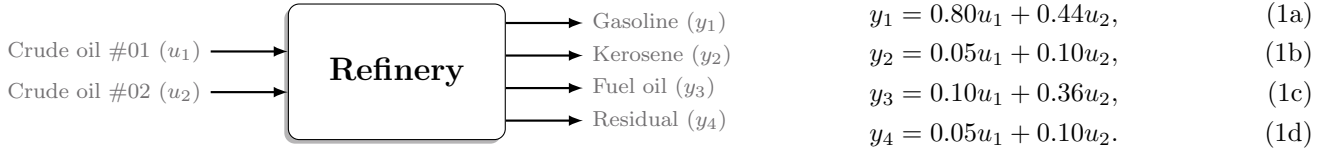


Homework 02 – Nonlinear programming for process systems engineering

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Problem Setup

A refinery converts two types of crude oil (u_1 and u_2) into four products: gasoline (y_1), kerosene (y_2), fuel oil (y_3), and some residual (y_4). After some analysis, engineers determined that it follows the *steady-state input-output* model



Our goal is to find the amount of feedstock u_1 and u_2 we must buy to maximize our daily profit (profit = revenue – costs) of selling the products y , given the production model in Eq. (1a)–(1d) and the general information in Table 1.

Variable	Description [Units]	Buy/Sell limits		Price	
		Lower	Upper	Cost	Revenue
u_1	Crude oil #01 [bbl/day]	0	–	\$48/bbl	
u_2	Crude oil #02 [bbl/day]	0	–	\$30/bbl	
y_1	Gasoline [bbl/day]	0	24 000		\$72/bbl
y_2	Kerosene [bbl/day]	0	2 000		\$48/bbl
y_3	Fuel oil [bbl/day]	0	6 000		\$42/bbl
y_4	Residual [bbl/day]	0	–		\$20/bbl

Table 1. Description, constraints, and buy/selling prices of the feedstock (u) and products (y).

Task 1. (10 points) Formulate the maximization problem described above as a linear program (LP).

Task 2. (10 points) Solve the linear program and report the results. Do you observe anything worth mentioning? (for instance, what is the optimal production strategy? Are there any active constraints?)

Hint: The decision variables are both the feedstock ($u \in \mathbb{R}^2$) and the products ($y \in \mathbb{R}^4$). You can use them as separate decision vectors, but I recommend formulating the problem using a concatenated vector $z = (u_1, u_2, y_1, \dots, y_4) \in \mathbb{R}^6$.