



d-learn.ir/orpy

دوره آموزشی بهینه سازی پایتون

مدرس
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INSTRUCTOR



- TITLE
- Decision n
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- Power Sys
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Springer 1, 2
- A probabili
distribution



NEWSLETTER

Optimization in open-source

Business Intelligence using optimal decision making tools

By **Alireza Soroudi**
Lead Data Scientist @ bluecrux || SMIEEE || Optimiz...

Published weekly
9,379 subscribers

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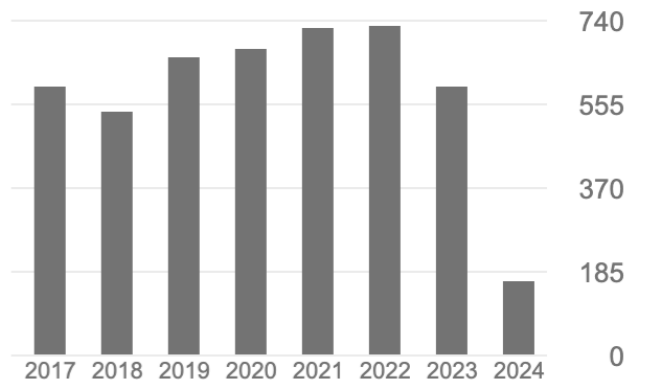
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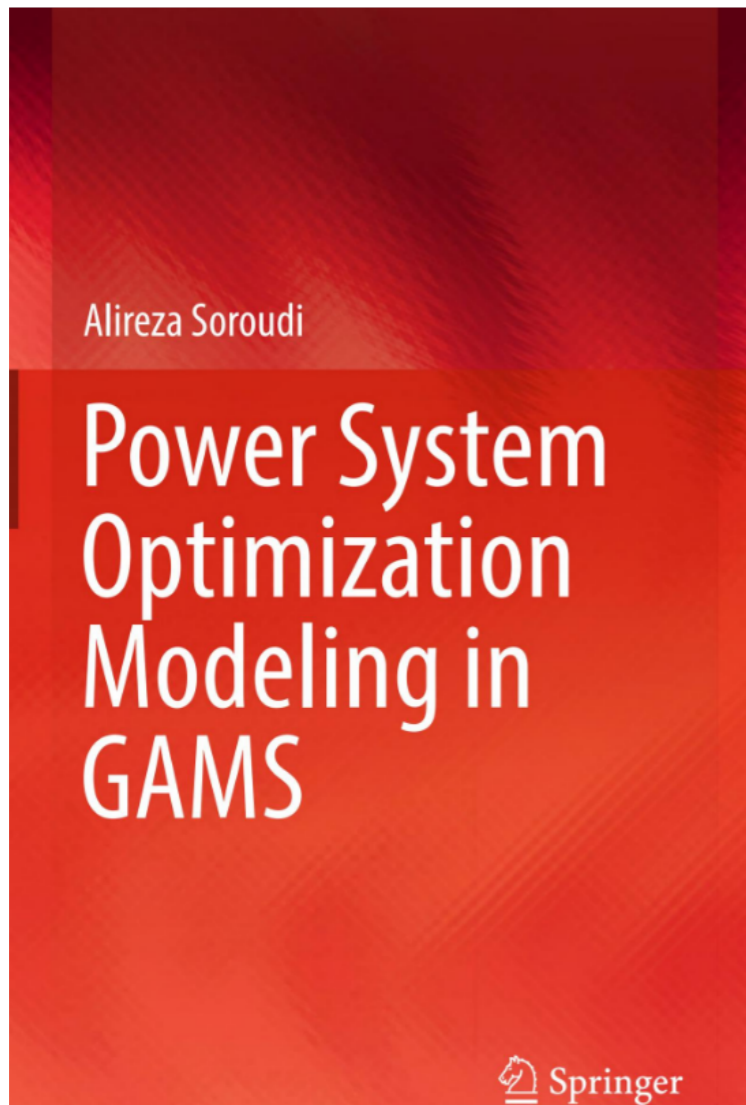
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INSTRUCTOR



The screenshot shows the GAMS IDE interface. The 'Model Libraries' menu is open, listing various model libraries. A blue arrow points from the book cover to the 'Power System Optimization Modelling (A. Soroudi)' entry in the menu. Below the menu, a detailed table of model contents is displayed.

