



Structural Mathematics: Structural Thinking, Structural Planning, Structural Programing

Etabey Karatoprak*

Department of Mathematics, Middle East Technical University, Ankara, Turkey

*Corresponding author: Etabey Karatoprak, The Faculty of Art and Science, Department of Mathematics, Middle East Technical University, 1979, Kizilcikli mah. Hasanaga toki 2. kisim C05 blok D : 37 Nilüfer Bursa Ankara, Turkey, Tel: +31 6 53423618; E-mail: etabey@hotmail.com

Received Date: 10 December 2018; Accepted Date: 05 January 2019; Published Date: 14 January 2019

Structural Mathematics

This paper first describes the functionality of science and based on that the functionality of mathematics. Then the method of structural mathematics which allows to define a problem and a solution is explained.

Function of science: Science is used to analyze a given entity's structure, position, functionality, and the possible transformations of it within time. This analysis provides information about that entity and further information is generated by analyzing this information and the relevant interaction and links in between.

Entities can either be physical or abstract. Some entities may not have physical shapes(e.g. water, air) even though they are physical whereas some might not be visible though still can be recognized by their functionality such as the wind or the electricity. Every branch of science focuses on the investigation of the relevant one.

Abstracted Mathematics

The word "Mathematics" which derives from the Greek word "mathema= I know" was added "tique" by the French. Mathematics is considered as the first branch of science. As mathematics includes physics and the other positive sciences, it has the supremacy of "I know". The number is defined in terms of piece, as the first standard unit of measure. In Arabic, the words unit size, number, quantity and amount are synonyms. "How many pieces (amount) of pencils are there?" and "Do you know the number of pens?" are different uses of same meanings. Besides, the pens may have different features of measurements or quality like short-tall, black-white, with-without an eraser. The set obtained without taking quality into consideration is the universal set of the pens. As all the quantities disappear, the subject is no more concrete being transformed into units (that is, 1) and thus, becomes tangible. In the universal set, as the quantities are not taken into account, their only mutual feature is their consisting of "ones", that is, pieces. And this provides them for being attached. 1, and plus one, and plus one, and plus one... that is how the string of counting numbers come into existence. The numbers arising from the need of determining the quantity can be accepted as the social consensus of humankind. Therefore, the mathematics gained acceptance as the common language of the universe, that is, the nature. Any entire subject is considered as one, that is, one piece. The human beings have made check whether their entities are increased or decreased

with symbols instead of subjects (sticks and stones and later lines). Human has also got the chance to compare, evaluate and make decisions on numbers. In a clearer sense, it has been proved that power is measurable. When any attribute is introduced, the universal set is divided into 2 sub-sets, i.e, 2 sub-sets, for those with or without such qualities. when each attribute enters the circuit, new divisions and associated sub-clusters are formed. The empirical sciences make this determination and measure because it will be observed and experimented to determine if any entity carries the specified qualities. After acquiring abstraction by mathematical numbers, empirical sciences such as physics, chemistry, biology have been separated from mathematics. The second social consensus provided by mathematics was after the French Revolution. All the value judgments in the society have gone to erosion and the rules of trade have been out of control. Such that: a trader buys fabric from a weaver by measuring the length of worker's arms like a monkey, but sells it to a customer by measuring the length of worker's arms like a duck. On top of this, the French Academy of Sciences established the MKS (Meters, Kilograms, Seconds) unit system to standardize local measures and ensure that large-scale market entry is possible. For this reason, Emperor Napoleon appointed Laplace, a mathematician, as minister of interior affairs (together with security and justice). In this way, the biggest problem of the country, the security and judicial system, the math will cure the belief is settled. Three months later, these hopes are fading as the empire is overthrown.

The Function of Mathematics

The function of mathematics is to write and solve numerical problems in every science. It forms the definitions and theorems that you need to write and solve problems. For this reason today's mathematics is evaluated in two parts.

Applied mathematics (Mathematical applications)

Pure mathematics

Also known as Analysis Mathematics, which makes definitions of terms and operations in mathematics and forms theorems and proofs from them. In the years of 300-200 BC cone and hyperbola discoveries and then hundreds of theorem writers did not consider it useful for others. They did not know that they had also laid the foundations of today's satellite communications. Like other branches of science, mathematics makes writing and solving problems with its own methods. It is the method of solution in Applied mathematics described here. In Pure Mathematics it can be said that the function is to define the operations and theorems that are missing in the application.

