Distribution XML reference for Warteschlangensimulator

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This reference refers to version 5.9.0 of Warteschlangensimulator.
Download address: https://a-herzog.github.io/Warteschlangensimulator/.

When storing distribution settings to xml files the following xml tags will be used:

English version:
<ModelElementDistribution>distribution name (parameters)</ModelElementDistribution>

German version:
<ModellElementVerteilung>distribution name (parameters)</ModellElementVerteilung>

The English or German version will be used when storing xml data in Warteschlangensimulator. When reading xml files Warteschlangensimulator will always understand both versions.

In the following sections the possible values for "distribution name" and the corresponding "parameters" will be listed. Distribution parameters "mean" and "sd" correspond directly to the stochastic characteristics mean and standard deviation.

Empirical data

Empirical data (point1;point2;point3;...)
Empirische Daten (point1;point2;point3;...)

The data points are interpreted as pdf values at equidistant points on the predefined range of the distribution.

One point distribution

One point distribution (point)
Ein-Punkt-Verteilung (point)

Conversion between distribution parameters and stochastic characteristics

$$mean = point$$
$$sd = 0$$

Uniform distribution

Uniform distribution (lower;upper)
Gleichverteilung (lower;upper)

Conversion between distribution parameters and stochastic characteristics

$$\begin{aligned} mean &= (lower + upper)/2 \\ sd &= (upper - lower)/\sqrt{12} \\ lower &= mean - sd \cdot \sqrt{12}/2 \\ upper &= mean + sd \cdot \sqrt{12}/2 \end{aligned}$$

Exponential distribution

`Exponentialverteilung (mean)`
`Exponential distribution (mean)`

Conversion between distribution parameters and stochastic characteristics

$$sd = mean$$

Normal distribution

`Normal distribution (mean;sd)`
`Normalverteilung (mean;sd)`

Lognormal distribution

`Lognormal distribution (mean;sd)`
`Lognormalverteilung (mean;sd)`

Erlang distribution

`Erlang distribution (shape;scale)`
`Erlang-Verteilung (shape;scale)`

Conversion between distribution parameters and stochastic characteristics

$$\begin{aligned} mean &= shape \cdot scale \\ sd &= \sqrt{shape} \cdot scale \\ scale &= sd^2/mean \\ shape &= mean^2/sd^2 \end{aligned}$$

Gamma distribution

`Gamma distribution (shape;scale)`
`Gamma-Verteilung (shape;scale)`

Conversion between distribution parameters and stochastic characteristics

$$
\begin{aligned}
mean &= shape \cdot scale \\
sd &= \sqrt{shape} \cdot scale \\
scale &= sd^2/mean \\
shape &= mean^2/sd^2
\end{aligned}
$$

Beta distribution

`Beta distribution (alpha;beta;lower;upper)`
`Beta-Verteilung (alpha;beta;lower;upper)`

Conversion between distribution parameters and stochastic characteristics

$$
\begin{aligned}
mean &= alpha/(alpha+beta) \cdot (upper-lower) + lower \\
sd &= (upper-lower)^2 \cdot alpha \cdot beta/(alpha+beta)^2/(1+alpha+beta)
\end{aligned}
$$

Cauchy distribution

`Cauchy-Verteilung (median;scale)`
`Cauchy distribution (median;scale)`

Half Cauchy distribution

`Halbe Cauchy-Verteilung (mu;sigma)`
`Half Cauchy distribution (mu;sigma)`

Weibull distribution

`Weibull distribution (scaleInvers;shape)`
`Weibull-Verteilung (scaleInvers;shape)`

Conversion between distribution parameters and stochastic characteristics

$$
\begin{aligned}
mean &= scale \cdot \Gamma(1+(1/shape)) \\
sd &= scale \cdot \sqrt{\Gamma(1+2/shape) - (\Gamma(1+1/shape))^2}
\end{aligned}
$$

Chi distribution

`Chi distribution (degreesOfFreedom)`
`Chi-Verteilung (degreesOfFreedom)`

Conversion between distribution parameters and stochastic characteristics

$$
\begin{aligned}
mean &= \sqrt{2} \cdot \Gamma((degreesOfFreedom+1)/2)/\Gamma(degreesOfFreedom/2) \\
sd &= \Big[(2 \cdot \Gamma(degreesOfFreedom/2) * \Gamma(1+degreesOfFreedom/2) - \\
&\qquad (\Gamma((degreesOfFreedom+1)/2))^2)/\Gamma(degreesOfFreedom/2)\Big]^{\frac{1}{2}}
\end{aligned}
$$

