Where Data Meets Decisions 2:

More New Python Notebook Examples that Combine Data Science and Mathematical Optimization

March 28 – 11AM ET | WEBINAR

GUROBI OPTIMIZATION

Agenda

WELCOME

GUROBI'S EXAMPLE LIBRARY

More about our educational python notebooks

ABOUT OPTIMIZATION

Why do data scientists care about optimization and how can they combine predictive and prescriptive analytics?

THE NEW NOTEBOOKS

1. Planning for Airline Disruption
2. Text Similarity
3. Avocado Price Optimization – Part 2

- (Now using Gurobi Machine Learning & Gurobi Pandas)

March 28 – 11AM ET | ACADEMIC WEBINAR

Where Data Meets Decisions – Part 2:

More New Python Notebook Examples that Combine Data Science and Mathematical Optimization

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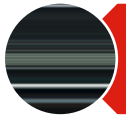
GUROBI OPTIMIZATION

Gurobi's Example Notebook Library

Introductory to advanced examples



Key features of Gurobi and the Python API

Covers numerous industries

Experiment and learn with mathematical optimization

Find inspiration for your projects

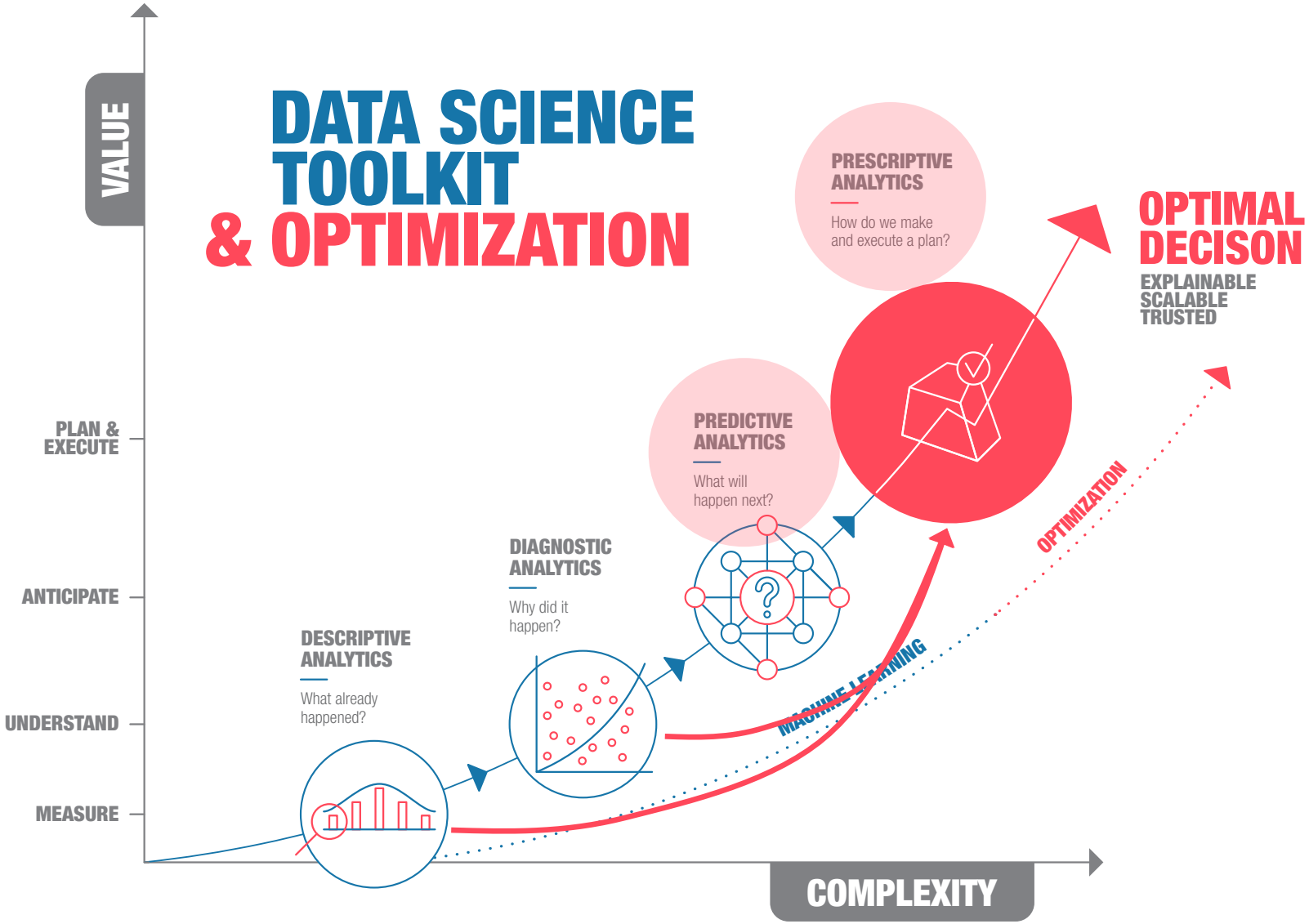
NEW: DS EXAMPLE LIBRARY

- Fantasy Basketball
- Price Optimization
- Music Recommendations
- Renewable Scheduling
- Airline Disruption
- Text Similarity