SeqNr	Lic	Name	Chapter	FigureNr	Description
01	D	SimpleLP	Simple Examples in GAMS	Gcode2.1	Simple linear programming model
02	D	BoundaryLP	Simple Examples in GAMS	Gcode2.2	Simple linear programming model for determination of boundary values of an objective function
03	D	SimpleMIP	Simple Examples in GAMS	Gcode2.3	Simple Mixed Integer Linear Programming model
04	D	EmergencyCentreAllocation	Simple Examples in GAMS	Gcode2.5	Mixed integer linear programming model for optimal allocation of Emergency Centres
05	D	TransportationOn-Off	Simple Examples in GAMS	Gcode2.12	Transportation model with On/off state modeling of production side
06	D	ParetoOptimalFront	Simple Examples in GAMS	Gcode2.16	Pareto optimal front determination
07	D	ED	Power Plant Dispatching	Gcode3.1	Economic Load Dispatch
08	D	EDsensitivity	Power Plant Dispatching	Gcode3.2	Sensitivity Analysis in Economic Load Dispatch
09	D	EnvironmentalED	Power Plant Dispatching	Gcode3.3	Environmental Load Dispatch
10	D	MOED	Power Plant Dispatching	Gcode3.4	Multi-objective Economic-Environmental Load Dispatch
11	D	DED	Dynamic Economic Dispatch	Gcode4.1	Dynamic Economic Load Dispatch
12	D	RampSenDED	Dynamic Economic Dispatch	Gcode4.2	Ramp rate sensitivity analysis for Dynamic Economic Load Dispatch
13	D	DED-wind	Dynamic Economic Dispatch	Gcode4.4	Dynamic Economic Load Dispatch considering Wind generation
14	D	DED-PB	Dynamic Economic Dispatch	Gcode4.5	Price based Dynamic Economic Load Dispatch
15	L	DED-LP	Dynamic Economic Dispatch	Gcode4.7	Linearized Dynamic Economic Load Dispatch
16	L	UC	Unit commitment	Gcode5.1	Unit commitment
17	L	PBUC	Unit commitment	Gcode5.5	Price based Unit commitment
18	D	OPF2bus	Multi-Period Optimal Power Flow	Gcode6.1	Optimal power flow for a simple two-bus system
19	D	OPF3bus	Multi-Period Optimal Power Flow	Gcode6.2	Optimal power flow for a three-bus system
20	D	OPF5bus	Multi-Period Optimal Power Flow	Gcode6.3	Optimal power flow for a five-bus system
21	C	MultiPeriodDCOPF24bus	Multi-Period Optimal Power Flow	Gcode6.6	Multi-period DC-OPF for IEEE 24-bus network considering wind and load shedding
22	L	MultiPeriodACOPF24bus	Multi-Period Optimal Power Flow	Gcode6.7	Multi-period AC-OPF for IEEE 24-bus network considering wind and load shedding
23	D	DEDESS	Energy Storage Systems	Gcode7.1	Cost based Dynamic Economic Dispatch integrated with Energy Storage
24	D	DEDESSwind	Energy Storage Systems	Gcode7.2	Cost based Dynamic Economic Dispatch integrated with Energy Storage and Wind
25	C	ESSDCOPFwind	Energy Storage Systems	Gcode7.3	DC-OPF integrated with Energy Storage and Wind
26	D	PMU	Power System Observability	Gcode8.1	PMU allocation for IEEE 14 network without considering zero injection nodes
27	D	PMU-cost	Power System Observability	Gcode8.2	Min Cost PMU allocation for IEEE 14 network without considering zero injection nodes
28	D	PMU-OB1	Power System Observability	Gcode8.4	Maximizing the network observability using a limited number of PMU for IEEE 14 network without considering zero injection
29	D	TEP	Topics in Transmission Operation Planning	Gcode9.1	Transmission Expansion Planning
30	D	WaterEnergy	Energy System Integration	Gcode10.1	Water-Energy Nexus
31	D	EnergyHub	Energy System Integration	Gcode10.3	Optimal operation of energy hub

SESSION ONE

Introduction





WHY PYTHON?



