

# Goldsmith Functions

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# **1 Abstract**

This paper presents the Goldsmith functions. These functions describe a fully adjustable system for quality scoring, notation and handling. One of the main advantages is standardisation. Since the functions are customizable in terms of range, sensitivity and scaling, they can operate from single digit ppq (parts per quadrillion) up to 12N (99.9999999999%) inputs and even outside of that range, offering a standardized notation for almost all branches of industry, science, medicine, education, engineering and mathematics.

## 2 Introduction

text (introduction)

## 3 Proceedings

### 3.1 Inputs

The formulas have several inputs. While some are used as placeholders in definitions, others have actual meaning in the context of the application of the functions.

#### 3.1.1 Definition of Input Variables

Universal input variables of the function set:

- $r$  is a variable which controls the sensitivity of the  $\Lambda_0, \Lambda_{n_s}, \Phi_e, \Phi_0$  and  $\Phi_{n_s}$  functions.  $r \in \mathbb{Z}$
- $n_s$  is a variable which controls the scaling strength of the  $Rd_{n_s}, Ex_{n_s}, \Phi_{n_s}$  and  $\Lambda_{n_s}$  functions.  $n_s \in \mathbb{N}_0$
- $n_r$  is a variable which controls the rounding precision of the  $\Gamma_{n_r}$  and  $\mathcal{U}_{n_r}$  functions. In  $\Gamma_{n_r}$   $n_r$  controls the number of decimal digits, while in  $\mathcal{U}_{n_r}$  it controls the total number of relevant digits.  $n_r \in \mathbb{N}_0$
- $s$  is the score calculated from  $c$  using  $\Phi_0$  or  $\Phi_{n_s}$ .  $s \in [100 \cdot (1 - 10^{-n_s}); 100]$
- $q$  controls whether  $\Gamma_{n_r}$  and  $\mathcal{U}_{n_r}$  use flooring (truncation) or rounding.  $q \in \{0; 1\}$
- $c$  is the main input variable of the  $\Phi$  functions and describes the „purity“ or other quality which should be converted into a score.  $c \in [0; 1]$ , except for  $\Phi_0$ , where  $c \in [\Theta(r); 1]$ .
- $\lambda$  is a variable which controls the weight in the averaging function  $\Xi_\lambda$ . A higher  $\lambda$  value results in a higher weight for lower inputs, while a  $\lambda$  value close to 0 results in a less adjusted average.  $\lambda \in [0; \infty[$

## 3.2 Formulas

$$Rd_{n_s}(x) = x \cdot 10^{n_s} + 100 \cdot (1 - 10^{n_s}) \quad (1)$$

$$Ex_{n_s}(x) = Rd_{-n_s}(x) \quad (2)$$

$$\Theta(r) = (1 + 10^{-r})^{-9} \quad (3)$$

$$\beta(r) = 9 \cdot \log_{10}(1 + 10^{-r}) \quad (4)$$

$$\Phi_e(c; r) = 100 \cdot \sqrt{1 + \frac{\log_{10}(c)}{\beta(r)}} \quad (5)$$

$$\Phi_0(c; r) = \begin{cases} \Phi_e(c; r) & \text{for } c \geq \Theta(r) \\ 0 & \text{for } c < \Theta(r) \end{cases} \quad (6)$$

$$(7)$$

$$\Phi_{n_s}(c; r) = Rd_{n_s}(\Phi_0(c; r)) \quad (8)$$

$$\Lambda_0(s; r) = 10^{\beta(r) \cdot \left(\left(\frac{s}{100}\right)^2 - 1\right)} \quad (9)$$

$$\Lambda_{n_s}(s; r) = \Lambda_0(Ex_{n_s}(s); r) \quad (10)$$

$$\delta(x) = -\log_{10}(1 - x) \quad (11)$$

$$\delta_s(x) = \lfloor -\log_{10}(1 - x) \rfloor \quad (12)$$

$$\chi(x) = \sum_{k=1}^x \left( \frac{9}{10^k} \right) = 1 - 10^{-x} \quad (13)$$

$$\Gamma_{n_r}(x; q) = \frac{\lfloor x \cdot 10^{n_r} + 0.5 \cdot q \rfloor}{10^{n_r}} \quad (14)$$

$$\mathcal{U}_{n_r}(x; q) = \begin{cases} \Gamma_{n_r-1-\lfloor \log_{10}(|x|) \rfloor}(x; q) & \text{for } x \neq 0 \\ 0 & \text{for } x = 0 \end{cases} \quad (15)$$

$$(16)$$

$$\Xi_\lambda(x_1; \dots; x_n) = \frac{\sum_{i=1}^n (x_i \cdot (e^{-\lambda \cdot x_i}))}{\sum_{i=1}^n ((e^{-\lambda \cdot x_i}))} \quad (17)$$