FULL EXAMPLE LIBRARY

- Telecommunications
- Logistics
- Financial Services
- Energy and Utilities
- Healthcare
- Food and Agriculture
- Research, Analytics, and Optimization
- Manufacturing
- Metals and Mining
- Oil and Gas
- Transportation
- Services
- Government
- Professional Services
- Airlines

Predictive and Prescriptive Analytics



When is Math Optimization the Right Tool?

What is mathematical optimization?

An approach to solving complex decision problems where you want to…

1. Find the best course of action
2. Among *many* possibilities
3. That the decision maker can set
4. Given specified limitations
5. With some particular objective(s) in mind
6. Guarantee the solution is **feasible** and **optimal**!

Quantities
- Continuous (Ex: setting the price of produce)
- Integer (Ex: manufacturing cars)

Alternatives
- Binary (Ex: yes/no decision to use and aircraft for a given flight)

Decision problems to optimization models

$$\text{Max } c_1 x_1 + c_2 x_2$$
$$\text{Subject to:}$$
$$a_{1,1} x_1 + a_{1,2} x_2 \leq b_1$$
$$a_{2,1} x_1 + a_{2,2} x_2 = b_2$$
$$l_1 \leq x_1 \leq u_1$$
$$l_2 \leq x_2 \leq u_2$$

