



無線通訊暨訊號處理研究室 Wireless Communications & Signal Processing Lab



Webpage

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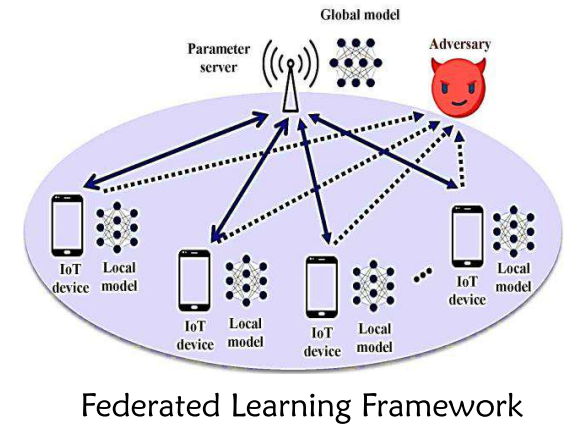
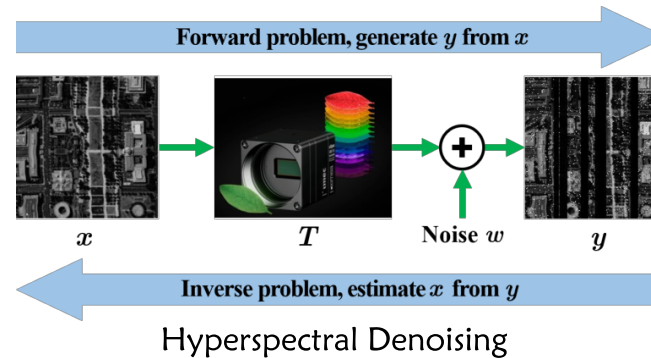
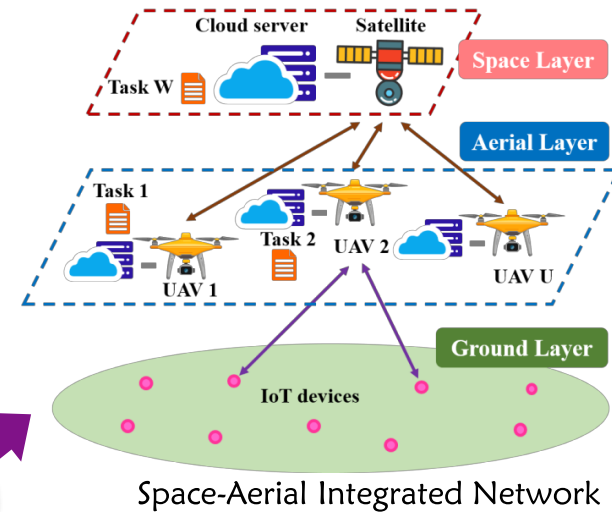
Wireless Communications: 5G Beyond and 6G System Design

- Machine Learning for Intelligent Resource Management
- Enhanced Mobile Broadband (eMBB) in 5G Beyond and 6G
- Security and Privacy Protection
- Integrated Sensing and Communications

Intelligent Fusion CVXopt & AI

Big Data Analytics and Machine Learning

- Hyperspectral Unmixing, Denoising, Inpainting
- Graph-Based Learning
- Federated Learning
- Unsupervised learning



