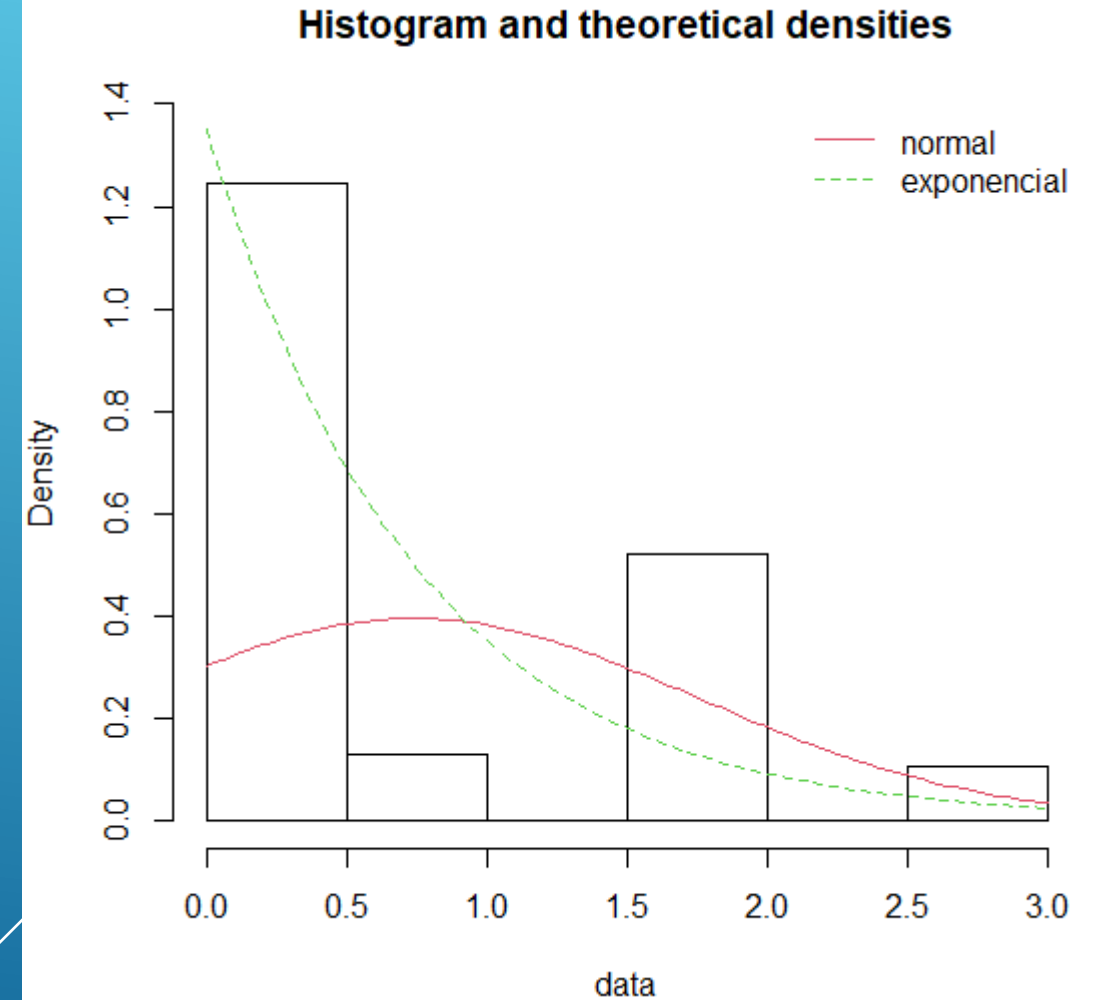
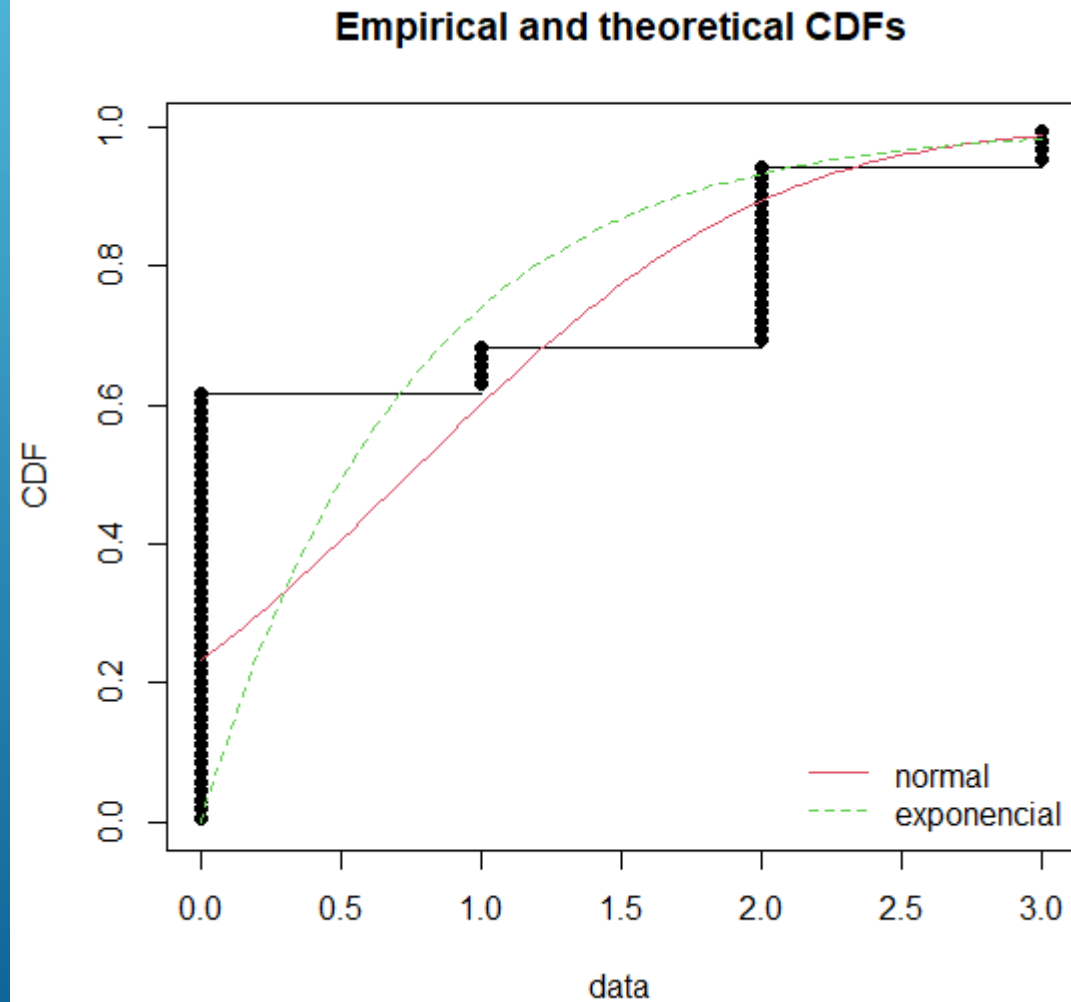
Akaike's Information Criterion	811.5628
Bayesian Information Criterion	813.9066

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

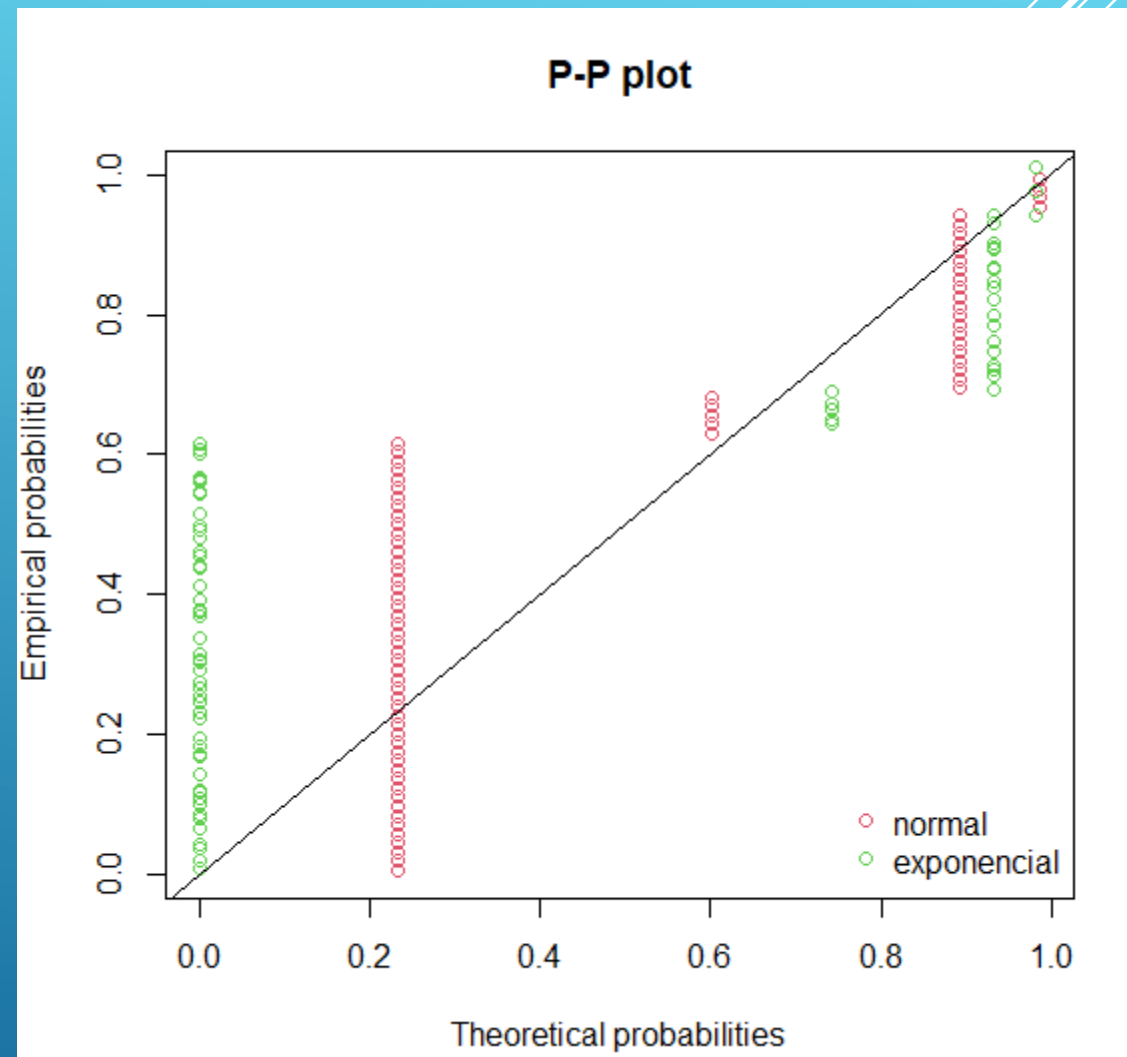
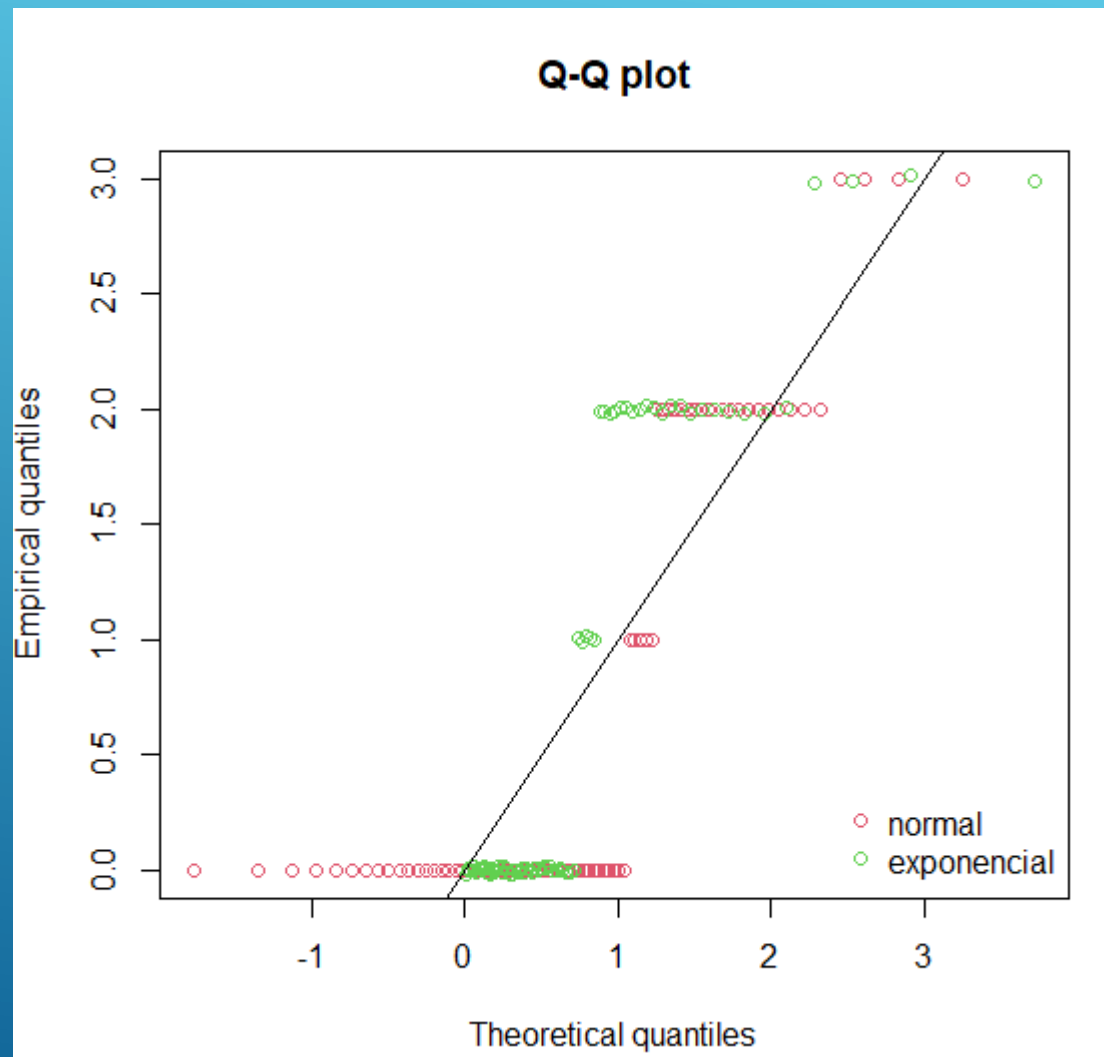
data: vari
D = 0.035065, p-value = 0.7323
alternative hypothesis: non-unimodal, i.e., at least bimodal

```
> 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] 0.281152
```

