Don Bosco’s tips

- Use time well
- Eat and drink moderately
- Do what pleases God
- Do good to others
- Make studious friends
- When it’s time to play, play
- Concentrate on your work
- Above all, pray

Algorithmic Thinking

It’s a mindset

- A disciplined way of solving problems
- Break into small parts
- Solve them all systematically
- Combine them
- Putting a structure to complex problems, hence simplifying them

But why is this essential?

Why?
To find a solution, start with the MAIN ESSENCE / DEFINITION

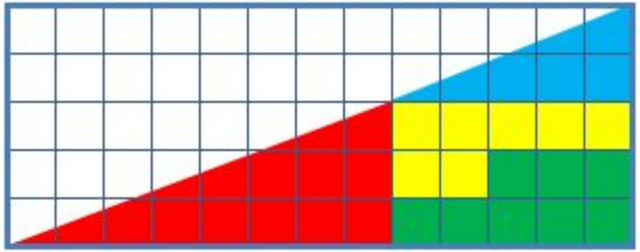
What is it? Break down into simple parts, solve each part, combine.

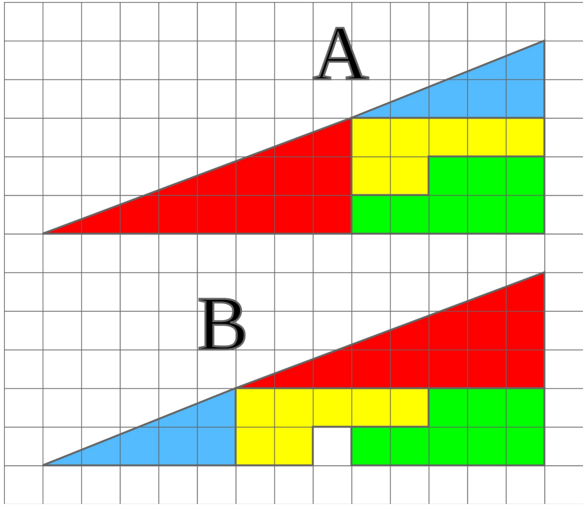
- Break how?
- Solve how?
- Combine how?

‘How’ comes after ‘why’. What do you want to achieve by solving the problem?

- Typically the answer looks like “I want the best possible …..”.
- Eg: most profitable investment, most time-saving way of doing 5 of my HWs due tomorrow, optimize my schedule for productivity, coding project, doctors prescribing medication.
- The answer to ‘how’ usually just comes from what you want to achieve. Requires a lot of thought, but possible.

Famous example: Missing square puzzle





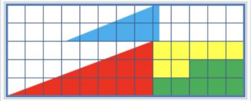
Missing square puzzle

25 languages

Article Talk Read Edit View history Tools

From Wikipedia, the free encyclopedia

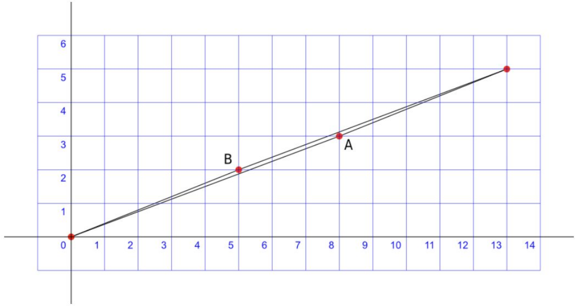
The **missing square puzzle** is an optical illusion used in mathematics classes to help students reason about geometrical figures; or rather to teach them not to reason using figures, but to use only textual descriptions and the axioms of geometry. It depicts two arrangements made of similar shapes in slightly different configurations. Each apparently forms a 13×5 right-angled triangle, but one has a 1×1 hole in it.

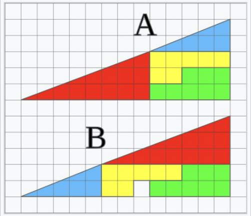


Animation of the missing square puzzle, showing the two arrangements of the pieces and the "missing" square

Solution [edit]

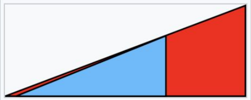
The key to the puzzle is the fact that neither of the 13×5 "triangles" is truly a triangle, nor would either truly be 13x5 if it were, because what appears to be the hypotenuse is bent. In other words, the "hypotenuse" does not maintain a consistent slope, even though it may appear that way to the human eye.





Both "total triangles" are in a perfect 13×5 grid; and both the "component triangles", the blue in a 5×2 grid and the red in an 8×3 grid.

A true 13×5 triangle cannot be created from the given component parts. The four figures (the yellow, red, blue and green shapes) total 32 units of area. The apparent triangles formed from the figures are 13 units wide and 5 units tall, so it appears that the area should be $S = \frac{13 \times 5}{2} = 32.5$



What the "magician presentation" does not show. The

Example: doctors prescribing medication

(Subject to the doctor’s judgement of the situation).

