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Defining shadow prices in industrial mathematics

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Abstract: In Linear Programming, the meaning of dual variables as shadow prices is well-known: Lagrange multipliers signal the marginal effect of perturbing the constraint set of an optimization problem. When the constraint expresses satisfaction of consumer demand for goods and services, the multiplier measures the willingness to pay for one more unit of the item. For an environmental constraint limiting the emission of greenhouse gases in some industrial process, the multiplier can be seen as revealing the price of decarbonizing the process under consideration.

The concept is straightforwardly applicable to Nonlinear Programming but not to optimization problems with mixed-integer variables. Industrial processes often involve binary decisions, such as turning on or off some production unit, which amounts to having some variable components taking the values 0 or 1. In this setting, the optimization problem does not have Lagrange multipliers and the useful notion of shadow price is not available.

We discuss how to circumvent this drawback by means of Variational Analysis. All along the presentation, simple examples are used to illustrate the interest of the approach. Credit to various co-authors will be given during the talk.