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May 11, 2015

Outline

What is Summer Internship?

- like any other course
- posing Questions for Answers
- previous experience in understanding different jargons
  - What is Programming?
  - What is Artificial Intelligence?
  - What is Discrete Mathematics?
  - What is Computer Science?
  - What is Research?
  - What is *?

Why not ask?

What is what?

Most Important Axiom what

- **what is what?**
  - It is difficult to define
  - Well known fact from Gödel's First Incompleteness Theorem
  - We understand its meaning from the type of occurrences of answers to it
  - which can also be understood simply as
  - "what is and what is it not"
  - our formulas: **what** $\wedge \neg$ **what**

$$\Phi \wedge \neg \Phi$$

Fundamental axioms of any language

- **6Ws and 1H** - 6 Wives and 1 Husband
- **What?, Why?, Which?, Who?, When?, Where?**
- **How?**

- But we finally learn the meaning of "what" from 5Ws and 1H

Thats the title

- **what $\wedge \neg$ what, an universal paradox**

  is circular, oscillating, and self-referential

Defining Circularity [1][2]

Let us take an example

$$x^2 + 1 = 0$$

$$x = \frac{-1}{x}$$

- to get a value of x you need to put its value
- put x = 1 , you get x = -1
- put x = -1, you get x = 1
- a **paradox!**
- which is same as i (imaginary)
- - - - - - "What" is like that i

Circularity and Self-Referentiality

- i as imaginary and circular
- these are oscillations, never stable imaginary as $\sqrt{-1}$ is not defined in this real world
- which can be understood in higher dimensions as in string theory which talks about oscillations
- but our mind cannot think so much beyond real world dimensions

i and $\Phi \wedge \neg \Phi$

Establishing Connections

- i is imaginary w.r.t real values
- $\Phi \wedge \neg \Phi$ is also imaginary w.r.t. real ture knowledge world
- $\Phi \wedge \neg \Phi$ is the mother theory in CS - still an open problem [3]

Living with Paradox

Why Paradoxes are important?

- Cleanth Brooks, 'The language of paradox' talks, "Paradox, we dont like it, but when presented in some form like poems we appreciate"

- Brooks bases his position on the contradictions that are inherent in poetry and our feelings that if those contradictions didnt exist then neither would some of the best poetry we have today.

Paradox examples in Poetry

"**Our sweetest songs are those that tell of saddest thought**"

An echo by Francis Thompson

"**I come back to where I have never been**"

Wordsworths Westminister Bridge

What we have to do

- We have not evolved programmatically but logically with deductive inferences and fallacies
- It is hard to change with paradoxes around us
- Understand the importance of 6Ws and 1H

What we have to do

- If you have been able to pose questions and challenge yourself to answer them, you would understand those fundamental axioms

contd...

What we get

- In turn, you will learn those and be able to understand how we learn
- Which may motivate you in doing any problem solving
- And mind you, they are no different then doing M.Tech thesis or Ph.D thesis.
- Even for that matter, every problem in you life wont be different than this.

Motivation for using 6W and 1H

"I keep six honest serving men. They taught me all I knew. Their names are What and Why and When and How and Where and Who "

–Rudyard Kipling

"You need 6Ws and 1H along with their complements for perfection"