- Doc removed some medicines and kept the last medicine to same dosage
- Dad asked why not reduce dosage of that as well
- Doc’s reply - It’s sticky fat and unless it is zero, can’t risk lowering the dose. But can risk removing the other three meds. Minimum risk.
- What if he had lowered - *maybe* the effect of that med would be reversed.

Example: what people say during filling an important form

“Do you want to take another 30 mins to revise your input OR do you want to risk spending 3 more hours on a fresh form when the current one is rejected?”

Brings me to an important tip during your exams: if you have time, revise your answers.

Why?
Drives Creativity

- If you don’t have to think about the same situational problem again and again (i.e., make it a robotic task for yourself), you free up your brain space that processes creativity.
- Creativity doesn’t mean just creative writing. It includes coming up with new ways to tackle problems and express yourself. In the exam, in life …
- When you do something robotically, you already know the solution along that path. This lets you find/explore new paths. Makes you stand out.
- Robert Frost: “Two roads diverged in a wood, and I – I took the one less traveled by, And that has made all the difference.”

Why?
Empowers decision making

- Structured thinking lets you abstractify a problem, and solve it within your comfort zone. Being within your comfort zone means that you can draw more meaningful conclusions.
- Gives clarity. Hence better decisions.
- More information. Hence well-informed decisions.
- Very important in technology, social policy designing, business, healthcare…

Why?
Cultivates collaboration

- Maybe different people solve different problems.
- Eg: some days your dad cooks when your mom’s late from office, and on other days, the mom cooks when your dad is late.
- Eg: you divide the tasks of kitchen cleaning, vegetable cutting, cooking, floor cleaning among your hostel mates.
- Eg: different teams working on different themes to make Bosco’tsav work as one functioning school fest.

Keywords

- Divide-and-conquer
- Optimize
- Experience (from failure)
- Risk/cost minimization
- Practise (and hence free up brain space)
- Try a different path
- Decision-making
- Collaboration

A math example of optimization

Ram has a wood for a rectangular fence of perimeter 100m. He wants to build it around his sheep so that it doesn't run away. But Ram also wants to ensure that he gives his sheep the maximum possible grazing area.

What do you do?

- `2(l+b) = 100`
- `Maximize lb subject to the above and that l,b >= 0.`
- Could apply various solving techniques - calculus or AM-GM inequality.
- Answer is `625 sq m` when `l = b = 25m`.

Radiation Treatment Planning

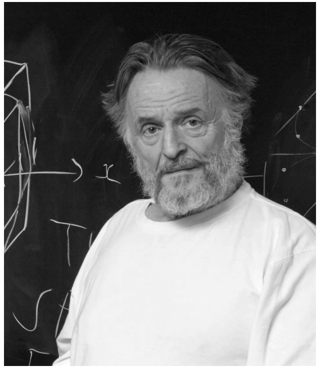
In radiation treatment, radiation is delivered to a patient, with the goal of killing or damaging the cells in a tumor, while carrying out minimal damage to other tissue. The radiation is delivered in beams, each of which has a known pattern; the level of each beam can be adjusted. (In most cases multiple beams are delivered at the same time, in one 'shot', with the treatment organized as a sequence of 'shots'.) We let b_j denote the level of beam j, for $j = 1, \ldots, n$. These must satisfy $0 \leq b_j \leq B^{\max}$, where $B^{\max}$ is the maximum possible beam level. The exposure area is divided into m voxels, labeled $i = 1, \ldots, m$. The dose d_i delivered to voxel i is linear in the beam levels, i.e., $d_i = \sum_{j=1}^{n} A_{ij} b_j$. Here $A \in \mathbb{R}_{+}^{m \times n}$ is a (known) matrix that characterizes the beam patterns. We now describe a simple radiation treatment planning problem.

A (known) subset of the voxels, $\mathcal{T} \subset \{1, \ldots, m\}$, corresponds to the tumor or target region. We require that a minimum radiation dose D^{target} be administered to each tumor voxel, i.e., $d_i \geq D^{\text{target}}$ for $i \in \mathcal{T}$. For all other voxels, we would like to have $d_i \leq D^{\text{other}}$, where D^{other} is a desired maximum dose for non-target voxels. This is generally not feasible, so instead we settle for minimizing the penalty

$$E = \sum_{i \notin \mathcal{T}} (d_i - D^{\text{other}})_+,$$

where $(\cdot)_+$ denotes the nonnegative part of its argument (i.e., $(z)_+ = \max\{0, z\}$). We can interpret E as the total nontarget excess dose.

