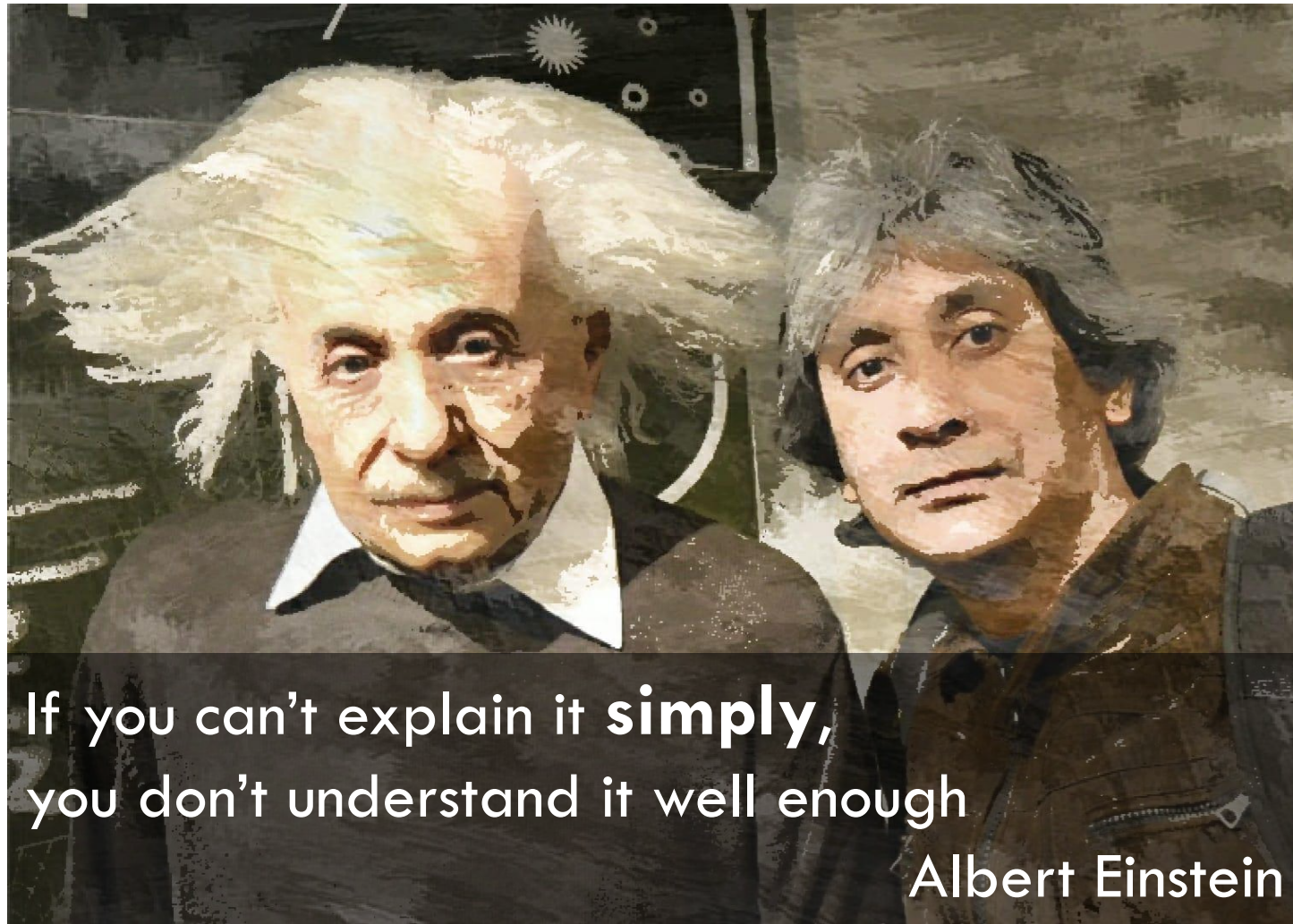




# ECO-FUZZY DECISION MODEL: OPTIMIZING AGRICULTURAL INVESTMENT

Assoc.Prof. Dr.rer.nat. Ditdit Nugeraha Utama, S.Kom, MMSI, M.Comm(IS)  
RIG for Quantitative and Decision Sciences, BINUS University, Indonesia

December 5, 2024  
Wageningen University & Research, The Netherlands



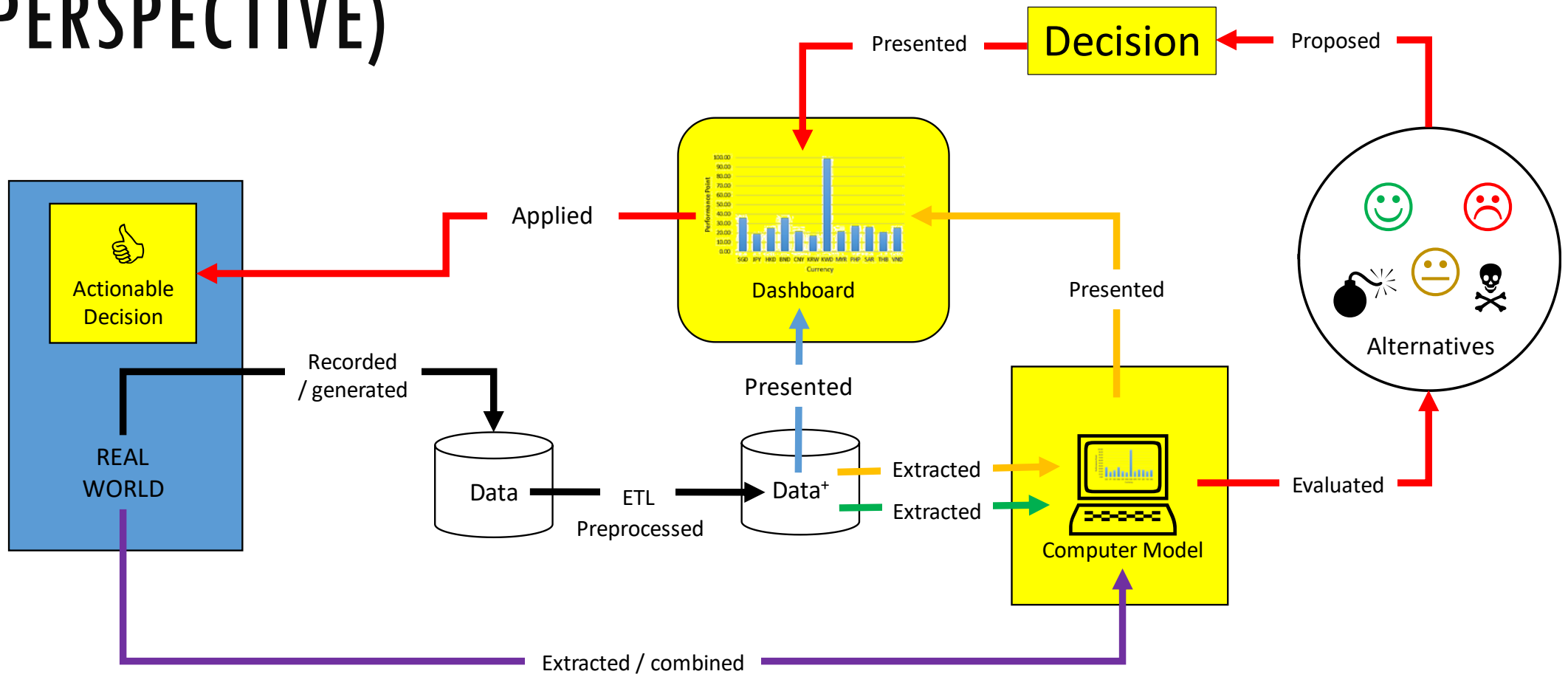
If you can't explain it **simply**,  
you don't understand it well enough

Albert Einstein

# AGENDA

1. Helicopter view of descriptive, predictive, prescriptive (DPP) in the context of data sciences
2. Decision model and plant (computational) modeling
3. Computer modelling
4. Fuzzy logic as Introduction
5. Case in agricultural investment
6. Q&A

