Independent University, Bangladesh

School of Engineering, Technology and Sciences
Department of Computer Science & Engineering
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CSC501, CSC301, CSE437, CEN437: Finite Automata and Computability

Assignment – 03

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Answer to the question no: 1

Prob definition: Godel numbering is a function that assigns each symbol and well formed formula of language a unique natural number, called is Godel number.

Solution: [B] IF $X \neq 0$ GOTO C

$I_1 \rightarrow \langle 2, \langle 5, 1 \rangle \rangle = \langle 2, 95 \rangle = 763$

GOTO D $I_2 \rightarrow \langle 0, \langle 6, 1 \rangle \rangle = \langle 0, 191 \rangle = 382$

$I_3 \rightarrow \langle 3, \langle 2, 5 \rangle \rangle = \langle 3, 43 \rangle = 695$

[C] $X_3 \leftarrow X_3 - 1$ $I_4 \rightarrow \langle 0, \langle 1, 0 \rangle \rangle = \langle 0, 1 \rangle = 2$

$Y \leftarrow Y + 1$ $I_5 \rightarrow \langle 0, \langle 1, 8 \rangle \rangle = \langle 0, 33 \rangle = 66$

$Z_4 \leftarrow Z_4 + 1$ $I_6 \rightarrow \langle 0, \langle 4, 8 \rangle \rangle = \langle 0, 271 \rangle = 542$

GOTO B

[D] IF $Z_4 \neq 0$ GOTO E $I_7 \rightarrow \langle 4, \langle 7, 8 \rangle \rangle = \langle 4, 2175 \rangle = 69615$

So, The program is: $2^{763} \cdot 3^{382} \cdot 5^{695} \cdot 7^{2} \cdot 11^{66} \cdot 13^{542} \cdot 17^{69615} - 1$

2. Prob definition: The deduction theorem holds for all the first order theories with the usual deductive systems for first order logic.

Solution; 8399

a) $z+1 = 8399 + 1 = 8400$

$= 2^4 \times 3^1 \times 5^2 \times 7^1$

$\Rightarrow [4, 1, 2, 1]$

$I_1 \rightarrow 4 = \langle 0, 2 \rangle = \langle 0, \langle 0, 1 \rangle \rangle \rightarrow X \leftarrow X+1$

$I_2 \rightarrow 1 = \langle 1, 0 \rangle = \langle 1, \langle 0, 0 \rangle \rangle \rightarrow [A] \; Y \leftarrow Y$

$I_3 \rightarrow 2 = \langle 0, 1 \rangle = \langle 0, \langle 1, 0 \rangle \rangle \rightarrow Y \leftarrow Y+1$

$I_4 \rightarrow 1 = \langle 1, 0 \rangle = \langle 1, \langle 0, 0 \rangle \rangle \rightarrow [A] \; Y \leftarrow Y$

(b) 564299

$z+1 = 564299 + 1 = 564300$

$= 2^2 \times 3^3 \times 5^2 \times 7^0 \times 11^1 \times 13^0 \times 17^0 \times 19^1$

$\Rightarrow [2, 3, 2, 0, 1, 0, 0, 1]$

$I_1 \rightarrow 2 = \langle 0, 1 \rangle = \langle 0, \langle 1, 0 \rangle \rangle \rightarrow Y \leftarrow Y+1$

$I_2 \rightarrow 3 = \langle 2, 0 \rangle = \langle 2, \langle 0, 0 \rangle \rangle \rightarrow [B] \; Y \leftarrow Y$

$I_3 \rightarrow 2 = \langle 0, 1 \rangle = \langle 0, \langle 1, 0 \rangle \rangle \rightarrow Y \leftarrow Y+1$

$I_4 \rightarrow 0 = \langle 0, 0 \rangle = \langle 0, \langle 0, 0 \rangle \rangle \rightarrow Y \leftarrow Y$

$I_5 \rightarrow 1 = \langle 1, 0 \rangle = \langle 1, \langle 0, 0 \rangle \rangle \rightarrow [A] \; Y \leftarrow Y$