Image Compression



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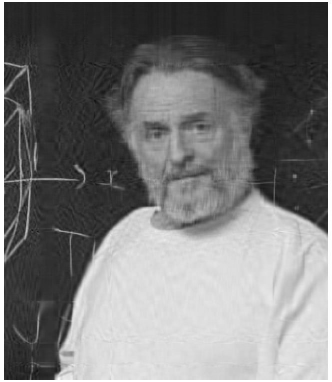

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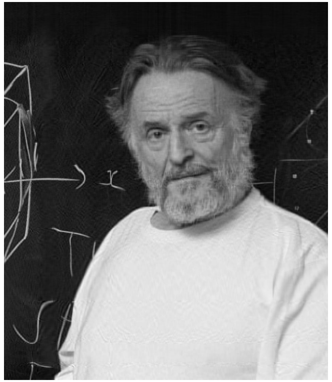

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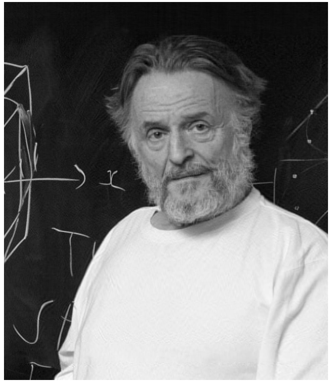

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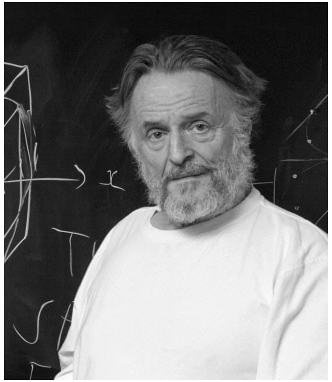


Some more "buzzword" applications

- Machine Learning
- [Market design]
- Stock prediction
- Fair division
- Auctions
- Analyze fighting behaviour
- Evolutionary stable strategy
- Chemical Game Theory

The Logic of Animal Conflict

J. MAYNARD SMITH
School of Biological Sciences, University of Sussex, Falmer, Sussex BN1 9QG

G. R. PRICE
Galton Laboratory, University College London, 4 Stephenson Way, London NW1 2HE

Conflicts between animals of the same species usually are of "limited war" type, not causing serious injury. This is often explained as due to group or species selection for behaviour benefiting the species rather than individuals. Game theory and computer simulation analyses show, however, that a "limited war" strategy benefits individual animals as well as the species.

and ask what strategy will be favoured under individual selection. We first consider conflict in species possessing offensive weapons capable of inflicting serious injury on other members of the species. Then we consider conflict in species where serious injury is impossible, so that victory goes to the contestant who fights longest. For each model, we seek a strategy that will be stable under natural selection; that is, we seek an "evolutionarily stable strategy" or ESS. The concept of an ESS is fundamental to our argument; it has been derived in part from the theory of games, and in part from the work of MacArthur[13] and of Hamilton[14] on the evolution of the sex ratio. Roughly, an ESS is a strategy such that, if most of the members of a population adopt it, there is no "mutant" strategy that would give higher reproductive fitness.

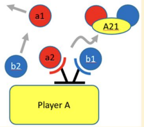
Chemical Game Theory

Darrell Velegol,* Paul Suhey, John Connolly, Natalie Morrissey, and Laura Cook

Department of Chemical Engineering, The Pennsylvania State University, University Park, Pennsylvania 16802, United States

ABSTRACT: The purpose of this paper is to describe a new framework for representing and solving strategic game theory problems. This framework, called "Chemical Game Theory" (CGT), uses well-known, rigorous principles from chemistry and chemical engineering to solve strategic decision problems that could be analyzed using "Traditional Game Theory" (TGT). In strategic decisions, players each can choose from among two or more alternative possibilities, and the outcome depends upon the collective choices from all players. In this article we will analyze some of the premises of TGT as compared with CGT. In CGT, the players' choices are treated as metaphorical molecules, and outcomes are calculated according to chemical reaction methods. The important concept of entropic choices is introduced, and pre-bias effects are included naturally as initial concentrations of reactants. CGT is not a generalization of TGT; rather, it represents contested decision problems differently, and gives different solutions. In this article we use the formalism of chemistry to provide a "knowlecular" approach to analyzing contested decisions. This approach has a rich capacity to represent decision-making scenarios and serve as a decision-making algorithm for contested decisions, where leadership power plays an important role.

	b1 = quiet	b2 = tell
a1 = quiet	*+1*, +1	*+3*, 0
a2 = tell	*0*, +3	*+2*, +2



The most important takeaway

Discipline and Structure

Some practical qualities/skills to have to survive out there

- Whatever you do, do it well.
- Practise over and over again even if you know how to do something. Don't stop until you're the fastest in the world to solve a given kind of problems.
- Get yourself a goal to wake up to everyday. But set a goal you believe you can achieve - it doesn't matter what others think.
- Be open to suggestions from experienced people. Weigh the risks.
- Backtrack from that goal, and decide what you need to do next.
- Never give up hope if that goals seems too far. Or try something adjacent.
- Solve problems daily. Whatever sort of problems. I do CodeForces.
- Spend time with yourself.
- Never be dishonest. Always help your fellow neighbors.
- Never fear to try something out-of-the-box. You never know where the less-taken-path could take you.

Thankyou