

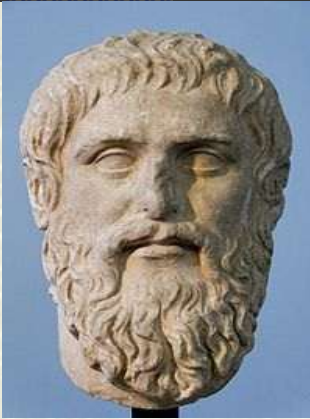
$$\frac{(x^2 + \frac{9}{4}y^2 + z^2 - 1)^3 - x^2z^3}{80y^2z^3} = 0$$

$$-3 \leq x, y, z \leq 3$$

# *Mathematical Modeling*

*HS Jang HYFL*

# Pure Math vs Math Modeling

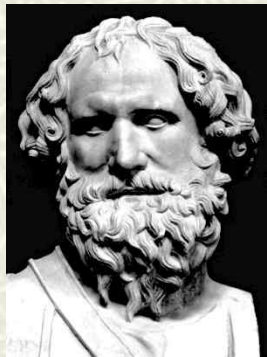


*“Μηδείς ἀγεωμέτρητος εἰσίτω μου τὴν στέγην.”*

“기하학을 모르는 사람은 이 건물에 들어오지 말라”

*Λογιστική ἐστὶ θεωρία τῶν ἀριθμητῶν, οὐχὶ δὲ τῶν ἀριθμῶν μεταχειριστική, οὐ τὸν ὄντως ἀριθμὸν*

병참학(Logistic)은 수 자체가 아니라  
수량화된 사물에 대한 학문이다.



*“ Ἐπίστηθι, ὦ ἄνθρωπε, τοῦ διαγράμματός μου.”*

“여보게 내 그림에서 멀리 떨어져 주게 ” 알키메데스



# MATHEMATICAL MODELING EXPERIENCE

From Burning Ship To Parachute Design





# Why MME?

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- # Fundamental and quantitative way to understand and analyze complex systems and phenomena
  - # Becoming widespread in:  
(Application of Math for Future Careers)
  - # Motivation for learning
  - # Better Spec for Students
-