The problem can be described as the first function of philosophy that the subject is directed to the object. Most importantly, the subjects of the questions and the subjects of the information forming the solutions are different. Conventional problem solving method is applied by direct processes. For this reason, "intuition and ability" is seen as the basic condition of mathematics learning and problem solving. However, the solution in structural mathematics is THINKING THAT IS THE SECOND FUNCTION OF PHILOSOPHY. In the historical process, the concept of thinking has changed

depending on the living conditions. Philosophy under the influence of theological life in the middle ages had to think about the solution depending on God. Then modern rational thinking becomes dominant. By the beginning of the production of scientific knowledge, each science has created its own method of systematic thinking and knowledge, Ample history philosophy, engineering philosophy etc. Well, what is the philosophy of mathematics? According to Professor Dr. Cahit Arf, after World War II, "STRUCTURAL THINKING, PLANNING AND PROGRAMMING" is regarded as philosophy of mathematics. Cahit Arf did not explain the subject although he said these. The articles written on structural mathematics also explain "the structure of the solution is obtained with intuition".

According to the structural thinking, every solution is equality. The terms on both sides of the equality must be determined. If there are unknown elements, these unknowns are calculated by another equality. If there is an unknown in the new equation, it must be continued by writing a third equation to find it.

Problem: A worker with a daily wage of 40 TL does a job alone in 10 days. The same work is done in 15 days for the second worker whose daily price is 60 TL. After working together for 4 days, the first worker leaves his job and the second worker finishes the remaining job. How much is the fee paid to each other.

Structural Thinking

Begin by calculating the answer to the problem as if all the information was present.

(1) Total wages paid = 1. Work wages + 2. Work wages.

(2) Labor paid = Number of working days \times Daily fee

(2.1) 1. Worker's fee = 4 days \times 40 TL.

(2.2) 2. Worker's wage = (4 days + days worked alone) \times 60 TL

(3) t = the number of days the worker has worked alone is not known.

All work = work done by the 1st worker + work done by the 2nd worker

$$1 = 4 \times 1/10 + (4 + t) \times 1/15$$

Now that the unknown is over, it is passed to the 2nd stage.

Structural Planning

At this stage, the order of processing of calculations arranged in the thinking phase is specified and the type of mathematical operation is determined. Solution of the problem will be done with arithmetic operations and the sequence 3, 2.2, 2.1, 1

Structural Programming

At this stage, operations are performed according to the order determined in the plan.

(3) $4 \times 1/10 + (4 + t) \times 1/15 = 1$ work done

$$(3 \times 4)/30 + (2 \times (4 + t))/30 = 1$$

denominator equalization $12 + 8 + 2t = 30$

$$2t = 30 - 20 \quad t = 5 \text{ days}$$

(2.2) Second worker wage = $(4 + 5) \times 60 = 540$ TL

(2.1) First worker wage = $4 \times 40 = 160$ TL

(1) Total wages paid = $160 + 540 = 700$ TL.

This problem is a two-stage question.

a) How many days did the second worker work?

b) What is the sum of the fees paid?

If the problem was asked in this way, the steps of structural thinking and planning would have been given. In this problem although the prompt is only asked for the answer of "b", there is no answer without solving stage of "a". Structural thinking makes it easier to find other stages of questions. This problem is two-fold. The main stage is the completion period of the work and the second stage is the platform on which the total payment is calculated.

Problem: A factory produces aluminum vehicle bumper with two presses. The first press produces 5 bumpers per hour with one worker while the other press produces 15 bumpers per hour with two workers. Each bumper is 20 kg. The cost of aluminum is 60 liras per kg. The workers' diaries are 110 liras. Beginning to work, the first one of the presses is broken after 5 days, and 3 days of repairs cannot participate in the production. The factory pays 1500 TL in repair. Other press work is continuing. Find an average unit cost of 4200 bumpers to be produced.

Structural Thinking: Asked average cost is required. The calculation starts with finding the average cost.

(1) Average Cost = total expenditure/production quantity

Production quantity = 4200 pieces were given. Total expenditures are unknown.

(2) Total Expenditures = Labor Cost + Material Cost + Repair Cost

Repair cost = 1500 TL is given, the amount of material and the amount of labor, respectively should be calculated.

(3) Quantity of material = amount of aluminum consumed \times price

price = 60 TL given The amount of consumed aluminum is unknown.

(4) Amount of aluminum consumed = Number of buffers \times Consumption of a bumper.

bumper Consumption = 20 kg given, bumpers count = 4000 units

(5) Workmanship = number of workers \times daily wage

Daily wage = 110 TL given. The completion of the work depends on the production of the presses. It must first be calculated how many days the press will finish the job.

