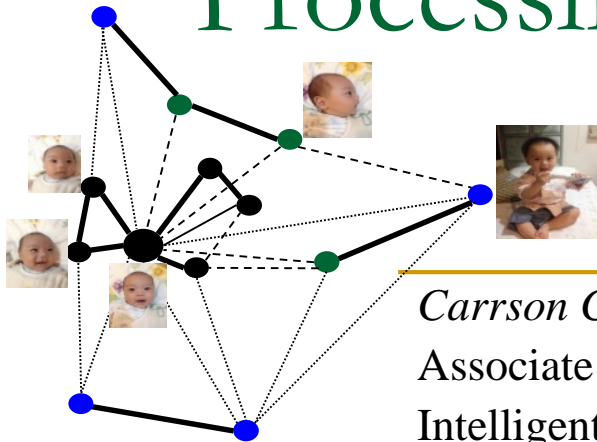


# Data Science With Signal Processing



*Carrson C. Fung*

Associate Professor

Intelligent Modeling and Optimal Design Group (IMOD)

Communication Electronics and Signal Processing Lab (CommLab)

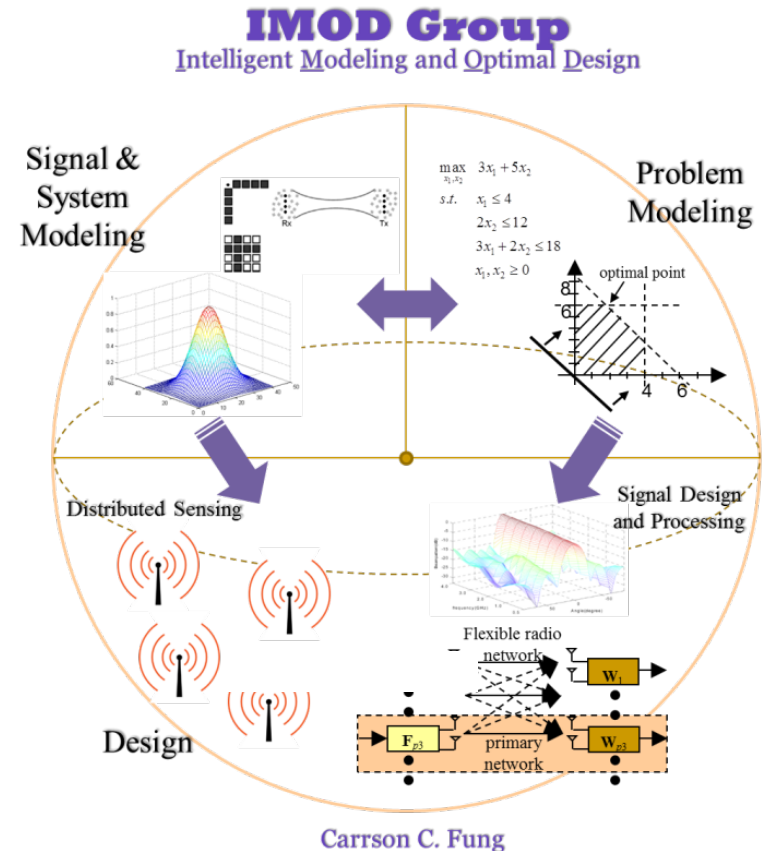
Institute of Electronics

National Chiao Tung University



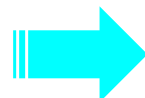
# IMOD Group

- Research focuses on
  - **Graph signal processing and graph learning**
  - **Supervised and self-supervised federated and distributed learning**
  - **6G: transmission using intelligent reflective surface (IRS)**
- Summer internship **abroad** for Ph.D. candidates are strongly encouraged (possible for outstanding M.S. students)
  - M.S. and 1<sup>st</sup>-year Ph.D. students encouraged to apply for the industrial Ph.D. program (教育部產學博計畫)
- Group members
  - 1 Ph.D., 6 M.S., 1 U.G.
- Possible to get jobs with skills you learned in my group
  - **Foxconn** (researcher), **Google** (Mountain View), **Qualcomm** (San Diego), **Amobee** (data scientist), **Realtek** (patent engineer), **Umbo Computer Vision**