# HELICOPTER VIEW OF DPP (IN DATA SCIENCE PERSPECTIVE)

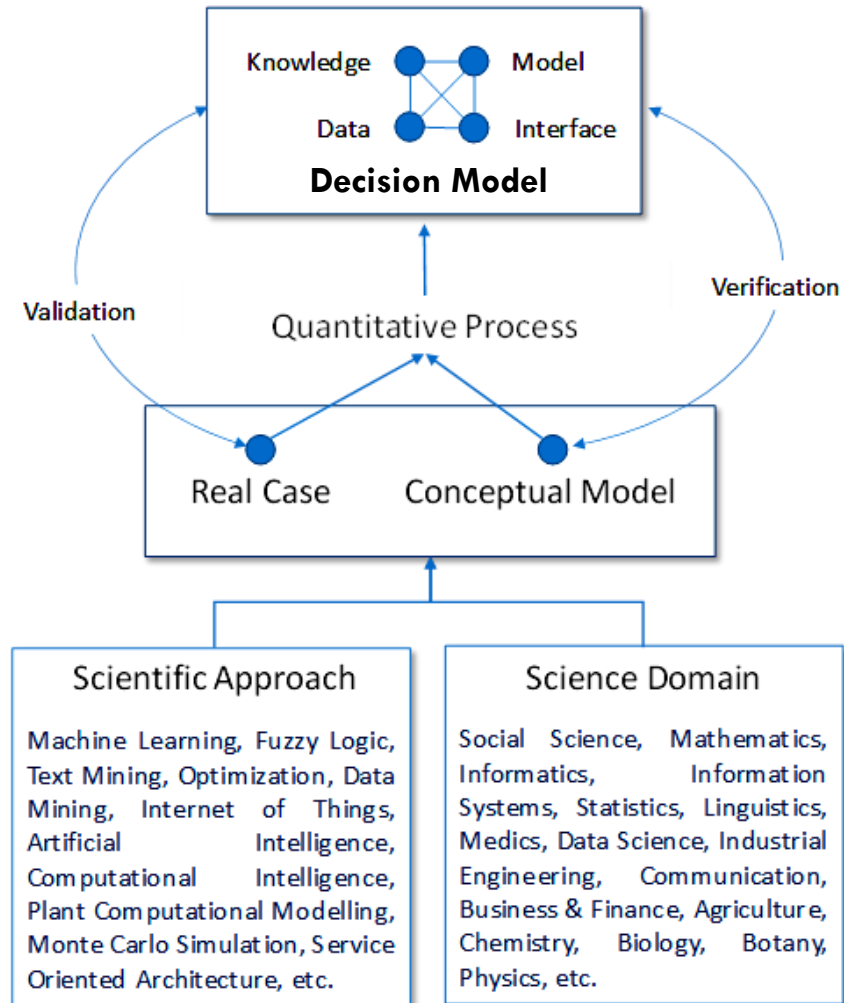


## Explanations:

→ Data management → → Descriptive → → Predictive → → → **Prescriptive (data oriented decision making)**

→ → → + → → **Phenomenon oriented decision making**

# DM AND DM HEXAGON



# EXPERTISES

Experts' judgement, top level managements' view

# DATA

extracted, generated, collected

# KNOWLEDGES

Modeller's knowledge, users' knowledge, environment view

# DECISION MODEL

# CASE

Ideas, challenges, problems, issues, etc.

# EXPERIENCES

Users' justification, societies' perception

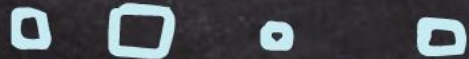


# TECHNOLOGIES

Languages, databases

# SCIENCES

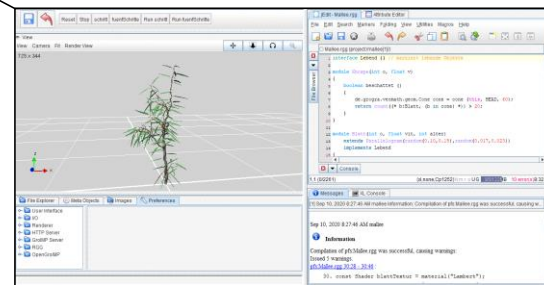
Methods, approaches, theories, concepts, algorithms