Razão molar inerte/metano na alimentação do reator



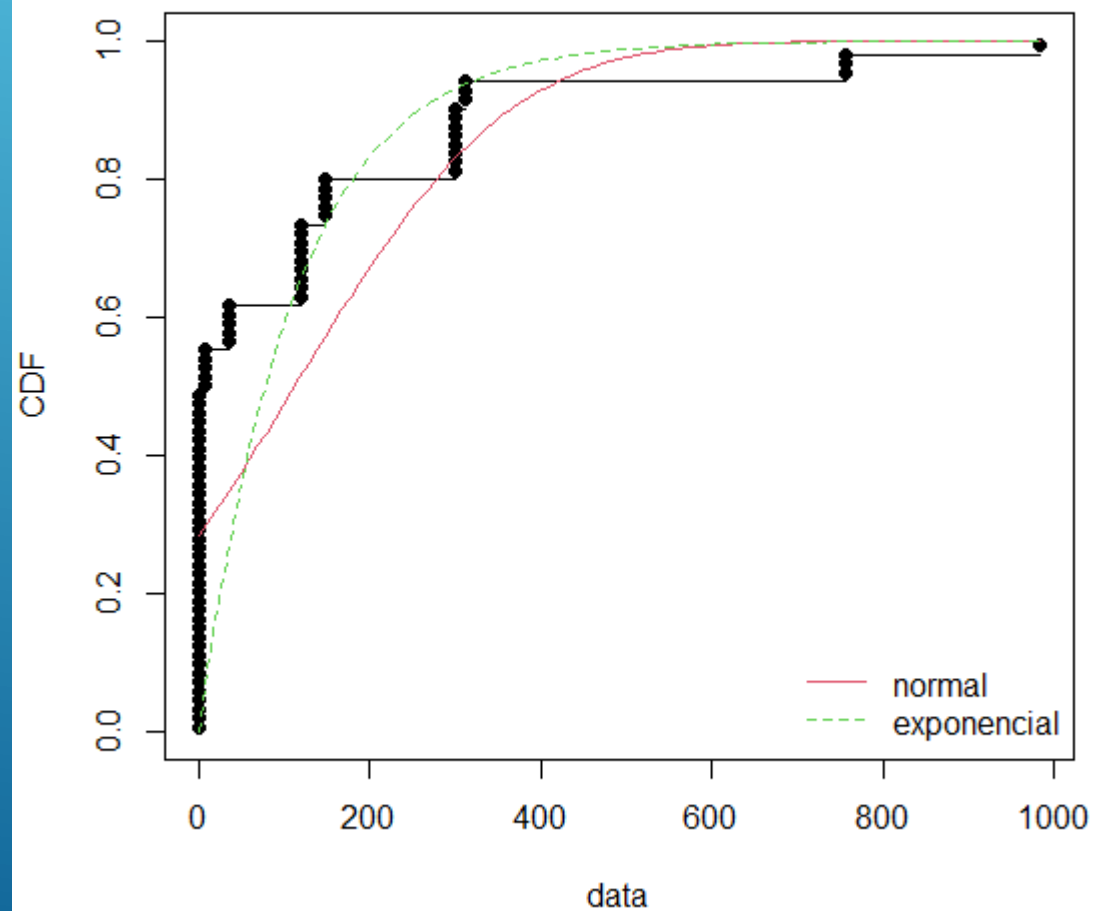
Razão molar inerte/metano na alimentação do reator



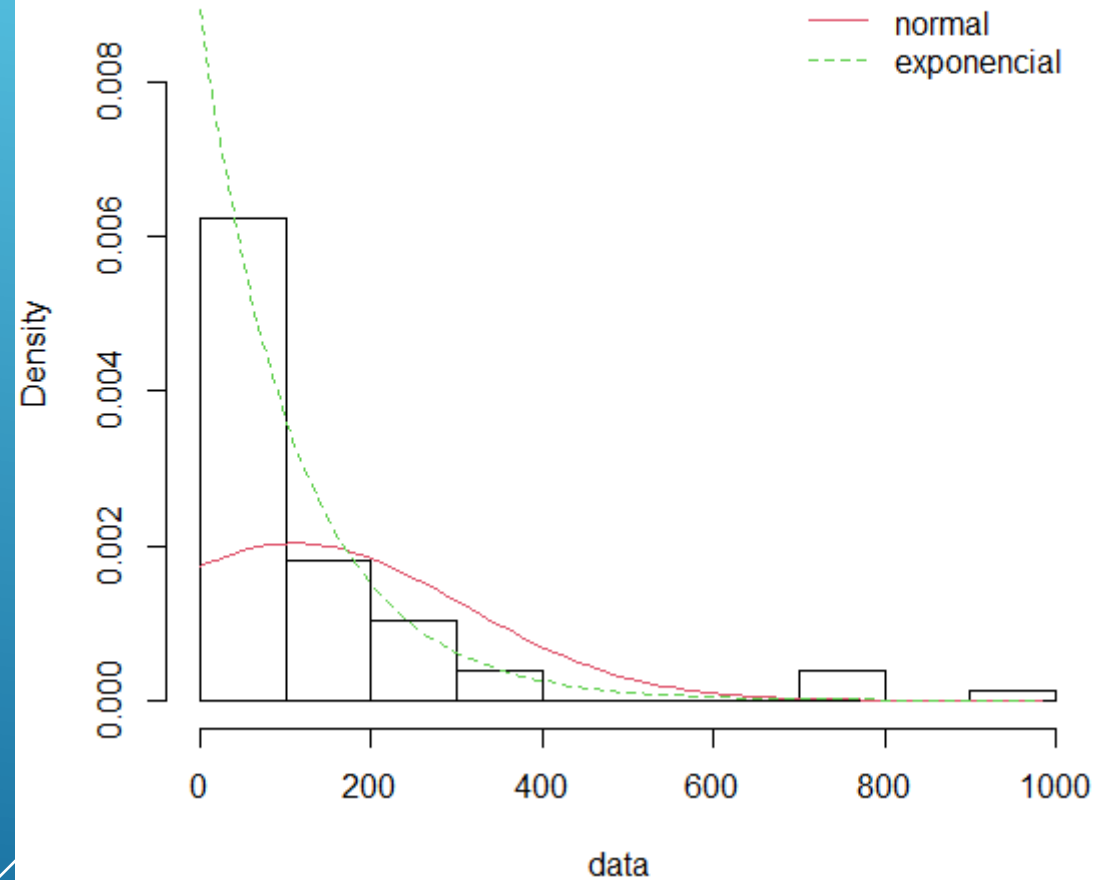
Razão molar inerte/metano na alimentação do reator

```
Hartigans' dip test for unimodality / multimodality  
data: vari  
D = 0.12987, 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] 0.7722314
```

Empirical and theoretical CDFs

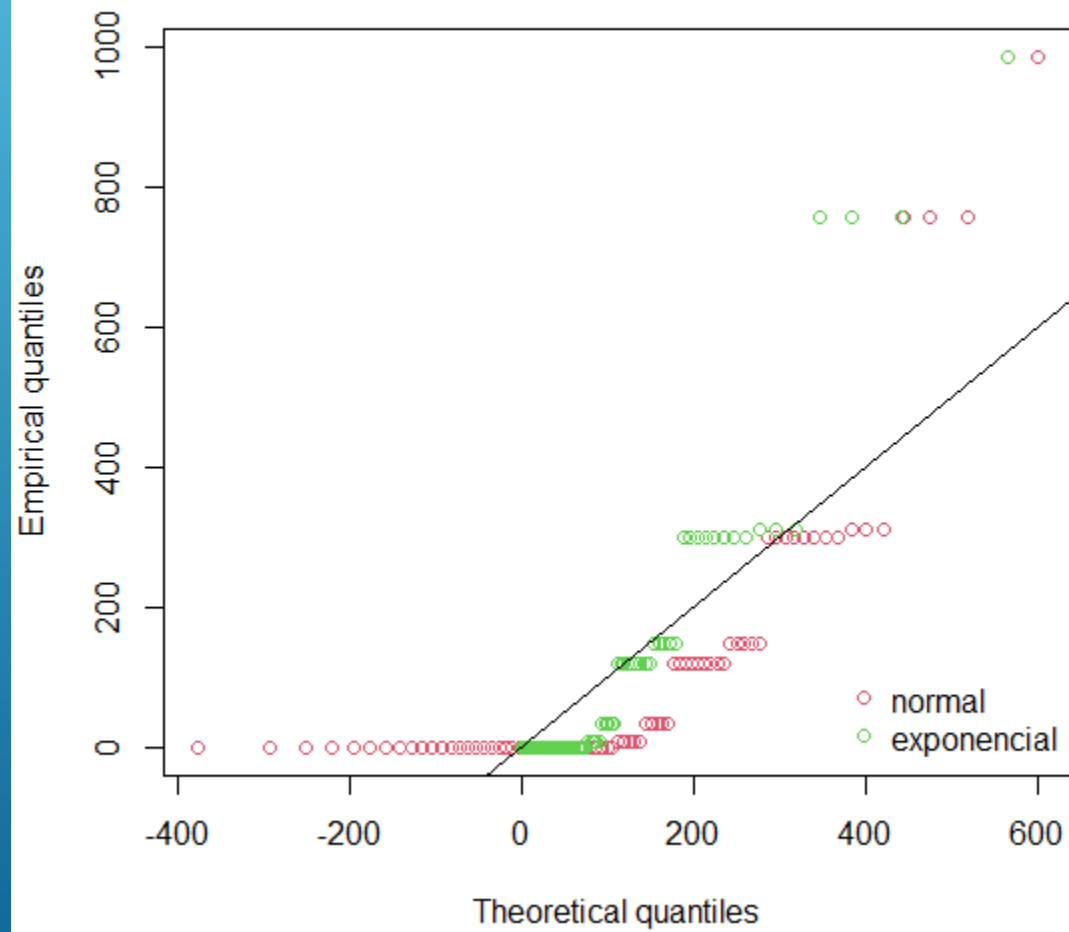


Histogram and theoretical densities

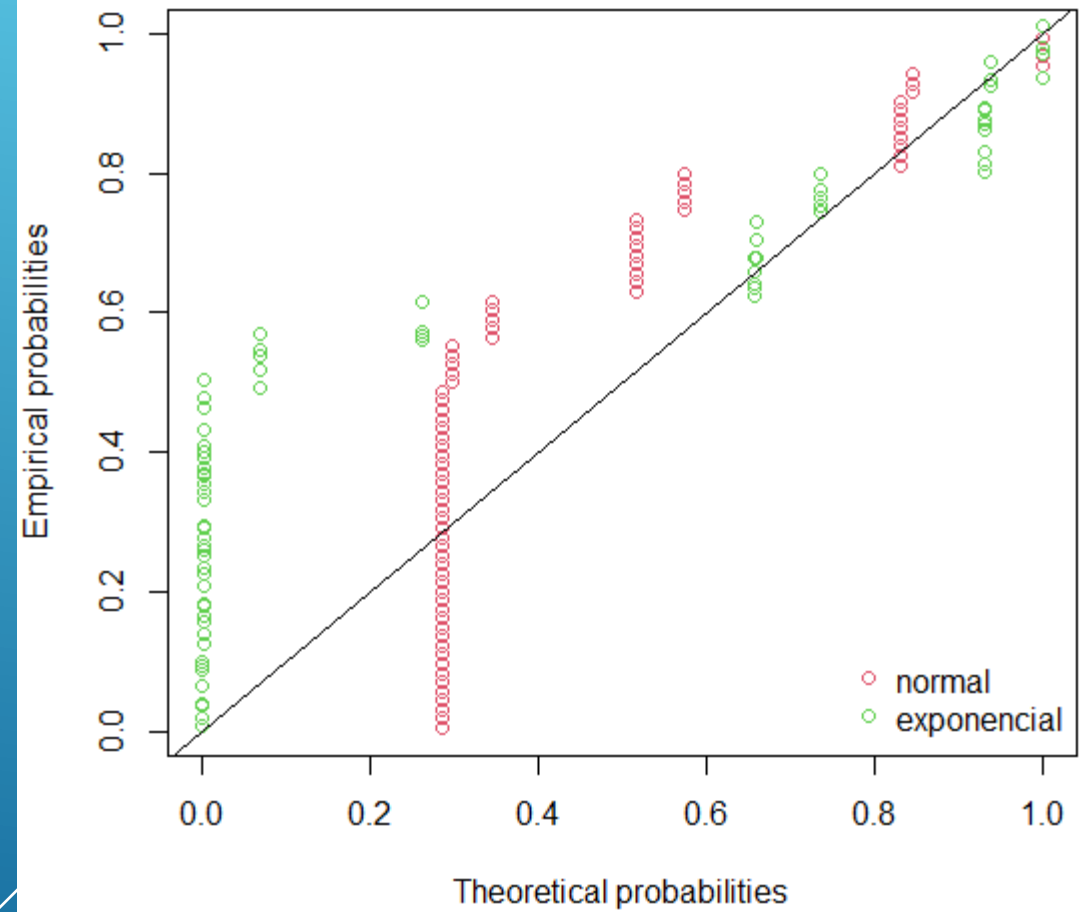


Velocidade espacial WHSV (h-1)

Q-Q plot



P-P plot



Velocidade espacial WHSV (h-1)

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

	normal	exponencial
Kolmogorov-Smirnov statistic	0.2842869	0.4902169
Cramer-von Mises statistic	1.8809359	4.6996165
Anderson-Darling statistic	10.2625200	Inf


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

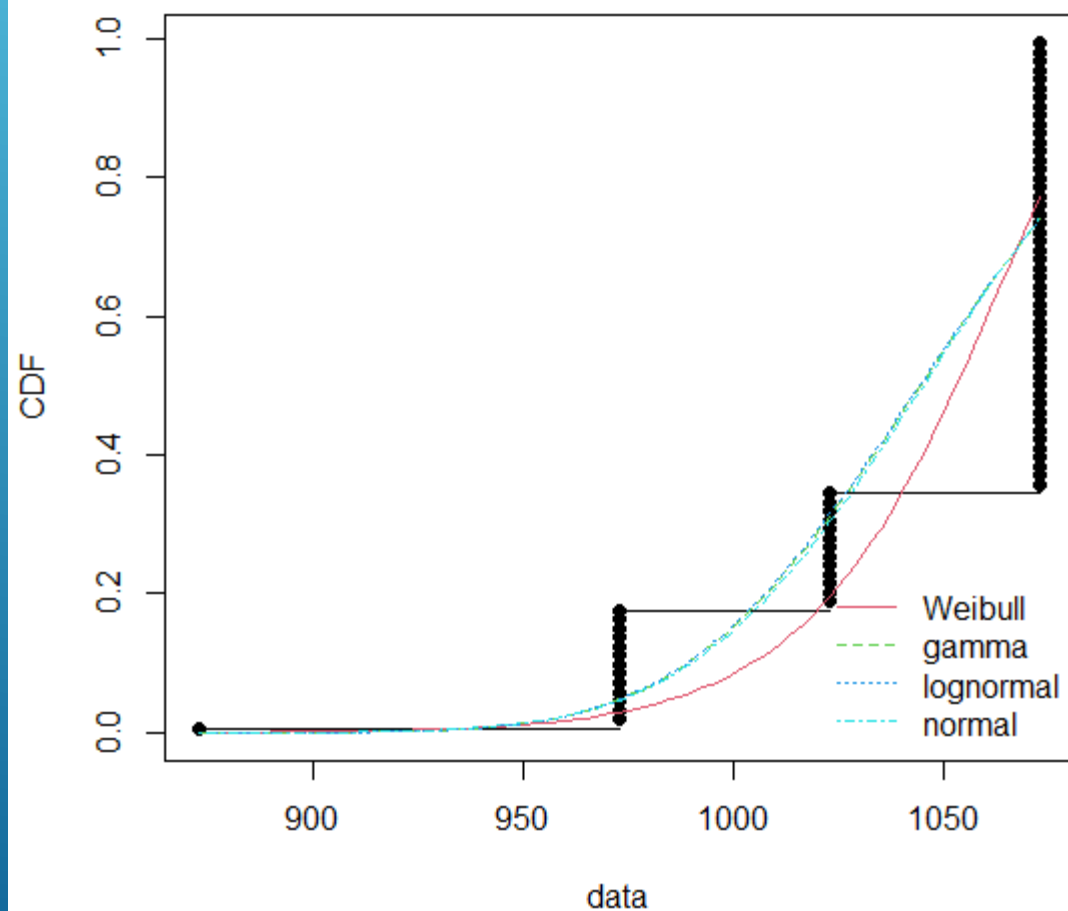
	normal	exponencial
Akaike's Information Criterion	1035.675	882.6335
Bayesian Information Criterion	1040.363	884.9773

