# Analytics Projects, Part 2
## *Data-Driven Prescriptive Analytics Projects*

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# Outline

# Instructor: Mansur Maturidi Arief

- **Background**:
  - BE (ST) in Industrial Engineering, ITS
  - MSE in Industrial & Operations Engineering, University of Michigan, USA
  - Ph.D. in Mechanical Engineering, Carnegie Mellon University, USA
  - Postdoc in Aeronautics and Astronautics, Stanford University, USA
  - Research Engineer/Scientist in Stanford Intelligent Systems Laboratory and Stanford Mineral-X
  - (Remote) Lecturer, SIMT ITS
- **Research interests**: AI for safety and sustainability
- **Webpage**: `https://mansurarief.github.io/`
- **LinkedIn**: `https://www.linkedin.com/in/mansurarief/`
- **Email**: `mansur.maturidi@its.ac.id`

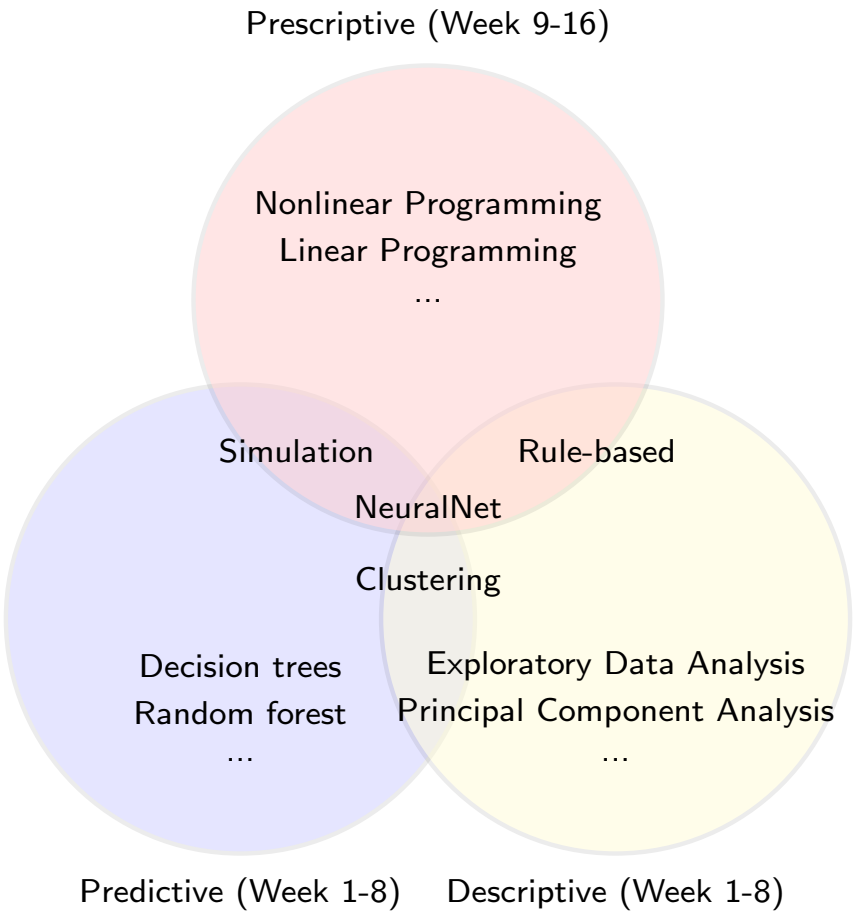
# Course Objectives

1. **identify** real life problems that require analytics
2. choose the **appropriate** methods or tools applicable to a certain problem
3. **apply** tool and methods to address certain problem
4. showcase the skills in **presenting** the results and **explain** the insights obtained from the projects

# Relationship with Part 1

- **Descriptive analytics**: analyzing what has happened in the past
- **Predictive analytics**: predicting what is likely to happen in the future.
- **Prescriptive analytics**: using data to *recommend actions* that will *optimize outcomes*.
  - **Optimization** is the key method in prescriptive analytics.
  - It goes **beyond predicting outcomes** by also **suggesting actions** to benefit from the predictions.

# Analytics Algorithms and Models



# Topics Covered in Part 2

1. Overview of Prescriptive Analytics Projects
2. Optimization Modeling Basics
3. Data-Driven Optimization
4. Verification and Validation (V&V)
5. Optimization Solvers
6. Evaluation and Benchmarking
7. Monitoring and Maintenance
8. Beyond This Course

# Available Resources

- **Course website**: `https://analytics-project-simt-its.github.io/`
- **Lectures and presentations** (every Friday, 6:30-8:10 PM, on Zoom)
- **Reading materials** (posted in MyITS classroom every week)
- **Lecture recordings and slides** (in MyITS and the course website)
- **Office hours** (every Saturday, 8-9 AM, on Zoom)

# Assignments

- Due dates & weights also listed in the course website:
  1. Reflection 1 & 2 (10%), due Nov 1 & Dec 13
  2. Proposal presentation (10%), due Nov 8, 15, & 22 (random order)
  3. Midterm report (15%), due Nov 15
  4. Peer review (10%), due Nov 22
  5. Final report (25%), due Dec 13
  6. Final presentation (30%), due Dec 13
  7. Project repo/website (extra 5%), due Dec 13
- Rubrics (strict) are available in the course website
- Deadlines are 23:59:59 AoE (Anywhere on Earth)