objective function

decision variables

constraints

+

Your favorite programming language

Two New Notebooks

1. **Flight Planning After Disruption**

2. **Text Similarity**

I. Flight Planning After Disruption

More than 1,700 flights canceled as winter storm hits US

WEATHER

Dozens of flights delayed at San Diego airport amid storm

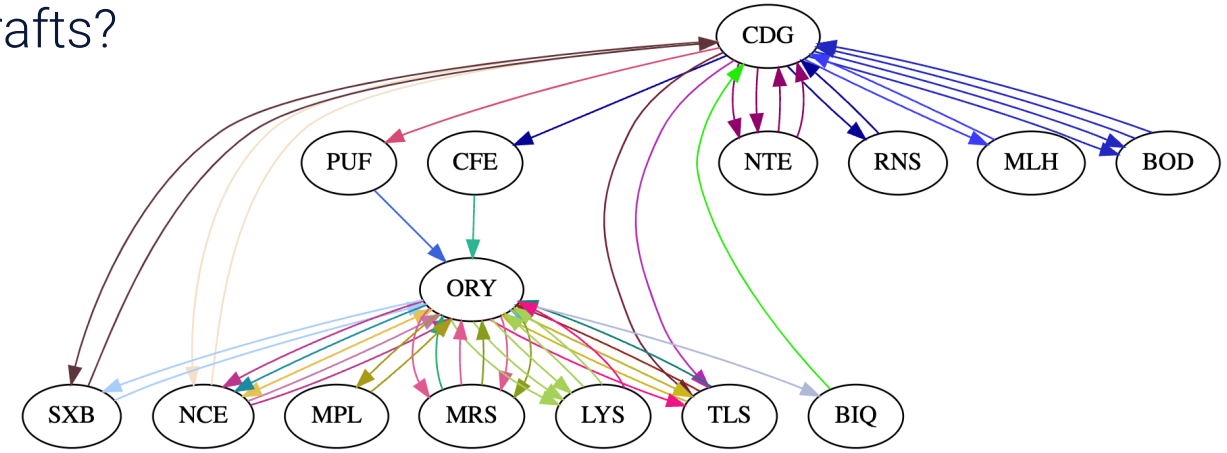
EUROPE

German airport strikes force hundreds of flight cancellations

2022 was a bad year for flight cancellations and delays. Here's why

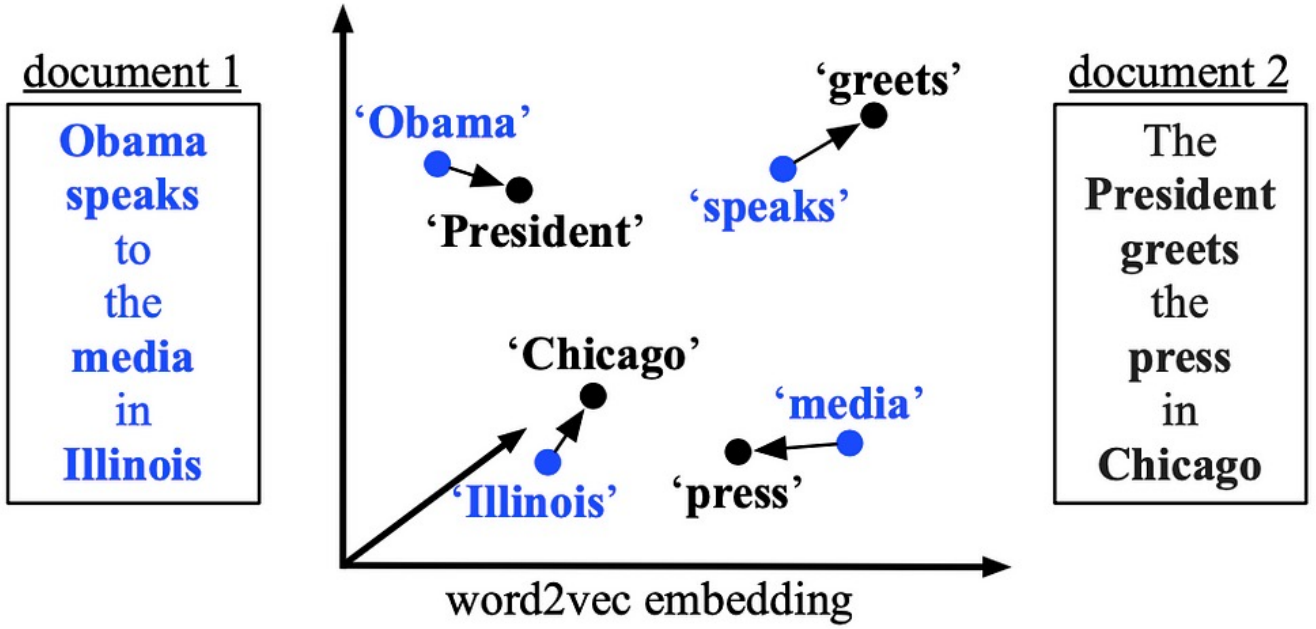
I. Flight Planning After Disruption

- During a weather event, airport **capacities** are diminished
- Let's say you are running airline operations (how fun!)
- You have made **flight plans** for all your aircrafts for 24 hours
- Goals: **Re-optimize** the flight plan during the disruption day
  - Which flights to **cancel**?
  - What are the **new routes** for the aircrafts?
- Real data from AMADEUS (France)



II. Text Dissimilarity with Linear Programming

Word Mover's Distance



- What is the smallest semantic distance between two documents? Transportation problem!
- **Goals**:
  1. Find **text similarity** between two passages
  2. Given a (plagiarized) passage, find the semantically closest passage from a book

III. Integrating ML into an MIP model

Part 1: Price Optimization with Avocado Sales

REVIEW OF THE ORIGINAL EXAMPLE

- You supply avocados to the US and need to:
  - Decide avocado price
  - Amount to supply to each region
  - Maximize profit
- Use data available from Hass Avocado Board
  - Ordinary Least Squares model (OLS) to predict demand
- Formulate optimization model to find the best price and allocation for each region

Image courtesy: DALL·E

III. Integrating ML into an MIP model

Part 2: Price Optimization with Avocado Sales

WHAT'S NEW IN PART 2

- Two open-source, experimental packages from Gurobi:

1. **Gurobi Machine Learning**
   - Replaces the OLS model with a trained Scikit Learn object directly as a constraint
   - `add_predictor_constr`

2. **Gurobipy Pandas**
   - Easily create decision variables using a pandas data frame and corresponding constraints
   - `add_vars, add_constrs`
   - Offers a small glimpse of functionality

- Links to documentation for each will be provided

Image courtesy: DALL·E

GUROBI: ALWAYS FREE FOR ACADEMICS & RECENT GRADUATES

OPTIMIZATION SUCCESS STARTS HERE

Special opportunities for the academic community:

- Gurobi: Always free for academics
- Gurobi user community page
- Educational Resources:
  - www.gurobi.com/academia

Email academicprogram@gurobi.com to learn more.

TAKE GUROBI WITH YOU

Gurobi is also available to recent graduates through our Take Gurobi With You Program

Introducing:

www.BurritoOptimizationGame.com

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Optimization 101 for Data Scientists:

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LEAD INSTRUCTOR

Jerry Yurchisin

Data Science Strategist, Gurobi & Former Instructor of Mathematics and Statistics

WITH GUEST INSTRUCTOR/PARTNER

Ehsan Khodabandeh

Principal OR Scientist, Decision Spot & Lecturer, Northwestern University: MS in Analytics

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Decision Spot

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QUESTIONS?

Thank You

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