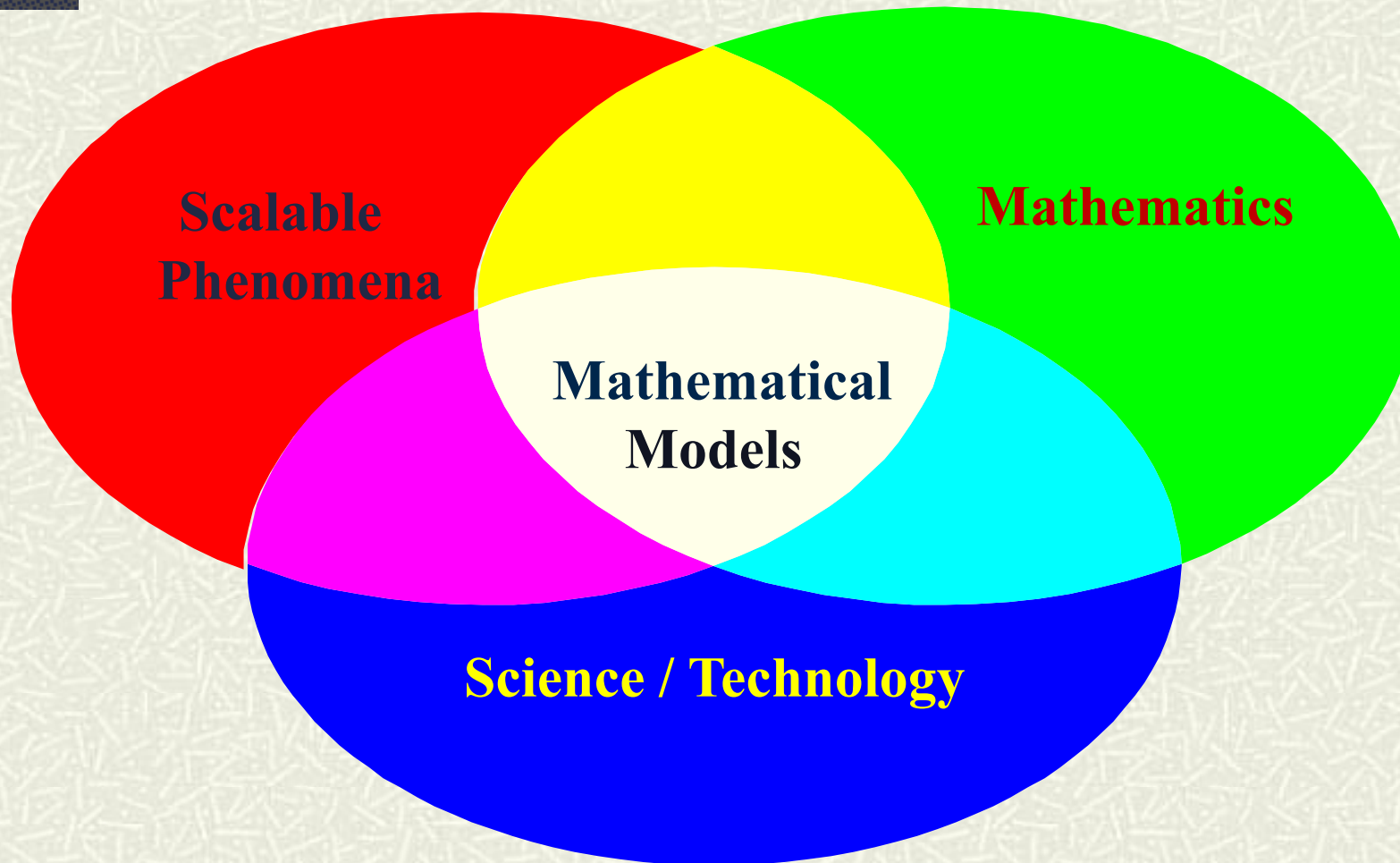
# Goals for MME

---

- # Appreciation of **broad use** of modeling
  - # **Hands-on an experience**  
with simulation techniques
  - # Develop **communication** skills
-

# Mathematical Modeling

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# Areas for Math Modeling

---

A powerful, indispensable tool for studying a variety of problems.

- **Seismology**
- **Climate modeling**
- **Economics**
- **Environment**
- **Material research**
- **Drug design**
- **Manufacturing**
- **Medicine**
- **Biology**

*Analyze - Predict*

---

‘Ὡς Μάρκελλος δ’ ἀπέστησε βολὴν ἐκείνας τόξου,  
‘Εξάγωνόν τι κάτοπτρον ἐτέκτηνεν ὁ γέρων,



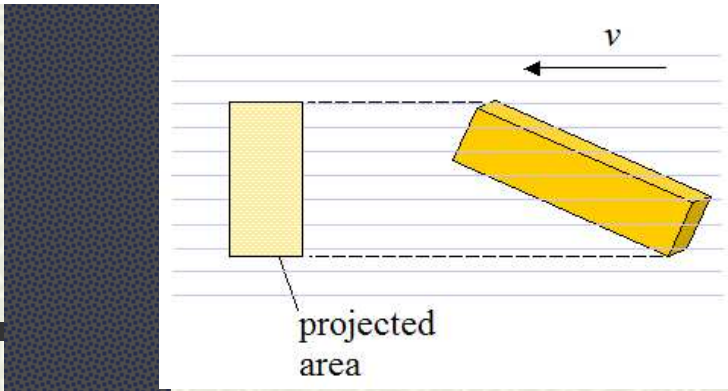
마르셀루스가 활의 사정거리를 벗어나자 그 노인(알키메데스)은  
육각형모양의 거울들을 제작하고 ..... Tzetzes, Book of Histories ii