# Course Schedule (screenshot of the course website)

| Week | Date | Session Details* | Assignment Due** |
|---|---|---|---|
| 8 | Oct 18 | Overview, Prescriptive Analytics Projects (L) | - |
| 10 | Nov 1 | Optimization Modeling (L) | Reflection 1 |
| 11 | Nov 8 | Data Collection (L), Group 1 & 2 Proposal (P) | - |
| 12 | Nov 15 | V&V (L), Group 3 & 4 Proposal (P) | Midterm report |
| 13 | Nov 22 | Solvers (L), Group 5 & 6 Proposal (P) | Peer review |
| 14 | Nov 29 | Evaluation (L), In-class Office Hour (O) | Midterm feedback |
| 15 | Dec 6 | Monitoring (L), In-class Office Hour (O) | - |
| 16 | Dec 13 | Final Presentation (P) | Final presentation |
| | | | Final report |
| | | | Reflection 2 |

*Legend: **(L)** = Lecture, **(P)** = Student Presentation, **(O)** = Open-ended Session

**All assignments are due at 11:59pm (AOE - Anywhere on Earth)

# AI Usage Policy

- **You may use AI tools** and libraries for your projects.
- However, you must use them **ethically** and **responsibly**.
- Any AI-assisted work must be **clearly stated** in your reports and presentations.
- For any AI-assisted assignments, you must also **submit AI Usage and Reflection Form**: `https://mansurarief.github.io/ai-usage-and-reflection-form.docx`
- See the course website for the **full policy**.

# Take Care of Yourself

- **Mental health** is important. If you feel overwhelmed with the course, please reach out to me. **I am here to help.**
- **Physical health** is also important. Please get enough sleep. It is okay to ask for extension if you are not feeling well.
- **Time management** is crucial. Do not wait until the last minute to work on your assignments (especially the final project).
- **Academic integrity** is a must. This class has absolutely 0 tolerance for cheating. You will fail this class if you do not do your own work.

# How to Reach Me

- **Email** is your best bet:
  - `mansur.maturidi@its.ac.id`,
  - + cc `mansur.arief@stanford.edu` (if you want more visibility)
- **Office hours** every Saturday, 8-9 AM, on Zoom. The link will be posted in MyITS.
- **By appointment**: if you cannot make it to the office hours but need to talk to me, set up an appointment at `https://mansurarief.github.io/calendar/`
- **WhatsApp**: If you think it is urgent, send me a WA message at +1-734-881-0531 (though note that we live in different time zones).

# Ask me questions about the course!

- Let's take a few minutes break to ask questions about the course.

# Your turn

- Please introduce yourself (30 sec - 1 min each):
  - Name, year of study, & current position and institution
  - How much (hands on) experience do you have in optimization or data processing?

# Prescriptive Analytics Scope

- **Descriptive analytics**: analyzing what has happened in the past
- **Predictive analytics**: predicting what is likely to happen in the future.
- **Prescriptive analytics**: using data to *recommend actions* that will *optimize outcomes*.

# [Exercise 1.1] Scope of each analytics type

1. List of products sold last year and their sales volume aggregated by month and by stores
2. Statistical summary of sales data (average, standard deviation, and trends) for each product
3. Clustering of products based on sales volume and their co-occurrences
4. Forecast of sales for the product clusters for the next quarter
5. Simulation and what-if analysis of different promotion strategies
6. Recommendations for pricing strategies to increase sales
7. Allocation of marketing budget across different product categories

Which of the above items belong to **descriptive, predictive, and prescriptive analytics?**

# Major Steps in Prescriptive Analytics Projects

1. Problem scoping and definition
   - Define the objectives and tdentify stakeholders and their needs
2. Data collection
   - Identify data sources
   - Collect and preprocess data
   - Data quality assessment
   - Data privacy and security
   - Data storage and management
   - Data visualization
3. Optimization process
4. Implementation and monitoring

# Problem Scoping and Definition

- What are the business objectives of the project?
- What are the key performance indicators (KPIs) that will measure the success of the project?
- Who are the stakeholders involved in the project, and what are their roles and responsibilities?
- What data sources are available? How much can we trust the data? Are there any limitations or biases in the data that we need to be aware of?
- What are the expected outcomes of the project, and how will the results be used to make decisions?

# [Exercise 1.2] Discuss with your group

You are a sales manager tasked to increase sales for the upcoming quarter. You want to optimize allocation of the marketing budget to achieve this goal. You work with the marketing team, the sales team, the inventory management team, and the data and IT for the project.

1. The marketing team has historical data on the marketing budget allocation for all products, but they only use customer engagement metrics.
2. The sales team has data on the sales volume for each product item but only record sales if the product is in stock.
3. The inventory team has data on the inventory levels for each product item and the order received from the sales team, but not on lost sales.
4. The data and IT team maintains the data infrastructure and systems for the company. They can provide historical data and predictive models for sales volume with 100% accuracy!

**Identify a proper scope for the project! What risks and obstacles you might face?**

# What's next?

- Next week:
  - Discuss the group acvitity (Exercise 1.2)
  - Optimization Modeling Basics
- Next reading: Ch. 2 – Optimization Modeling
- Upcoming assignment: Reflection 1 (due Nov 1)
- No office hour for Oct 19.

# Thank you!

- Questions?