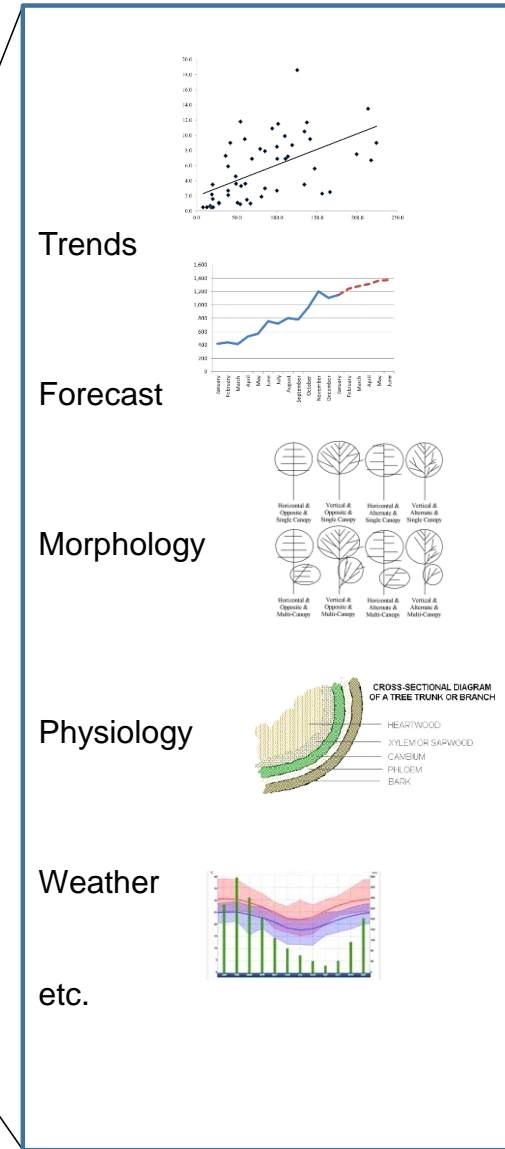
# Plant Modelling → DM



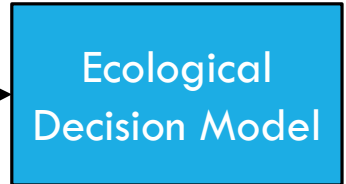
Real Plant



Virtual Plant Model



Data and Information

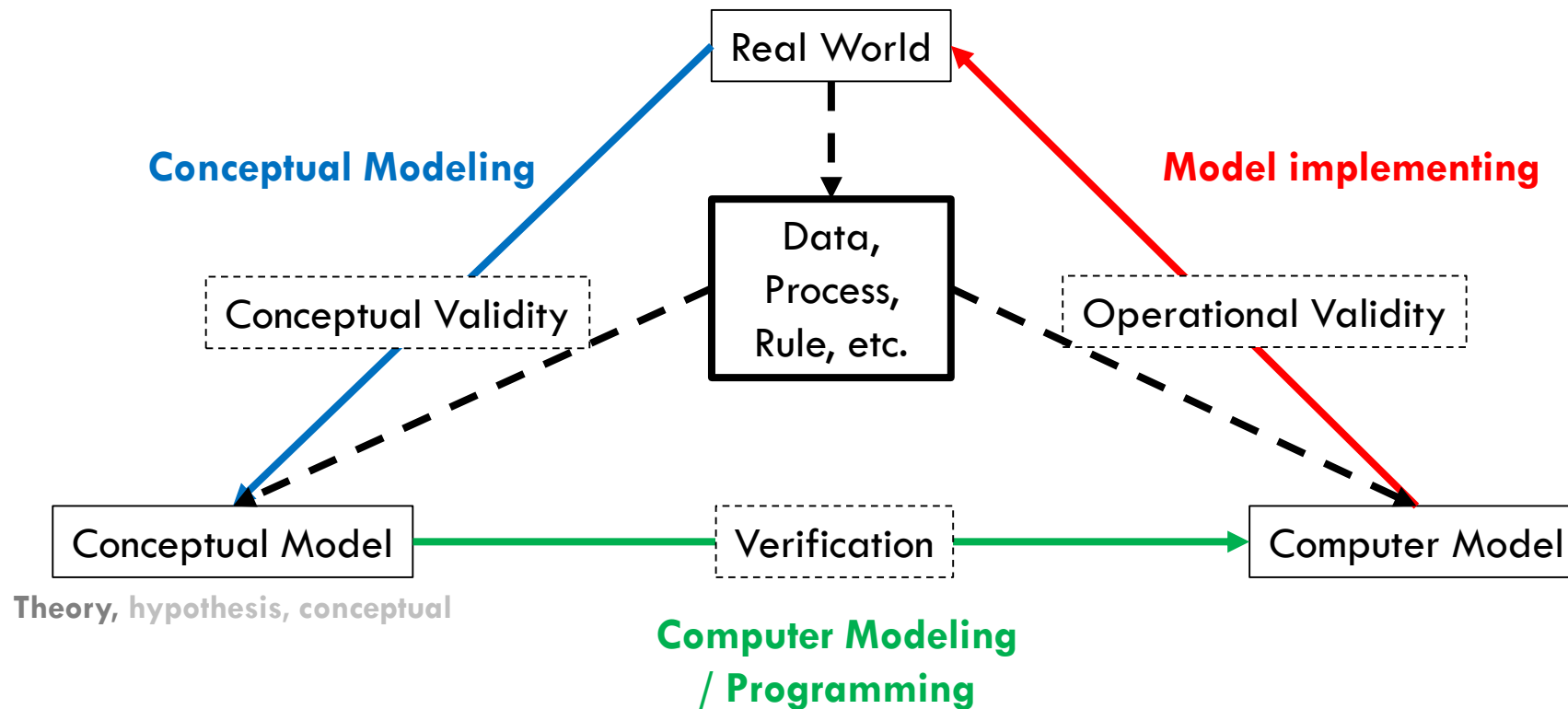


# PHILOSOPHY OF COMPUTER MODEL/ING

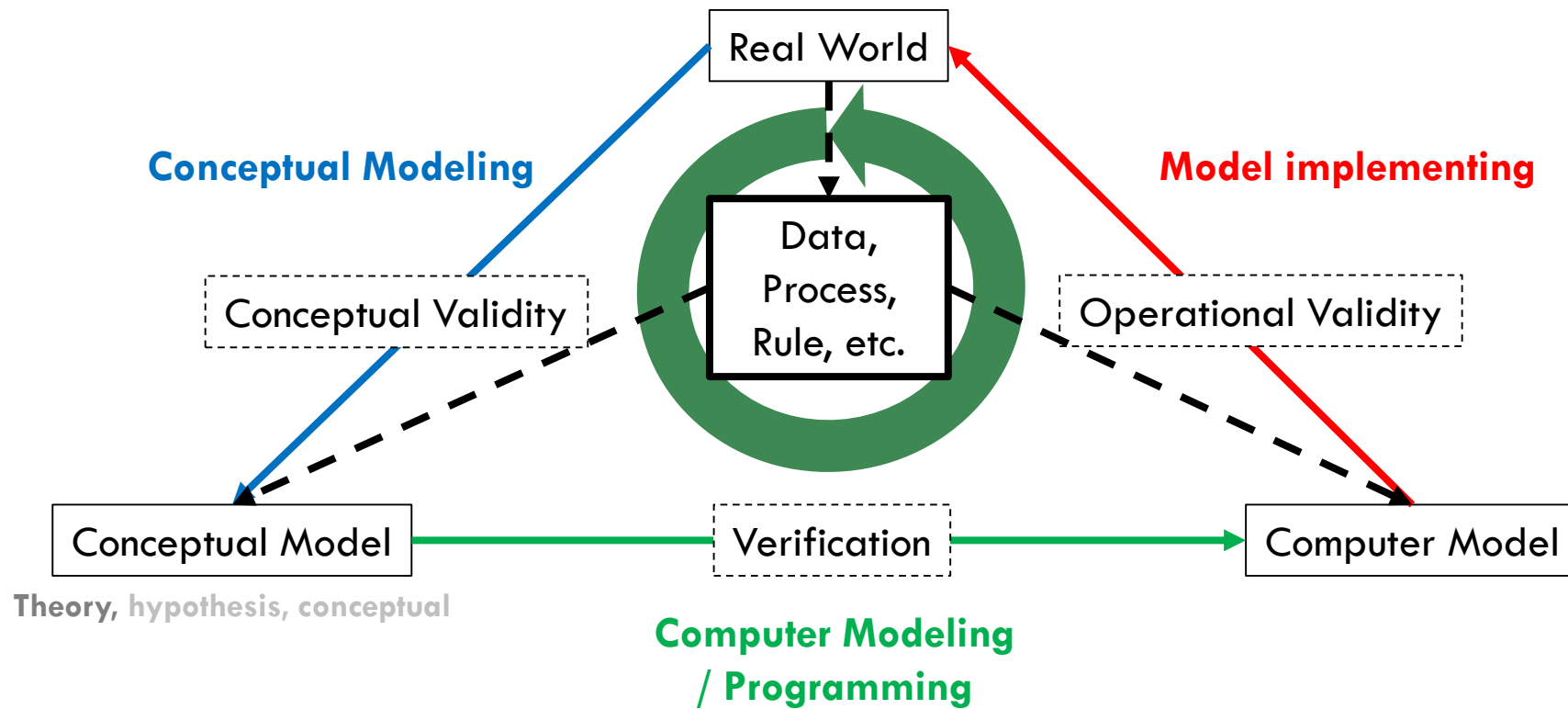
- Replica of something
- Instance based (case/instance study)
- Mathematical representation (presented in form of computer code/program)
- Built on assumption consequently (thru constraints)
- All models are wrong but some are fruitful enough
- Should be academically true via verifying and validating