Vast library

Open Source

Enterprise level

Easy to learn

OOP

WHY PYTHON?



WHY PYTHON?

LinkedIn Search: MATLAB
Worldwide | 345,244 results | Risk Manager (m/w/d) in Energy Risk Management

LinkedIn Search: Julia
Worldwide | 134 results | Verkoopmedewerker Julia's Leiden

LinkedIn Search: Python
Worldwide | 1,279,041 results | Test automation developer (PHP)

LinkedIn Search: Python
Worldwide | 1,279,041 results | Test automation developer (PHP)

Open Source or Commercial ?

Open Source

Commercial

Positive

- Free
- Capable of using both open-source and commercial solvers
- Great Visualisation
- Capable of linking to different databases
- Using other Python Packages

- Stable
- Good Support

Negative

- You need to wait for Stack-overflow

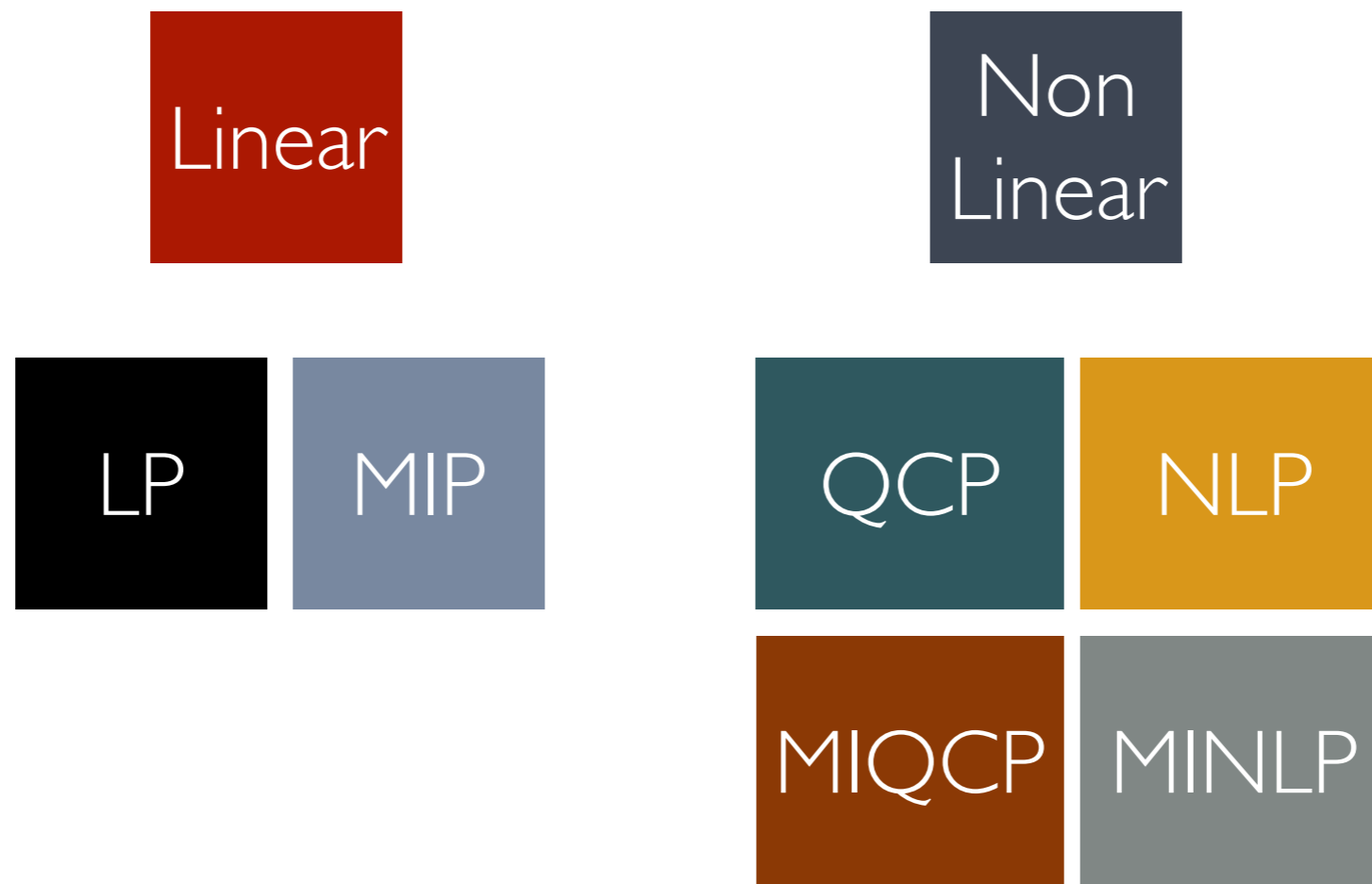
- Expensive
- No Visualisation
- Limited databases to communicate with

