RWS-210236

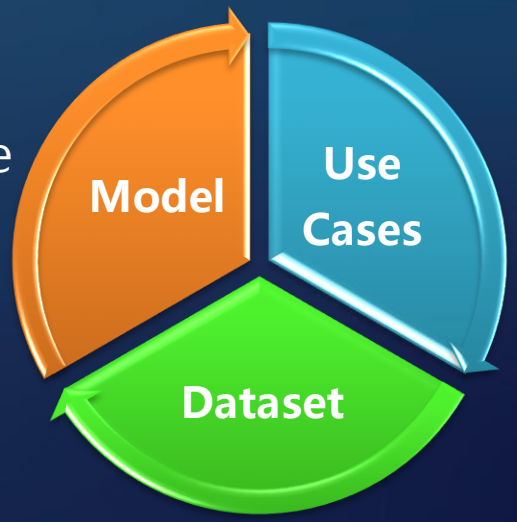
Introduction of the 1st Wireless communication AI competition(WAIC)

CAICT, OPPO

Background

- The integration of wireless communication and AI becomes one of the most popular topics both in academic and industry
- Competition is an important way in AI area to promote the development of AI technologies.
- IMT-2020(5G) Promotion Group hosted the 1st Wireless Communication AI Competition (WAIC) in the spring of 2021 with the theme of "AI Enlightens Wireless Communication"

Provide typical AI models and explore the performance boundaries



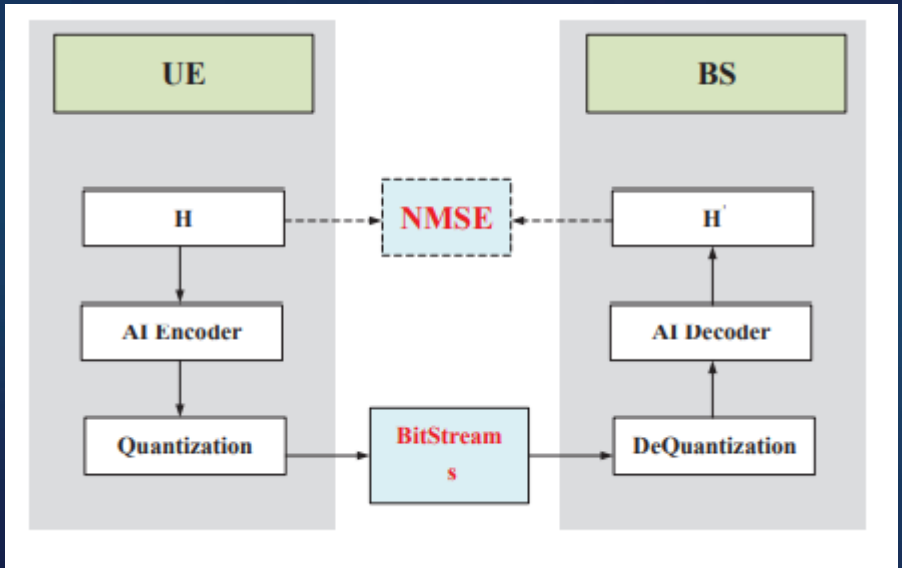
Focus on classic wireless AI problems and extract proper use cases for real deployment

Build classic datasets for academic research, specification and product verification

Subject of the 1st WAIC

Full-CSI feedback

- UE encodes channel matrix H to a M-dimensional bitstream **s** through an AI-Encoder and forwards it to the BS
- The BS decodes the received bitstream s to H′ through an AI-decoder to recover the Full-CSI
- A normalized MSE is used as the criterion to evaluate the difference between the recovered channel H′ and original channel H