# COMPUTER MODEL/ING



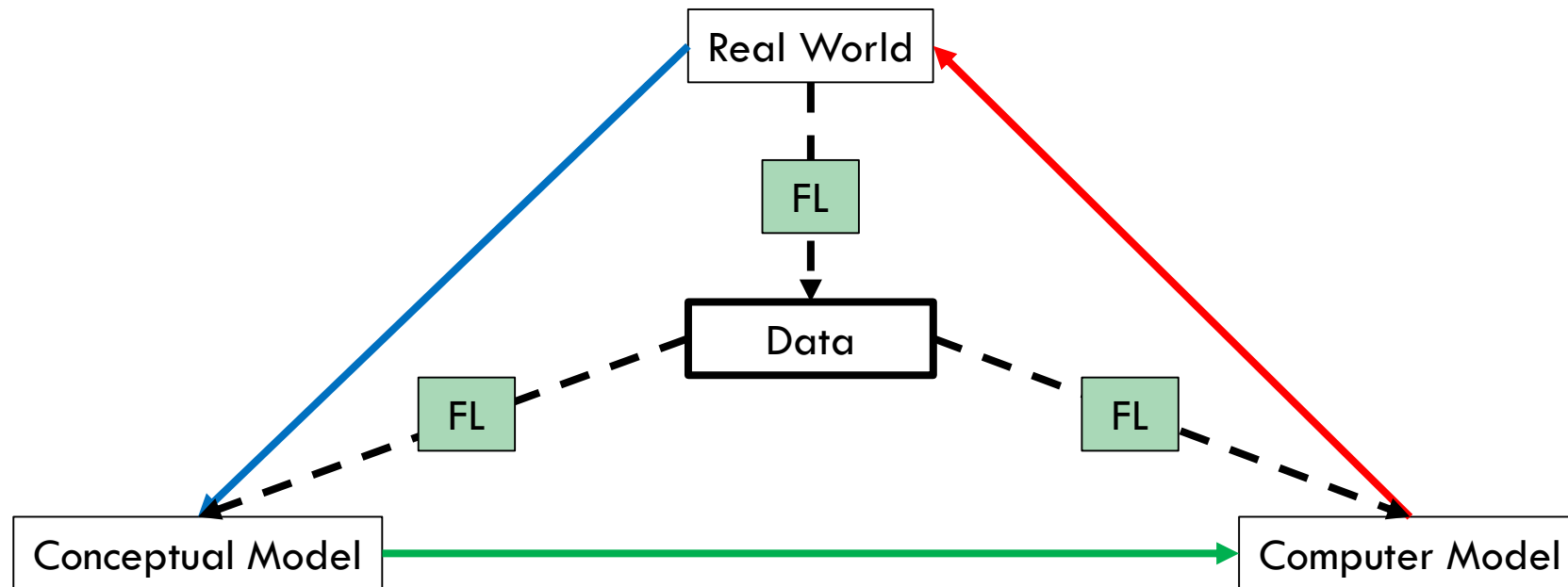
# COMPUTER MODEL/ING



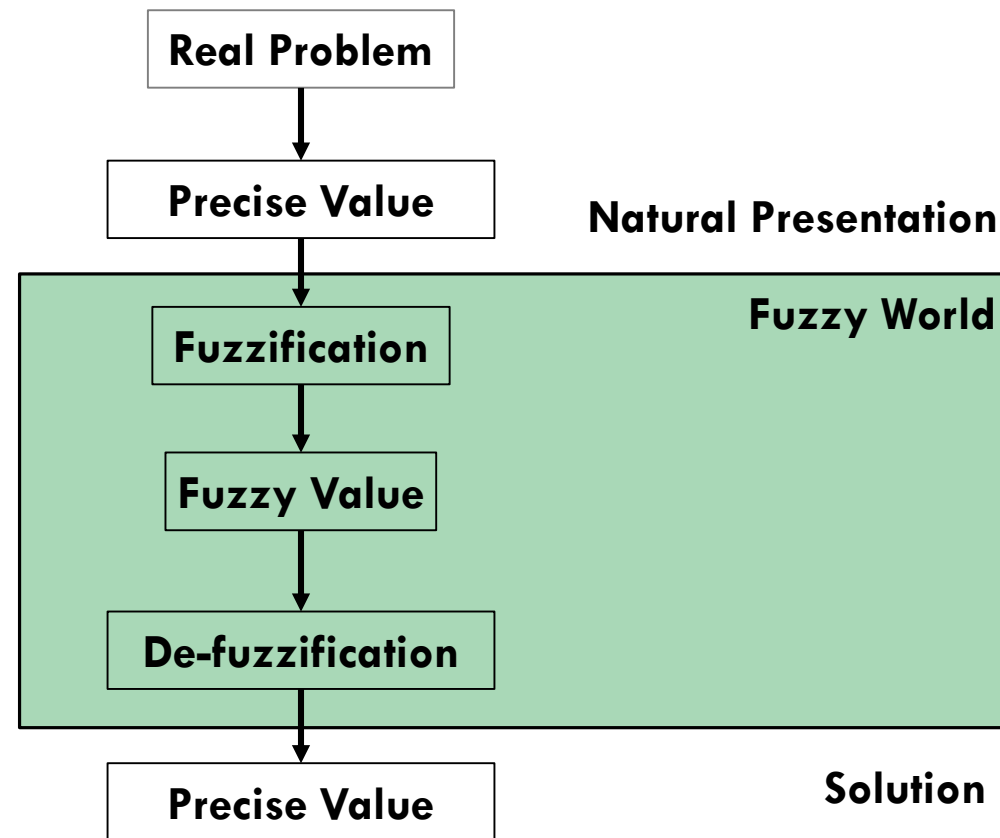
# PHILOSOPHY OF FUZZY LOGIC

- It is not logic, it is fuzzy
- Bias (not clear or vague)
- Verbal and Numerical combined-judgment (human decision making methodology)
- Scientifically open concept/method, fitted to be integrated with other methods