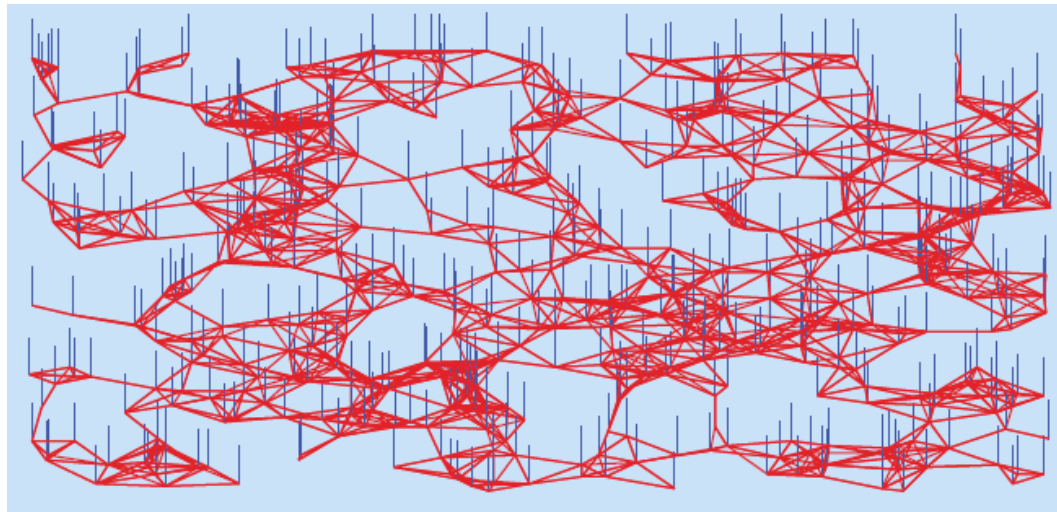
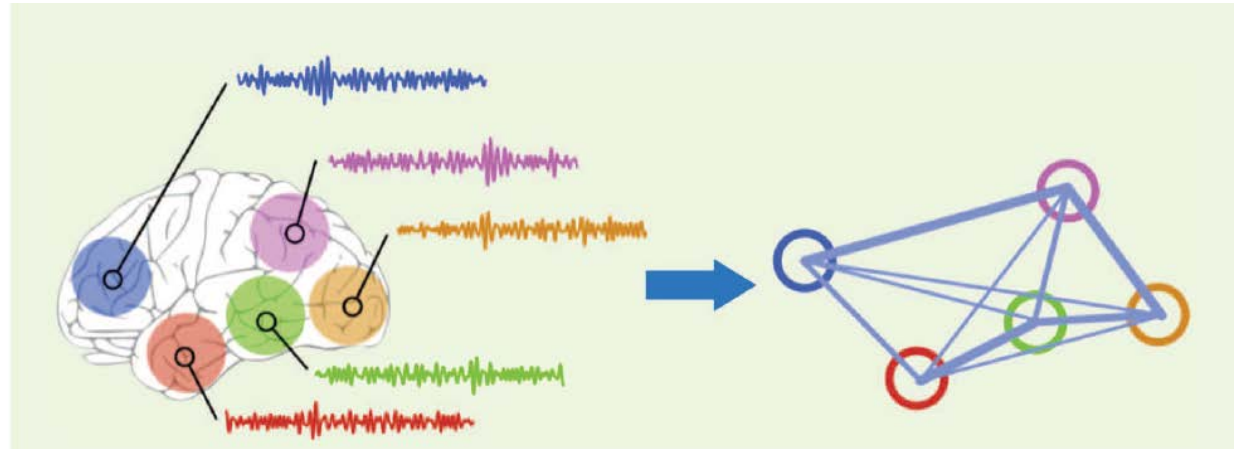
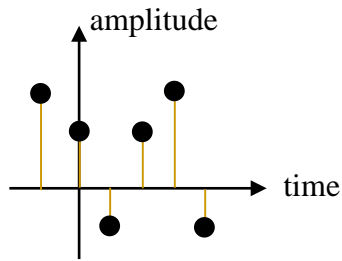
# What I WON'T Do

- Designing (and “optimizing”?) deep neural networks architecture for certain applications by trial and error
- Parameter tuning by trial and error
- Arbitrarily increase network size (and therefore hardware) to cope with more difficult problems

