

Dr. Chun's Numb3rs & Løgic

Circus Problem



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Cows, Pigs, and Chickens

Ask Marilyn, Parade Magazine, (July 6, 1997), p. 8

Say a farmer buys **100** animals for **\$100**. The animals include **at least** one **cow**, one **pig**, and one **chicken**, but no other kind. If a **cow** costs **\$10**, a **pig** costs **\$3** and a **chicken** costs **\$0.50**, how many of each did he buy?



- Frank Davenport, Port Charlotte, Fla.

■ Variables

X = Number of **cows**

Y = Number of **pigs**

Z = Number of **chickens**

■ Constraints

$$X + Y + Z = 100$$

$$10X + 3Y + 0.5Z = 100$$



* Dilemma

- Only **two equations** for **three unknown variables**!



* **Simultaneous equations**

(a) $X + Y + Z = 100$

(b) $10X + 3Y + 0.5Z = 100$

* **Diophantine equation**

- Multiply (b) by 2.

(c) $20X + 6Y + Z = 200$

- Subtract (a) from (c).

(d) $19X + 5Y = 100$ or $Y = 20 - (19/5)X$

where X and Y are **integers** larger than or equal to 1.

* **Optimal solution**

- You may find the solution by a **complete enumeration!**

X	0	1	2	3	4	5	6	7
Y	20	16.2	12.4	8.6	4.8	1.0	-2.8	-6.6

- Thus, the unique **optimal solution** is $(X, Y, Z) = (5, 1, 94)$.

Circus Problem



Dear Marilyn: "I solved this problem a few years ago by the 'trial and error' method, and since then, I've been trying to solve it mathematically but have had no success. Can you help me? I want to take 100 people to the circus, and I have \$95 to spend. Admission for men is \$10, for women \$2.5, and for children, \$.50. How many of each can I take?"

- Fred M. Bullock, Cerro Gordo, N.C.

* Variables

- X = Number of men
- Y = Number of women
- Z = Number of children

* Constraints

$$\begin{aligned} X + Y + Z &= 100 \\ 10X + 2.5Y + 0.5Z &= 95 \end{aligned}$$

* Dilemma

- Only two equations for three unknown variables!

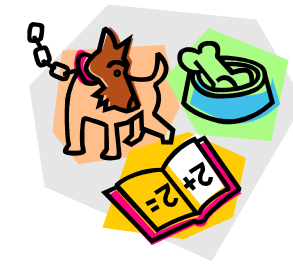




* Simultaneous equations

$$(a) X + Y + Z = 100$$

$$(b) 10X + 2.5Y + 0.5Z = 95$$



* Diophantine equation

- Multiply (b) by 2.

$$(c) 20X + 5Y + Z = 190$$

- Subtract (a) from (c).

$$(d) 19X + 4Y = 90 \quad \text{or} \quad Y = 90/4 - (19/4)X$$

where X and Y are non-negative integers.

* Optimal solution

- You may find the solution by a complete enumeration!

X	0	1	2	3	4	5	6
Y	22.50	17.75	13.00	8.25	3.50	-1.25	-6.00

- Thus, the unique optimal solution is $(X, Y, Z) = (2, 13, 85)$.

Movie Trivia



A veterinary student abandons his studies after his parents are killed and joins a traveling **circus** as their vet.



Water for Elephants (2011)



A veterinary student abandons his studies after his parents are killed and joins a traveling **circus** as their vet.