# FUZZY IN COMPUTER MODEL/ING

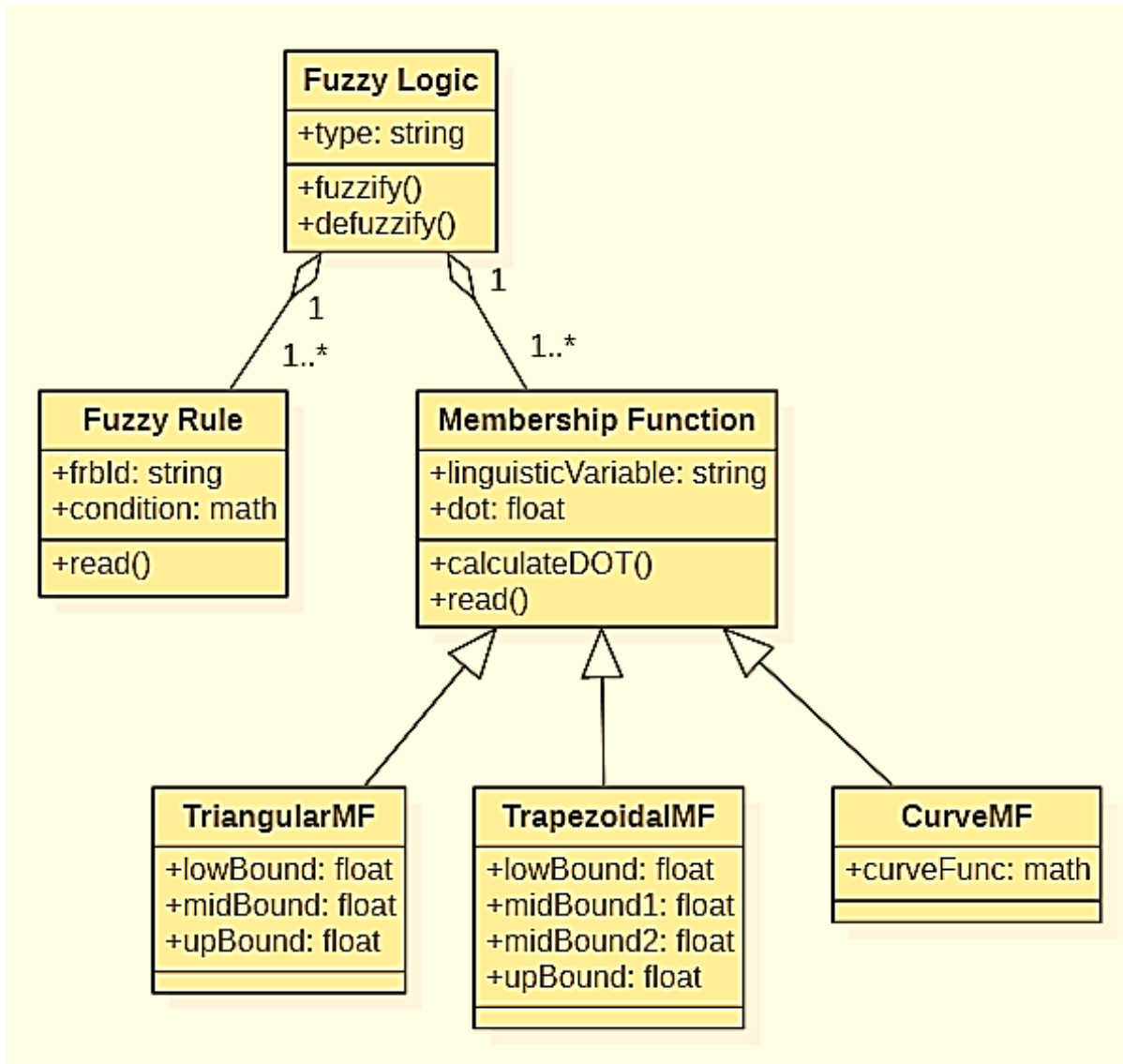


# FUZZY LOGIC STAGES

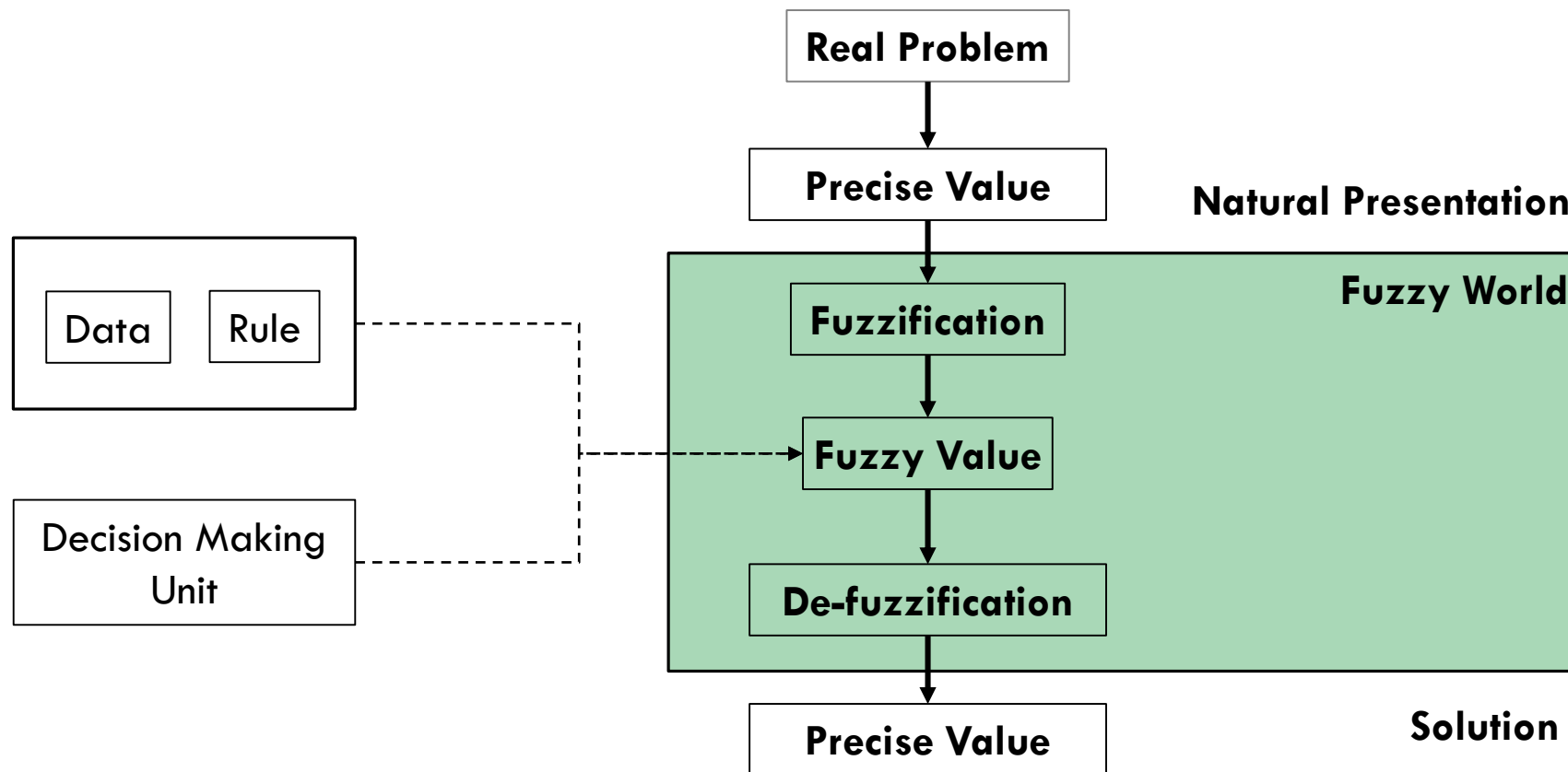


(Utama, 2020)

# THE CLASS DIAGRAM OF FUZZY LOGIC CONCEPTION



# FUZZY INFERENCE SYSTEM (FIS)



(Utama, 2020)

# VIRTUAL PLANT OF BASIL (*OCIMUM BASILICUM*) FOR INVESTMENT

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## Assessing Potential Investment Return of Basil (*Ocimum Basilicum P.*) using Fuzzy Logic and Investment Analysis Criteria for Environmental-Based Agriculture

Heraldo Yusron Purwanto<sup>1</sup> and Ditdit Nugeraha Utama<sup>1</sup>

<sup>1</sup> Department of Computer Science, BINUS Graduate Program - Master of Computer Science, Bina Nusantara University, Jakarta, Indonesia

### Abstract

Indonesia is one of Southeast Asia's most populous and big countries. It was well-known for its richness of natural resources. Indonesia is one of the world's largest tropical countries, because of its tropical environment. According to the statistics, however, arable land in Indonesia has declined dramatically over the years in response to increased demand for residential areas. This data reveals a fairly alarming fact: It is feasible that, despite its wealth of natural resources, Indonesia

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Original Research Paper

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Corresponding Author:  
Department of Computer Science, BINUS Graduate Program - Master of Computer Science, Bina Nusantara University, Jakarta, Indonesia  
Email: heraldo.purwanto@binus.ac.id

**Abstract:** Indonesia is one of Southeast Asia's most populous and big countries. It was well-known for its richness of natural resources. Indonesia is one of the world's largest tropical countries, because of its tropical environment. According to the statistics, however, arable land in Indonesia has declined dramatically over the years in response to increased demand for residential areas. This data reveals a fairly alarming fact: It is feasible that, despite its wealth of natural resources, Indonesia could one day be unable to meet its domestic food demands. Furthermore, rivalry and obstacles faced by Indonesian farmers may exacerbate the country's restricted food supply. The assessments of potential investment in basil plant (*Ocimum basilicum P.*) were conducted, to support the agricultural innovation to be more appealing among stakeholders, researchers, and farmers. In assessing the potential investment, the financial aspect of the feasibility study is used in this study, where this assessment was commonly used in planning and forecasting the financial gains of a project or investment. The Decision Support Model (DSM) was using a fuzzy logic method in determining the investment decision. We hope this study will provide better analysis and accurate decisions for stakeholders, researchers, and farmers.

**Keywords:** DSM, Fuzzy Logic, Basil Plant, Hydroponic, Investment Analysis



# BASIL PLANT

- Species for Research Object (*Ocimum Basillicum* L.)
- Could grow up to 30 - 90 cm
- Leaf length up to 5 cm and width up to 2 cm
- Plantation period (HSS)  $\pm 60$  cm
- Benefits:
  - ↳ "Holy Basil" Raw material for traditional medicine (India & Nepal) (Singletary, 2018)
  - ↳ Astiri oil content which is processed into the combination of Carbopol 940 and hydroxypropyl Methyl Cellulose can inhibit the growth of antibacterial *S. Aureus* and *E. Coli* replace handsanitizer made alcohol (Cahyani, 2014, Farid N, et al., 2020)
  - ↳ Species that includes antibacterial compounds including:

} (Peter, 2012)



Ocimum Basillicum



Ocimum Sanctum



Ocimum Canum



# GATHERED DATASETS



- **Seed** (Length & Width)
- **Cotyledon** (Length, Width, Internode Length, Internode Width, Angle)
- **MainStem** (Length, Width, Bending Corner)
- **MainLeaf** (Length, Width, Internode Length, Internode Width, Angle)
- **ChildNode** (Length, Width, Bending Corner)
- **ChildLeaf** (Length, Width, Internode Length, Internode Width, Angle)

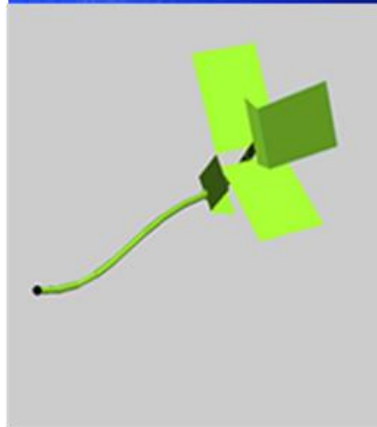
# REAL PLANT VS VIRTUAL PLANT



Day 10



Day 20



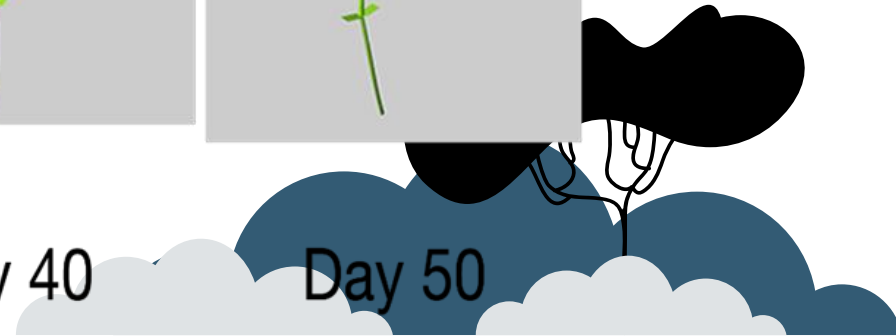
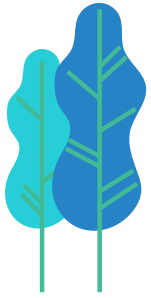
Day 30



