ESR Project title: Energy-efficient coding and modulation for wireless edge learning [ESR7]

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Institution: Imperial College London

Application deadline: **May 31, 2021**

ESR Project Description:
The success of many emerging applications from autonomous vehicular networks to smart cities will depend on the network's capability to efficiently collect and process sensor field data. Such data is often used for machine learning tasks, in which case the goal of communication is to convey the semantics information within the data, rather than high-fidelity reconstruction. For example, security camera videos would be used for detecting intruders, in which case, transmission of the full-quality video signal may be superfluous. Therefore, the collection and communication of the whole dataset is often not needed. This project's goal is to develop semantic communication techniques that are specifically tailored to the requirements of data transmission for learning, rather than simply the transmission of the underlying data at the highest fidelity, as it is done in conventional systems. In this project, we will first study coding and modulation techniques for wireless edge learning from an information theoretic perspective. Then we will design practical coding and physical layer schemes for low-power wireless communications using deep learning techniques. Our initial results show that such deep learning based coding techniques can outperform current designs based on existing image/video compression codes followed by existing channel codes, particularly in the low signal-to-noise-ratio regimes, making them particularly attractive for edge learning applications.

Expected Results:
(1) Identify fundamental information theoretic performance bounds for distributed learning over noisy communication channels at the network edge. (2) Design practical coding and modulation techniques based on deep learning, which can approach the identified fundamental performance bounds. (3) Implement and test the developed schemes on a USRP-based communication testbed.

Supervision and Mobility Program:
Once hired, the candidate:
- will be employed at Imperial College London as a Research Assistant, performing full-time research under the supervision of Prof Deniz Gündüz.
- will also be enrolled in the PhD program at the same institution,
- will additionally pursue two secondments at University of Pennsylvania (UPenn) and Nokia Bell Labs for durations of 6 and 4 months, respectively.

Required, Preferred and Desired Prerequisites/Skills:[1]

- **Required:** At the time of recruitment, the applicant must not have lived in UK for more than 12 months in the previous 36 months (3 years).
- **Required:** No more than 4 years spent in research/work activities after the achievement of the MS degree.
- **Preferred:** A Master's degree in Telecommunications, Electrical Engineering, Computer Science, Data Science or equivalent.
- **Preferred:** Very good communication skills in oral and written English**.**
- **Preferred:** Open-mindedness, strong integration skills and team spirit.
- **Desired:** Strong mathematical background and desire to work with theoretical concepts.
- **Desired:** Background in information theory, coding theory, and communication theory.
- **Desired:** Good command of the Python programming language.
- **Desired:** Working level experience with modern machine learning techniques.
- **Desired:** Prior experience of successfully conducting research and publishing results in top scientific journals and/or conferences.

Additional requirements for this position

The candidate must satisfy all the PhD level entry requirements (country specific academic requirements, as well as English requirements) of Imperial College London as specified at: https://www.imperial.ac.uk/study/pg/apply/requirements/

[1] **Required**, means mandatory to pass the eligibility check. **Preferred**, means highly welcome and recommended. **Desired**, means additional, not strictly needed, but still very much appreciated.