CODING PLATFORM





DIFFERENT OPTIMISATION MODELS





DIFFERENT OPTIMISATION MODELS

LP

$$\begin{aligned} OF &= x_1 + x_2 \\ 2x_1 + x_2 &\leq 1 \\ x_i &\in R^+ \end{aligned}$$

NLP

$$\begin{aligned} OF &= x_1 + x_2 \\ 2x_1^2 + x_2^2 + x_3 &\leq 5 \\ x_i &\in R^+ \end{aligned}$$

MIP

$$\begin{aligned} OF &= x_1 + x_2 \\ 2x_1 + x_2 &\leq 1 \\ x_1 &\in R^+, x_2 \in B \end{aligned}$$

MIQCP

$$\begin{aligned} OF &= x_1 + x_2 \\ 2x_1^2 + x_2^2 &\leq 5 \\ x_1 &\in R^+, x_2 \in B \end{aligned}$$

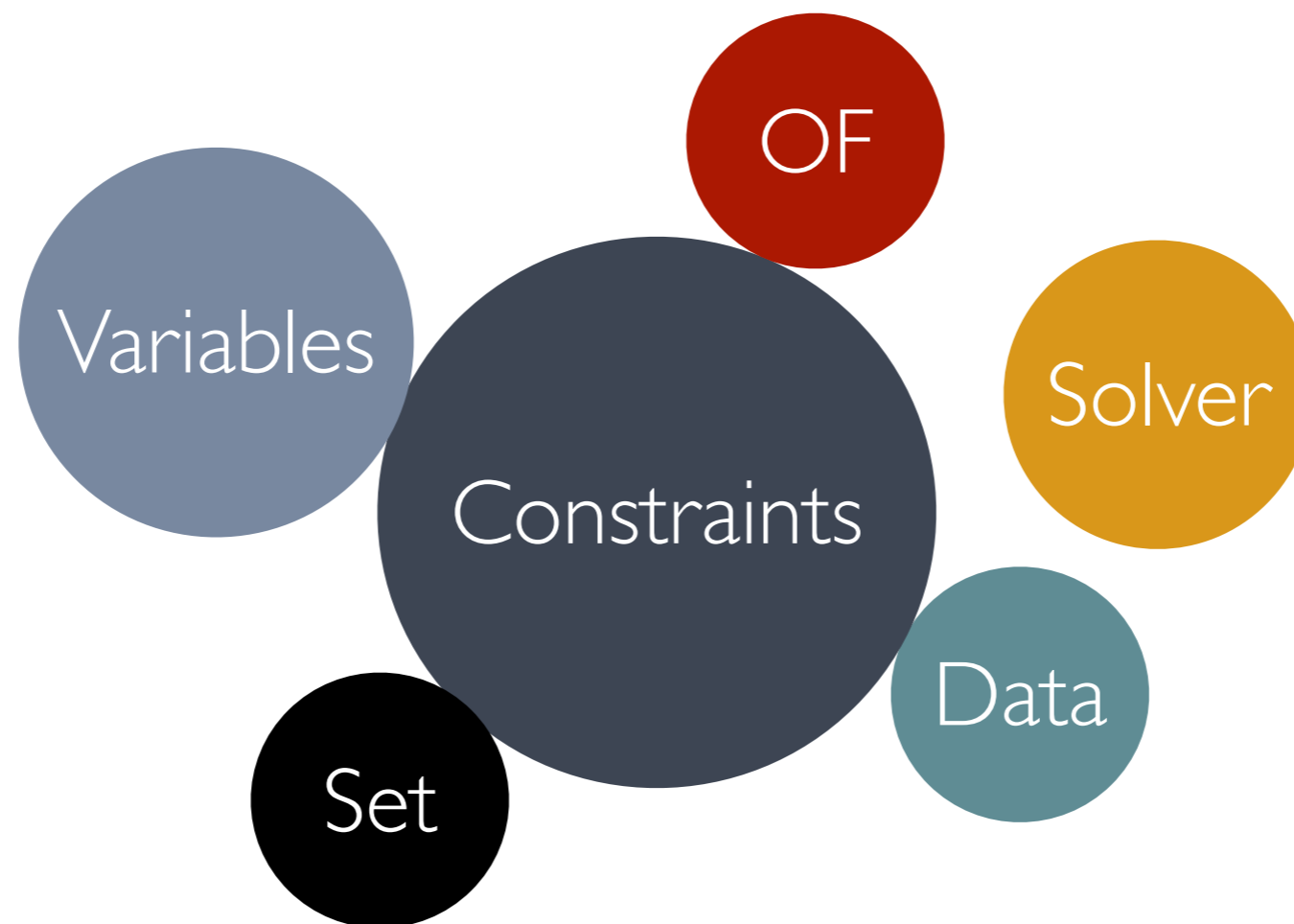
QCP

$$\begin{aligned} OF &= x_1 + x_2 \\ 2x_1^2 + x_2^2 &\leq 5 \\ x_i &\in R^+ \end{aligned}$$

MINLP

$$\begin{aligned} OF &= x_1 + x_2 \\ 2x_1^2 + x_2^2 + x_1^3 &\leq 5 \\ x_1 &\in R^+, x_2 \in B \end{aligned}$$

STRUCTURE OF MODEL?



STRUCTURE OF MODEL?



Total costs

Risk of failure

Total income

Probability of happening

Emission weight

Time of arrival



STRUCTURE OF MODEL?

Variables

Investment decisions

Vehicle to pick

Sequence of nodes

Asset Location



STRUCTURE OF MODEL?



Cost of each item Vehicle's capacity

Job duration

Required sequence



STRUCTURE OF MODEL?



Index for referring an item

Generator i

Passenger j

Car n

STRUCTURE OF MODEL?



Constraints

Cost of all items \leq Budget

\forall_i arrival time of $i \leq T_i^{max}$

$\forall_i \quad P_i^{min} \leq P_i \leq P_i^{max}$

$\forall_i \quad P_i^{min} \times U_i \leq P_i \leq P_i^{max} \times U_i$

STRUCTURE OF MODEL?

The table below lists the LP solvers available in OR-Tools and indicates which of the three families of algorithms is implemented in each solver.