 Design algorithms to solve specific problems in a **systematic manner**



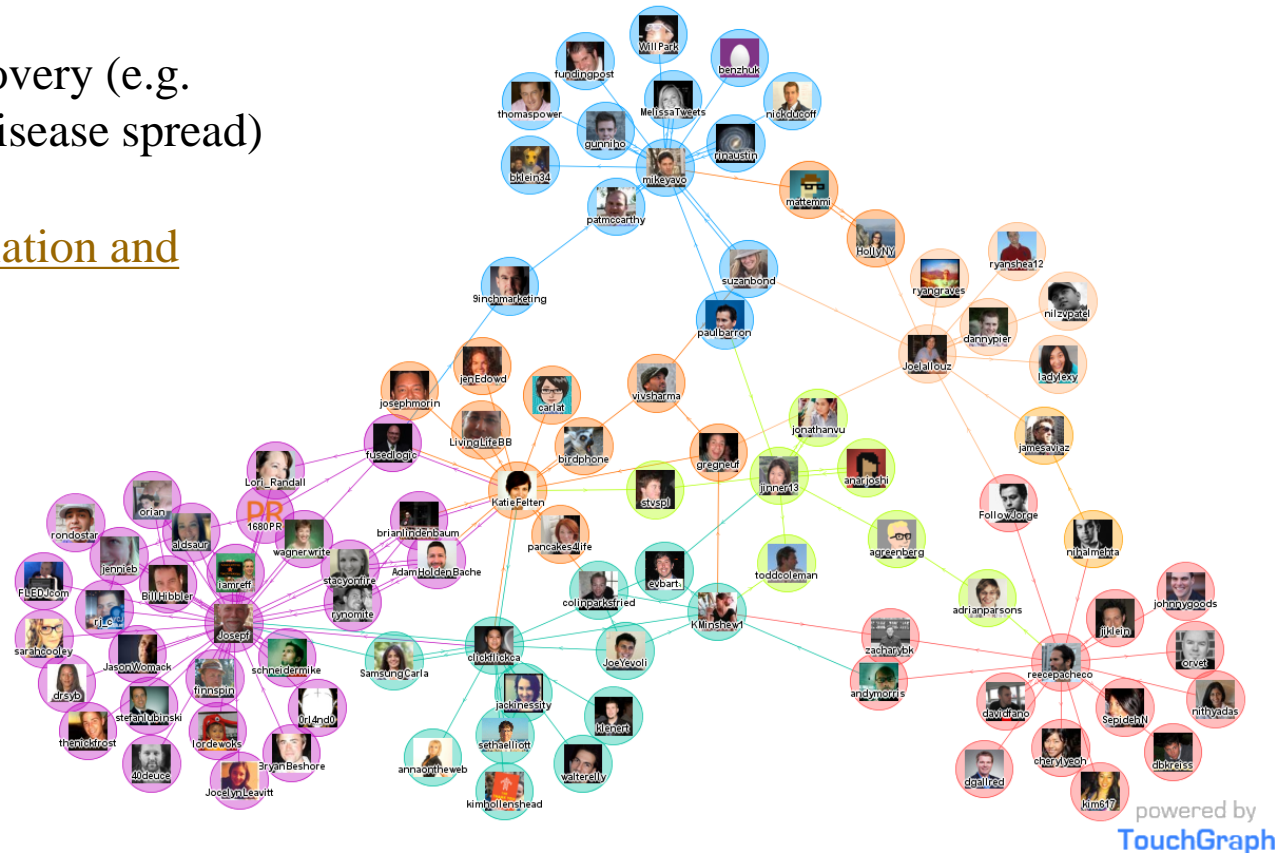
# Signals on Graph: Physical Network



# Signals on Graph: Information Network

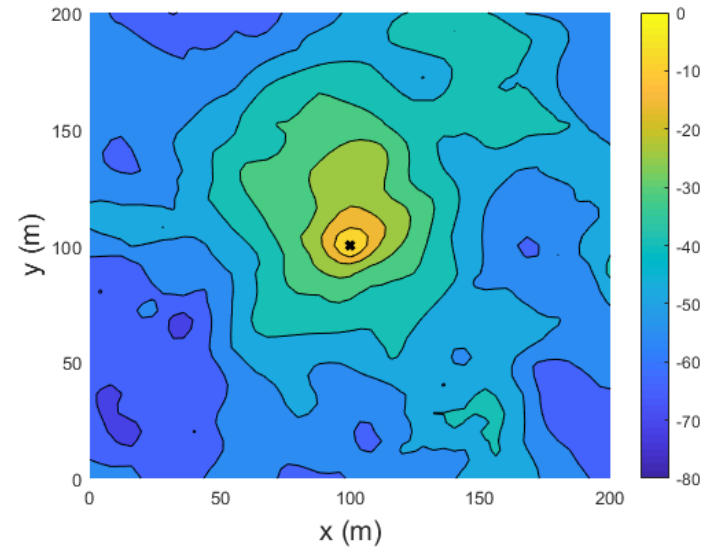
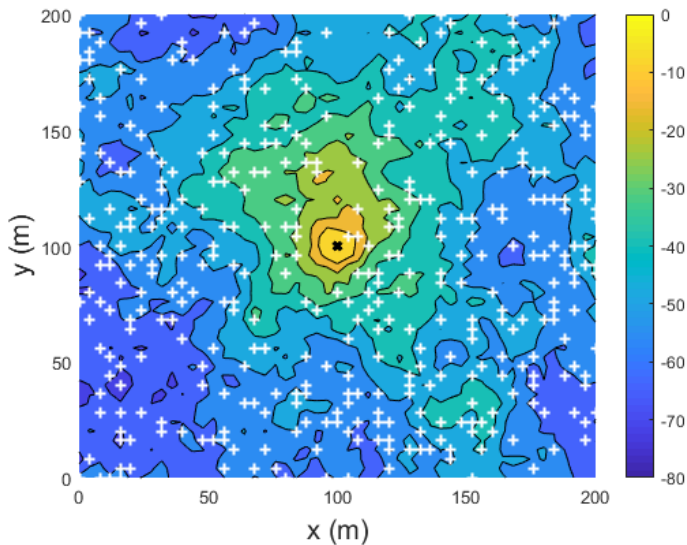