Chi^2 distribution

`Chi^2 distribution (degreesOfFreedom)`
`Chi^2-Verteilung (degreesOfFreedom)`

Conversion between distribution parameters and stochastic characteristics

$$mean = degreesOfFreedom$$
$$sd = \sqrt{2 \cdot degreesOfFreedom}$$

F distribution

`F distribution (NumeratorDegreesOfFreedom;DenominatorDegreesOfFreedom)`
`F-Verteilung (NumeratorDegreesOfFreedom;DenominatorDegreesOfFreedom)`

Conversion between distribution parameters and stochastic characteristics
(let $m := NumeratorDegreesOfFreedom$ and $n := DenominatorDegreesOfFreedom$)

$$mean = \frac{n}{n-2}$$
$$sd = \sqrt{2 \cdot n^2 \cdot \frac{m+n-2}{m \cdot (n-2) \cdot (n-2) \cdot (n-4)}}$$
$$m = round\left(2 \cdot (2 \cdot \widetilde{m})^2 \cdot \frac{2 \cdot \widetilde{m} - 2}{sd^2 \cdot (2 \cdot \widetilde{m} - 2)^2 \cdot (2 \cdot \widetilde{m} - 4) - 2 \cdot (2 \cdot \widetilde{m})^2}\right) \text{ with } \widetilde{m} := mean/(mean-1)$$
$$n = round(2 \cdot mean/(mean-1))$$

Johnson SU distribution

`Johnson SU distribution (gamma;xi;delta;lambda)`
`Johnson-SU-Verteilung (gamma;xi;delta;lambda)`

Conversion between distribution parameters and stochastic characteristics

$$mean = xi - lambda \cdot \exp(1/(2 \cdot delta^2)) \cdot \sinh(gamma/delta)$$
$$sd = \sqrt{lambda^2/2 \cdot (\exp(1/delta^2) - 1) \cdot (\exp(1/delta^2) * \cosh(2 * gamma/delta) + 1)}$$

Triangular distribution

`Triangular distribution (lowerBound;mostLikelyX;upperBound)`
`Dreiecksverteilung (lowerBound;mostLikelyX;upperBound)`

Conversion between distribution parameters and stochastic characteristics

$$mean = (lowerBound + mostLikelyX + upperBound)/3$$
$$sd = \Big[(lowerBound^2 + upperBound^2 + mostLikelyX^2 - lowerBound \cdot upperBound - lowerBound \cdot mostLikelyX - upperBound \cdot mostLikelyX)/18\Big]^{\frac{1}{2}}$$
$$lowerBound = mean - sd \cdot \sqrt{6}$$
$$mostLikelyX = mean$$
$$upperBound = mean + sd \cdot \sqrt{6}$$

Trapezoid distribution

`Trapezoid distribution (a;b;c;d)`
`Trapezverteilung (a;b;c;d)`

Conversion between distribution parameters and stochastic characteristics

$$h = \frac{2}{c + d - a - b}$$
$$mean = h \cdot 16 \left(\frac{d^3 - c^3}{d - c} - \frac{b^3 - a^3}{b - a} \right)$$
$$sd = \sqrt{h \cdot 112 \left(\frac{d^4 - c^4}{d - c} - \frac{b^4 - a^4}{b - a} \right) - mean^2}$$

Pert distribution

`Pert distribution (lowerBound;mostLikelyX;upperBound)`
`Pert-Verteilung (lowerBound;mostLikelyX;upperBound)`

Conversion between distribution parameters and stochastic characteristics

$$mean = (lowerBound + 4 \cdot mostLikelyX + upperBound)/6$$
$$sd = \Big[((lowerBound + 4 \cdot mostLikelyX + upperBound)/6 - lowerBound) \cdot (upperBound - (lowerBound + 4 \cdot mostLikelyX + upperBound)/6)/7\Big]^{\frac{1}{2}}$$
$$lowerBound = mean - sd \cdot \sqrt{7}$$
$$mostLikelyX = mean$$
$$upperBound = mean + sd \cdot \sqrt{7}$$

Laplace distribution

`Laplace distribution (mean;b)`
`Laplace-Verteilung (mean;b)`

Conversion between distribution parameters and stochastic characteristics

$$sd = b \cdot \sqrt{2}$$

Pareto distribution

`Pareto distribution (xmin;alpha)`
`Pareto-Verteilung (xmin;alpha)`

Conversion between distribution parameters and stochastic characteristics

$$\begin{aligned} mean &= alpha \cdot xmin/(alpha - 1) \\ sd &= xmin^2 \cdot alpha/(alpha-1)^2/(alpha-2) \\ alpha &= mean/(mean - xmin) \end{aligned}$$