Solver	Simplex	Barrier	First order
Clp	X	X	
CPLEX ^L	X	X	
Glop ^G	X		
GLPK	X	X	
Gurobi ^L	X	X	
PDLP ^G			X
Xpress ^L	X	X	

G indicates the solver is developed by Google. **L** indicates that the solver requires a license issued by the respective third-party developer.



CP-SAT SOLVER

	8					2		
				8	4		9	
		6	3	2			1	
	9	7					8	
8			9		3			2
	1					9	5	
	7			4	5	8		
	3		7	1				
		8					4	

RESOURCES



ORTOOLS

<https://developers.google.com/optimization>

The screenshot shows the Google OR-Tools website. The browser address bar displays `developers.google.com/optimization/introduction`. The page header includes the Google OR-Tools logo and navigation links for OR-Tools and OR API. A search bar is located in the top right corner. The main navigation bar is blue and contains links for Installation, Guides, Reference, Examples, and Support. A sidebar on the left features a filter and a list of categories: Get Started (with a sub-link for About OR-Tools), MathOpt, CP-SAT, Network Flows, Linear Optimization, Integer Optimization, Assignment, Packing, Routing, and Scheduling. The main content area is titled 'About OR-Tools' and includes a breadcrumb trail (Home > Products > OR-Tools > Guides), a 'Was this helpful?' feedback prompt, and a 'Send feedback' button. The text describes OR-Tools as open source software for combinatorial optimization and lists three examples: Vehicle routing, Scheduling, and Bin packing. It also mentions that OR-Tools includes solvers for Constraint Programming.