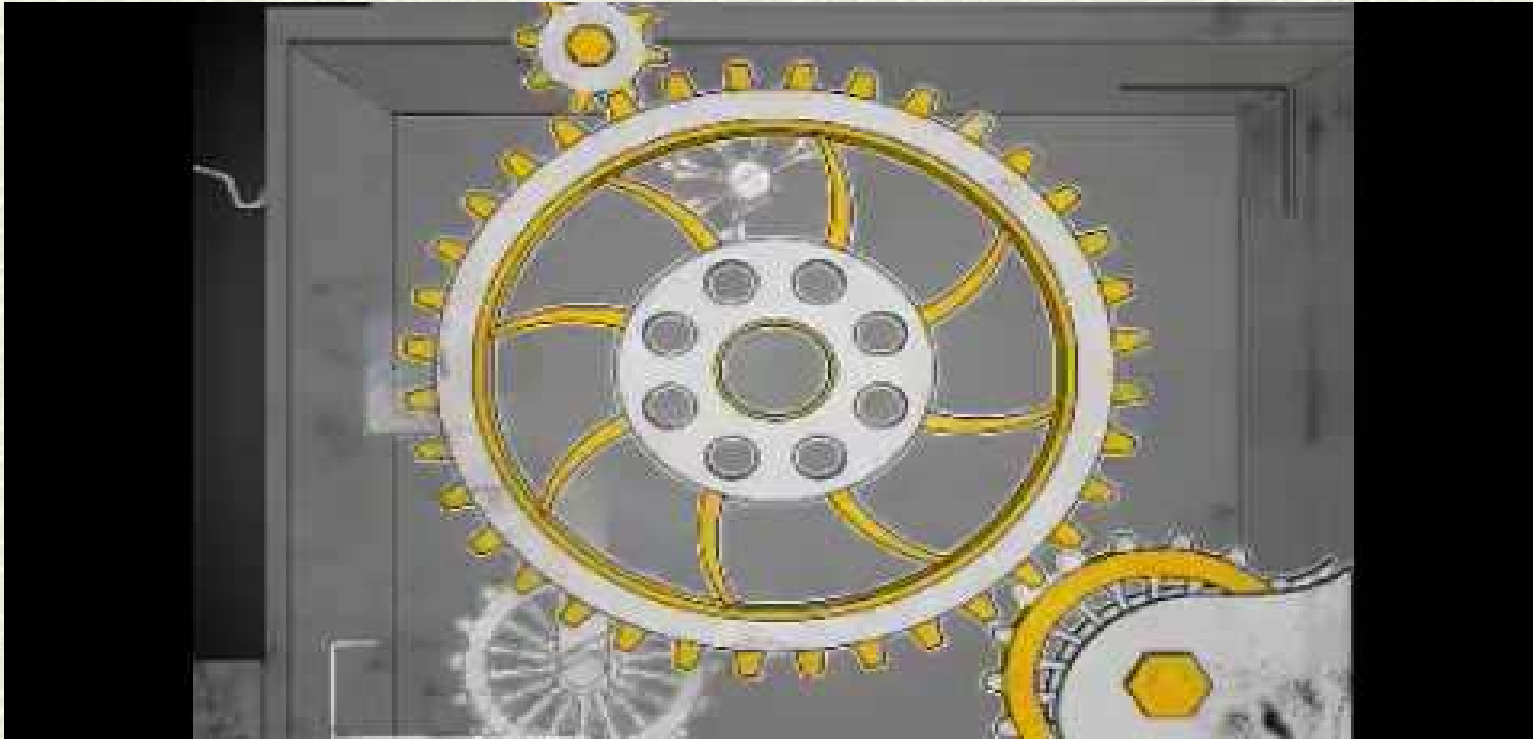
# Parachute Problem

## 낙하산문제 (HiMCM 2006)

- # Using the modeling process, build a mathematical model for the opening of the parachutes. We are concerned with how the parachute inflates. Use your model to explain how the geometry of the folding of the parachute affects the inflation and then discuss how we might affect the rate of inflation of the parachute.
- # 낙하산 이 펼쳐지는 과정을 수학적 모델을 사용하여 설명해 보시오. 우리는 낙하산이 어떻게 부풀려지는가 에 대한 관심을 가지고 있다. 그 모델을 사용하여 낙하산 접기의 기하가 낙하산 부풀리기에 어떠한 영향을 미칠 지 설명해 보고 낙하산 이 부푸는 비율에 어떠한 영향을 미칠 지 논의하시오.



