# INTERVIEW WITH PROF.DONGMEI FU


The middle is Prof. Dongmei Fu

## Brief introduction for you and your team

My team, named as 'the team of bio-inspired computing and intelligent algorithm', belongs to the department of control science and engineering, school of automation and electrical engineering, University of Science and Technology Beijing (USTB). It has a combination of the old, the middle-aged and the young teachers, in which Prof. Dongmei Fu serves as the leader, and Prof. Lizhen Shao, Prof. Li Liu, associate Prof. Chunhong Wu and Tao Yang are members. The research directions of my team include the study of data (image) processing, storage and application; the study of artificial neural networks and applications; the study of intelligent, optimization algorithms and the study of knowledge graph with its applications.

## What are your team's main objectives and responsibilities?

As the position of my team is teaching and scientific research' in the school, every teacher of the team should undertake quite a lot teaching tasks. Also, the whole team or the member need to apply for research direction related projects from national, provincial institution or enterprises. In terms of myself, I take the lead of or take part in over eight national and provincial projects, in which four of them study about material corrosion data processing and its application, two of them focus on management and decision programming, and the other two of them research about optimization computing. Moreover, I take the charge of seven projects with enterprises

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in which three of them study about material corrosion data processing and its application, two of them center on management and decision programming, and the others are about industrial fault diagnosis. Those research projects train the graduate and PhD students. In this way, the team promotes the study of deep learning, obtains research findings and now comes into a positive cycle. In conclusion, the team strives to achieve good teaching results (I have achieved the titles of Excellent Teacher of Beijing and Beijing Famous Teacher of Teaching), to cultivate masters and doctors with excellent character and learning ability and to promote scientific research. Meanwhile, the team makes the teaching and research develop and promote together and become a positive cycle. Those are the objectives and responsibilities of the team.

## In your opinions, what are the opportunities and challenges for your research topic? For the above challenges, how do you deal with them?

The team has been lasting for 15 or 16 years and the research interests are always around bio-inspired computing and artificial intelligence as the name of the team said. This interested direction develops and changes rapidly, from the early traditional neural network to the current deep network, from traditional optimization algorithms (gradient descent, simplex method and etc.) to swarm intelligence (ant colony optimization, genetic algorithm, immune algorithm and etc.), from expert systems to knowledge graphs. In this rapid development, the team and me are always in the midst of opportunities and challenges.

The so-called traditional neural networks are specific to shallow networks being concerned around the year of 2000. The shallow and deep networks can be both as the data models (such as BP, RBF, CMAC and etc.), unsupervised classification models, specific filters and etc. While, shallow networks only focus on the mapping relationship between input and output. It leads to not enough understanding of inner features of data. Although the shallow networks do not require a huge amount of data, they are affected by the quality of data. Deep networks obtain features of data by computing and analyzing big data, and then achieve the learning objectives like 'filter' (human motion is reduced to skeleton motion, blurred images are transformed to much higher resolutions and etc.), and classification (image segmentation, object detection and etc.). In this view, deep networks are robust to fake or interference signals.

Confront with opportunities and challenges, the general practices that never change are diligence, more learning, more thinking and more communication. In actions, we need to stick to the right direction. Start 2 to 4 sub-directions in relevance with a much more general direction, which plays a role of cooperative operation or complement each other. In the direction of material corrosion data analysis, our research works range from theory to practice. In theory, there are corrosion data analysis based on manifold theory or based on evidence theory. These studies can be further extended and used in other background without corrosion data. In practice, we mainly analyze the problems from practical background, especially the corrosion data with different background (like small-sampled, multi-frequency online collected data, multi-resource data and etc.). The research works aims at data modelling, classification, missing data filling, visualization and etc., and make the research results develop much deeper. Meanwhile, we are also responsible for some projects with enterprises and make theoretical works become practical applications (applicable software, hardware and etc.).

**AI empowers everywhere nowadays including molecular design, drug discovery, and science. As materials science is the strength of your university, what do you think of the future for AI-based computational materials science? And how will you develop this direction in your lab?**

Specific to the data of material science, especially for material corrosion science, I think it is a special kind of data with much background knowledge and prior experience. Strictly speaking, it is difficult to become 'big' data in the true sense for material corrosion data. This kind of 'big' data with background knowledge and prior experience is really a common data type in industry.

Material science pays equal attention to theory and experiment and traditional material studies may be more inclined to experiment. This trait is more prominent in material corrosion. It makes the traditional corrosion studies either emphasize "knowledge or experience" like expert systems, reasoning based on knowledge and etc., or focus on corrosion data mining like neural network modelling, classification and decision based on trees and etc. Considering the analysis process of human expert, the problem solving and decision making not only model the data itself, but also make use of knowledge and accumulated experience from that expert. Hence, it is very significant to study a theory that combines both "knowledge or experience" and data modeling methods. For now, the most basic and promising aspect of this research is to try to combine knowledge graphs with neural networks (including deep learning).

In our lab, some students start from data itself and use methods of deep learning as usual but has tried to integrate "knowledge" into the data models, such as the physics-informed neural networks (PINNs) proposed in 2019 and etc. Some students start from "knowledge or experience", such as knowledge graph, and characterize and mining knowledge graph successively.

**From your perspective, can you share some of your ideas that what will AI and deep learning be in the next 10-20 years?**

Based on my thinking, any knowledge should be ultimately intended to guide practice. I feel either artificial intelligence or deep learning should be attributed to the application. Interdisciplinary application is undoubtedly a way of "slacking off" or "short-cut" in mildly speaking.

In my view, a really good research should have a solid theoretical foundation, make contributions to the theory, be able to solve the difficult problems or pain points of that discipline and can stand the trials of practical applications. For example, there is a doctoral student in my team, who is jointly trained by Microsoft Research Asia (MSRA). Under the careful guidance in MSRA and individual efforts, a kind of fast human pose estimation based on video is proposed and is applied to Winter Olympic Games ultimately. That is a really good research.

**You are our beloved teacher and enjoy respectful relationships with students. Do you have any encouragement words for young scientists and students?**

In student life, I hold a relaxed management (including concern and understanding). Academically, a tensed and flexible guidance is in my team. As for academic habits, it is strictly demanding a good study habit. In terms of specific studies, encourage exploration and allow mistakes and etc.

No matter what era we are in, the future belongs to young people. This is a time of rapid development and under this condition, you strive to learn and store knowledge, unite a group of people, work hard and keep on, you will succeed at last.