Dataset

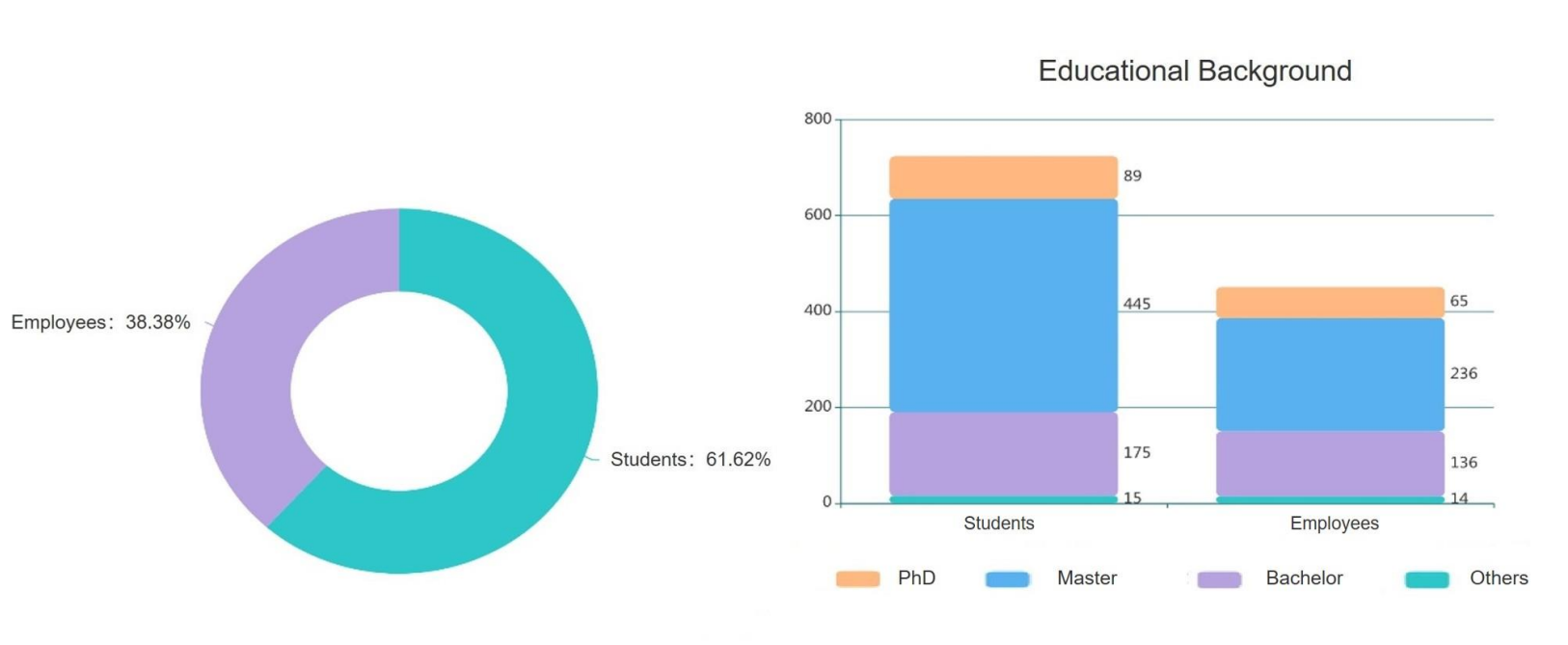
3GPP Uma scenario

- Small scale fast fading with 100% NLOS is considered
- 3000 (UEs)* 200 (slots)=600000 samples are used for training set, where the 200 slots are uniformly sampled with a interval of 100 slots.

Parameter	Value
Channel model	UMa & NLoS
Carrier frequency F_c	3.5GHz
Subcarrier spacing B_{sc}	15KHz
Number of resource block N_{RB}	48
Number of Tx antennas N_t	4
Number of Rx antennas N_r	4
Number of clusters N_d	24
Number of cells N_c	57
Number of UEs in training set N_{train}	3000
Number of UEs in testing set N_{test}	400
Number of sampling slots N_{slot}	200
Number of interval slots T	100

Scales of the 1st WAIC

- There are more than **900 teams** involving **1175 contestants** from **210 companies, 160 universities and research institutes** participating in the competition
- Students from worldwide universities are full of enthusiasm and account for 61.62% of the participants



Potential Enhanced Schemes

Channel Data Analysis and Preprocessing

- Data Analysis
- Path Cutting
- Domain Transforming
- Additional Information Exploiting
- Data Augmentation

AI Model Design

- Fully Connected Neural Network Based Model
- Convolutional Neural Network Based Model
- Transformer Based Model

Quantization Enhancement

- Scalar Quantization
- Vector Quantization
- Path-level Non-uniform Quantization
- Learnable Quantization Error Offset
- Derivable Quantized Step Function

Competition Results

Solution ID	Bits[1]	Scheme											
		Data Preprocessing				Backbone			Quantization Enhancement				
		Path Cutting	Domain Transforming	Additional Info. Exploiting	Data Augmentation	FCN	CNN	Transformer	Adaptive Scalar Quan.	Vector Quan.	Path-level Non-uniform Quan.	Learnable Quan. Error Offset	Derivable Quantized Step Function
1	286	√						√		√	√		
2	354	√				√				√	√		
3	363	√	√				√						
4	369			√			√		√				
5	372						√		√				
6	375				√		√					√	
7	378				√		√					√	
8	379						√						
9	379							√					
10	379						√		√				√

24576 bits can be compressed to 286 bits with NMSE ≤ 0.1 utilizing the best solution

Summary

- WAIC provides a good platform for exploring AI technologies to solve wireless communication problems
  - In the 1st WAIC, DL-based solutions could achieve excellent performance for Full-CSI feedback problem with complex 3GPP channel
  - AI based CSI Feedback and channel estimation will be further studied during the 2nd WAIC in July 2021.

- Although AI-based solutions show good potentials in solving wireless communication problems, the ways of dataset construction and AI model usage should be still further studied for real commercial deployment

Thanks