# Analysis of RT distributions with R

## Implementing the Ex-Wald distribution

---

**EW** Since there is no package containing the Ex-Wald density and distribution, we will code it by hand. Start your Tinn-R editor and follow the subsequent steps to implement the Ex-Wald functions:

1) For reasons of convenience define a function Phi(x) to be the CDF of the standard normal distribution (mean = 0, sd = 1).

2) Now code a function pwald(w, μ, σ, a) being the CDF of the *Wald process*:

$$F(w \mid \mu, \sigma, a) = \Phi\left(\frac{\mu w - a}{\sigma\sqrt{w}}\right) + \exp\left(\frac{2a\mu}{\sigma^2}\right) \cdot \Phi\left(-\frac{\mu w + a}{\sigma\sqrt{w}}\right),$$

   where Φ is the normal distribution (Phi) from above.

3) Since every CDF is the integral over its density function, there is a simple trick to aqcuire the density dwald of the Wald process via its associated CDF pwald:

   Define dwald(w, μ, σ, a) to be the shifted difference of pwald(w, μ, σ, a), i.e. xx <- pwald(w, μ, σ, a) and res <- xx[-1] – x[-n], where n is the length of xx. Add xx[n-1] as the n-th component of the resulting vector xx, since the differentiation eliminates one value.

4) Now you can use the already defined functions to implement the density of the *Ex-Wald process*:

$$h(t \mid \mu, \sigma, a, \gamma) = \gamma \exp\left[-\gamma t + \frac{a(\mu - k)}{\sigma^2}\right] \cdot F(t \mid k, \sigma, a)$$

where

$$k \equiv \sqrt{\mu^2 - 2\gamma\sigma^2}$$

.and F is the pwald from above.

5) The CDF of the Ex-Wald then reads as

$$H(t \mid \mu, \sigma, a, \gamma) = F(t \mid \mu, \sigma, a) - \frac{1}{\gamma} \cdot h(t \mid \mu, \sigma, a, \gamma)$$

,

where again F is pwald and h is dexwald.

6) Check the obtained commands by plotting densties and distributions of values t = (-100, 700) produced by the following parameter sets:

| **μ** | **σ** | **a** | **γ** |
|---|---|---|---|
| 0.320 | 1 | 108 | 1/22 |
| 0.321 | 1 | 97 | 1/12 |
| 0.348 | 1 | 98 | 1/20 |