Logistic distribution

`Logistic distribution (mean;s)`
`Logistische Verteilung (mean;s)`

Conversion between distribution parameters and stochastic characteristics

$$sd = s \cdot \pi/\sqrt{3}$$

Inverse gaussian distribution

`Inverse gaussian distribution (lambda;mu)`
`Inverse Gauß-Verteilung (lambda;mu)`

Conversion between distribution parameters and stochastic characteristics

$$\begin{aligned} mean &= mu \\ sd &= mu \cdot \sqrt{mu/lambda} \\ lambda &= mean^3/sd^2 \end{aligned}$$

Rayleigh distribution

`Rayleigh distribution (mean)`
`Rayleigh-Verteilung (mean)`

Conversion between distribution parameters and stochastic characteristics

$$sd = \sqrt{(4-\pi)/2} \cdot \sqrt{2/\pi} \cdot mean$$

Log-logistic distribution

`Log-logistic distribution (alpha;beta)`
`Log-Logistische Verteilung (alpha;beta)`

Conversion between distribution parameters and stochastic characteristics

$$\begin{aligned} mean &= alpha \cdot \pi/beta/\sin(\pi/beta) \\ sd &= alpha \cdot \sqrt{2 \cdot \pi/beta/\sin(2 \cdot \pi/beta) - \pi^2/beta^2}/sin(\pi/beta) \end{aligned}$$

Power distribution

`Power distribution (a;b;c)`
`Potenzverteilung (a;b;c)`

Conversion between distribution parameters and stochastic characteristics

$$mean = a + (b - a) \cdot c/(c + 1)$$
$$sd = (b - a)/(c + 1) \cdot \sqrt{c/(c + 2)}$$

Gumbel distribution

`Gumbel distribution (mean;sd)`
`Gumbel-Verteilung (mean;sd)`

Fatigue life distribution

`Fatigue life distribution (mu;beta;gamma)`
`Fatigue-Life-Verteilung (mu;beta;gamma)`

Conversion between distribution parameters and stochastic characteristics

$$mean = mu + beta \cdot (1 + gamma \cdot gamma/2)$$
$$sd = beta \cdot gamma \cdot \sqrt{1 + 5 \cdot gamma^2/4}$$

Frechet distribution

`Frechet distribution (delta;beta;alpha)`
`Frechet-Verteilung (delta;beta;alpha)`

Conversion between distribution parameters and stochastic characteristics

$$mean = delta + beta \cdot gamma(1 - 1/alpha)$$
$$sd = beta \cdot \sqrt{gamma(1 - 2/alpha) - gamma(1 - 1/alpha)^2}$$

Hyperbolic secant distribution

`Hyperbolic secant distribution (mean;sd)`
`Hyperbolische Sekanten-Verteilung (mean;sd)`

Left sawtooth distribution

`Left sawtooth distribution (a;b)`
`Linke Sägezahnverteilung (a;b)` Conversion between distribution parameters and stochastic characteristics

$$mean = (2 \cdot a + b)/2$$
$$sd = (b - a)^2/18$$

Right sawtooth distribution

`Right sawtooth distribution (a;b)`
`Rechte Sägezahnverteilung (a;b)` Conversion between distribution parameters and stochastic characteristics

$$mean = (a + 2 \cdot b)/2$$
$$sd = (b - a)^2/18$$

Levy distribution

`Levy distribution (mu;c)`
`Levy-Verteilung (mu;c)`

Maxwell Boltzmann distribution

`Maxwell Boltzmann distribution (a)`
`Maxwell-Boltzmann-Verteilung (a)`

$$mean = 2 \cdot a\sqrt{\frac{2}{\pi}}$$
$$sd = \sqrt{\frac{a^2(3\pi - 8)}{\pi}}$$
$$modus = a\sqrt{2}$$
$$a = \frac{mean}{2} \cdot \sqrt{\frac{\pi}{2}}$$

Student t-distribution

`Student t-distribution (mu;nu)`
`Studentsche t-Verteilung (mu;nu)` Conversion between distribution parameters and stochastic characteristics

$$mean = \mu$$
$$sd = \sqrt{\frac{\nu}{\nu - 2}} \quad \text{for } \nu > 2$$

Half normal distribution

`Halbe Normalverteilung (s;mu)`
`Half normal distribution (s;mu)`

Conversion between distribution parameters and stochastic characteristics

$$\theta = \frac{1}{\mu}$$
$$mean = \frac{1}{\theta} + s$$
$$sd = \frac{\pi - 2}{2\theta^2}$$