$I_6 \to 0 = \langle 0,0\rangle = \langle 0,\langle 0,0\rangle\rangle \to Y \leftarrow Y$

$I_7 \to 0 = \langle 0,0\rangle = \langle 0,\langle 0,0\rangle\rangle \to Y \leftarrow Y$

$I_8 \to 1 = \langle 1,0\rangle = \langle 1,\langle 0,0\rangle\rangle \to [A]\ Y \leftarrow Y$

Answer to the question: 3

Prob definition: Here encoding string with a unique positive integers each symbol in the alphabet is assigned a pretermined integer code.

Solution: Let $A = \{a, b, c, d, i, m, o, t, u, v\}$ and $(a, b, c, d, i, m, o, t, u, v) = (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)$

(a) covid

Let ϵ = "covid", $x = 26943$

Hence, $x_1 = 2, x_2 = 6, x_3 = 9, x_4 = 4, x_5 = 3$

$$\therefore y = 2^2 + 2^{2+6+1} + 2^{2+6+9+2} + 2^{2+6+9+4+3} + 2^{2+6+9+4+3+4} - 1$$

$$= 285737475$$

(b) iub

Let ϵ = "iub", x = "481"

Hence, $x_1 = 4, x_2 = 8, x_3 = 1$

$$\therefore y = 2^4 + 2^{4+8+1} + 2^{4+8+1+2} - 1$$

$$= 40975$$

(c) automata

Let G = "automata", x = "08765070"

Hence,

$x_1 = 0, x_2 = 8, x_3 = 7, x_4 = 6, x_5 = 5, x_6 = 0,$

$x_7 = 7, \quad x_8 = 0$

$\therefore y = 2^0 + 2^{0+8+1} + 2^{0+8+7+2} + 2^{0+8+7+6+3} + 2^{0+8+7+6+5+4}$

$+ 2^{0+8+7+6+5+0+5} + 2^{0+8+7+6+5+0+7+6}$

$+ 2^{0+8+7+6+5+0+7+0+7}$

$- 1 = 165250557593 6$

Answer to the que: 4

Prob definition:

Given A represent a number divided the number with 2. Then string for each number code.

Let, $A = \{m, n, o, p, q, r, s, t\}$ and (m, n, o, p, q, r, s, t)
$= (0, 1, 2, 3, 4, 5, 6, 7)$

(a) 5835

$y+1 = 5835+1 = 5836 = 2(2918) = 2^2(1459)$
$= 2^2(1458+1) = 2^2(1458) + 2^2$
$= 2^3(729) + 2^2 = 2^3(728+1) + 2^2 = 2^3(728) + 2^3 + 2^2$
$= 2^4(364) + 2^3 + 2^2 = 2^5(182) + 2^3 + 2^2 = 2^6(91) + 2^3 + 2^2$
$= 2^6(90+1) + 2^3 + 2^2 = 2^6(90) + 2^6 + 2^3 + 2^2 = 2^7(45) + 2^6 + 2^3 + 2^2$
$= 2^7(44+1) + 2^6 + 2^3 + 2^2 = 2^7(44) + 2^7 + 2^6 + 2^3 + 2^2$
$= 2^8(22) + 2^7 + 2^6 + 2^3 + 2^2 = 2^9(11) + 2^7 + 2^6 + 2^3 + 2^2$
$= 2^9(10+1) + 2^7 + 2^6 + 2^3 + 2^2 = 2^9(10) + 2^9 + 2^7 + 2^6 + 2^3 + 2^2$
$= 2^{10}(5) + 2^9 + 2^7 + 2^6 + 2^3 + 2^2 = 2^{10}(4+1) + 2^9 + 2^7 + 2^6 + 2^3 + 2^2$
$= 2^{10}(4) + 2^{10} + 2^9 + 2^7 + 2^6 + 2^3 + 2^2 = 2^{11}(2) + 2^{10} + 2^9 + 2^7 + 2^6 + 2^3 + 2^2$
$= 2^{12}(1) + 2^{10} + 2^9 + 2^7 + 2^6 + 2^3 + 2^2$
$= 2^{12} + 2^{10} + 2^9 + 2^7 + 2^6 + 2^3 + 2^2$