$$mg = \frac{1}{2} C_p A v_t^2 \quad v_t = \sqrt{\frac{2mg}{C_p A}}$$



**낙하산의 역사** 르네상스시대 이태리 (1470) 다빈치 (1514)  
S. 르노먼드 (1783) A.J. 가너린(1797)



## 2007 HiMCM Problem A : Smoke Alarms

## 화재경보문제

Fire is one of the leading causes of accidental deaths. It is important for everyone to take every preventative measure and precaution possible to be ready to deal with a fire emergency. More than half of all fatal fires occur between 10 p.m. and 6 a.m. when everyone in the home is usually asleep. Smoke alarms are necessary to alert you to fires when you sleep. Will smoke alarms allow enough time to evacuate safely?

***Build a mathematical model to determine the number and locations of smoke alarms to provide the maximum time for evacuation.***

Also include a model to determine the number and location of at-home fire extinguishers to have available. ***Build a mathematical model for evacuation of a family from both one and two story homes.***

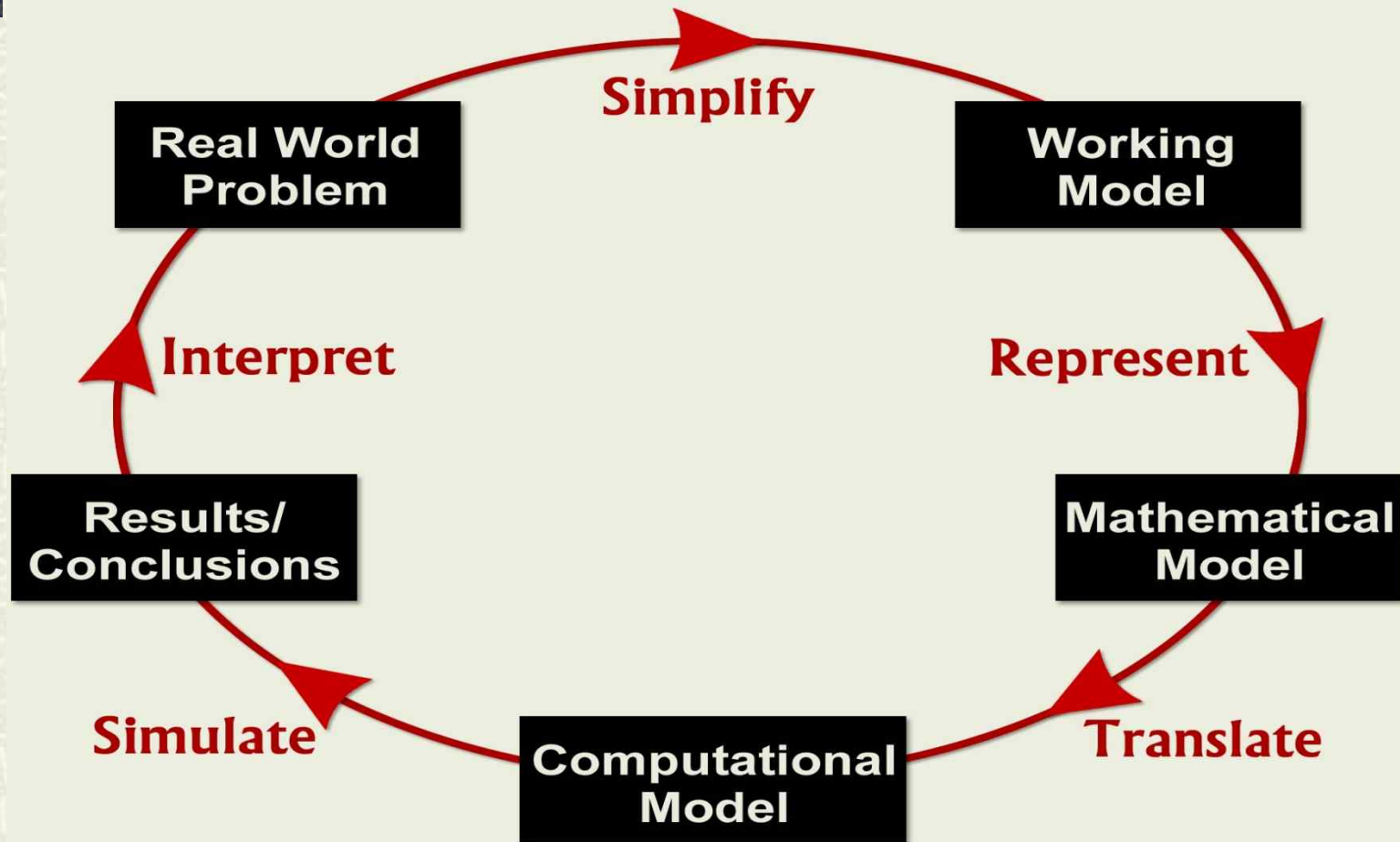
***Prepare an advertisement for your local fire department to pass out to the community that includes the main results of your mathematical models.***