U-quadratic distribution

`U-quadratische Verteilung (a;b)`
`U-quadratic distribution (a;b)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{a+b}{2}$$
$$sd = \frac{3}{20} \cdot (b-a)^2$$
$$a = mean - \frac{\sqrt{sd^2 \cdot \frac{20}{3}}}{2}$$
$$b = mean + \frac{\sqrt{sd^2 \cdot \frac{20}{3}}}{2}$$

Reciprocal distribution

`Reziproke Verteilung (a;b)`
`Reciprocal distribution (a;b)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{b-a}{\log\left(\frac{b}{a}\right)}$$
$$sd = \sqrt{\frac{b^2 - a^2}{\log\left(\frac{b}{a}\right)} - \left(\frac{b-a}{\log\left(\frac{b}{a}\right)}\right)^2}$$

Kumaraswamy distribution

`Kumaraswamy-Verteilung (a;b;c;d)`
`Kumaraswamy distribution (a;b;c;d)`

Conversion between distribution parameters and stochastic characteristics

$$mean_{\text{unscaled}} = \frac{b\Gamma\left(1+\frac{1}{a}\right)\Gamma(b)}{\Gamma\left(1+\frac{1}{a}+b\right)}$$

$$sd_{\text{unscaled}} = \sqrt{\frac{b\Gamma\left(1+\frac{2}{a}\right)\Gamma(b)}{\Gamma\left(1+\frac{2}{a}+b\right)} - mean^2_{\text{unscaled}}}$$

$$mean = mean_{\text{unscaled}} \cdot (d-c) + c$$

$$sd = sd_{\text{unscaled}} \cdot (d-c) + c$$

Irwin-Hall distribution

`Irwin-Hall-Verteilung (n)`
`Irwin-Hall distribution (n)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{n}{2}$$

$$sd = \sqrt{\frac{n}{12}}$$

Sine distribution

`Sinus-Verteilung (a;b)`
`sine distribution (a;b)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{a+b}{2}$$

$$sd = \sqrt{\frac{1}{4} - \frac{2}{\pi^2}} \cdot (b-a)^2$$

Cosine distribution

`Cosinus-Verteilung (a;b)`
`cosine distribution (a;b)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{a+b}{2}$$

$$sd = (b-a)\sqrt{\frac{\pi^2-6}{12\pi^2}}$$

Arcsine distribution

`Arcus Sinus-Verteilung (a;b)`
`arcsine distribution (a;b)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{a+b}{2}$$
$$sd = \frac{1}{8} \cdot (b-a)^2$$

Wigner half-circle distribution

`Wigner Halbkreis-Verteilung (m;R)`
`Wigner half-circle distribution (m;R)`

Conversion between distribution parameters and stochastic characteristics

$$mean = m$$
$$sd = \frac{R}{2}$$

Log-Cauchy distribution

`Log-Cauchy-Verteilung (mu;sigma)`
`Log-Cauchy distribution (mu;sigma)`

Conversion between distribution parameters and stochastic characteristics

$$median = \exp(mu)$$

Log-Gamma distribution

`Log-Gamma-Verteilung (a;b)`
`Log-Gamma distribution (a;b)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \left(1 - \frac{1}{b}\right)^{-a}$$
$$st = \sqrt{\left(1 - \frac{2}{b}\right)^{-a} - \left(1 - \frac{1}{b}\right)^{-2a}}$$

Log-Laplace distribution

`Log-Laplace-Verteilung (c;s)`
`Log-Laplace distribution (c;s)`

Conversion between distribution parameters and stochastic characteristics

$$mean = s + \frac{c^2}{(c-1)(c+1)}$$
$$st = \sqrt{\frac{c^2}{(c-2)(c+2)} - \frac{c^4}{(c-1)^2(c+1)^2}}$$

Geometric distribution

`Geometric distribution (p)` `Geometrische Verteilung (p)` Conversion between distribution parameters and stochastic characteristics

$$mean = = \frac{1-p}{p}$$
$$sd = \sqrt{\frac{1-p}{p^2}}$$
$$p = \frac{1}{1+mean}$$

Hypergeometric distribution

`Hypergeometric distribution (N;K;n)` `Hypergeometrische Verteilung (N;K;n)` Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{n \cdot K}{N}$$
$$sd = \sqrt{\frac{n \cdot K}{N} \cdot \left(1 - \frac{K}{N}\right) \cdot \frac{N-n}{N-1}}$$

Binomial distribution

`Binomial distribution (n;p)` `Binomialverteilung (n;p)` Conversion between distribution parameters and stochastic characteristics

$$mean = = n \cdot p$$
$$sd = \sqrt{n \cdot p \cdot (1-p)}$$
$$n = \frac{mean}{p}$$
$$p = 1 - \frac{sd^2}{mean}$$