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

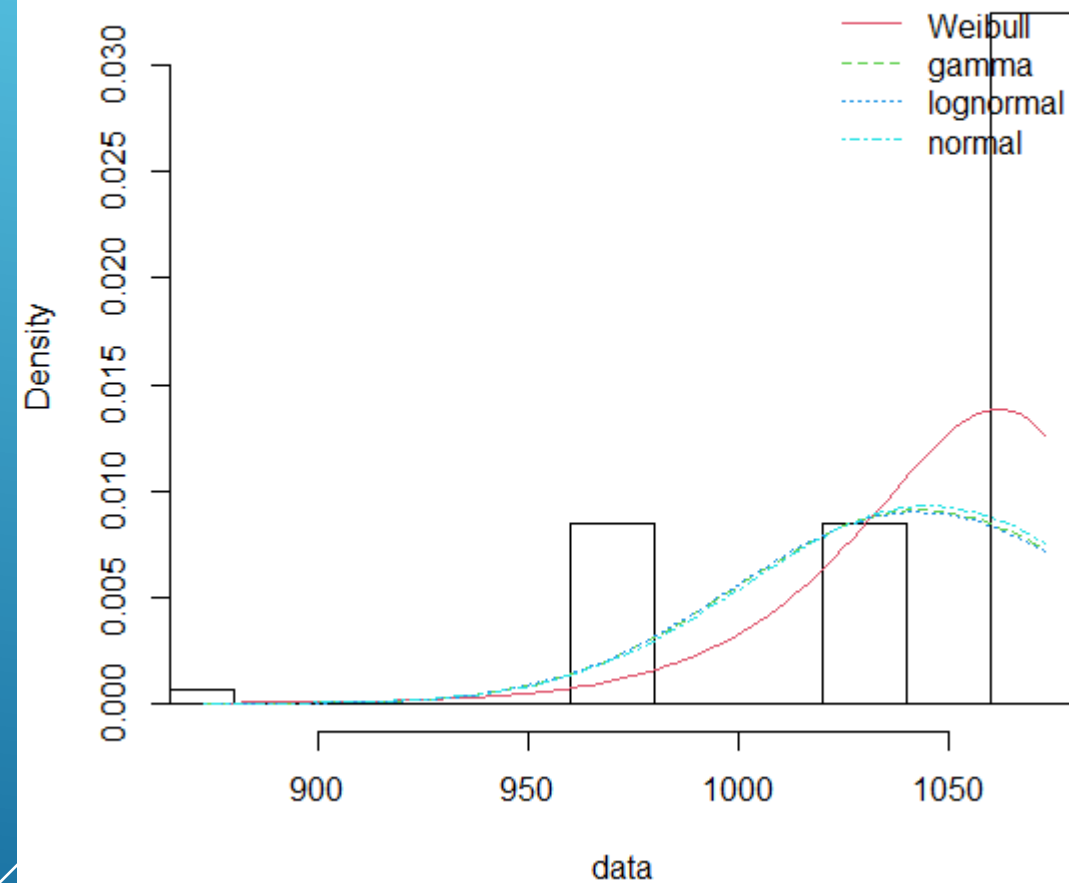
data: vari
D = 0.084416, p-value = 0.0001597
alternative hypothesis: non-unimodal, i.e., at least bimodal

```
> 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] 0.7397905
```

Empirical and theoretical CDFs

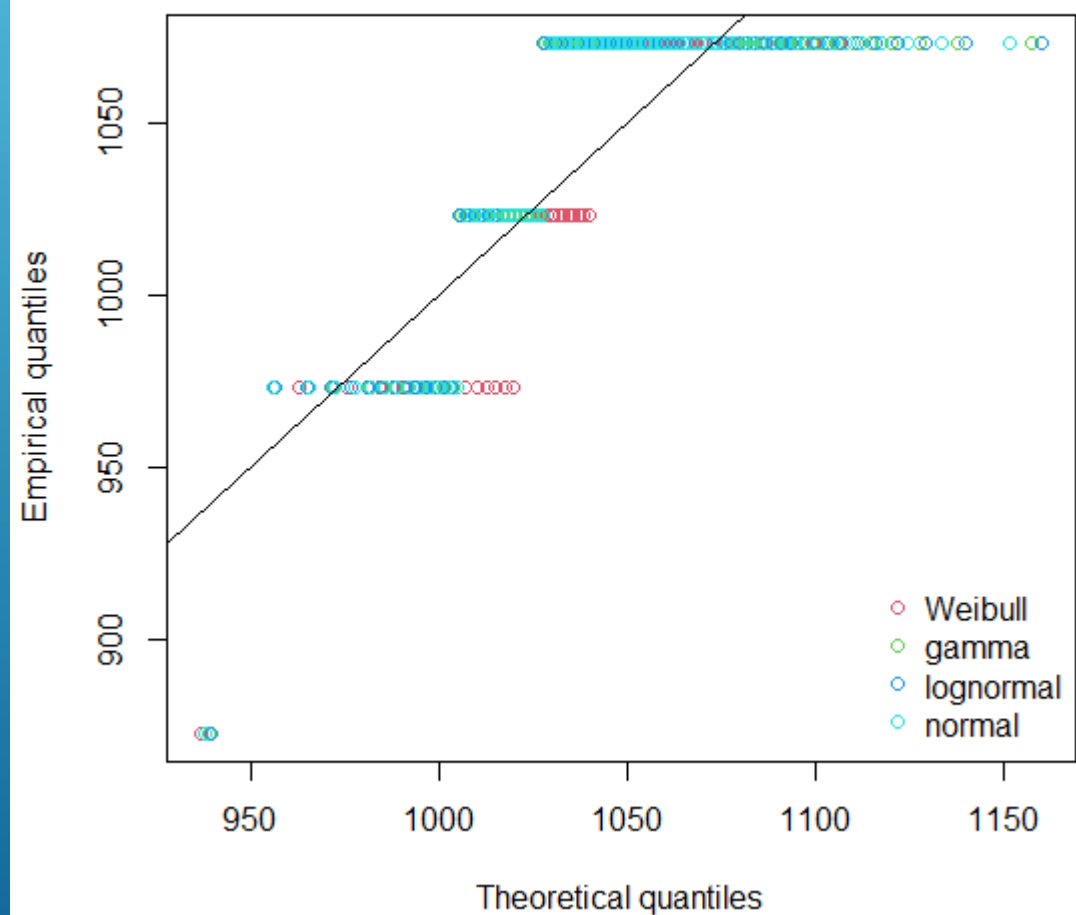


Histogram and theoretical densities

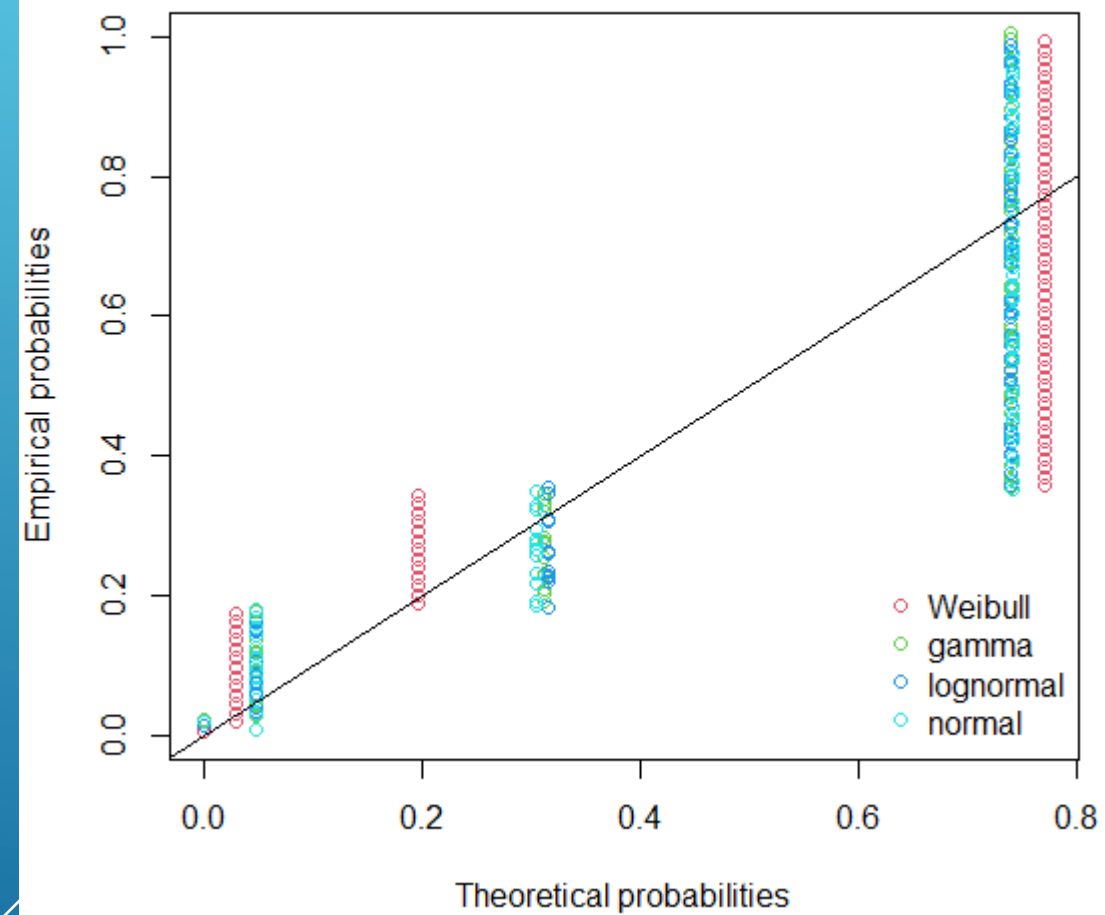


Temperatura de reação

Q-Q plot



P-P plot



Temperatura de reação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.420710	0.3894279	0.3884352	0.3912251
Cramer-von Mises statistic	2.403655	2.0867187	2.0841988	2.0917402
Anderson-Darling statistic	13.631999	11.2536545	11.2301959	11.3008751

Goodness-of-fit criteria

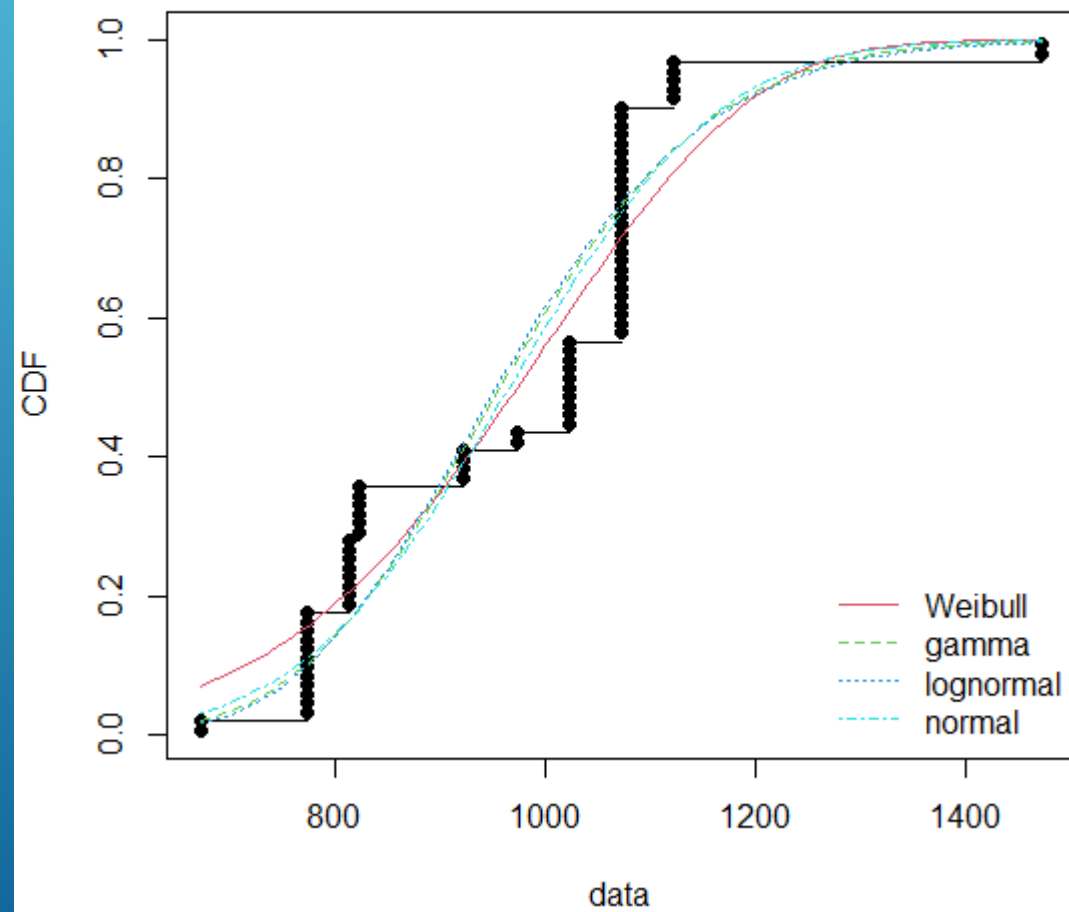
	weibull	gamma	lognormal	normal
Akaike's Information Criterion	768.3330	805.0617	806.7621	801.7925
Bayesian Information Criterion	773.0206	809.7493	811.4497	806.4801

Hartigans' dip test for unimodality / multimodality

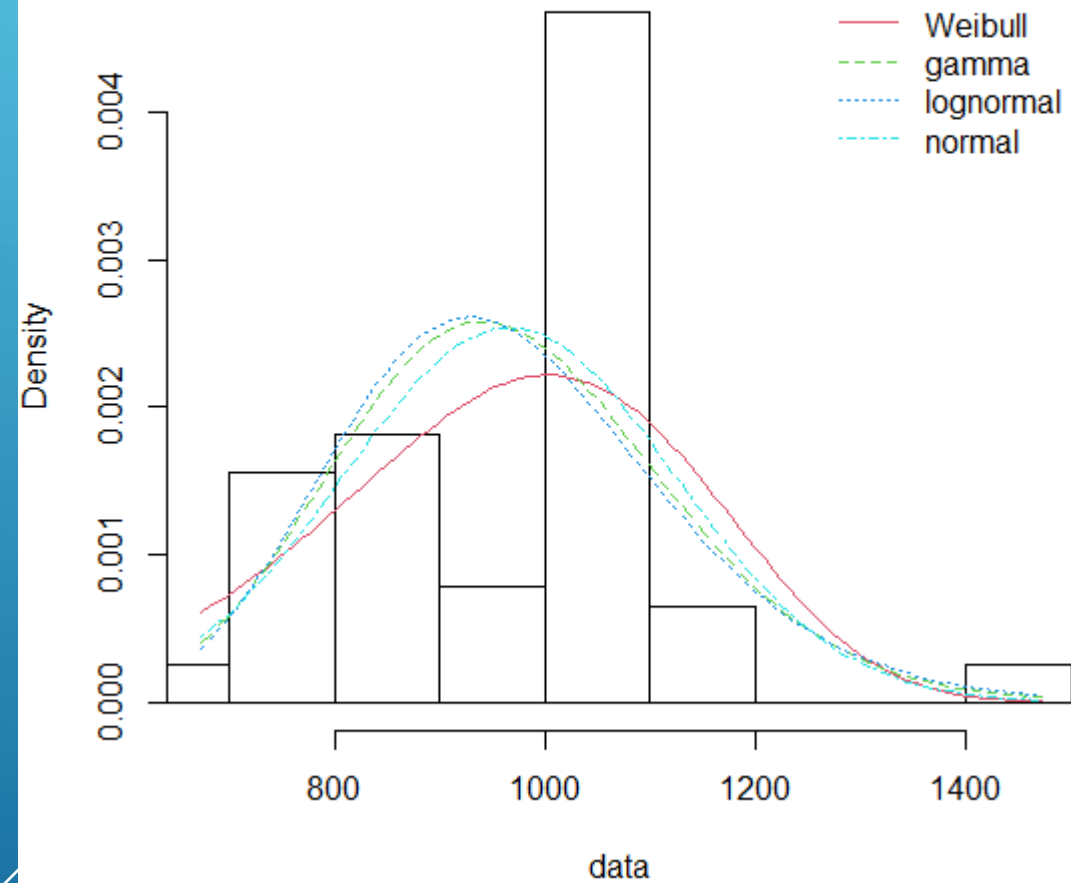
```
data: vari
D = 0.084416, p-value = 0.0001597
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.6362337
```