Day 40



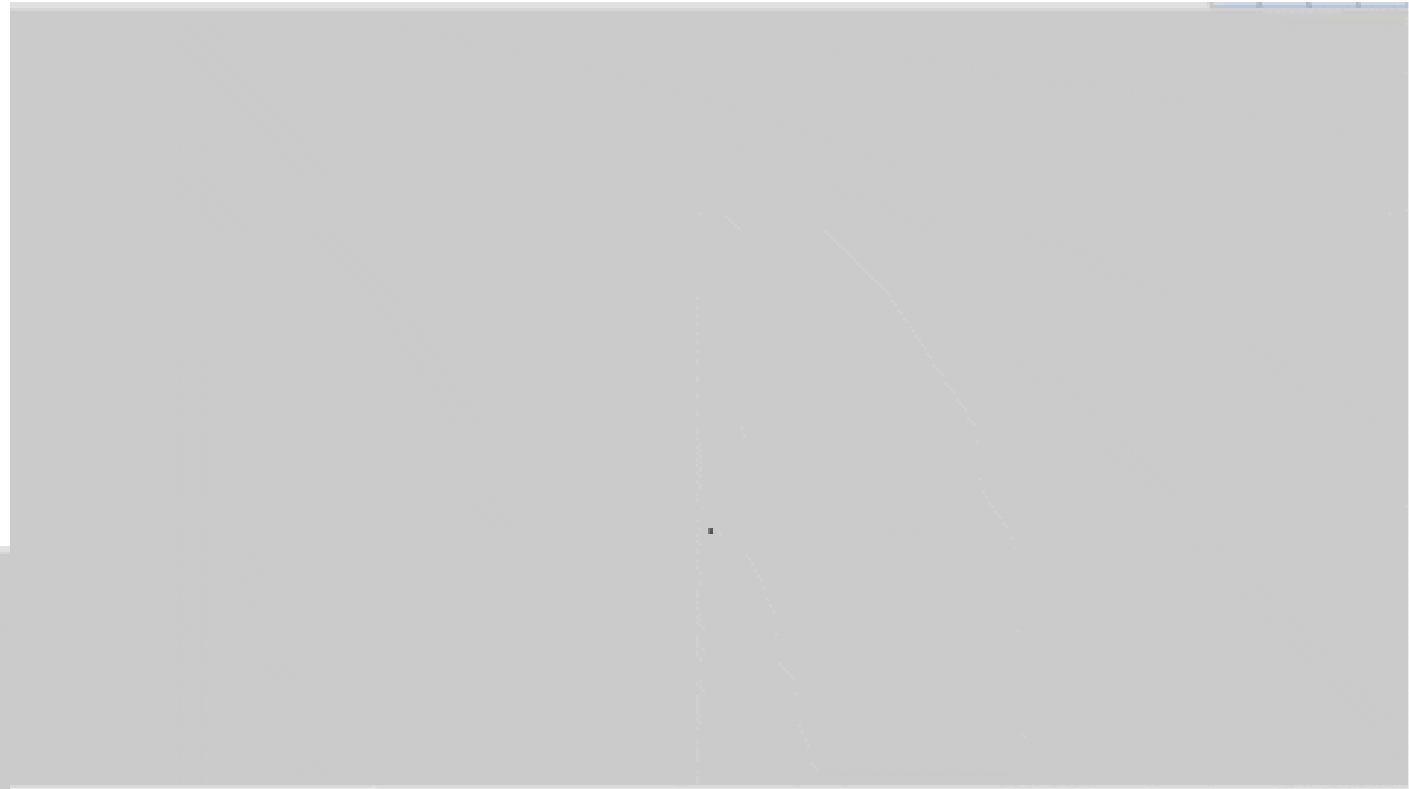
Day 50





# VIRTUAL SINGLE PLANT SIMULATION

SIDE VIEW



TOP VIEW



1400 x 279



SIDE VIEW

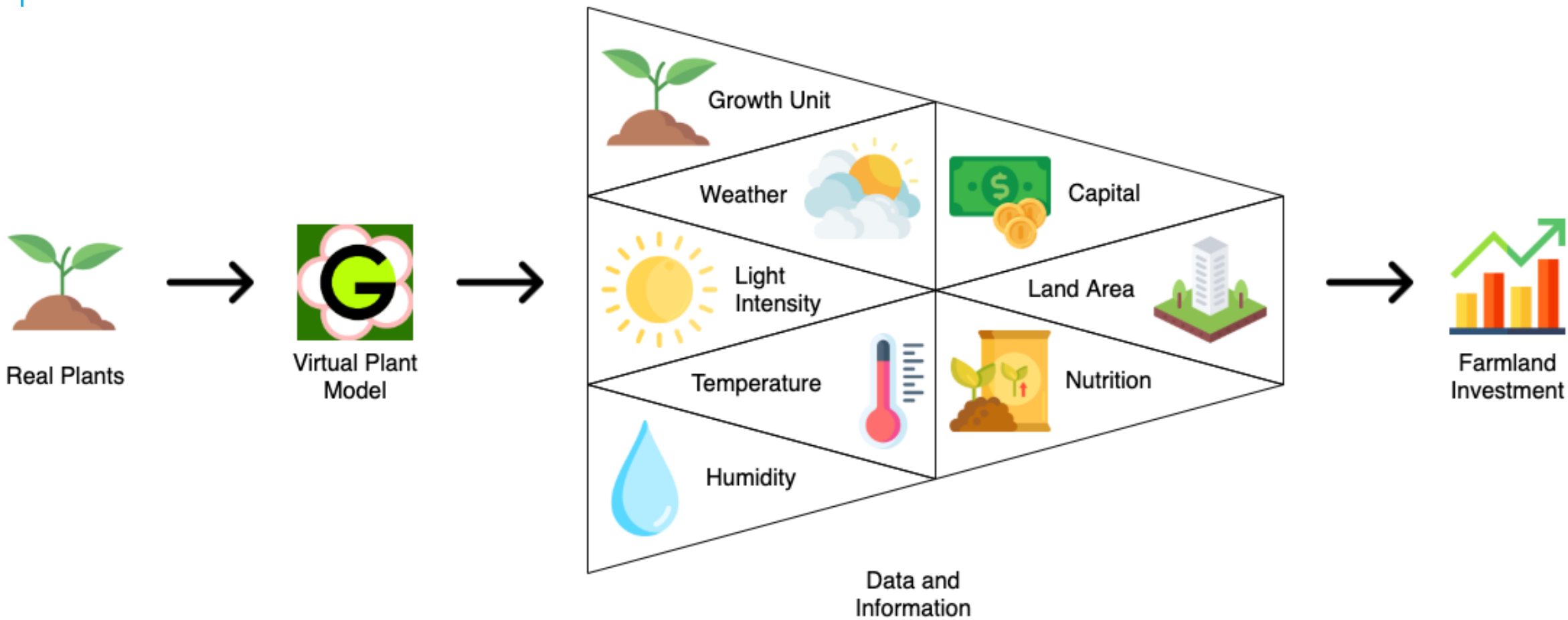


**VIRTUAL MULTI  
PLANTS SIMULATION**

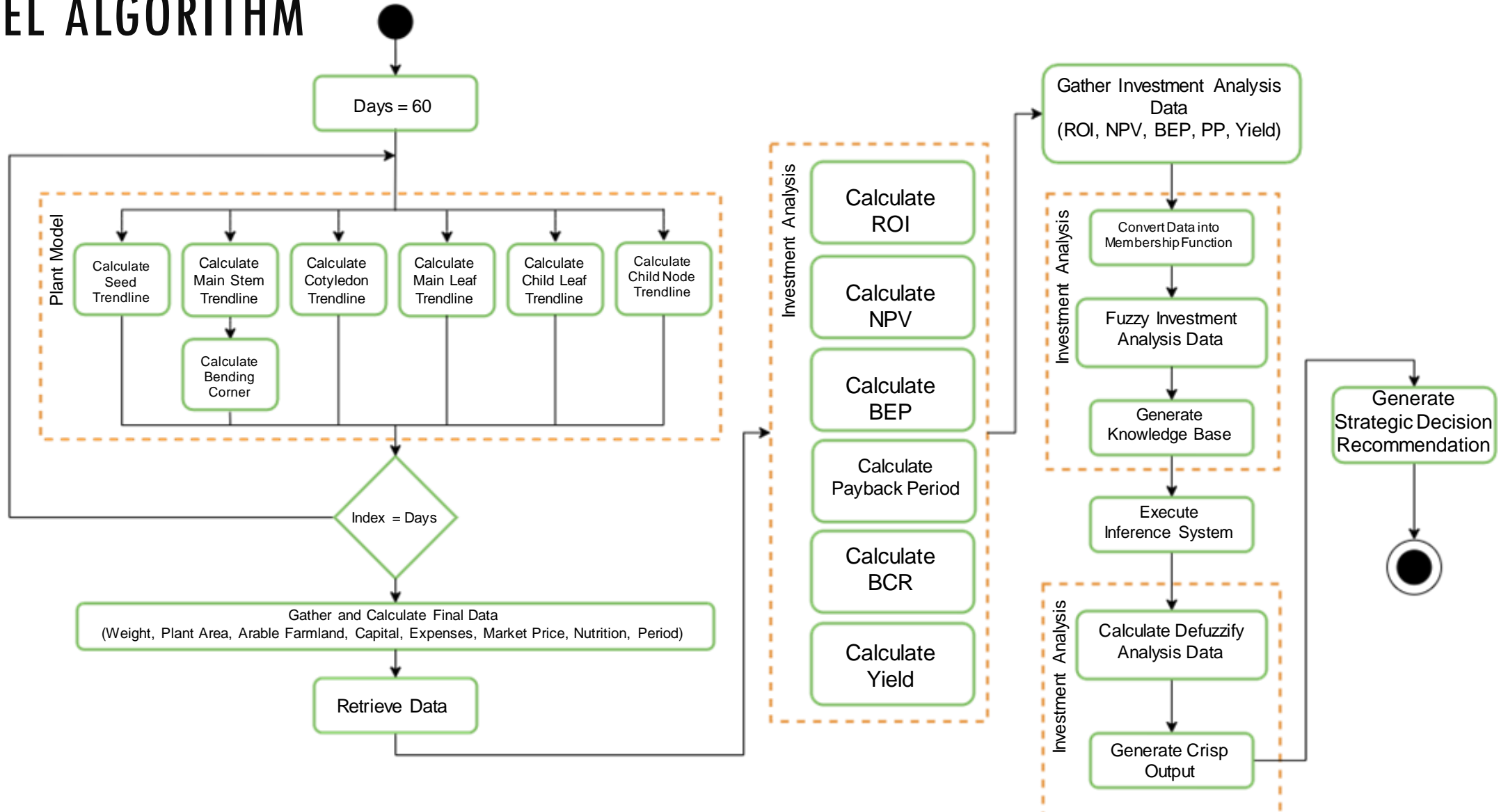


END RESULT

# MODEL CONFIGURATION

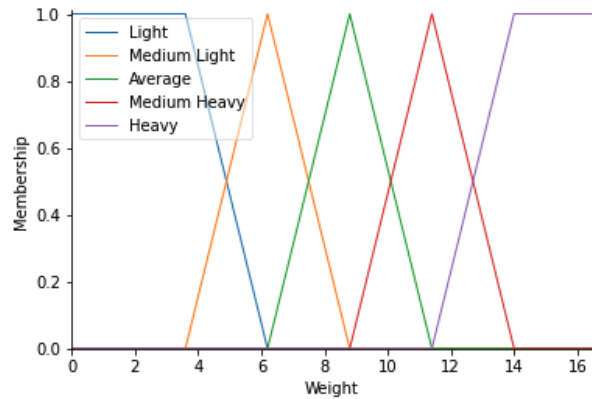