(6) the number of workmans = the number of days the press worked $1 \times$ + the number of days the press worked $\times 2$

(7) production quantity = the number of hours the press is working $\times 30$ + the number of hours the press was running $\times 45$

(8) Number of days of 2nd press operation = number of days of 1st press operation + 3

(9) The process (8) is to be replaced in the process (7)

Since there is no uncalculated value, we can go to the planning stage. As you can see, there is no need for systematic grouping of ideas. Someone else might think of these operations with a different order. The point that needs to be taken care of is not to consider which

process to start. Only processes that need to be done can be determined and written at random. Intuition is not essential in this system of thought. It is essential to determine the operations to be performed.

Structural planning: Process sequence as arithmetic operations sequence

$$9 - 7 - 8 - 6 - 5 - 4 - 3 - 2 - 1$$

Structural programming:

$$(9 - 7) 4200 = A \times 5 \times 8 + (A + 3) \times 15 \times 8$$

$$4200 = 40. A + 120. A + 360$$

$$160. A = 4200 - 360$$

A = 24 days, the number of days the 1st press is run is calculated.

(8) 8. Number of days the press is running = 24 + 3 = 27 days is calculated.

(6) Number of labor = 24 × 1 + 27 × 2 = 78 days.

(5) Labor amount = 78 × 110 = 8580 TL

(4) The amount of consumed aluminum = 4200 × 20 = 84000 kg.

(3) The cost of material amount = 84000 × 60 = 5040000 TL

(2) Total expenditures = 8.580 + 5.040.000 + 1500 = 5.050.080 TL

(1) Average Cost = 5.050.080/4200 = 1.202,40 TL.

Problem: An object lying on an oblique plane making a horizontal angle of 37° is launched along an oblique plane and upwards at an initial velocity of V₀ = 12 m / s. The friction coefficient between the object and the oblique plane is known as μ = 0.25. Accordingly, the object may travel along the oblique plane to any distance (Figure 1).

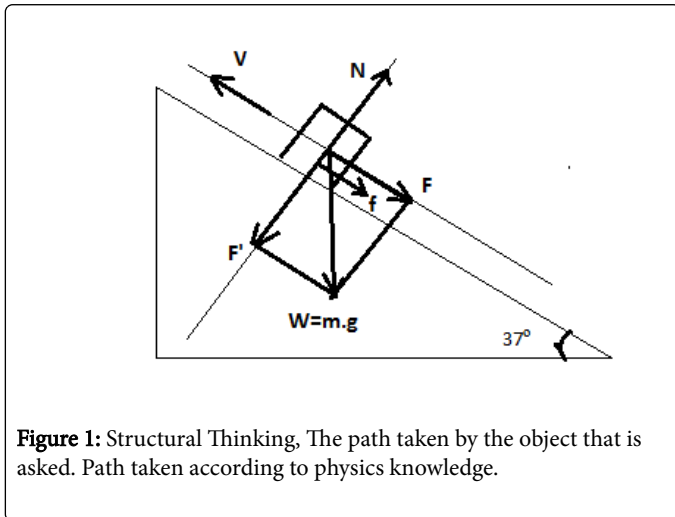


Figure 1: Structural Thinking, The path taken by the object that is asked. Path taken according to physics knowledge.

$$(1) X = X_0 + \frac{1}{2a} t^2$$

X₀=0 given a and t unknown. It is calculated by the order.

(2) Calculation of acceleration a .Since the sum of all forces is zero when the object stops. F₂ = F + f, and F = ma therefore

$$m.a = -m.g.\sin\alpha - m.g.k.\cos\alpha$$

then m are simplified

$$a = -g. (\sin\alpha + k.\cos\alpha).$$

unknown remains.

(3) t = elapsed time calculation: The time elapsed from the first given speed must be calculated.

For slow motion t is calculated by the formula

$$V_2 = V_1 - a.t$$

Where at the stopped velocity is V₂=0, and the initial velocity is V₁=12.

4) By replacing steps (3) and (2) are into step (1) the path taken is calculated.

Structural planning: As seen , the process order is 2,3,4,1. The calculation will be done firstly arithmetically, secondly by differential equations and then solved using computer programming.