Empirical and theoretical CDFs

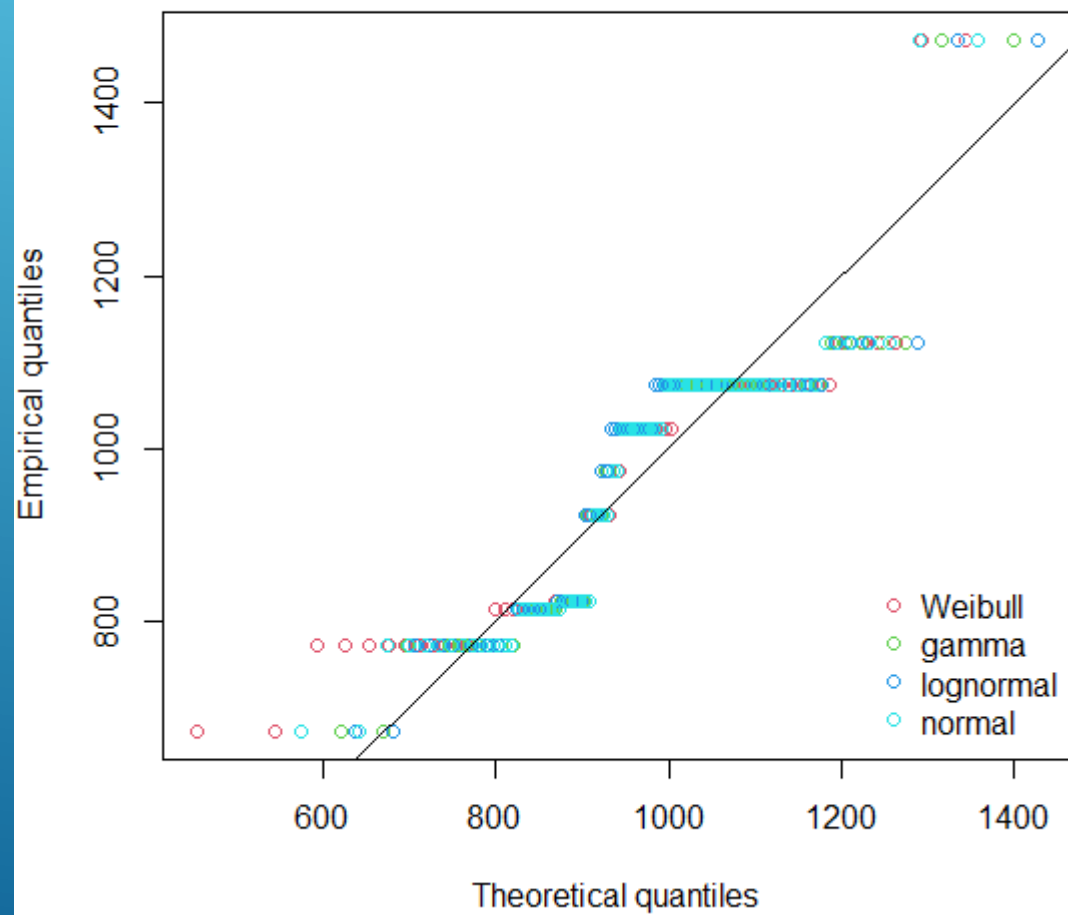


Histogram and theoretical densities

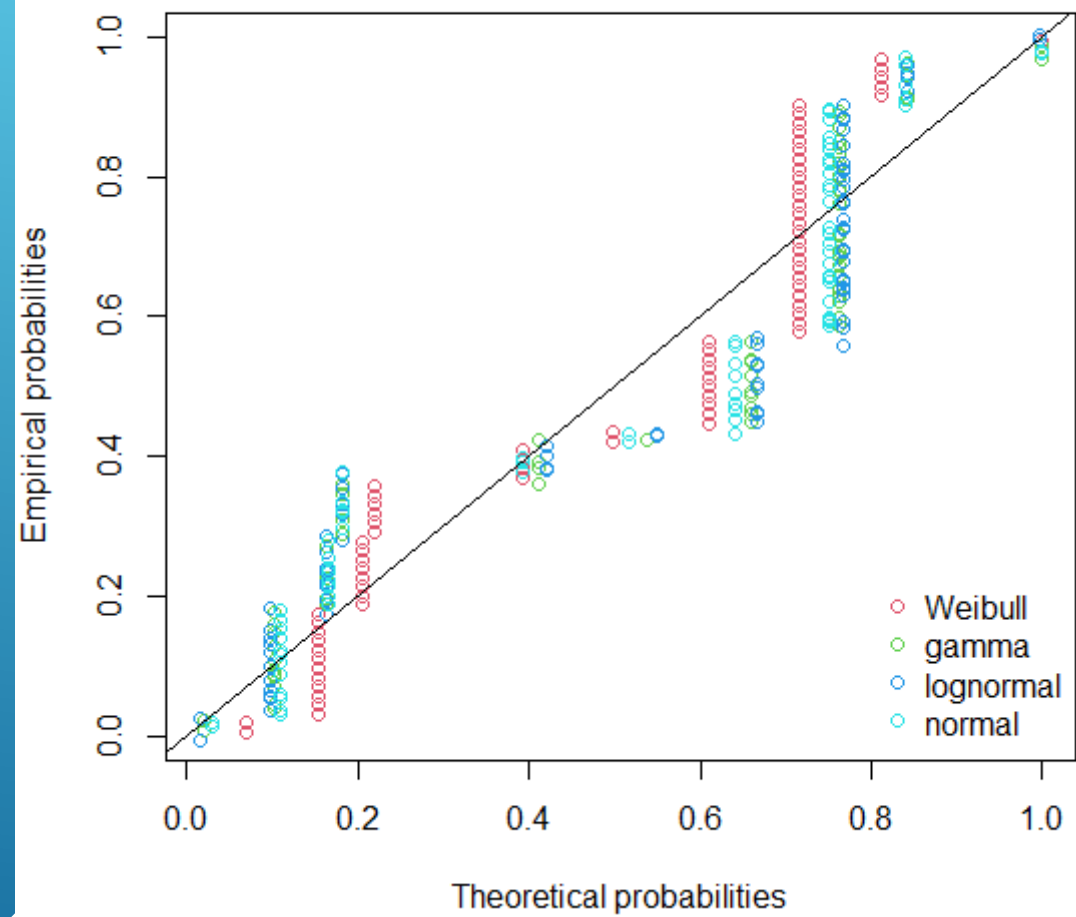


Temperatura de calcinação

Q-Q plot



P-P plot



Temperatura de calcinação

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1926355	0.2177301	0.2259485	0.1996804
Cramer-von Mises statistic	0.6258540	0.7825289	0.8185525	0.7124937
Anderson-Darling statistic	4.0304843	4.4284808	4.5634588	4.1948095

Goodness-of-fit criteria

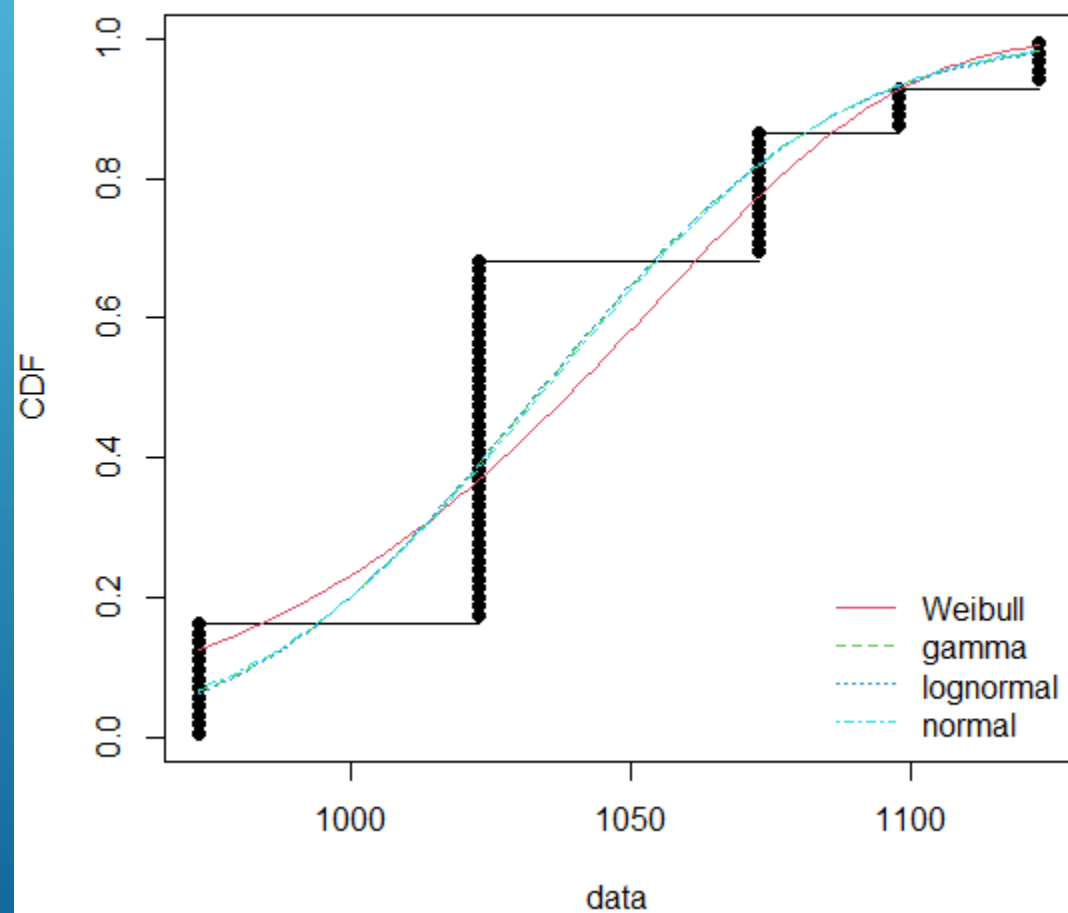
	weibull	gamma	lognormal	normal
Akaike's Information Criterion	1011.021	999.2673	999.161	1001.408
Bayesian Information Criterion	1015.709	1003.9549	1003.849	1006.096

Hartigans' dip test for unimodality / multimodality

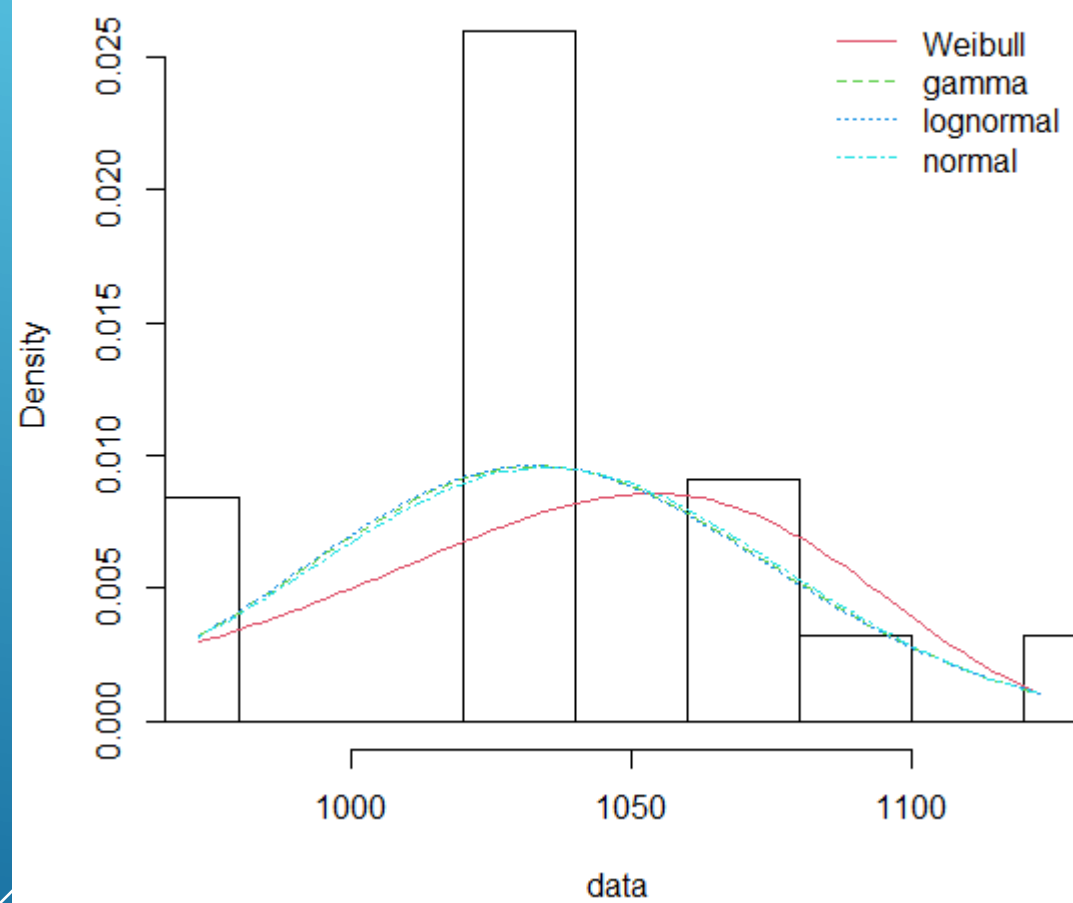
```
data: vari
D = 0.12727, p-value < 2.2e-16
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.2978584
```