# Simulation Activity



# Mathematical Modeling Process

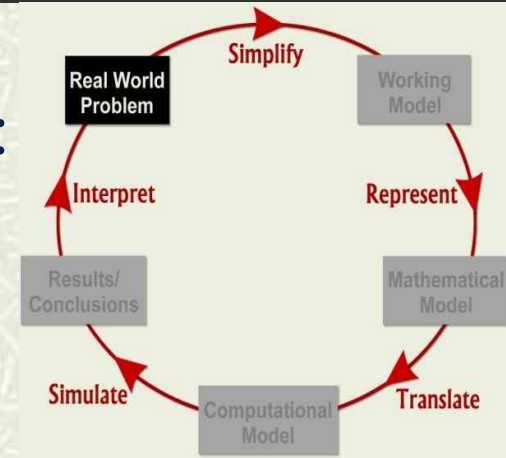


# Real World Problem

## Identify *Real-World Problem*:

- Perform **background** research, focus on a **workable problem**.
- Conduct **investigations** (Labs), if appropriate.
- Learn the use of a **computational tool**:

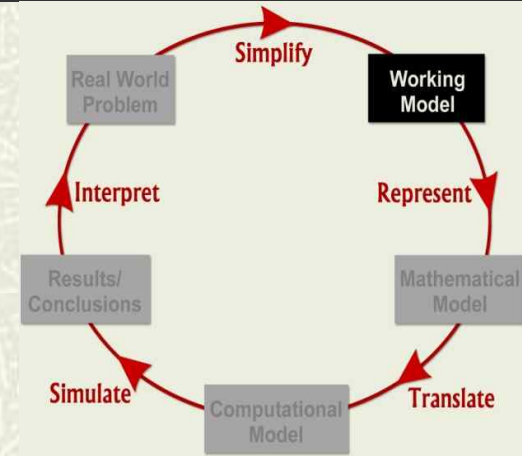
Matlab, Mathematica, Excel, Java.





# Working Model

**Simplify** → *Working Model*:



- State simplifying assumptions.
- Determine governing principles, physical laws.
- Identify model variables and inter-relationships.