## Sample applications:

- Community discovery (e.g. social network, disease spread)
- Radar data association and tracking

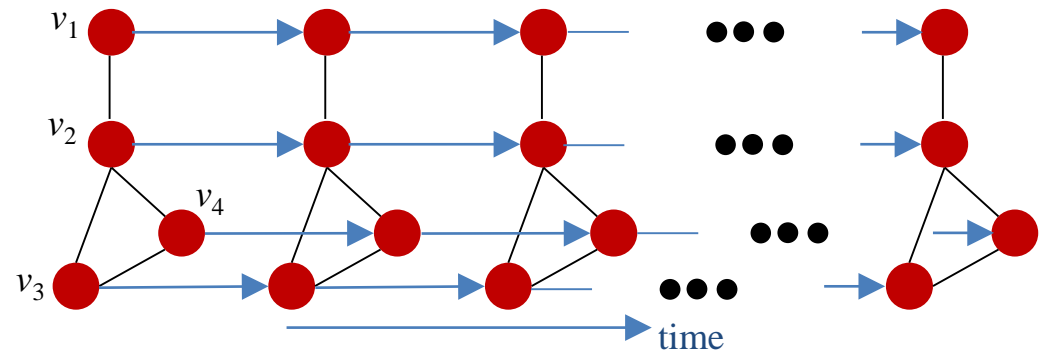


# GSP: Application and Graph Learning

Interpolation/prediction of received signal power



Online graph learning (graph tracking)