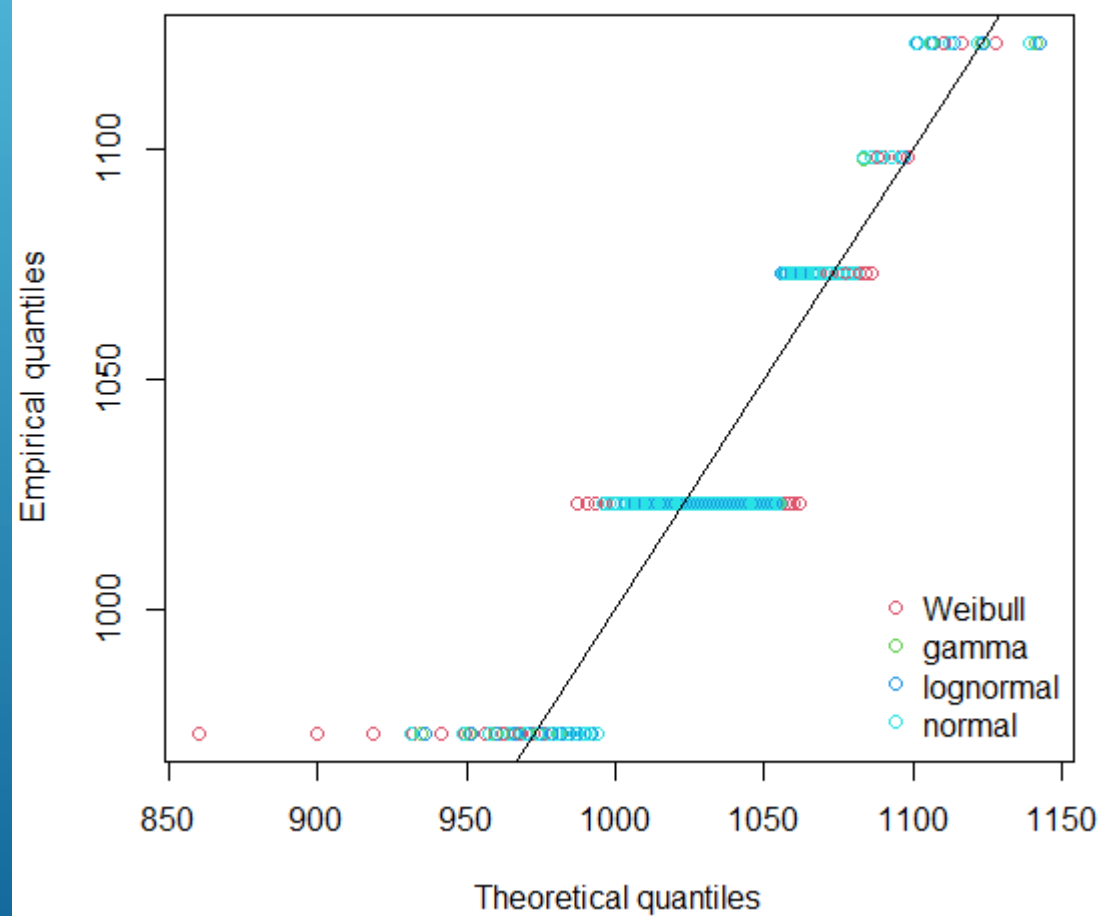

Empirical and theoretical CDFs



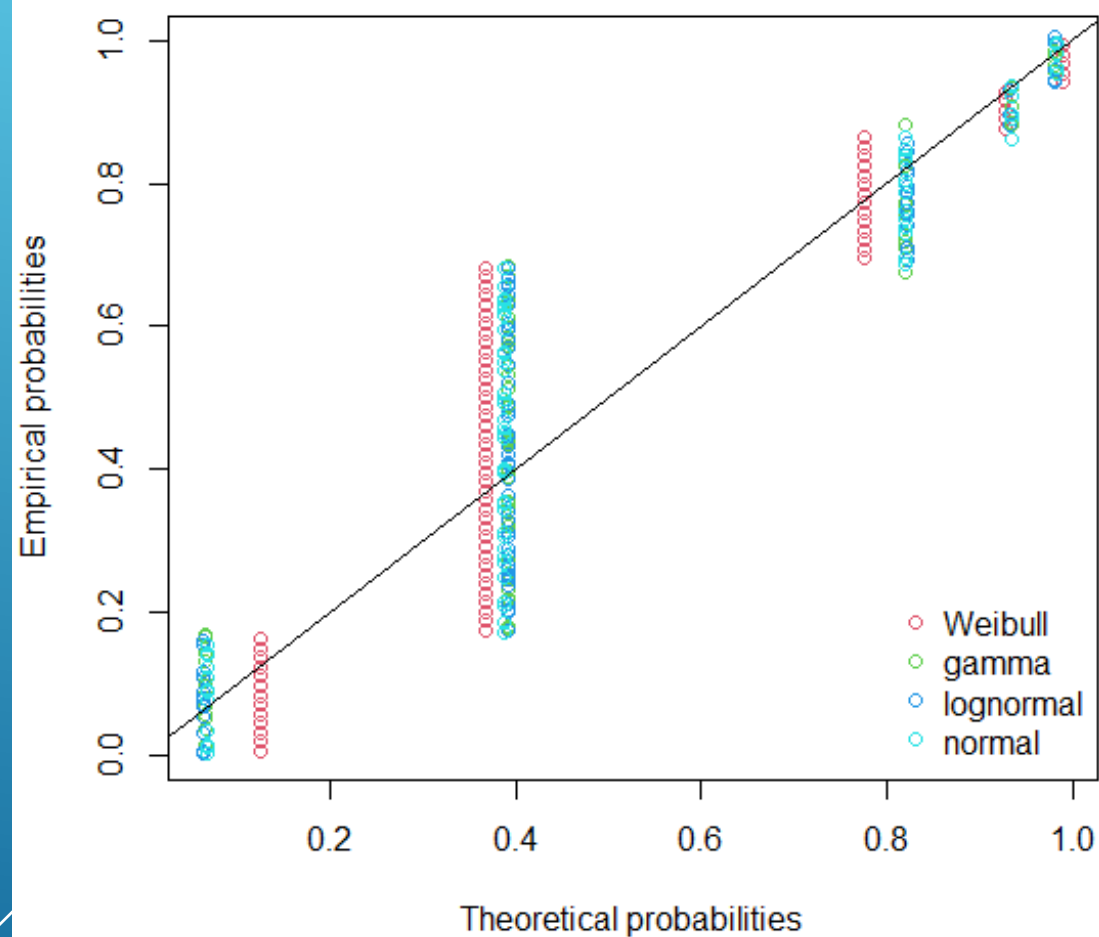
Histogram and theoretical densities



Q-Q plot



P-P plot



Temperatura de redução

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.3192421	0.2971286	0.2950516	0.3014156
Cramer-von Mises statistic	1.1420827	1.0617402	1.0570413	1.0725073
Anderson-Darling statistic	5.5798009	5.1179314	5.1025106	5.1574017

Goodness-of-fit criteria

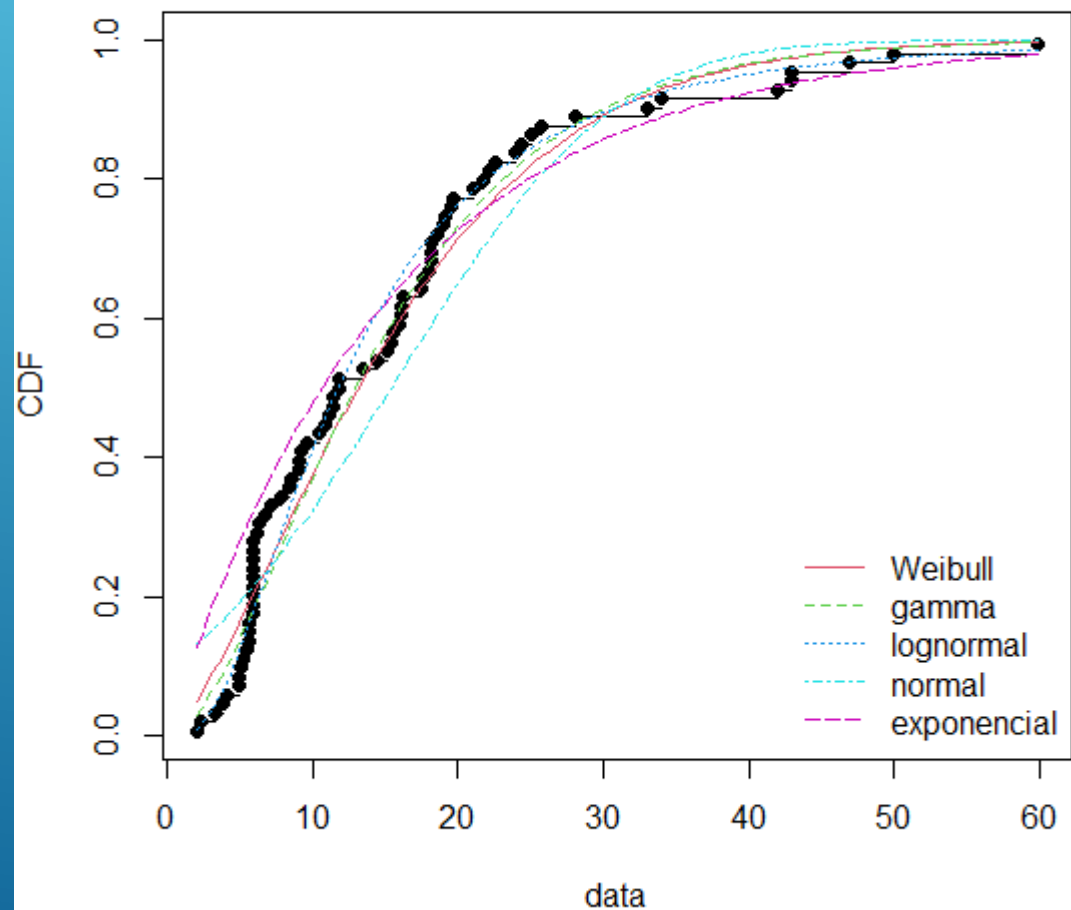
	weibull	gamma	lognormal	normal
Akaike's Information Criterion	811.9540	796.5879	796.2473	797.3686
Bayesian Information Criterion	816.6416	801.2755	800.9349	802.0562

Hartigans' dip test for unimodality / multimodality

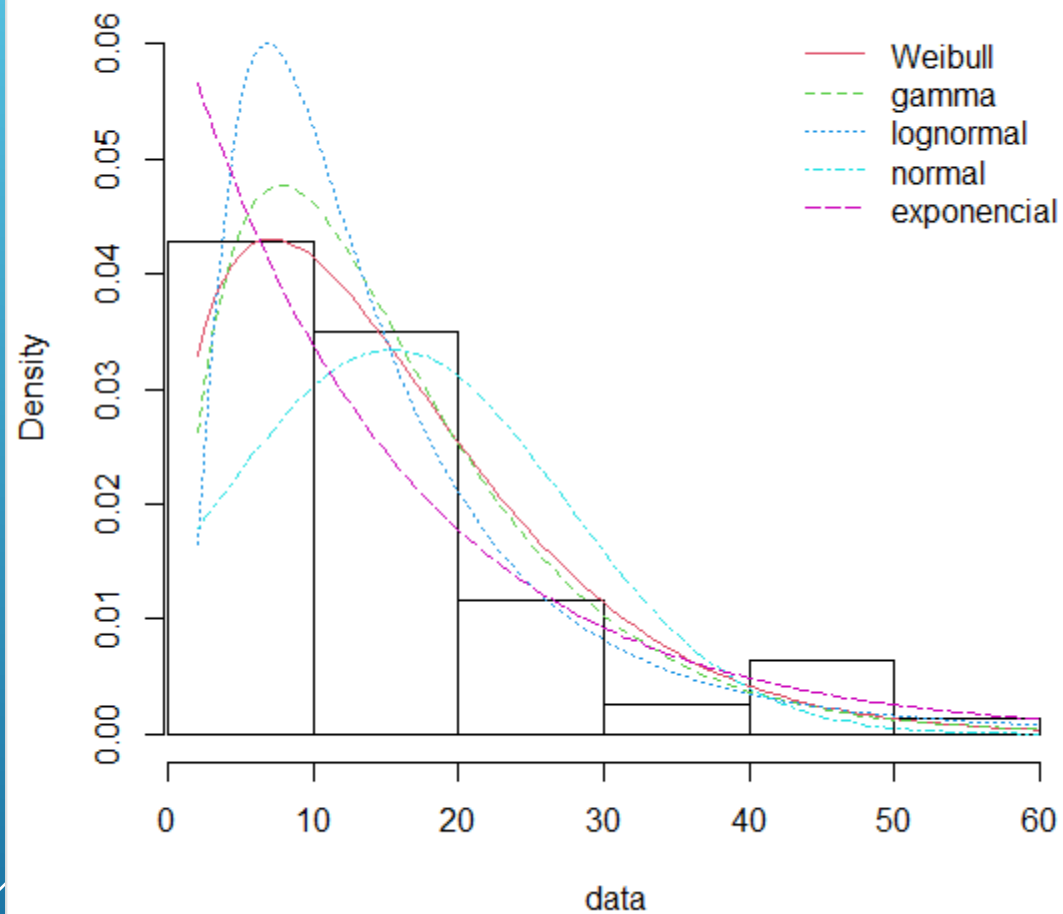
```
data: vari
D = 0.090909, p-value = 2.425e-05
alternative hypothesis: non-unimodal, i.e., at least bimodal
```

```
> 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] 0.4275018
```