–Nagesh Karmali

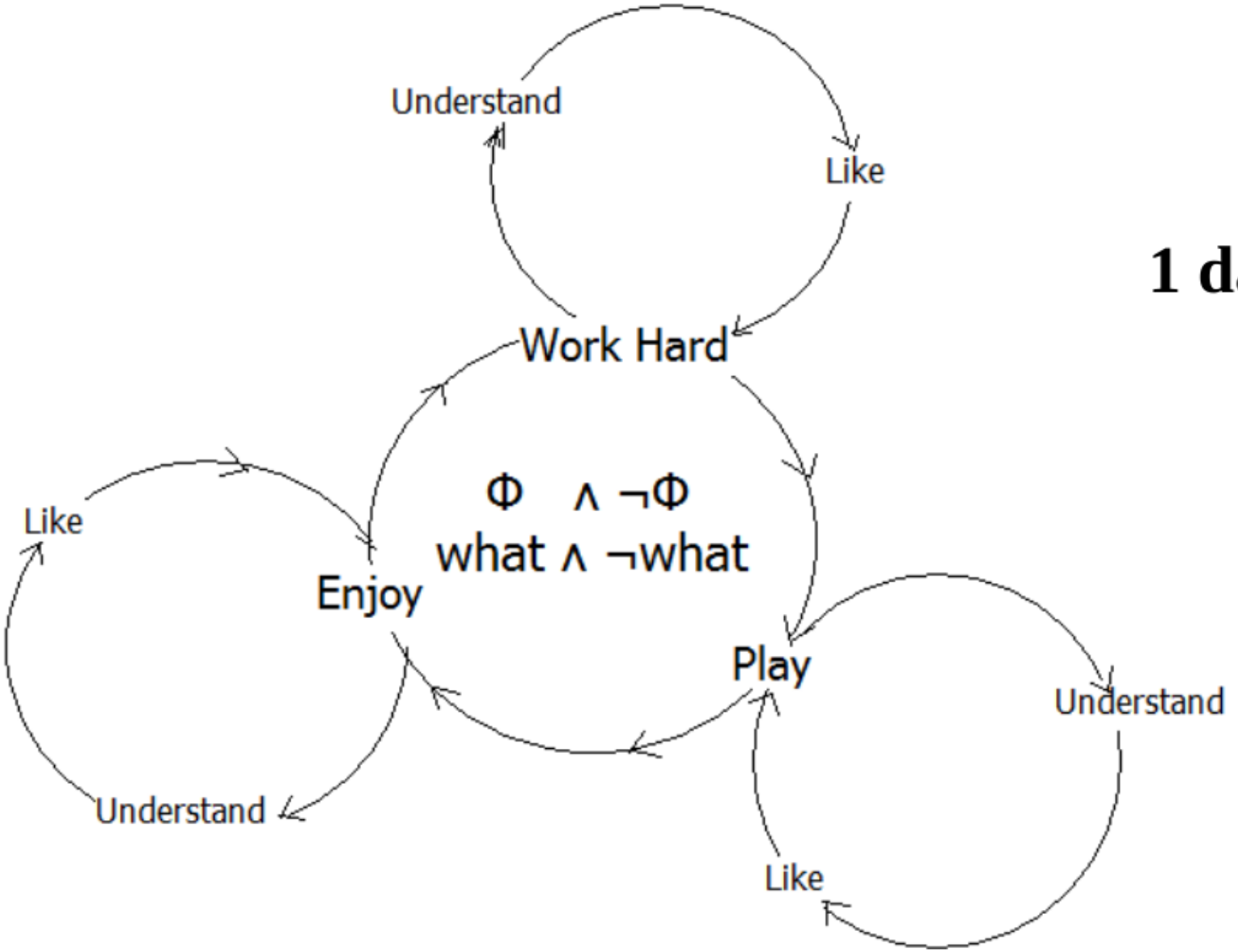
Achieving Perfection

- Anything that you do should take the help of 6Ws and 1H.
- Start by writing any sentence with the help of above atomic fundamental axioms.
- Testing the beauty of your sentence written with above 6Ws and 1H leads to changes and thus perfection

The Outcome

- Whatever you do now, the same thing will reflect in the future
- You wont be different than now
- If you change now, you can be better person tomorrow

Incremental Success Model



1 day cycle

How to Think Critically?

How to Think Critically?

Next slide taken from [4]

HOW TO SOLVE IT

First.
You have to *understand* the problem.

Second.
Find the connection between the data and the unknown. You may be obliged to consider auxiliary problems if an immediate connection cannot be found. You should obtain eventually a *plan* of the solution.

Third.
Carry out your plan.

Fourth.
Examine the solution obtained.

UNDERSTANDING THE PROBLEM

- *What is the unknown? What are the data? What is the condition?*
- Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory?
- Draw a figure. Introduce suitable notation.
- Separate the various parts of the condition. Can you write them down?

DEVISING A PLAN

- Have you seen it before? Or have you seen the same problem in a slightly different form?
- *Do you know a related problem?* Do you know a theorem that could be useful?
- *Look at the unknown!* And try to think of a familiar problem having the same or a similar unknown.
- *Here is a problem related to yours and solved before. Could you use it?* Could you use its result? Could you use its method? Should you introduce some auxiliary element in order to make its use possible?
- Could you restate the problem? Could you restate it still differently? Go back to definitions.
- If you cannot solve the proposed problem try to solve first some related problem. Could you imagine a more accessible related problem? A more general problem? A more special problem? An analogous problem? Could you solve a part of the problem? Keep only a part of the condition, drop the other part; how far is the unknown then determined, how can it vary? Could you derive something useful from the data? Could you think of other data appropriate to determine the unknown? Could you change the unknown or the data, or both if necessary, so that the new unknown and the new data are nearer to each other?
- Did you use all the data? Did you use the whole condition? Have you taken into account all essential notions involved in the problem?

CARRYING OUT THE PLAN

- Carrying out your plan of the solution *check each step.* Can you see clearly that the step is correct? Can you prove that it is correct?

LOOKING BACK

- Can you *check the result?* Can you check the argument?
- Can you derive the result differently? Can you see it at a glance?
- Can you use the result, or the method, for some other problem?

Steps for Conducting Research

- Purpose and motivation
- Review of the existing literature sources with proper criticism
- Problem identification and formulation
- Putting forward specific and main research questions or hypothesis.
- Devising a plan for solving problems and carrying it out subsequently
- Tackling a problem with critical analysis

Steps for Conducting Research

- Giving various solutions to the problems identified
- Case-study along with possible data collection.
- Demonstrating the research work
- Proper documentation and future recommendations (Project Report, papers, etc.)
- Clean cut presentation for layman to understand(no hi-fi presentations with jargons required).

Literature Sources

- Research Papers
  - Journals
  - Conference Proceedings
  - Technical Reports
  - B.Tech, M.Tech, Ph.D Thesis
- Monographs
- Renowned Books
- Whitepapers
- Technical Standards
- Software Documentation
- User Manuals
- Websites
- Dictonary, Newsletters, Magazines, Newspapers

Chinese Phrase

"I hear and I forget, I see and I remember, I do and I understand"

–Chinese phrase

References I

[1] G. S. Brown, "Laws of form," *Julian Press, New York*, 1969.

[2] D. Knuth, *The Art of Computer Programming, volume 1: Fundamental Algorithms*.
Addison-Wesley, 1997.

[3] Huth and Ryan, "Logic in Computer Science, modelling and reasoning about systems," *Cambridge University Press*, 2000.

[4] G. Polya, *How to Solve It: A New Aspect of Mathematical Method*.
Princeton University, 1988.

[5] B. Russell, "Roads to freedom," *Cornwall Press*, 1918.