# MODEL ALGORITHM

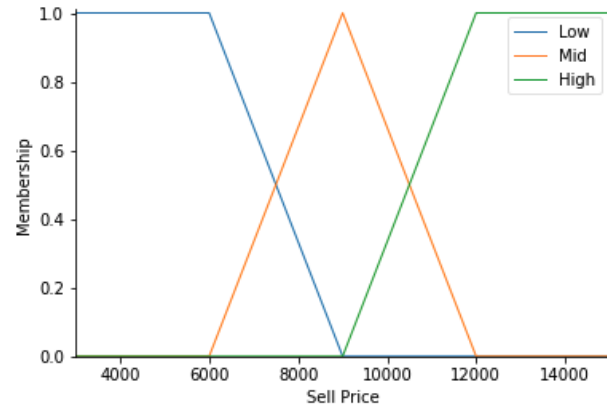


# FUZZY SETS FOR EACH PARAMETERS

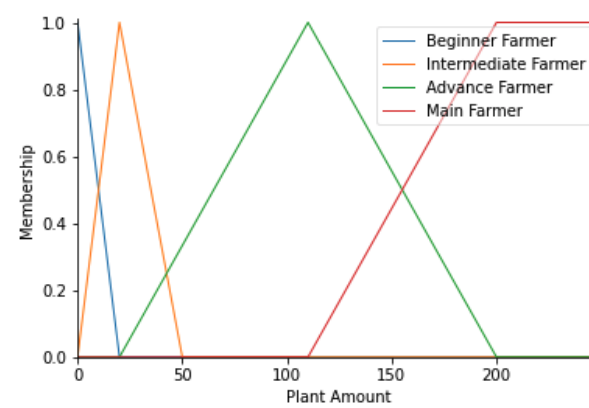
## WEIGHT



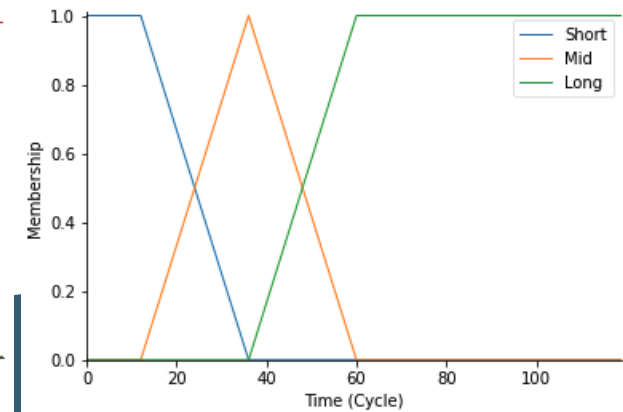
## SELLING PRICE



## PLANT NUMBER

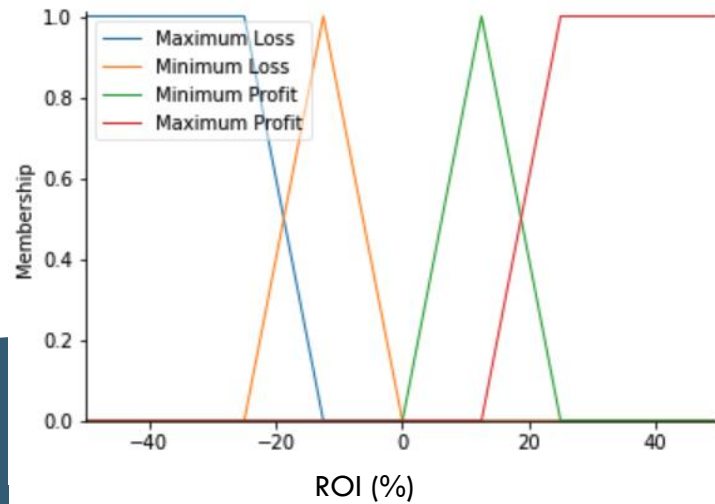


## INVESTMENT PERIOD





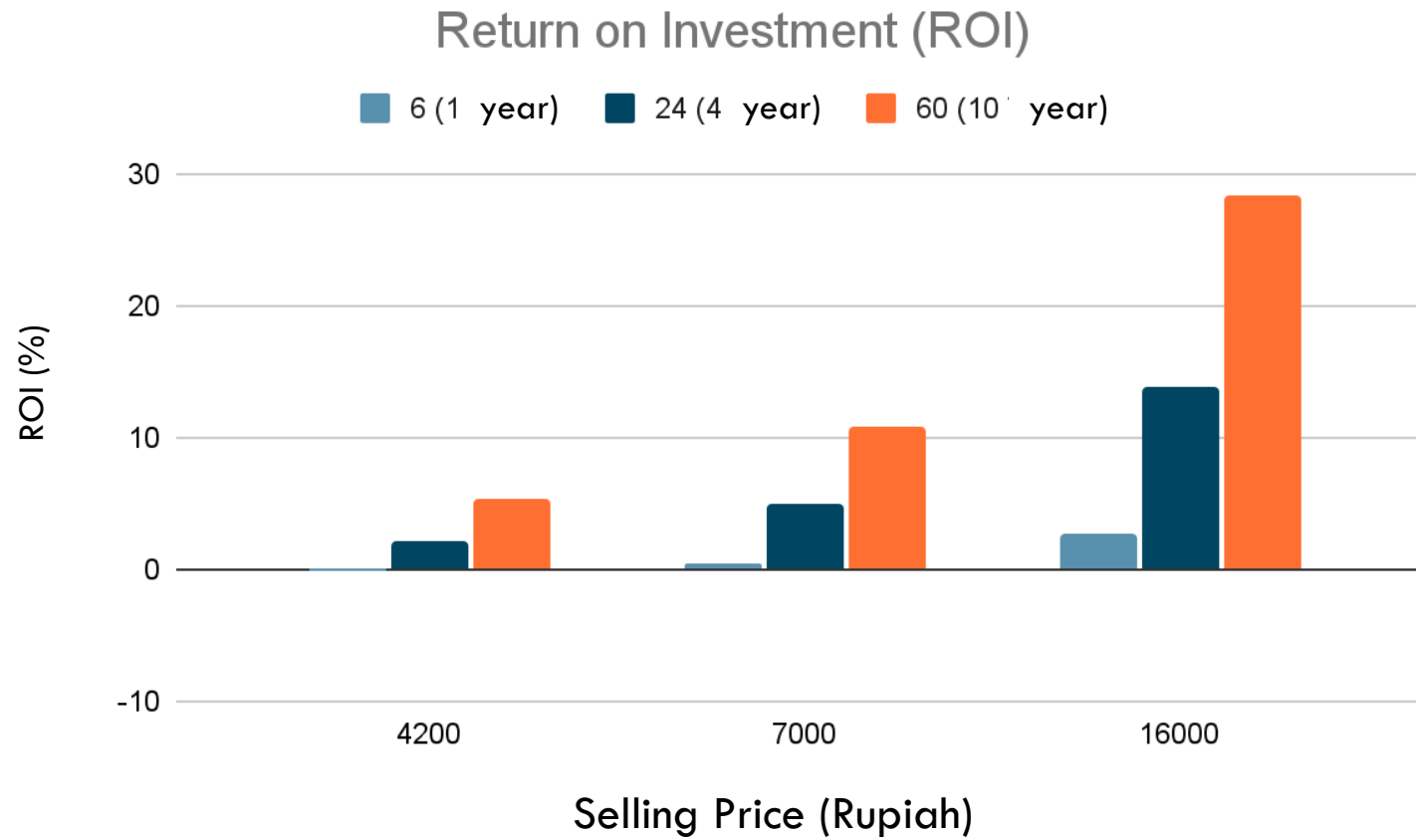
# RETURN ON INVESTMENT (ROI)