Empirical and theoretical CDFs

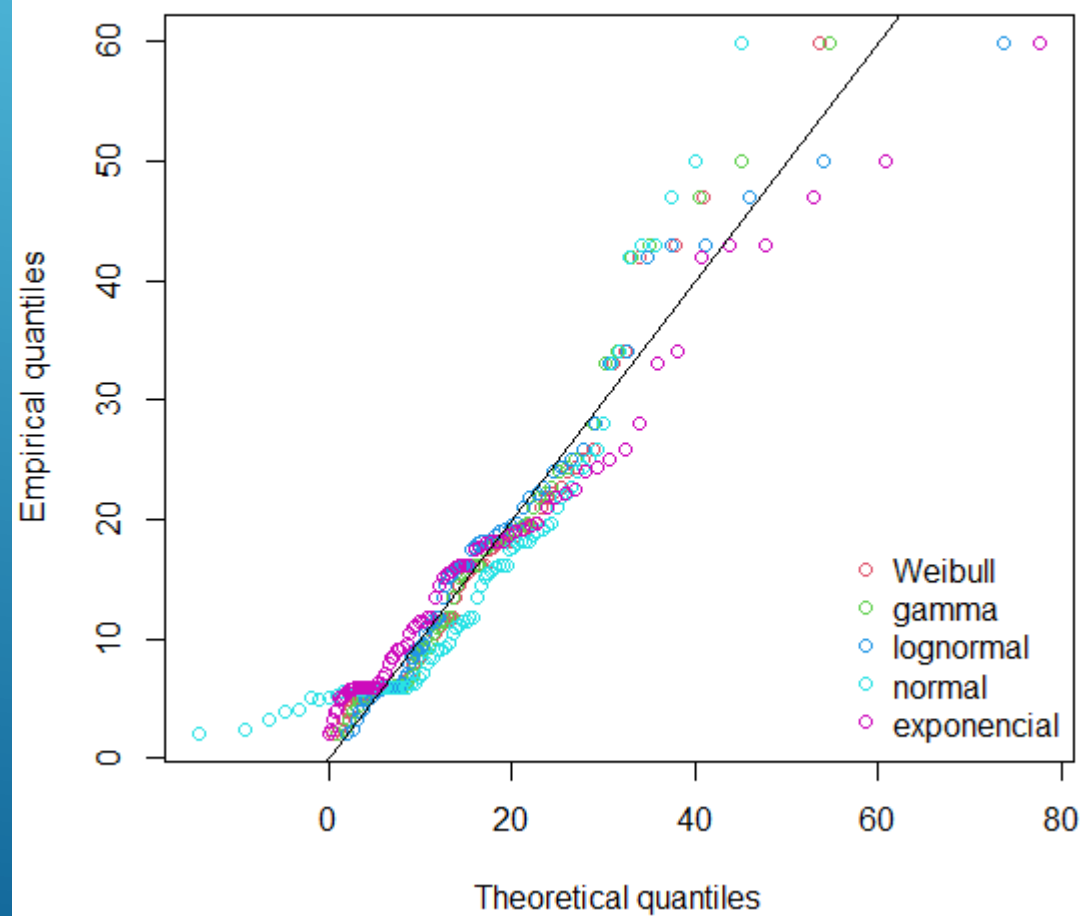


Histogram and theoretical densities

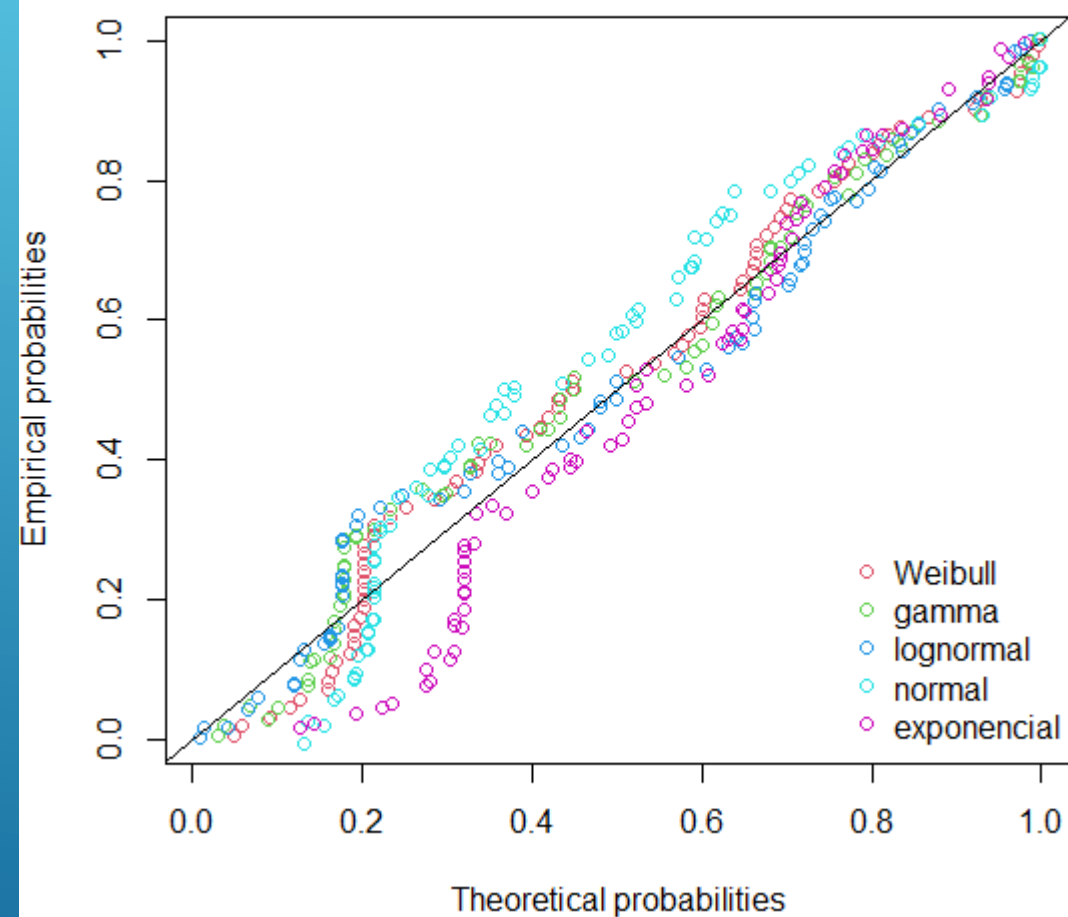


Tamanho de cristalito da fase ativa

Q-Q plot



P-P plot



Tamanho de cristalito da fase ativa

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.09616547	0.1175979	0.1159457	0.1399006
Cramer-von Mises statistic	0.17443883	0.1634230	0.1385214	0.5767595
Anderson-Darling statistic	1.28166474	1.1079911	0.8021182	3.7819807

```
exponencial
```

Kolmogorov-Smirnov statistic	0.2117914
Cramer-von Mises statistic	0.5663934
Anderson-Darling statistic	3.6021834

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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	565.3392	560.9760	555.8116	604.1705
Bayesian Information Criterion	570.0268	565.6636	560.4992	608.8581

```
exponencial
```

Akaike's Information Criterion	577.4285
Bayesian Information Criterion	579.7723

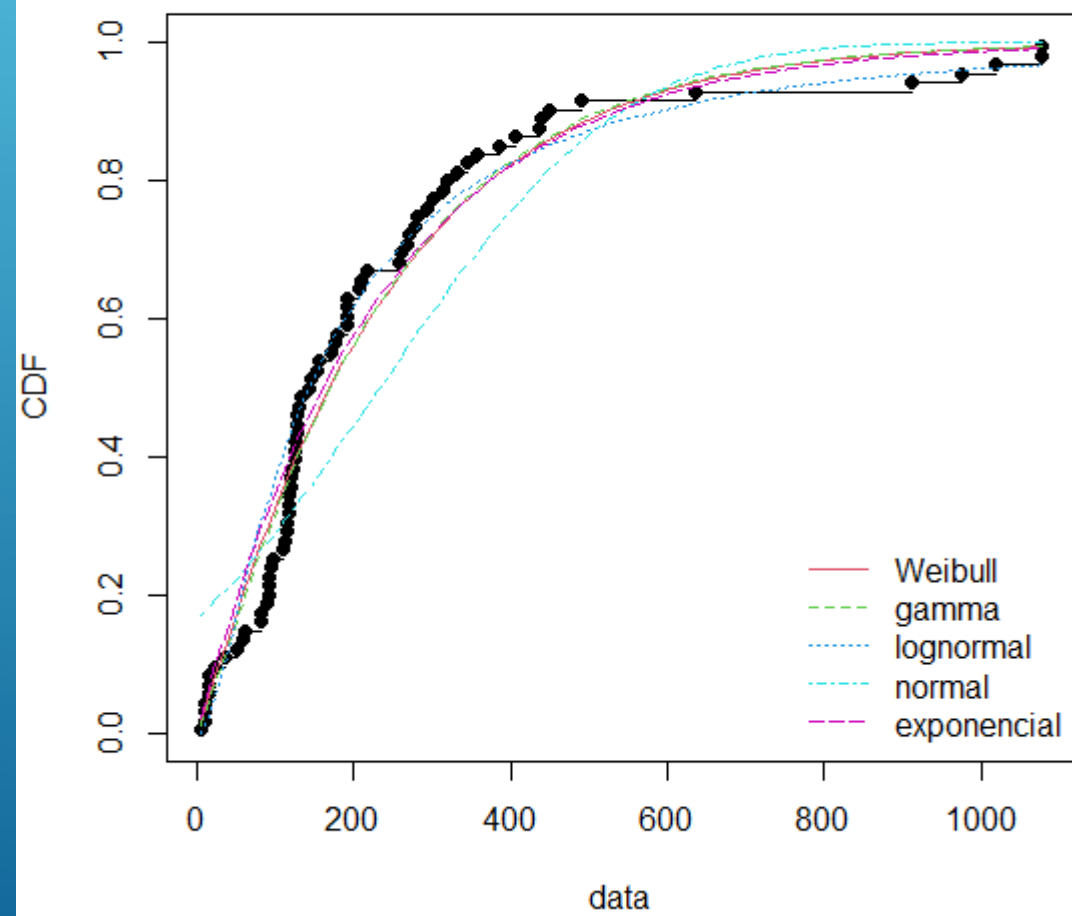
```
Hartigans' dip test for unimodality / multimodality
```

data: vari
D = 0.04146, p-value = 0.4325
alternative hypothesis: non-unimodal, i.e., at least bimodal

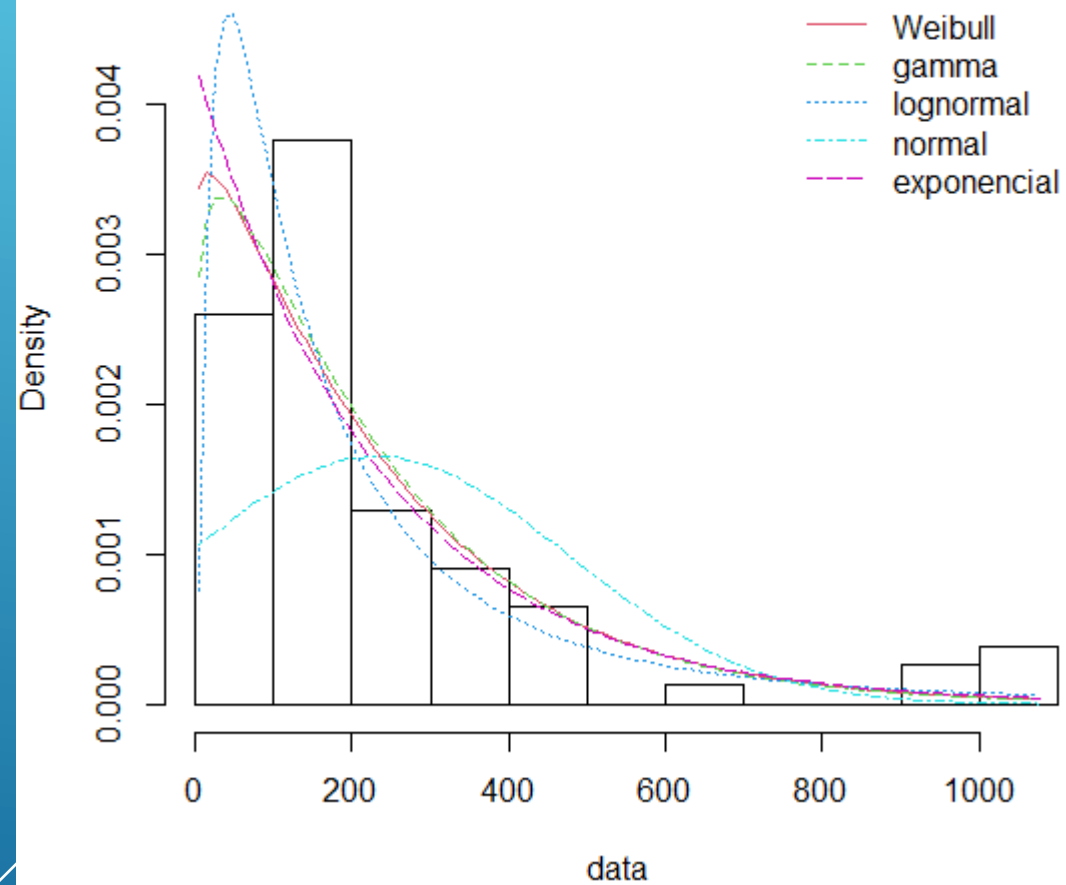
```
> is.amodal(vari)
[1] FALSE
> is.unimodal(vari)
[1] TRUE
> is.bimodal(vari)
[1] FALSE
> is.trimodal(vari)
[1] FALSE
> is.iterquad(vari)
[1] FALSE
> bimodality_coefficient(vari)
[1] 0.6247125
>
```

Área específica do catalisador

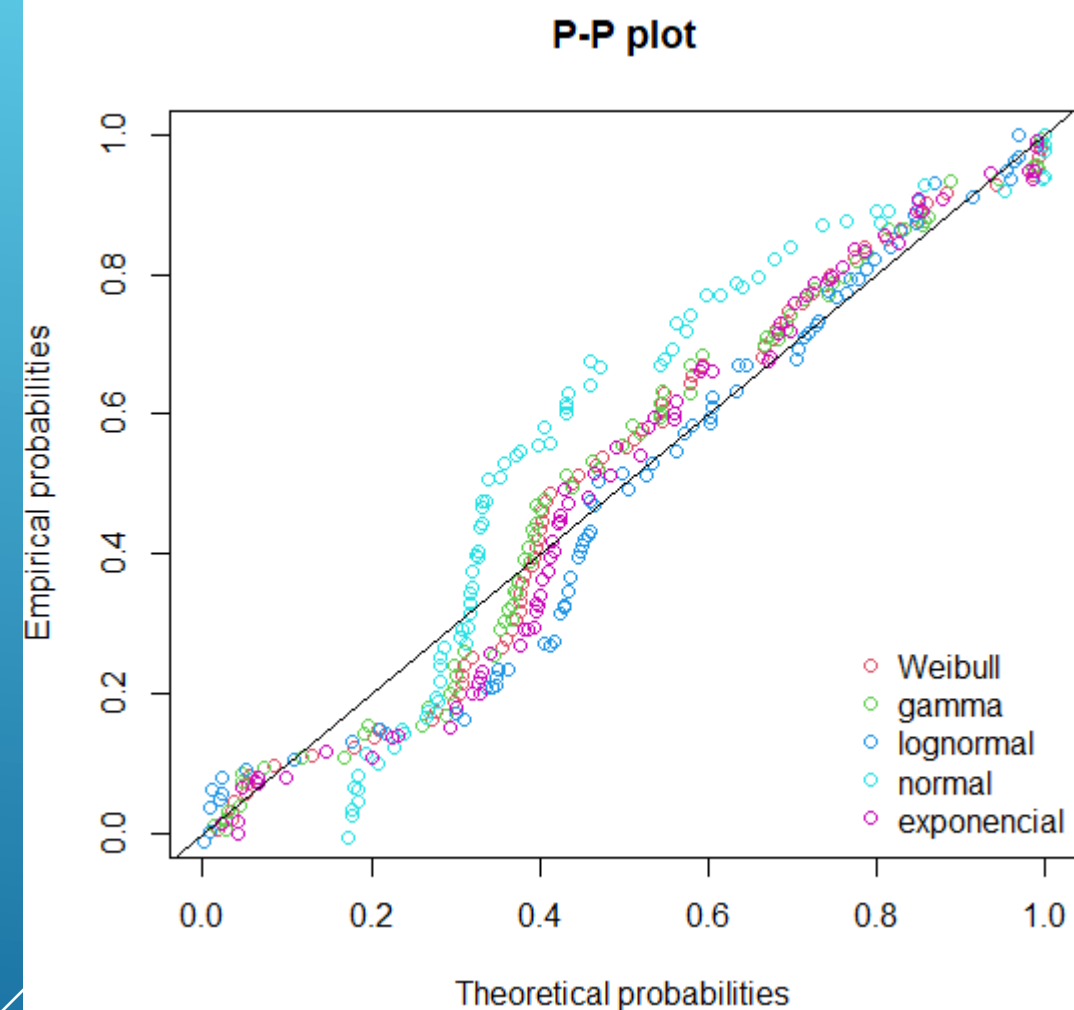
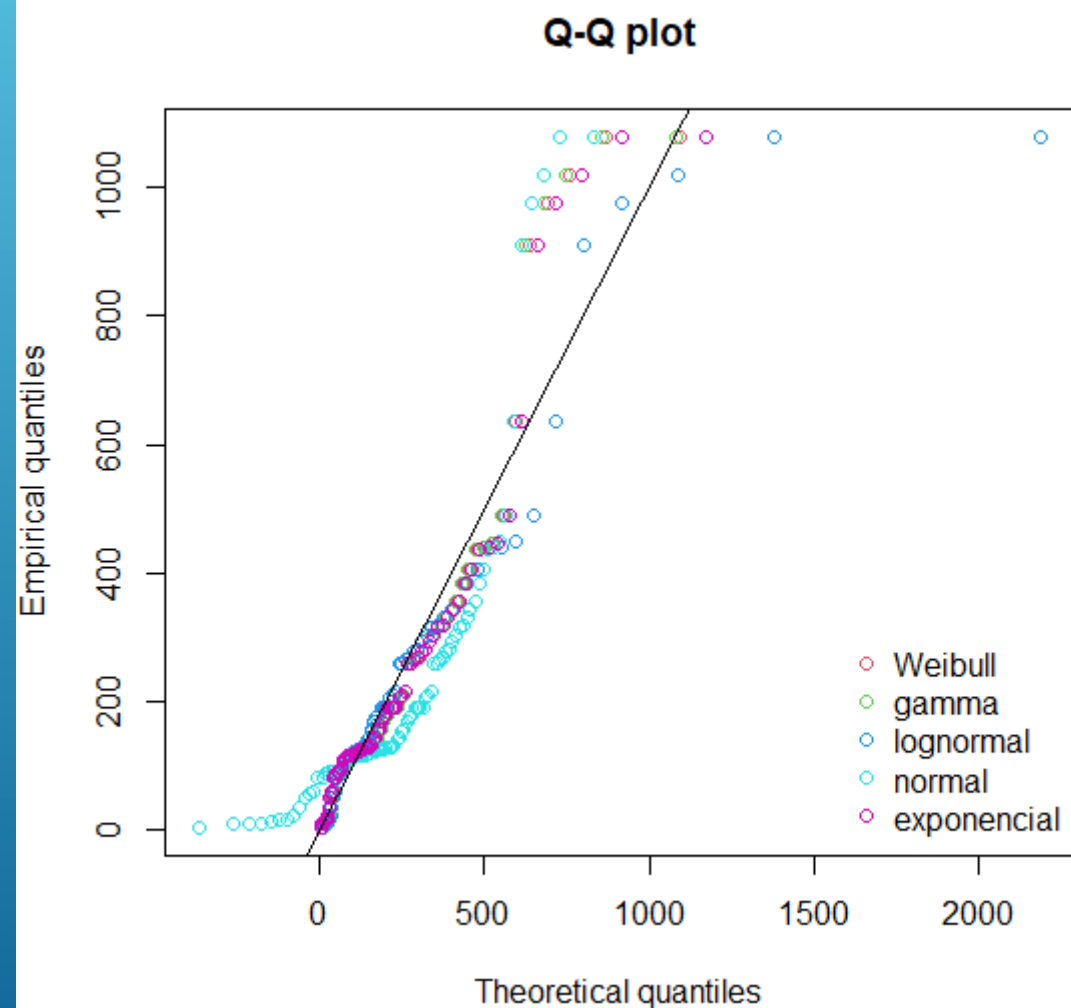
Empirical and theoretical CDFs