## Application

- Preemptive communications



# Self-supervised Learning (SSL)

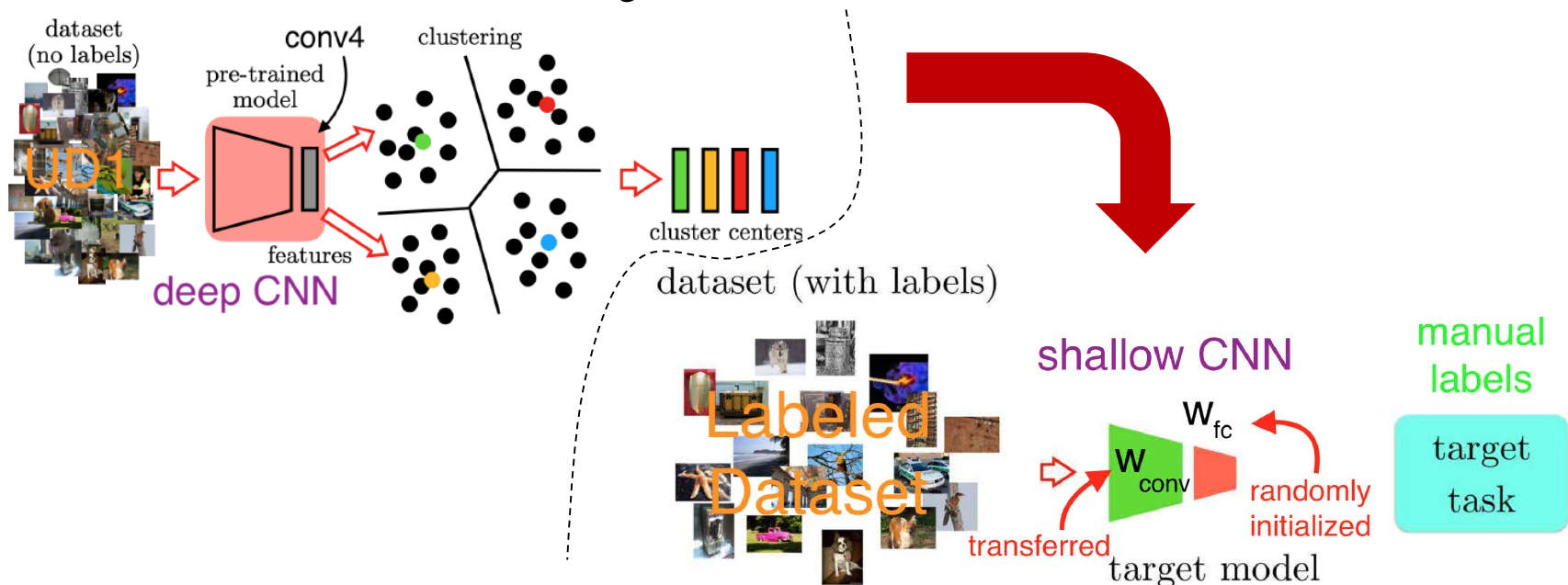
## Problem with supervised learning

Training a deep neural network (DNN) (with many parameters) requires lots of **handcrafted labeled** data

2 “2”