$\therefore y_1 = 2, y_2 = 3, y_3 = 6, y_4 = 7, y_5 = 9, y_6 = 10, y_7 = 12$

$\therefore x_1 = 2, x_2 = 3-2-1 = 0, x_3 = 6-3-1 = 2, x_4 = 7-6-1 = 0,$
$x_5 = 9-7-1 = 1, x_6 = 10-9-1 = 0, x_7 = 12-10-1 = 1$

Therefore the string is "omomnmn".

(b) 753

$y+1 = 753+1 = 754 = 2(377) = 2(376+1)$

$= 2(376)+2^1 = 2^2(188)+2^1$

$= 2^3(94)+2^1 = 2^4(47)+2^1 = 2^4(46+1)+2^1$

$= 2^4(46)+2^4+2^1$

$= 2^5(23)+2^4+2^1 = 2^5(22+1)+2^4+2^1$

$= 2^5(22)+2^5+2^4+2^1$

$= 2^6(11)+2^5+2^4+2^1 = 2^6(10+1)+2^5+2^4+2^1$

$= 2^6(10)+2^6+2^5+2^4+2^1 = 2^7(5)+2^6+2^5+2^4+2^1$

$= 2^7(4+1)+2^6+2^5+2^4+2^1 = 2^7(4)+2^7+2^6+2^5+2^4+2^1$

$= 2^8(2)+2^7+2^6+2^5+2^4+2^1 = 2^9(1)+2^7+2^6+2^5+2^4+2^1$

$= 2^9+2^7+2^6+2^5+2^4+2^1$

$y_1 = 1, y_2 = 4, y_3 = 5, y_4 = 6, y_5 = 7, y_6 = 9$

$\therefore x_1 = 1, x_2 = 4-1-1 = 2, x_3 = 5-4-1 = 0,$

$x_4 = 6-5-1 = 0, x_5 = 7-6-1 = 0, x_6 = 9-7-1 = 1$

Therefore the string is "nommmn".

(c) 621

$y+1 = 621+1 = 622 = 2(311) = 2(310+1)$

$= 2(310)+2^1 = 2^2(155)+2^1$

$= 2^2(154+1)+2^1 = 2^2(154)+2^2+2^1 = 2^3(77)+2^2+2^1$

$= 2^3(76+1)+2^2+2^1 = 2^3(76)+2^3+2^2+2^1 = 2^4(38)+2^3+2^2+2^1$

$= 2^5(19)+2^3+2^2+2^1 = 2^5(18+1)+2^3+2^2+2^1$

$= 2^5(18)+2^5+2^3+2^2+2^1 = 2^6(9)+2^5+2^3+2^2+2^1$

$= 2^6(8+1)+2^5+2^3+2^2+2^1 = 2^6(8)+2^6+2^5+2^3+2^2+2^1$

$= 2^7(4)+2^6+2^3+2^2+2^1 = 2^8(2)+2^6+2^5+2^3+2^2+2^1$

$= 2^9(1)+2^6+2^5+2^3+2^2+2^1$

$= 2^9+2^6+2^5+2^3+2^2+2^1$

$\therefore y_1 = 1,\ y_2 = 2,\ y_3 = 3,\ y_4 = 5,\ y_5 = 6,\ y_6 = 9$

$\therefore x_1 = 1,\ x_2 = 2-1-1 = 0,\ x_3 = 3-2-1 = 0,$

$x_4 = 5-3-1 = 1,\ x_5 = 6-5-1 = 0,\ x_6 = 9-6-1 = 2$

Therefore the string is "nmmnmo".

Conclusion:

01. Using formula & theory we've found the Godel number of any program.

2. We can deduce the program of any value using theory & formula.

3. Now we are able to find out the Godel numbers of any string using theorem & formula.

4. Any string Godel numbers can be found using theorem & formula.