Histogram and theoretical densities



Área específica do catalisador



Área específica do catalisador

Goodness-of-fit statistics

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.1166469	0.1062728	0.1541400	0.2034423
Cramer-von Mises statistic	0.2287294	0.2101858	0.2978715	1.1085488
Anderson-Darling statistic	1.3355333	1.2606962	1.8392123	6.6121406

	exponencial
Kolmogorov-Smirnov statistic	0.1388660
Cramer-von Mises statistic	0.2630414
Anderson-Darling statistic	1.4739802

Goodness-of-fit criteria

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	996.8014	996.1685	1001.500	1067.335
Bayesian Information Criterion	1001.4890	1000.8561	1006.187	1072.023

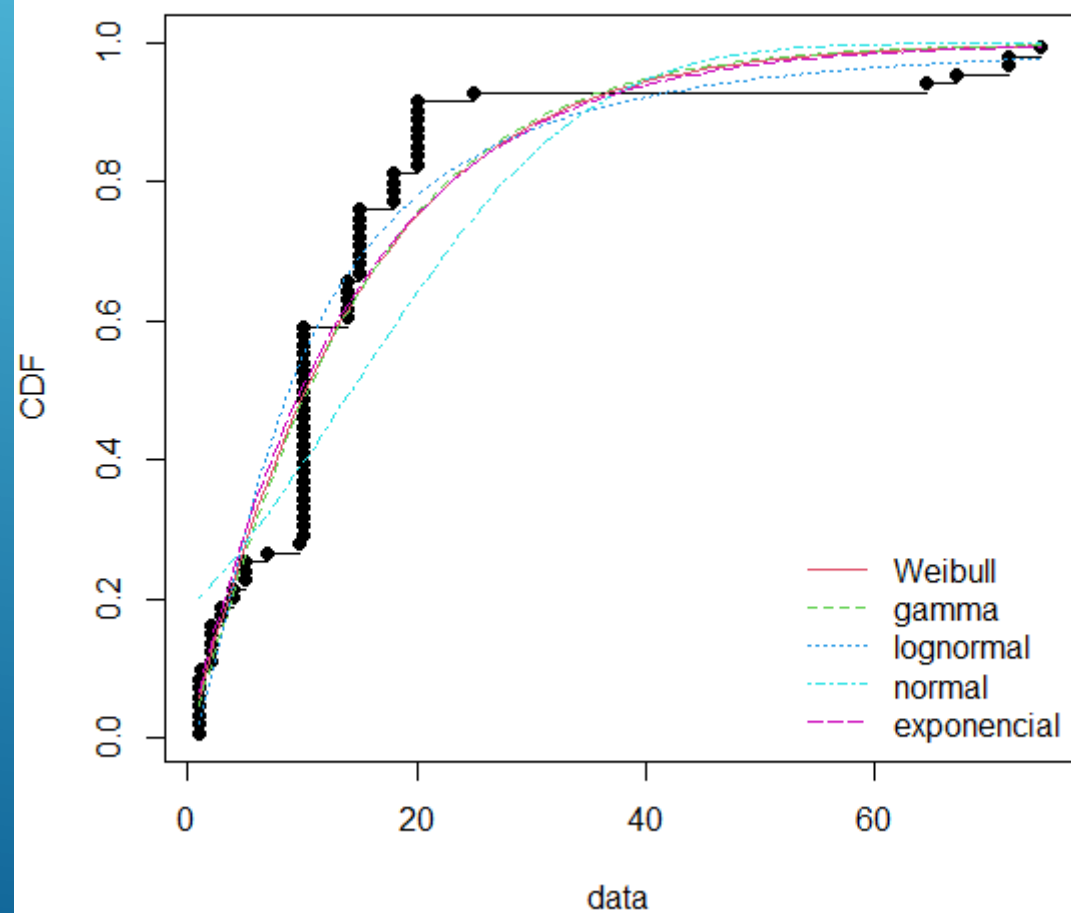
	exponencial
Akaike's Information Criterion	995.2993
Bayesian Information Criterion	997.6431

Hartigan's dip test for unimodality / multimodality

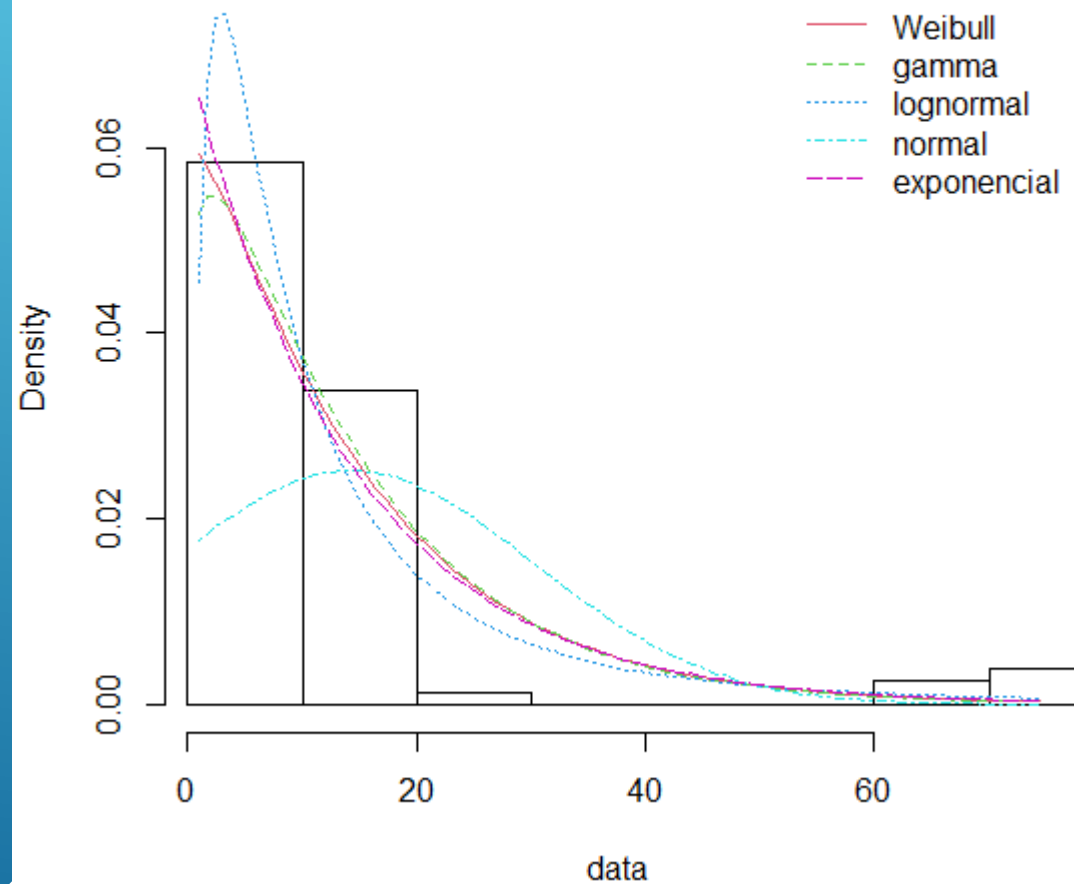
```
data: vari
D = 0.03444, p-value = 0.7606
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.7418216
```

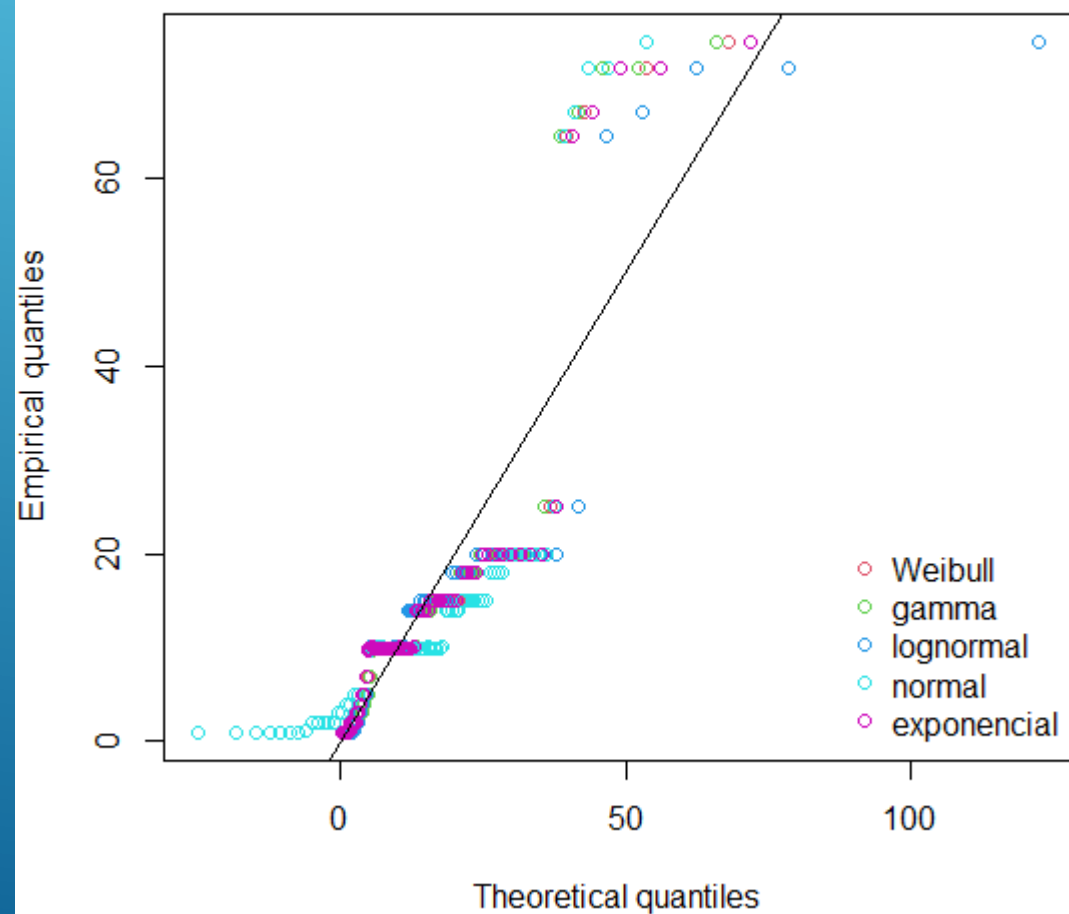
Empirical and theoretical CDFs



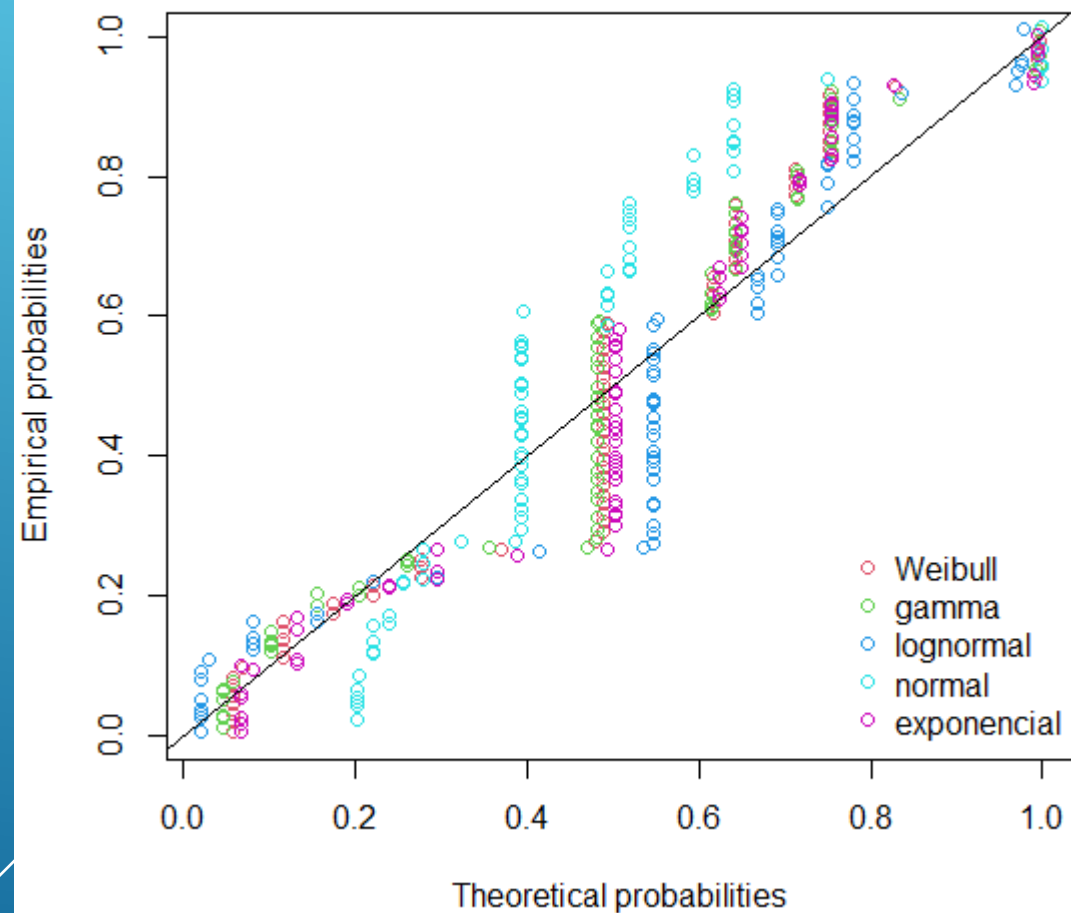
Histogram and theoretical densities



Q-Q plot



P-P plot



Teor total da fase ativa

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

	weibull	gamma	lognormal	normal
Kolmogorov-Smirnov statistic	0.2055849	0.1969993	0.2626054	0.2814217
Cramer-von Mises statistic	0.5270980	0.4991299	0.7007966	1.5405618
Anderson-Darling statistic	2.9862623	2.9257339	3.6441071	9.1360663

```
exponencial
```

Kolmogorov-Smirnov statistic	0.2200863
Cramer-von Mises statistic	0.5652602
Anderson-Darling statistic	3.0843383