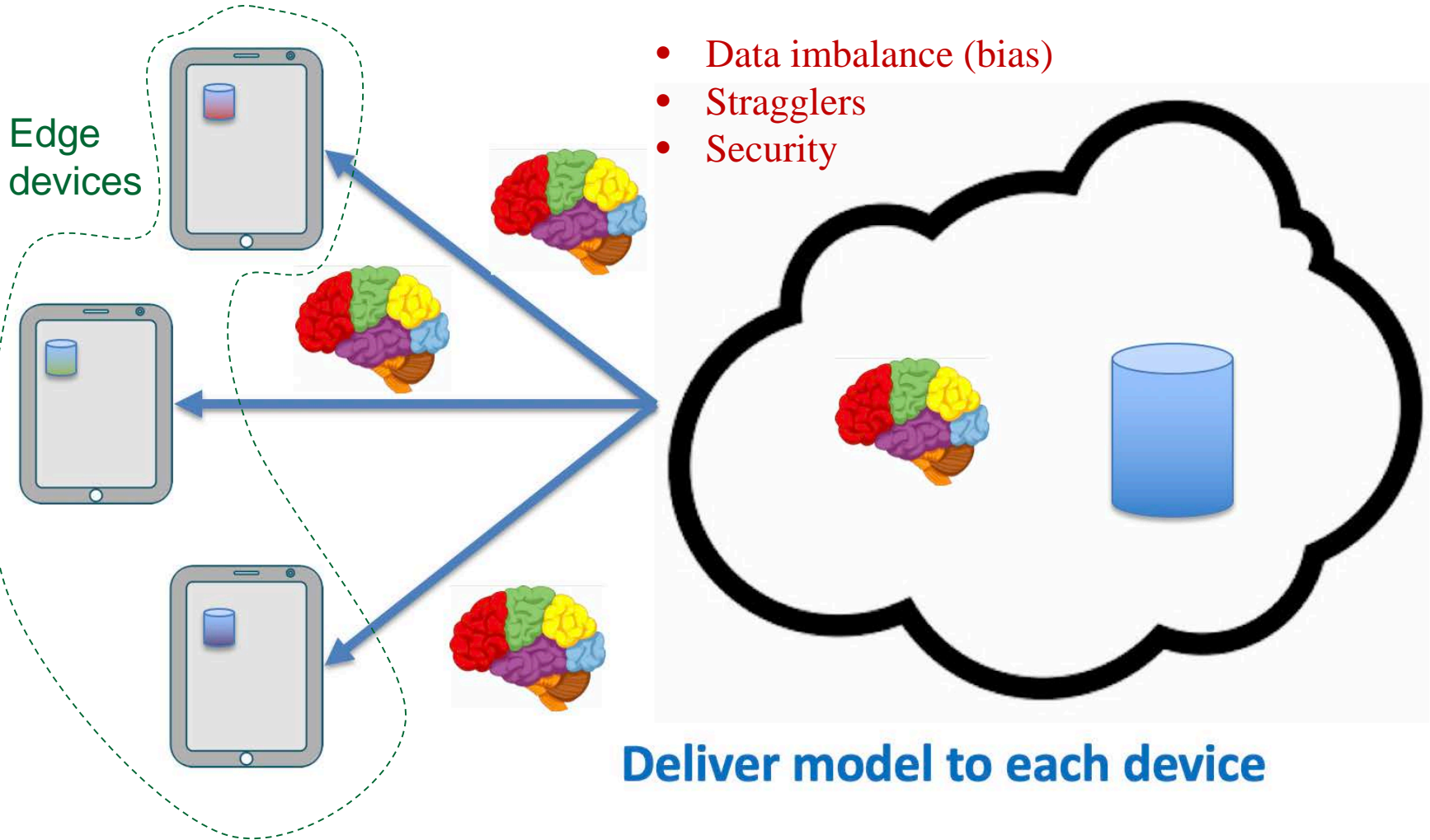
## Self-supervised learning

Train a DNN on pseudo labeled data (e.g computer generated labels) on some task and **transfer the knowledge** to the same or different network to continue training for a different task using **handcrafted labeled** data → allows for generalization of the network to different tasks





# SSL Federated Learning





# What skills are required/learned to be successful?

- Good in mathematics and programming
  - Optimization, graph theory (graph signal processing), statistics, Matlab+Python/Julia(?)
- Willingness and courage to explore and learn new (cross-disciplinary) subjects
- Ingenuity
- Be vocal, especially with your adviser

**THEN MY GROUP IS FOR YOU!!!**

**Stop by and talk to me (ED 639)!**

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***<https://mcube.nctu.edu.tw/~cfung>***

**or Google “Carrson Fung”**



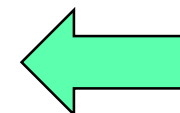


# 3D mmWave Radar

The screenshot displays the DriveRecorder3 software interface. The main window shows a top-down view of a red car with a yellow radar field of view. Several cyan circles represent detected objects. The interface includes several panels:

- Controller:** Shows file sources for CANData (20160929\_0300.dr2) and Video (20160929\_0300.avi).
- HW Monitor:** Displays status for CAN1 (1000k) and a message "No CAN-HW found!".
- TargetList I & II:** Lists detected targets, currently showing "Umrz2GID0".
- TargetDraw & CSV Export:** Provides controls for drawing and exporting target data.
- Status I & II:** Shows tracking data for TrackingBSD1 and TrackingBSD2, including fields like Device\_Mode, Source\_Device, Source\_Diagnosis, Time [s], Number\_Of\_Objects, and Number\_Of\_Message.
- Video:** A live video feed showing a person walking in an outdoor setting.
- CANDataGrid:** A table displaying CAN bus data.

#Msgs	Ident	Len	Data bytes [7...0]	CAN Nr	CANCard-Time
99	1F5	8	1E.FF.FF.CE.00.00.00.1	1	1805783210
196	400	7	00.00.00.00.00.00.01	1	1805752948
2778	401	8	87.8C.1C.1C.27.C8.D1.1	1	1805766407
2778	402	7	04.00.00.02.1A.00.1D	1	1805766635
196	410	7	00.00.00.00.00.00.01	1	1805767080
3564	411	8	80.2C.10.14.29.60.FB.1	1	1805782793



# Security Conscious Distributed Deep Neural Network (DNN) Learning