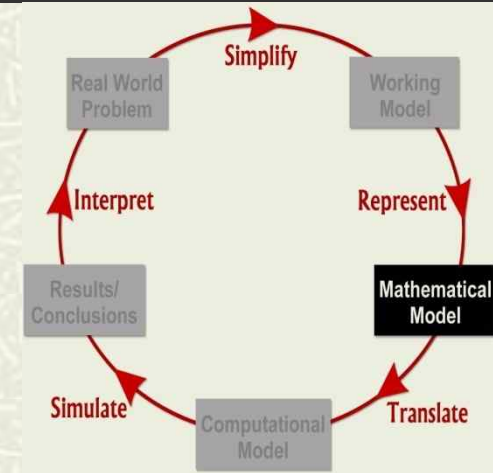
# Mathematical Model

*Represent*

→ *Mathematical Model:*

Express the *Working Model*  
in mathematical terms;

Write down mathematical equations whose  
solution describes the *Working Model*.





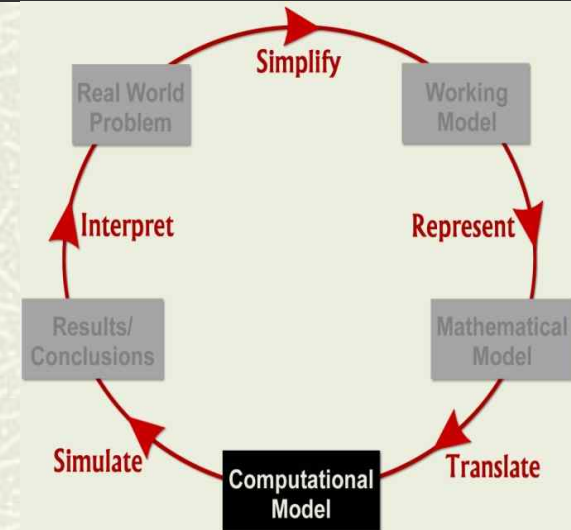
# Computational Model

*Translate*

*Mathematical Model*

→ *Computational Model:*

Computational models include software such as Matlab, Excel, or Mathematica, or languages such as Fortran, C, C++, or Java.





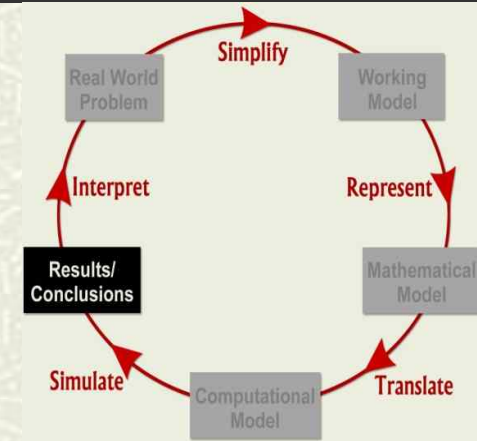
# Results/Conclusions

## Simulate

→ *Results/Conclusions:*

Obtain *Results*;  
draw *Conclusions*.

- Verify your computer program; use check cases; explore ranges of validity.
- **Graphs, charts, and other visualization tools** are useful in **summarizing results** and drawing **conclusions**.



# Problem Solving

**Πρόβλημα,**  
**ὅπερ Ἀρχιμήδης ἐν ἐπιγράμμασιν εὐρῶν τοῖς ἐν Ἀλεξανδρείᾳ περὶ ταῦτα πραγματευομένοις ζητεῖν ἐπέστειλεν ἐν τῇ πρὸς Ἐρατοσθένην τὸν Κυρηναῖον ἐπιστολῇ.**



*A Problem* = (προ + βαλλω) = front + throw

*which Archimedes solved in epigrams, and which he communicated to students of such matters at Alexandria in a letter to [Eratosthenes](#) of Cyrene.*

**“위대한 발견은 위대한 문제를 해결한다. 그러나 어떠한 문제를 풀더라도 그 발견의 기쁨이 있다.” G. Polya**

**Understanding the Problem / Devising a Plan**

**Carrying out the Plan / Looking Back**





# Structure of the HiMCM Course

---

- # Principles of modeling & Problem Solving
  - # Spaces and norms
    - Nominal, Ordinal, Interval, Rational Scales
  - # Basic numerical methods:
    - Interpolation , Curve fitting,
    - Descriptive Statistics, Least squares
  - # Algebraic Models / Geometric Models
  - # Stochastic Models / Dynamic Models
-

# Math Model Question

## Real & Cooked Specimen

### # Algebraic

A line segment is said to be cut in extreme and mean ratio when as the whole is to the longer segment so is the longer segment to the shorter. Evaluate the mean ratio and give real world examples.