Structural programming:

3.1. With arithmetic calculation

$$(2) a = -g. (\sin\alpha + k.\cos\alpha)$$

$$a = -10 \times (0,6 + 0,25 \times 0,8)$$

$$a = - 8 \text{ m / sn}^2 \text{ is calculated.}$$

$$(3) V_2 = V_1 - a.t \text{ de } V_2 = 0, V_1 = 12 \text{ initial velocity.}$$

When values are substituted

$$t = 12/a \text{ is founded. Then}$$

$$(4), (1) \times = 1/2 a .t^2$$

$$x = 1/2 . 8 . (1,5)^2$$

$$x = 4 . 2,25 = 9 \text{ meters is calculated.}$$

$$t = 12/8 = 1,5 \text{ sec is calculated.}$$

3.2 By establishing differential equations

In motion problems, the basic definitions of x = path, dx/dt = V (velocity), and

$$dv/dt = a \text{ (acceleration)}$$

$$(2) a = -g. (\sin\alpha + k.\cos\alpha)$$

$$a = -10 \times (0,6 + 0,25 \times 0,8)$$

$$a = - 8 \text{ m/sn}^2 \text{ bulunur}$$

$$(3) dv/dt = a$$

$$dv/dt = - 8$$

$$dv = - 8 dt \text{ integrates on both sides.}$$

$$v = -8 .t + c \text{ founded. . At the initial time } t=0 \text{ and}$$

$$V = 12 \text{ is given.}$$

replacing these values c = 12 is founded.

$$\text{When } v = 12 - 8 .t \text{ } V = 0, \text{ then } t = 12/8 = 1.5 \text{ sec.}$$

$$(1) dx / dt = v$$

$$dx / dt = 12 - 8 .t$$

$$dx = (12 - 8. t) dt \text{ integrates both terms.}$$

$x = 12. t - 4. t^2 + c$. Assignment of $x = 0$ at time $t = 0$. $c = 0$.

$x = 12. t - 4. t^2$ founded.

replacing $t = t$ in $x = 12. t - 4. t$

$x = 9$ m calculated.

3.3 Solution by computer programming:

If the problem is solved on the computer, then the general solution is made by changing the planning and the variables are read as data and general solutions are obtained.

Overall solution:

$m. (dv/dt) = - m.g.\sin\alpha - m.g.k.\cos\alpha$ when m is destroyed

$dv = - (g.\sin\alpha + g.k.\cos\alpha) dt$ is integrated on both sides

$v = -(g.\sin\alpha + g.k.\cos\alpha) .t + c$ becomes.

At $t=0$ $V = V_0$ fouded. these values are replaced in v

$c = V_0$ founded . Putting c into v

$v = V_0 - (g.\sin\alpha + g.k.\cos\alpha) .t$ the general solution is obtained.

From here

$t = V_0 / (g.\sin\alpha + g.k.\cos\alpha)$ (1) is founded the time to reach the stop point.

By the same way

$v = dx/dt$ is replaced instead of v

$dx/dt = V_0 - (g.\sin\alpha + g.k.\cos\alpha) .t$ founded . By integrating both sides

$x = V_0.t - (1/2)(g.\sin\alpha + g.k.\cos\alpha) .t^2 + c$ founded.

At time $t=0$ $x=0$ and $c=0$ calculated. By replacing these values into x

$x = V_0.t - (1/2) (g.\sin\alpha + g.k.\cos\alpha) .t^2$ (2) is founded.

These equations (1) and (2) are referred to as analytical motion formulas in physics books.

Different V_0, α, k values are read by computer as data and theobtained general solution is used when the program is run.

Computer program writing consists of 3 stages.

1) Algorithm for computer program:

Step 1: Reading the number datas and the datas

Step 1.1: Reading the number of data N

Step 1.2: To set up a loop and read n times the values of V_0, α, K, G

Step 2: executing and writing N operations in a loop

Step 2.1: Calculation of T time: $T = \frac{V_0}{G * \sin(\alpha) + G * K * \cos(\alpha)}$

Step 2.2: Calculation of X path:
 $X = V_0 * T - \frac{1}{2(G * \sin(\alpha) + G * K * \cos(\alpha)) * T^2}$