Poisson distribution

`Poisson distribution (lambda)` `Poisson-Verteilung (lambda)`

$$mean = \lambda$$
$$sd = \lambda$$

Negative binomial distribution

`Negative binomial distribution (n;r)` `Negative Binomialverteilung (n;r)`

$$mean = r(1-p)/p$$
$$sd = \sqrt{\frac{r(1-p)}{p^2}}$$
$$p = \frac{mean}{sd^2}$$
$$r = \frac{mean \cdot p}{1-p}$$

Negative Hypergeometric distribution

`Negative hypergeometric distribution (N;K;n)` **`Negative hypergeometrische Verteilung (N;K;n)`**
Conversion between distribution parameters and stochastic characteristics

$$mean = n \cdot \frac{N+1}{R+1}$$
$$sd = \sqrt{n \cdot \frac{(R+1-n)(N-R)(N+1)}{(R+1)^2(R+2)}}$$

Zeta distribution

`Zeta distribution (s)` **`Zeta-Verteilung (s)`**

$$mean = \frac{\zeta(s-1)}{\zeta(s)}$$
$$sd = \sqrt{\frac{\zeta(s)\zeta(s-2)-\zeta(s-1)^2}{\zeta(s)^2}}$$

Discrete uniform distribution

`Discrete uniform distribution (a;b)` **`Diskrete Gleichverteilung (n;r)`**

$$mean = \frac{a+b}{2}$$
$$sd = \frac{(b-a+1)^2-1}{12}$$
$$b = \frac{\sqrt{(12 \cdot sd^2+1)}}{2} + mean - \frac{1}{2}$$
$$a = 2 \cdot mean - b$$

Logarithmic distribution

`Logarithmic distribution (p)` **`Logarithmische Verteilung (p)`** Conversion between distribution parameters and stochastic characteristics

$$mean = = -\frac{p}{(1-p)\log(1-p}$$

Borel distribution

`Borel distribution (mu) Borel-Verteilung (mu)` Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{1}{1-\mu}$$
$$variance = \frac{\mu}{(1-\mu)^3}$$

Planck distribution

`Planck distribution (lambda) Planck-Verteilung (lambda)`

$$mean = \frac{1}{\exp(\lambda)-1}$$
$$sd = \frac{\sqrt{\exp(-\lambda)}}{1-\exp(-\lambda))}$$

Inverse Gamma distribution

`Inverse gamma distribution (shape;scale)`
`Inverse Gamma-Verteilung (shape;scale)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{scale}{shape-1}$$
$$sd = \frac{scale}{(shape-1)\sqrt{shape-2}}$$
$$shape = \frac{mean^2}{sd^2}+2$$
$$scale = \frac{mean^3}{sd^2}+mean$$

Generalized Rademacher distribution

`Generalized Rademacher distribution (a;b;pa)`
`Verallgemeinerte Rademacher-Verteilung (a;b;pa)`

Conversion between distribution parameters and stochastic characteristics

$$mean = a \cdot P(a) + b \cdot (1-P(A))$$
$$sd = sqrta^2 \cdot P(a) + b^2 \cdot (1-P(A)) - mean^2$$

Continuous Bernoulli distribution

`Continuous Bernoulli distribution (a;b;lambda)`
`Kontinuierliche Bernoulli-Verteilung (a;b;lambda)`

Conversion between distribution parameters and stochastic characteristics

$$mean = \frac{\lambda}{2\lambda - 1} + \frac{1}{2\tanh^{-1}(1-2\lambda)} \text{ if } \lambda \neq \frac{1}{2} \text{ for } \lambda = \frac{1}{2}:\ 2$$

$$sd = \sqrt{-\frac{(1-\lambda)\lambda}{(1-2\lambda)^2} + \frac{1}{(2\tanh^{-1}(1-2\lambda))^2}} \text{ if } \lambda \neq \frac{1}{2} \text{ for } \lambda = \frac{1}{2}:\ \frac{1}{\sqrt{2}}$$

Boltzmann distribution

`Boltzmann distribution (lambda;N) Boltzmann-Verteilung (lambda;N)`

$$mean = \frac{\exp(-\lambda)}{1-\exp(-\lambda)} - N \cdot \frac{\exp(-\lambda N)}{1-\exp(-\lambda N)}$$

$$sd = \sqrt{\frac{\exp(-\lambda)}{(\exp(-\lambda))^2} - N^2 \cdot \frac{\exp(-\lambda N)}{(1-\exp(-\lambda N))^2}}$$