ORTOOLS

https://developers.google.com/optimization/reference/python/sat/python/cp_model

The screenshot shows the Google OR-Tools website. At the top left is the Google OR-Tools logo. Below it is a navigation bar with links for Installation, Guides, Reference, Examples, and Support. The 'Reference' link is highlighted. On the left side, there is a sidebar with a 'Filter' button and a list of categories: OR-Tools Reference, Overview, C++ Reference, Python Reference, Overview, Algorithms, CP-SAT (highlighted), Network Flow and Graph, Linear Solver, Routing, and Domain Module. The main content area displays the page title 'Python Reference: CP-SAT' and the sub-title 'Module cp_model'. Below this, it states 'Methods for building and solving CP-SAT models.' and 'The following two sections describe the main methods for building and solving CP-SAT models.' followed by a bulleted list of methods: CpModel, Cpsolver, CpSolverSolutionCallback, ObjectiveSolutionPrinter, VarArraySolutionPrinter, and [VarArrayAndObjectiveSolutionPrinter]. There is also a 'Send feedback' button and a 'Was this helpful?' section. On the right side, there is a 'On this page' section with a list of links to various methods and classes, including BoundedLinearExpression, Bounds, Expression, Constraint, Index, OnlyEnforceIf, Proto, CpModel, Add, AddAbsEquality, AddAllDifferent, AddAllowedAssignments, AddAutomaton, AddBoolAnd, AddBoolOr, AddBoolXor, AddCircuit, AddCumulative, AddDecisionStrategy, AddDivisionEquality, AddElement, AddForbiddenAssignments, AddHint, AddImplication, and AddInverse.



https://github.com/or-tools/awesome_or-tools

The screenshot shows the GitHub repository page for 'Awesome OR-Tools'. The page title is 'Awesome OR-Tools' with an 'awesome' badge. Below the title, there is a description: 'A curated list of awesome OR-Tools community and official resources.' The main content is a 'Table of Contents' with the following items:

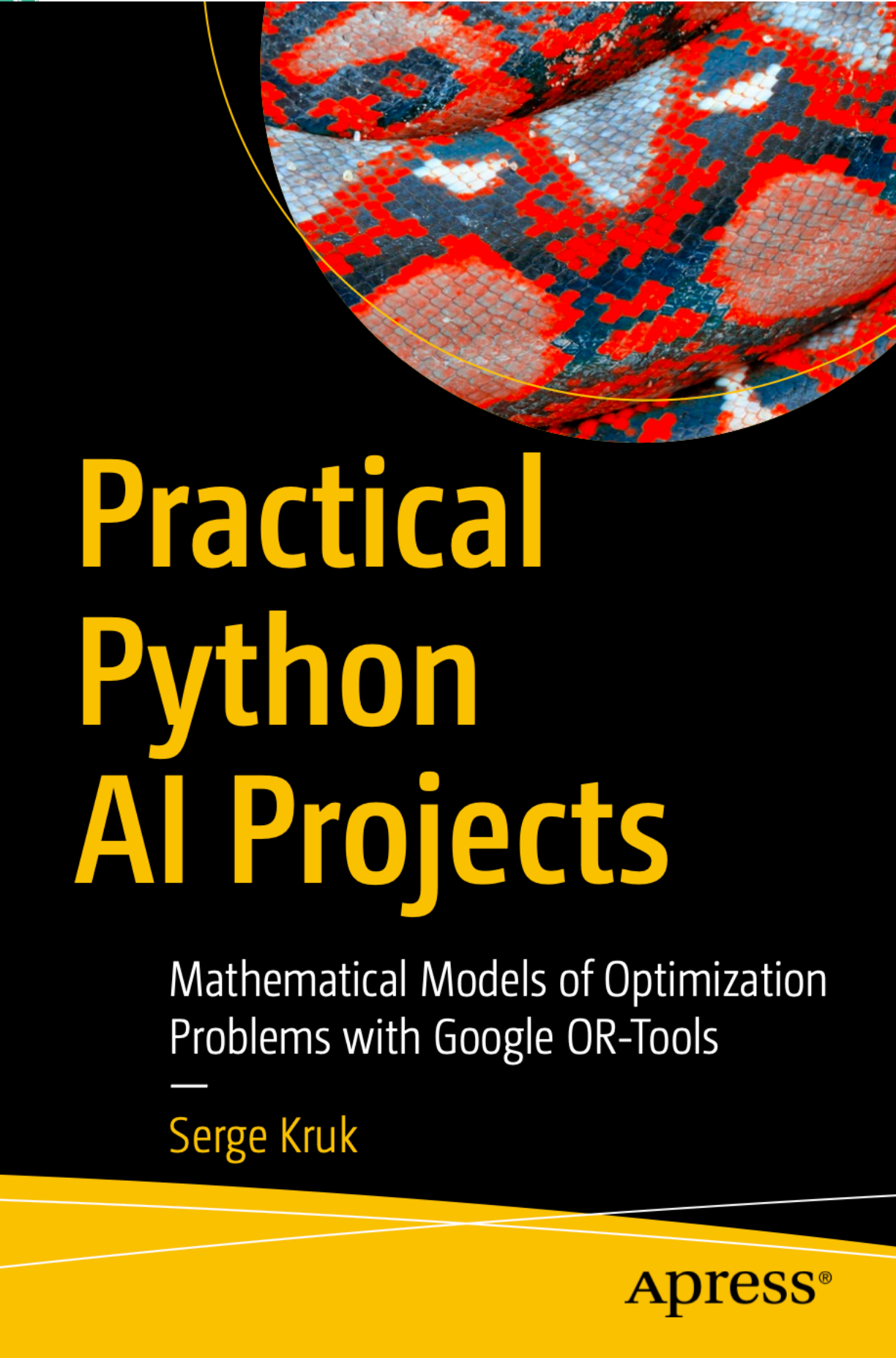
- [Reading](#)
 - [Official](#)
 - [Community](#)
 - [Research](#)
- [Watching](#)
- [Samples](#)
 - [Basic samples](#)
 - [Advanced samples](#)
- [Internal](#)
 - [Build systems](#)
 - [Wrappers](#)
 - [Algorithms](#)



<https://github.com/d-krupke/cpsat-primer>

The screenshot shows the GitHub repository page for 'd-krupke / cpsat-primer'. The repository is public and has 10 watchers, 23 forks, and 220 stars. The main branch is 'main' with 7 branches and 0 tags. The repository contains several files and folders, including 'evaluations', 'examples', 'images', 'utils', '.gitignore', '.pre-commit-config.yaml', 'CITATION.cff', 'LICENSE', 'README.md', 'old_how_does_it_work.md', and 'understanding_the_log.md'. The README file is selected, showing the title 'Using and Understanding ortools' CP-SAT: A Primer and Cheat Sheet' and the license 'CC-BY-4.0 license'. The repository also has 164 commits and 5 contributors.

File/Folder	Description	Time
evaluations	Added a section on Domain Variables	2 months ago
examples	Added a section on Domain Variables	2 months ago
images	Text about non-linear functions.	last month
utils	tiny things	2 weeks ago
.gitignore	making two benchmarks out of it.	5 months ago
.pre-commit-config.yaml	New text on intervals	2 months ago
CITATION.cff	Added explicit license	4 months ago
LICENSE	Added explicit license	4 months ago
README.md	Added a short section on overloading.	2 weeks ago
old_how_does_it_work.md	pre-commit	5 months ago
understanding_the_log.md	reformatting	2 months ago



Practical Python AI Projects

Mathematical Models of Optimization
Problems with Google OR-Tools

—
Serge Kruk

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