### # Geometric

If we took off a very large square to make the "L" shape quite thin, then the center of gravity would lie outside the L shape and we could not balance it at all. Then, What is the largest size of square that we can remove so that we can still just balance the L shape?





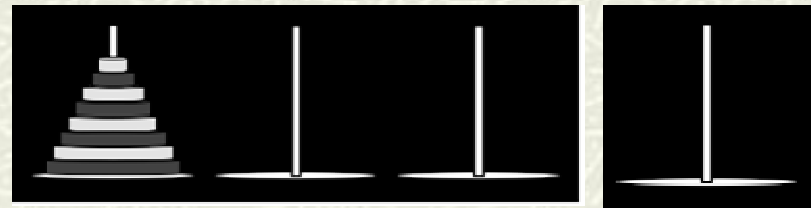
# Examples of Math Model Question Real & Cooked Specimen

## # Stochastic

- (a) Three points are taken at random on an infinite plane. Find a chance of their being the vertices of an obtuse-angled Triangle.
- (b) How thick should a coin to have  $1/3$  chance of landing on edge?

## # Dynamic

For Hanoi Tower problem, estimate the minimum number of moves with another empty rod.



# 수학적 모델링 학습의 교육적 효과

- ⌘ 문제 이해력
- ⌘ 문제 해결전략
- ⌘ 분석능력 / 추리능력
- ⌘ 기재사용능력
- ⌘ 창의력
- ⌘ 소통 / 정보수집 능력
- ⌘ 탐구(연구)능력

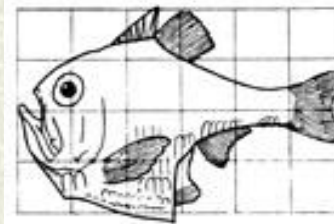


Fig. 146. *Argyropelecus offersi*.

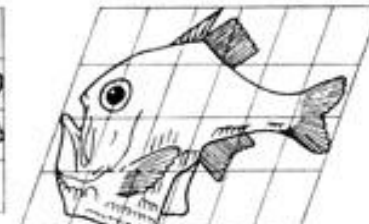


Fig. 147. *Sternoptyx diaphana*.

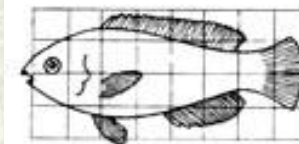


Fig. 148. *Scarus* sp.

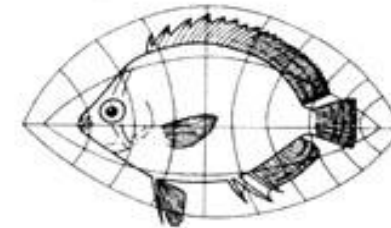


Fig. 149. *Pomocanthus*.

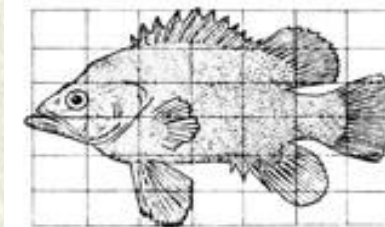


Fig. 150. *Polypriion*.

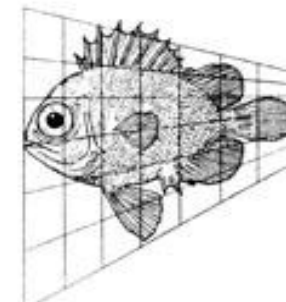


Fig. 151. *Pseudopriacanthus altus*.



# 감사합니다



허수의 세계 (Yves Tanguy, 1900~ 1955)