# 1 Optimization as a layer

## 1.1 Some Concepts

(.) is the alias:

- (**e2e**) End-to-end: raw-input to ultimate outputs of interests.
  - without tuned features/feature engineering
- (**optlayer**) Optimization as a Layer
  - inputs $\rightarrow$ outputs: $x \rightarrow y$, includes an optimization problem $y = \arg\min f(x)$
- Differentiation, forward-and-backward pass.
  - for differentiable (convex) problem, Jacobian can be calculated via KKT.
  - for LP, can be calculated via interior point HSD formulation, Ye et al. (1994)
  - other specified solvers, for QP, conic, …

## 1.2 Differentiations

[optimal condition] + solver

- KKT + QP solver, Amos and Kolter (2017)
- CVX -> Conic (HSD embedding) [optimal condition] -> conic solver (SCS, …), Amos and Kolter (2017)
- LP -> HSD, Mandi and Guns (2020)

## 1.3 Application

- e2e, stochastic programming (single stage.)
  - sp -> deterministic.
- sensitivity analysis
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## 1.4 Reference

10 Amos B, Kolter JZ (2017) Optnet: Differentiable optimization as a layer in neural networks. *International Conference on Machine Learning*. (PMLR), 136–145.

Mandi J, Guns T (2020) Interior Point Solving for LP-based prediction+ optimisation. *arXiv preprint arXiv:2010.13943*.

Ye Y, Todd MJ, Mizuno S (1994) An O (√ nL)-iteration homogeneous and self-dual linear programming algorithm. *Mathematics of operations research* 19(1):53–67.