1 Introduction to CVXopt

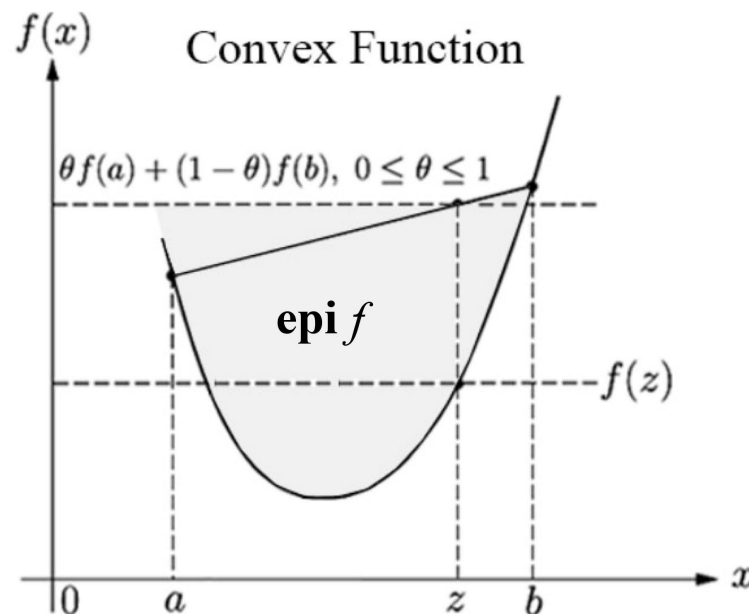
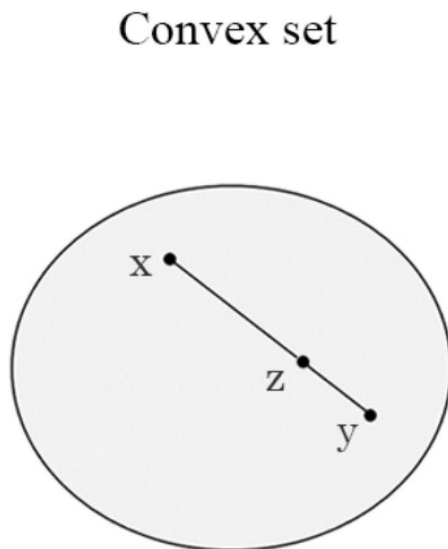
Optimization Problem:

$$\begin{aligned} & \text{minimize} && f(\mathbf{x}) \\ & \text{subject to} && \mathbf{x} \in \mathcal{C} \end{aligned}$$

where $f(\mathbf{x})$ is the objective function and $\mathcal{C}$ is the feasible set from which we intend to find an optimal solution $\mathbf{x}^*$ (or called a *global optimizer*).

CVX set $\mathcal{C}$ (left): $\mathbf{z} = \theta\mathbf{x} + (1 - \theta)\mathbf{y} \in \mathcal{C}, \theta \in [0, 1], \forall \mathbf{x}, \mathbf{y} \in \mathcal{C}$

CVX function $f(x)$ (right): $f(z) \leq \theta f(a) + (1 - \theta)f(b), \theta \in [0, 1], \forall z \in [a, b]$



Introduction to CVXopt & AI: Capacity Distinctions

Optimization Problem:

$$\begin{array}{ll} \text{minimize} & f(\mathbf{x}) \\ \text{subject to} & \mathbf{x} \in \mathcal{C} \end{array}$$

where $f(\mathbf{x})$ is the objective function and $\mathcal{C}$ is the feasible set from which we intend to find an **optimal solution** $\mathbf{x}^*$ (called a *global optimizer*).

- **CVXopt problem:** $f(\mathbf{x})$ is a convex function and $\mathcal{C}$ is a convex set. *Solving CVXopt problems has been a prevalent philosophy in sciences and engineering for decades.*
- **Strength:** Powerful **CVXopt** theory and convex solvers (e.g., CVX or SeDuMi) available for obtaining an $\mathbf{x}^*$, along with *insightful performance and convergence analyses.*
- **Weakness:** *Still hard to handle most NP-hard problems.*

CVXopt & AI: Capability Distinctions

Artificial Intelligence (AI): *A revolutionary philosophy for solving optimization problems*

- **Strength:** Machine Learning (**ML**) and Deep Learning (**DL**) widely used AI techniques, *especially for applications lacking math models.*
- Big data collection required; pre-training always needed.
- High computing power required; time-consuming hyperparameter tuning.
- **Weakness:** *Almost no tractable performance/convergence analysis.*

CVXopt & AI:

(a) Can they unitedly and jointly solve a problem?

(b) Prospective benefits on performance and/or efficiency?

Ans: CVXopt-aided AI or AI-aided CVXopt or other smart fusion.



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Funded PhD/Master/Postdoc positions at WCSP Lab NTHU



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The Wireless Communication and Signal Processing (WCSP) Group (led by Prof. Chong-Yung Chi), National Tsing Hua University (NTHU), Hsinchu, Taiwan, is seeking talented and motivated Ph.D./Master students (funded) and post-doctoral researchers to pursue

Intelligent Fusion of Convex Optimization (CVXopt) & Artificial Intelligence (AI): CVXopt-aided AI or AI-aided CVXopt

for WCSP and Network applications as follows (but not limited by):

Wireless Communications: Wireless Federated Learning (FL) and wireless space-aerial integrated network (SAIN).

Signal Processing: Deep Learning (DL) based hyperspectral imaging, graph based learning, and data security and privacy protection in FL.

For detailed information, please refer to the following link,

[Google-Scholar](#) (Citation Statistics of Publications)