Step 2.3 Printing printouts: V_0, F, G, T, X

Step 3: Stop the program

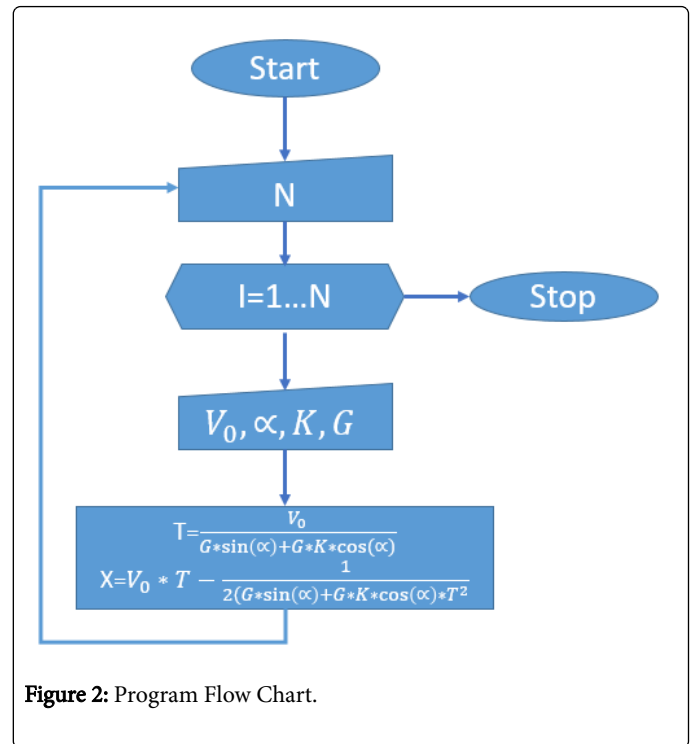


Figure 2: Program Flow Chart.

Computer program

```

import java.io.File;
import java.io.FileNotFoundException;
import java.util.Scanner;

public class Main {

    public static void main(String[] args) throws
    FileNotFoundException {

        Scanner scanner = new Scanner(new File(args[0]));
        int N;
        double V0, alpha, k, g, t, x;
        N = Integer.parseInt(scanner.nextLine());
        for (int i = 0; i < N; i++) {
            V0 = scanner.nextDouble();
            alpha = scanner.nextDouble();
            k = scanner.nextDouble();
            g = scanner.nextDouble();
            t = V0 / (g * Math.sin(alpha) + g * k * Math.cos(alpha));
            x = V0 * t - 0.5 * (g * Math.sin(alpha) + g * k * Math.cos(alpha)) *
            Math.pow(t, 2);
            System.out.printf("V0:%-8.2f alpha:%-8.2f k:%-8.2f g:%-8.2f t:%-8.2f
            x:%-8.2f\n", V0, alpha, k, g, t, x);
        }
    }
}
    
```

The program reads N points in an input file and writes the results to the screen:

V0: 12.00 alpha: 37.00 k: 0.25 g: 10.00 t:- 1.50 x:- 8.99

V0: 12.00 alpha: 37.00 k: 0.15 g: 10.00 t:- 1.66 x:- 10.01

V0: 12.00 alpha: 45.00 k: 0.25 g: 10.00 t:- 1.21 x: 7.27

The format of the input file is also clear as :

3

12 37 0.25 10

12 37 0.15 10

12 45 0.25 10

N in the first line,

In each subsequent line, the values V₀, k, alpha, k and g must be written in sequence.

3.4) Another way to solve with arithmetic operations.

F=ma

ma= mg $\sin 37^\circ$ + mgk $\cos 37^\circ$ when m is destroyed

a= g $\sin 37^\circ$ + gk $\cos 37^\circ$ replacing the values of g,k, g $\sin 37^\circ$ and $\cos 37^\circ$ then

a= 10 (6/10) + 10 (25/100) (8/10)

a= 8m/s² calculated.

V₂= V₁-a.t by replacing the values of V₂=0 and a=8 then

$$0 = 12 - 8 t$$

$$t = 1,5 \text{ sec funded.}$$

X = (V₂+V₁)/2 . t by replacing the values of V₂=0 , V₁=12 and t= 1,5 then

$$X = (0+12)/2 . 1,5$$

$$X = 9 \text{ m calculated.}$$

Conclusion

Is math only an interest for those who have the ability? The reason for this widespread opinion is that the first two stages in structural mathematics are intuitional and notional. The solution is to start directly from programming. With this method, not the talent, but knowledge comes to the fore.

How is an equation expressed? The left side is the result of the problem. The right side is the definition of the science where the problem takes place. For example, what is the body? The definition of biology can be used to write the equality of the question.

Depending on this definition

Body = Head + Body + Arms and legs

The solution is written by writing the equation. The definitions of the physics wavelength of the inclined plane problem were used.

Author would like to express his special thanks of gratitude to Mufattal Karatoprak for the exchange of views and ideas during the maturation of this approach to mathematics.