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

	weibull	gamma	lognormal	normal
Akaike's Information Criterion	567.2117	566.3196	566.8613	648.1068
Bayesian Information Criterion	571.8993	571.0072	571.5489	652.7944

```
exponencial
```

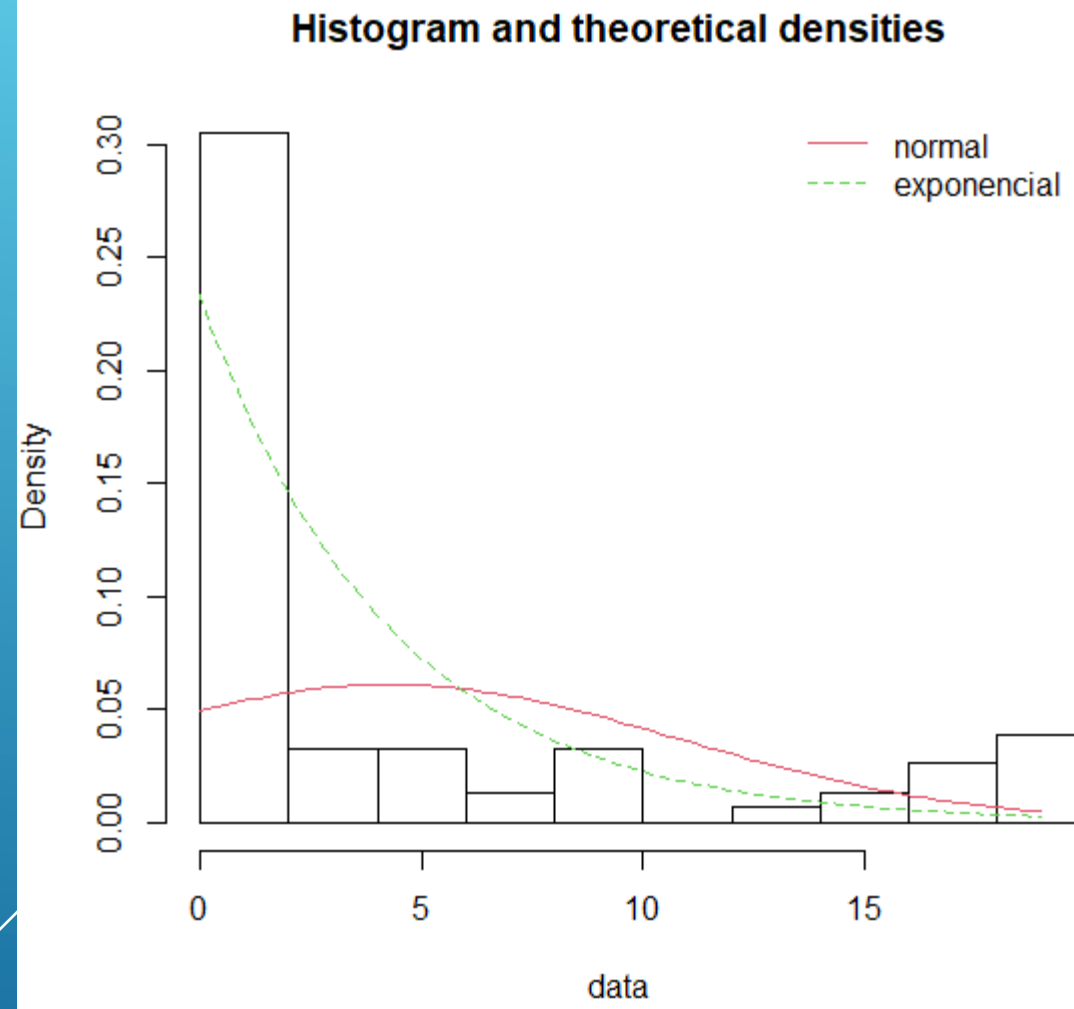
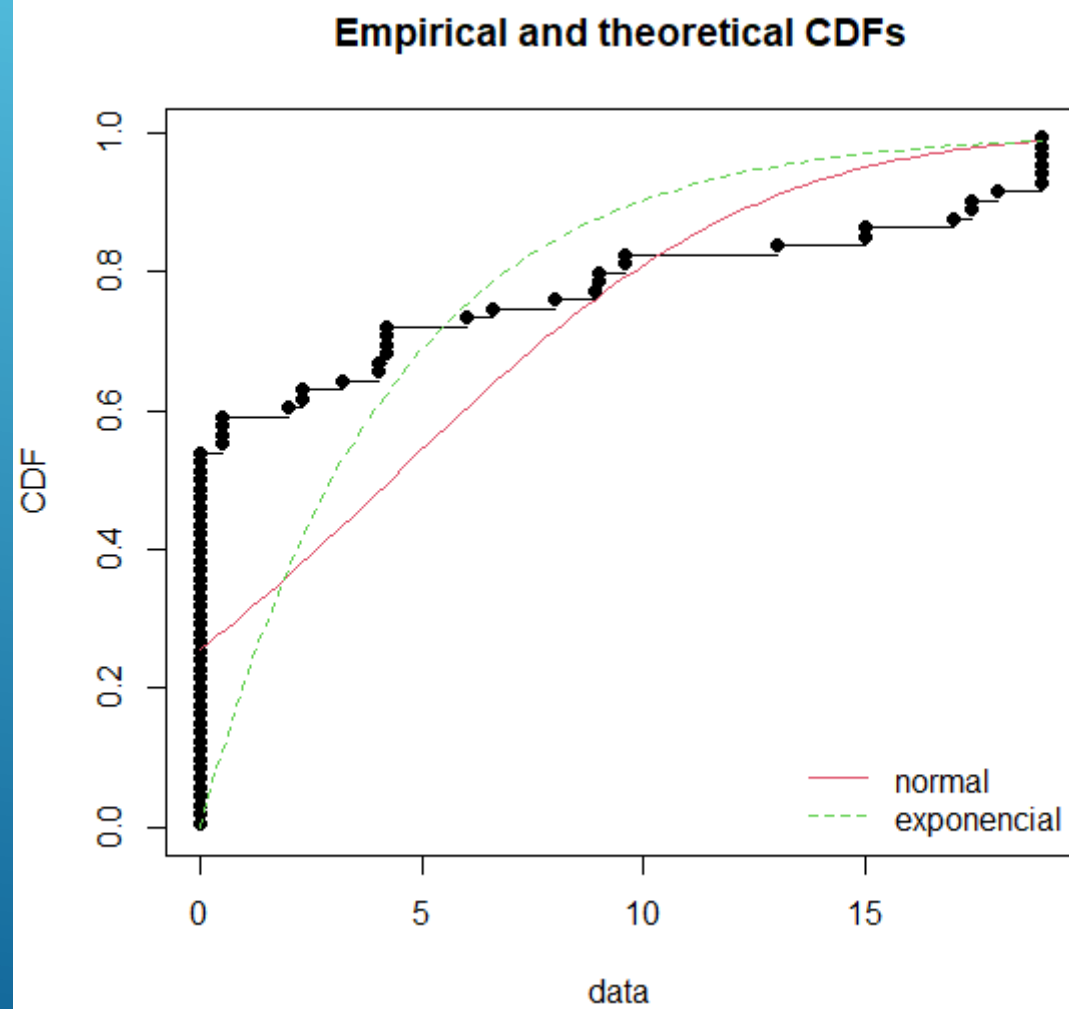
Akaike's Information Criterion	565.5540
Bayesian Information Criterion	567.8978

Hartigans' dip test for unimodality / multimodality

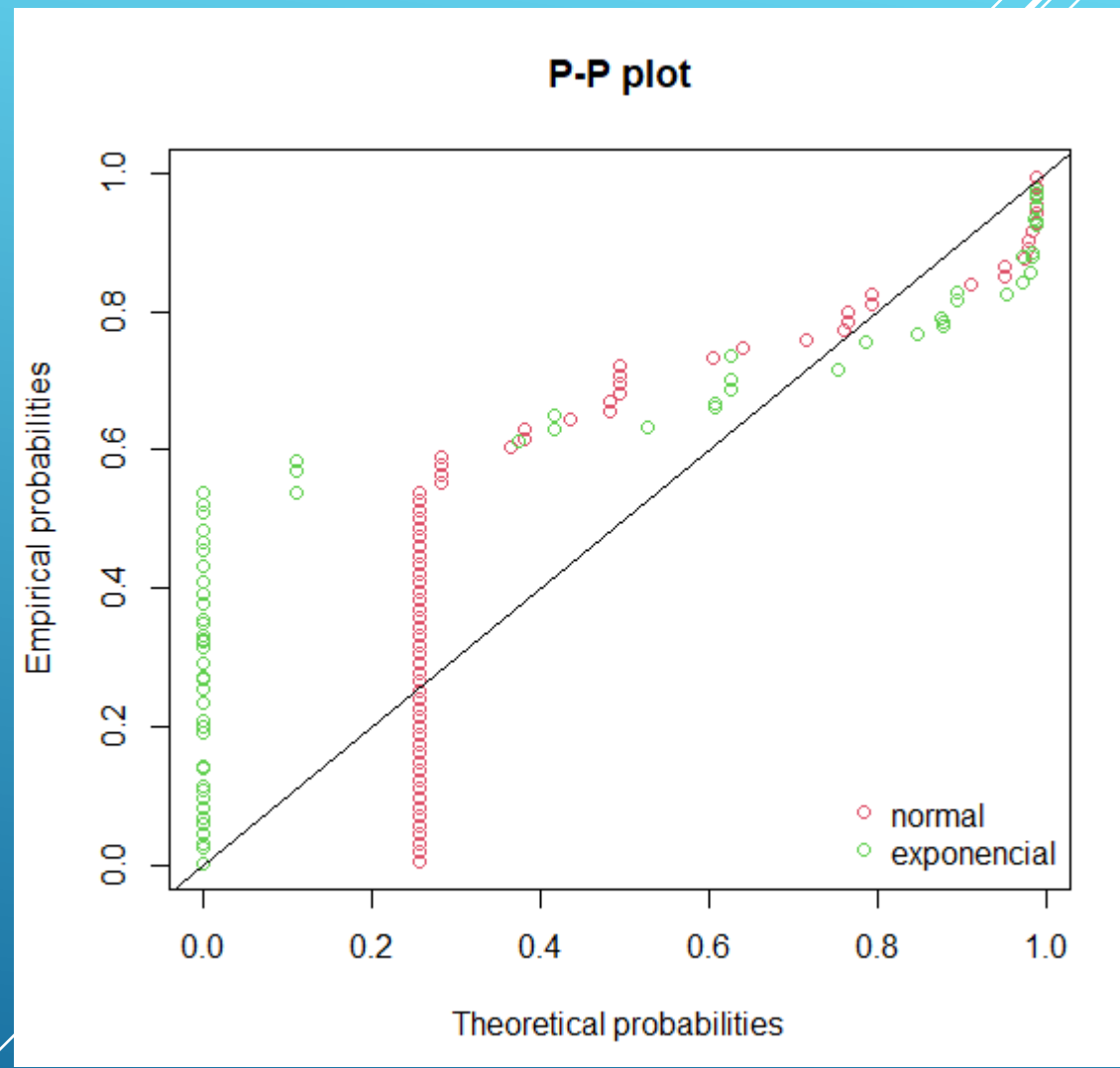
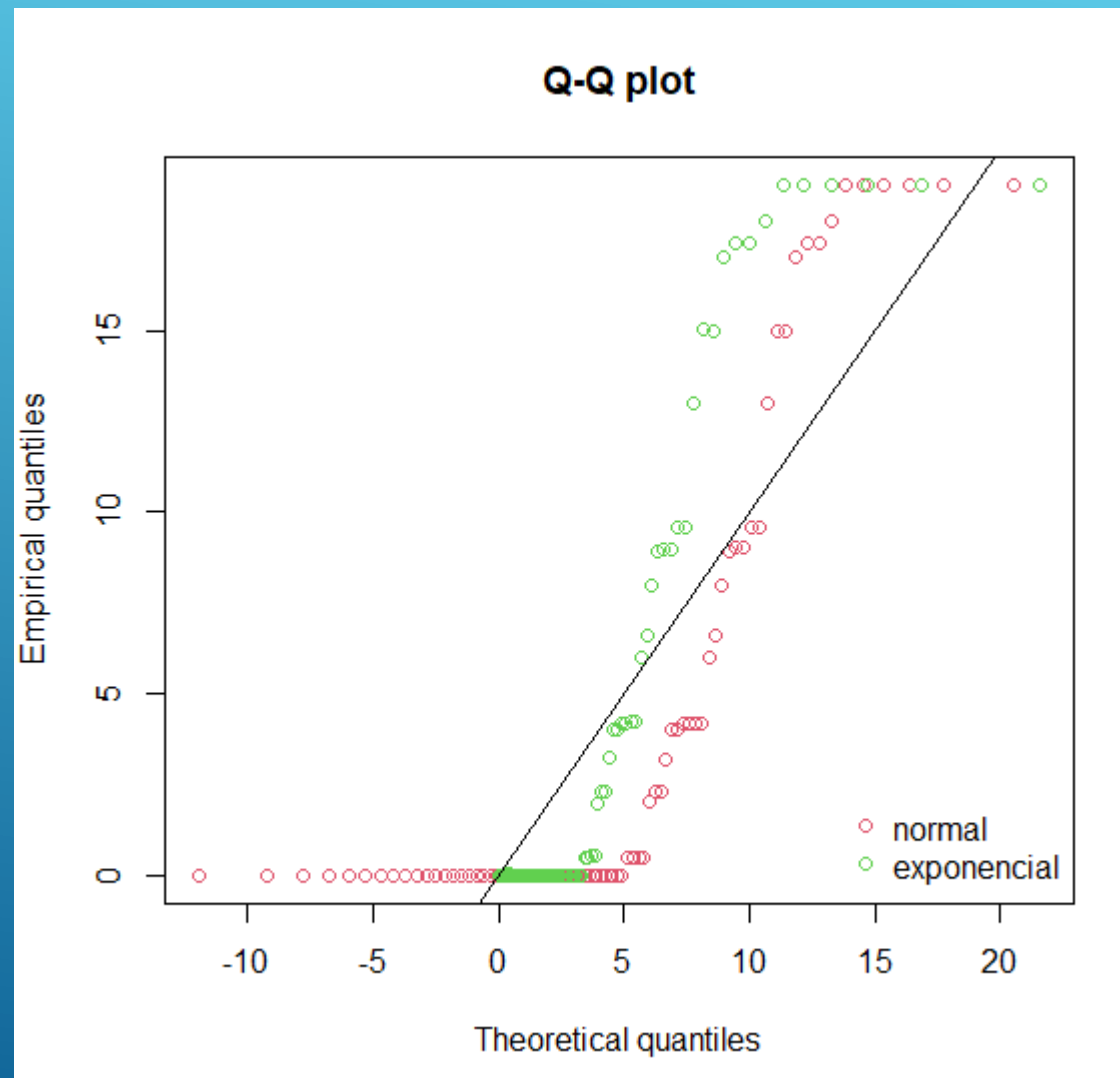
```
data: vari
D = 0.068742, p-value = 0.00656
alternative hypothesis: non-unimodal, i.e., at least bimodal

> 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] 0.8018153
```

Concentração de Dopante ou Promotor



Concentração de Dopante ou Promotor



Concentração de Dopante ou Promotor

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

	normal	exponencial
Kolmogorov-Smirnov statistic	0.316351	0.5454545
Cramer-von Mises statistic	1.938742	5.3247154
Anderson-Darling statistic	10.715981	Inf


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

	normal	exponencial
Akaike's Information Criterion	511.5418	380.1609
Bayesian Information Criterion	516.2294	382.5047

```
>
```

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

data: vari
D = 0.046974, p-value = 0.2342
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] 0.8225013
```