Gödelfish

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Abstract

The abstract text goes here.

1 Introduction

Gödelfish is a Gödel numbering for the esoteric programming language Deadfish. It also provides a range of output encodings for the results of executing the code.

A Gödelfish program, $\ddot{\varphi}$, can be formed from a Deadfish program by making the following subtitutions and interpreting the result as a base4 numeral.

Table 1: Gödel numbering.

Deadfish	**Gödelfish (base4)**
d	0
i	1
s	2
o	3

2 Conversion to Brainfoctal

A Gödelfish program, $\ddot{\varphi}$, can be converted to a corresponding Brainfoctal (a Turing complete Gödel numbering language) value, β, using the following bijective continuous piecewise linear function:

$$b : \mathbb{R} \to \mathbb{N} \text{ given by } b(\ddot{\varphi}) = \beta$$

$$b^{-1} : \mathbb{N} \to \mathbb{R} \text{ given by } b^{-1}(\beta) = \ddot{\varphi}$$

$$b(\ddot{\varphi}) = \sum_{i=0}^{\lfloor \log_4 \ddot{\varphi} \rfloor + 1} b_{\text{IDSO}}\left(\left\lfloor \frac{\ddot{\varphi}}{4^i} \right\rfloor \bmod 4\right) \cdot 8^{\sum_{j=0}^{i} \lfloor \log_8 \left(b_{\text{IDSO}}\left(\lfloor \frac{\ddot{\varphi}}{4^j} \rfloor \bmod 4\right)\right) \rfloor + 1} \tag{1}$$

$$b_{\text{IDSO}}(x) = \max(b_{\text{ID}}(x), b_{\text{SO}}(x)) \tag{2}$$

$$b_{\text{ID}}(x) = 216x \cdot 8^{136} + d \tag{3}$$

$$b_{\text{SO}}(x) = ox - g \tag{4}$$

$$d = 323707796654047055618076094899617351427724505952789484964243866676811498466981989811104890999757543102784705765256696455174 6 \tag{5}$$

$$o = 144055208977708612392953209657686280311552786088539899958780875103930357528837901465010674723308845745198393272981117534055502705215401519216382717090287010752089 2608 \tag{6}$$

$$g = 267542437541037652923308320859908284247442636012853538995313525287336865642378761150848303833261004734291866412941172248346965822131986986886118626464074126448133663 8 \tag{7}$$

This converted number can then be executed as Brainfoctal, and will produce the expected Deadfish output.

The crossover point for the two linear equations that make up $b_{\text{IDSO}}(x)$ is roughly 1.9

$$b_{\text{IDSO}}(x) = \begin{cases} b_{\text{ID}}(x), & \text{if } x \lessapprox 1.9 \\ b_{\text{SO}}(x), & \text{if } x \gtrapprox 1.9 \end{cases} \tag{8}$$

2.1 Variants

There are two variants of Gödelfish.

$\ddot{\varphi} \in \mathbb{N}$: *Natural* Gödelfish.

$\ddot{\varphi} \in \mathbb{R}$: *Real* Gödelfish.

Where $\ddot{\varphi} \in (\mathbb{R} - \mathbb{N})$ can be termed *Unnatural* Gödelfish.

3 Gödelfish Code Generation

The following function generates a Gödelfish program that sets the accumulator to i, where $i \in \mathbb{N}_{i \neq 256}$:

$$\phi(i) = \frac{4^{\frac{|\alpha(i)| + \alpha(i)}{2}} - 1}{3} + \gamma(i)(38^2 + 2)4^{|i - 17^2|} + \frac{0}{(4^4 - i)(|i| + i)} \tag{9}$$

where

$$\alpha(i) = i\big|1 - \gamma(i)\big| + \gamma(i)(i - 17^2) \tag{10}$$

and $\gamma : \mathbb{N} \to \{0, 1\}$ given by

$$\gamma(i) = \left\lceil \frac{i - 4^4}{1 + (i - 4^4)^2} \right\rceil \tag{11}$$

This is by no means an optimised conversion, but it does produce accurate output for all valid inputs. There are other possible code generation functions.

To modify a program to output the accumulator value, simply multiply by 4, and add 3:

$$\ddot{\varphi}_{\text{OUTPUT}} = 4\phi(i) + 3 \tag{12}$$

4 Evaluation and output encoding

$$O(\ddot{\varphi}, r, d) = \left\lfloor \frac{E(\ddot{\varphi}, r^d)}{r^d} \right\rfloor \tag{13}$$

where

$$E(\ddot{\varphi}, z) = \sum_{i=0}^{\lfloor \log_4 \ddot{\varphi} \rfloor + 2} v\Big(E\big(s(\ddot{\varphi}, i, 2), z\big) \bmod z, d\Big(E\big(s(\ddot{\varphi}, i, 2), z\big), c(\ddot{\varphi}, i), z \Big) \Big) \tag{14}$$

$$s(\ddot{\varphi}, i, n) = \left\lfloor \frac{\ddot{\varphi}}{4^{\lfloor \log_4 \ddot{\varphi} \rfloor - i + n}} \right\rfloor \tag{15}$$

$$c(\ddot{\varphi}, i) = s(\ddot{\varphi}, i, 1) - 4s(\ddot{\varphi}, i, 2) \tag{16}$$

$$v(a, x) = \begin{cases} -a, & \text{if } a + x < 0 \\ -a, & \text{if } a + x = 256 \\ x & \end{cases} \tag{17}$$

$$d(x, c, z) = \begin{cases} -1, & \text{if } c = 0 \\ 1, & \text{if } c = 1 \\ (x \bmod z)^2 - x \bmod z, & \text{if } c = 2 \\ x(z - 1) + x \bmod z, & \text{if } c = 3 \end{cases} \tag{18}$$

$\ddot{\varphi}$ = Gödelfish value, $\ddot{\varphi} \in \mathbb{N}$
and r = Radix of output values.
d = Number of digits per output value in base radix.

5 Conclusion

Gödelfish is TG.