## 3.3 Explanation

### 3.3.1 Explanation of Functions

- $Rd_{n_s}(x)$ :  $Rd_{n_s}$  describes a scaling function. Its mainly used to convert the output of  $\Phi_0$  from a 0 to 100 range to an  $100 \cdot (1 - 10^n)$  to 100 range.  $Rd_{n_s}(Rd_{n_s}(x)) = Rd_{2 \cdot n_s}(x)$ ;  $Rd_{n_s}(100) = 100$ ;  $Rd_0(x) = x$
- $Ex_{n_s}(x)$ :  $Ex_{n_s}$  is the inverse scaling function of  $Rd_{n_s}$ . Its mainly used to convert the input of  $\Lambda_{n_s}$  from a  $100 \cdot (1 - 10^n)$  to 100 range to an 0 to 100 range.  $Ex_{n_s}(Ex_{n_s}(x)) = Ex_{2 \cdot n_s}(x)$ ;  $Ex_{n_s}(100) = 100$ ;  $Ex_0(x) = x$
- $\Theta(r)$ :  $\Theta$  is a function used to determine the minimum  $c$  value required to get a  $\Phi_0$  score above 0 and it is equal to  $\Lambda_0(0; r)$ . It also defines the lower bound of the domain of the  $\Phi_e$  function.

- $\beta(r)$ :  $\beta$  is an intermediate function for  $r$ , and it forms the implimentation of the sensitivity controll in  $\Phi_e; \Phi_0; \Phi_{n_s}; \Lambda_0$  and  $\Lambda_{n_s}$ . It is not intended to be used as a stand-alone function.
- $\Phi_e(c; r)$ :  $\Phi_e$  is the main conversion function of the Goldsmith functions and converts a  $c$  between  $\Theta(r)$  and 1 to an  $s$  value between 0 and 100.
- $\Phi_0(c; r)$ :  $\Phi_0$  is used to extend the domain of  $\Phi_e$  to 0 to 1.
- $\Phi_{n_s}(c; r)$ :
- $\Lambda_0(s; r)$ :
- $\Lambda_{n_s}(s; r)$ :
- $\delta(x)$ :
- $\delta_s(x)$ :
- $\chi(x)$ :
- $\Gamma_{n_r}(x)$ :
- $\mathcal{U}_{n_r}(x)$ :
- $\Xi_\lambda(x_1; \dots; x_n)$ :

### 3.4 Outputs

#### 3.4.1 Interpretation of outputs

### 3.5 Examples

There are several possible areas of application for the goldsmith functions. Some of these applications include the purity of precious metals, reliability, accuracy of AI algorithms, data fidelity, purity of silicon in the semiconductor industry and many more.

Below there are some example values.

- $99.999998\% \text{ gold} \doteq 88.19r8 - 0 \text{ gold}$
- $99.99999999954\% \text{ silicon} \doteq 69.92r12 - 0 \text{ silicon}$
- $10.0\% \text{ gold content in ore} \doteq 79.43r0 - 0 \text{ gold content in ore}$
- $58.3\% \text{ gold content in 14k gold} \doteq 60.91r1 - 0 \text{ gold content in 14k gold}$
- $93.0\% \text{ process yield} \doteq 43.55r2 - 0 \text{ process yield}$
- $0.6\% \text{ copper content in ore} \doteq 42.42r0 - 0 \text{ copper content in ore}$
- $99.5\% \text{ uptime} \doteq 66.54r4 - 0 \text{ uptime}$

The general notation is given by the following standart.

- $[100 \cdot c]\% [quantity] \doteq [\Phi_{n_s}(c; r)]r[r] - [n_s] [quantity]$

The notation standard is intended for the use in various fields listed in the abstract and is deliberately kept concise.

## 4 Conclusions

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## 5 References

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## 6 Appendices

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