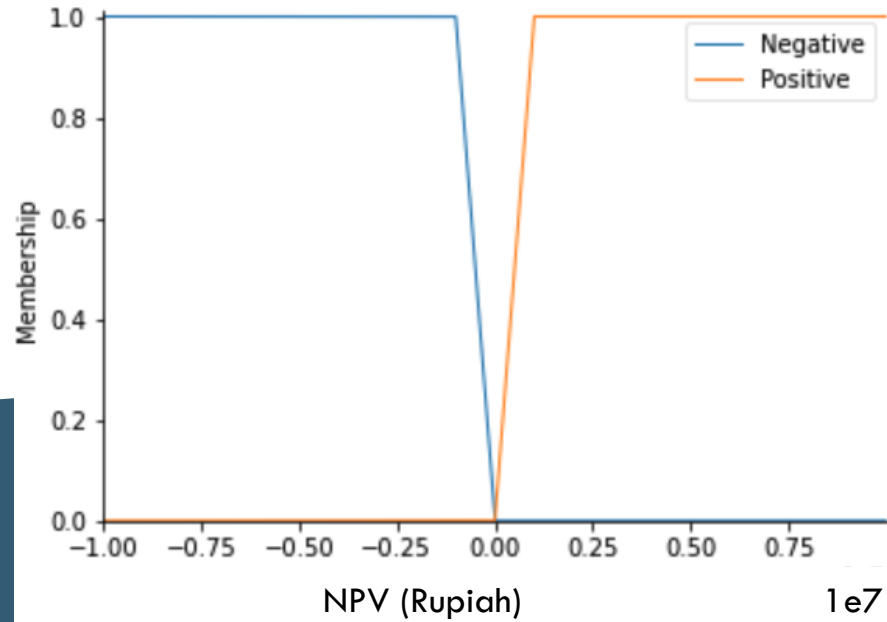
Maximum Loss	-50 — (-12.5)
Minimum Loss	-25 — 0
Minimum Profit	0 — 25
Maximum Profit	12.5 — 50

Rule 1	—
Rule 2	(weight['Light'] & sell_price['Low'] & amount['Beginner Farmer'] & time['Short'])   (weight['Light'] & sell_price['Low'] & amount['Intermediate Farmer'] & time['Short'])   ...
Rule 3	(weight['Light'] & sell_price['Low'] & amount['Beginner Farmer'] & time['Mid'])   (weight['Light'] & sell_price['Low'] & amount['Beginner Farmer'] & time['Long'])   ...
Rule 4	(weight['Light'] & sell_price['High'] & amount['Beginner Farmer'] & time['Long'])   (weight['Light'] & sell_price['High'] & amount['Intermediate Farmer'] & time['Long'])   ...

# FUZZY ROI



# NET PRESENT VALUE (NPV)



Negative	-10,000,000 — 0
Positive	0 — 10,000,000

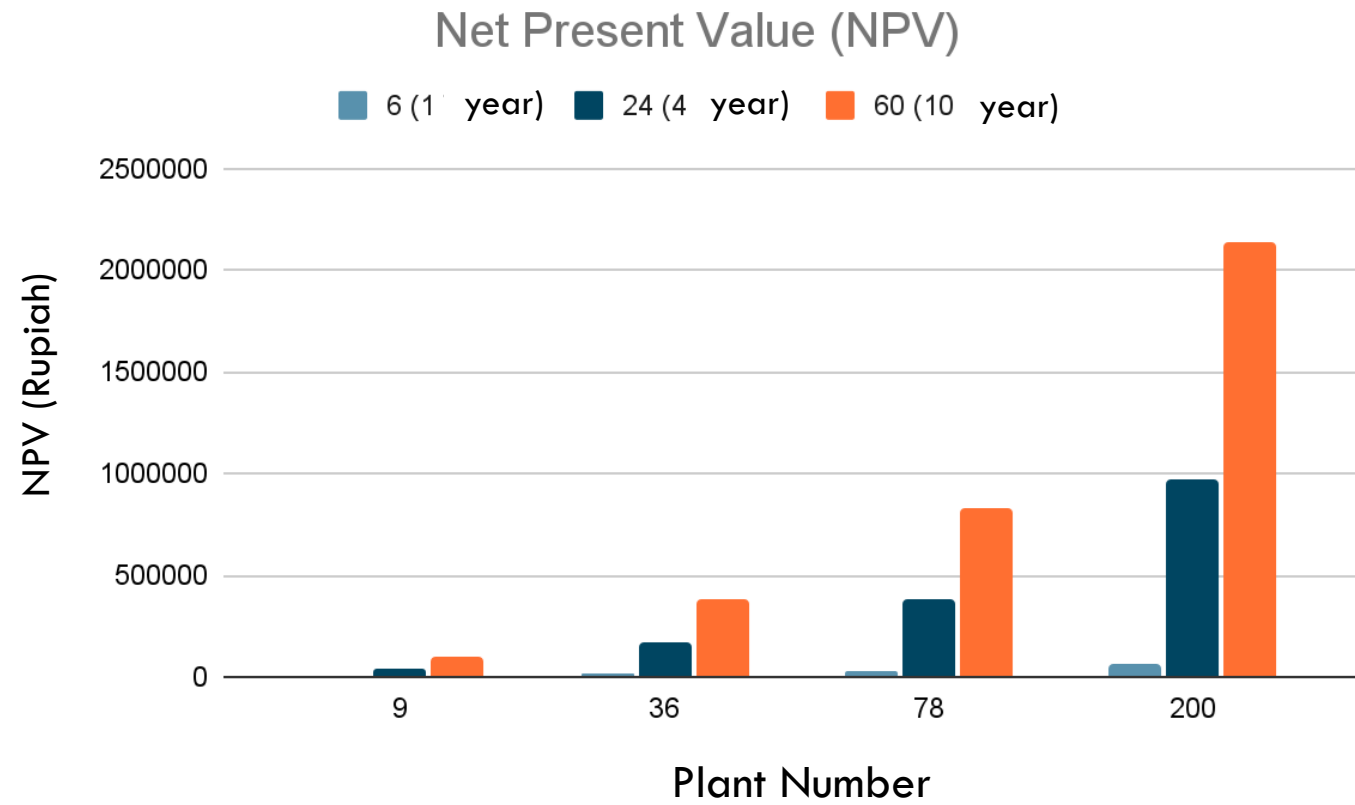
Rule 1

(weight['Light'] & sell\_price['Low'] & amount['Beginner Farmer'] & time['Short']) |  
 (weight['Light'] & sell\_price['Low'] & amount['Intermediate Farmer'] & time['Short']) |  
 ...

Rule 2

(weight['Light'] & sell\_price['Low'] & amount['Beginner Farmer'] & time['Mid']) |  
 |  
 (weight['Light'] & sell\_price['Low'] & amount['Beginner Farmer'] & time['Long']) |  
 ...

# NPV



# CONCLUSION

1. Ecological Decision Model (ecoDM) can involve plant modeling, particularly in the case of agricultural investment decision-making, by incorporating various types of financial instruments required.
2. Fuzzy logic serves as one of the alternative inference methods for evaluating decision alternatives in DM
3. Research opportunities that combine plant modeling and DM remain open and abundant.

# CONTACT NUMBER

- HP: +62-812-8961-4291
- RG: <https://www.researchgate.net/profile/Ditdit-Utama>
- Google Scholar: <https://scholar.google.com/citations?user=PB0xgKkAAAAJ&hl=en&oi=ao>
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**DANKE**