Fleshed Out Version of Outline:

Here is a more comprehensive version of the ten talks:

- Lecture 1: Introduction, finite element to shallow neural networks
    - This lecture gave a brief introduction to the short course and was followed by some introductory materials about shallow neural networks from the perspective of finite element functions.
- Lecture 2: Finite element and ReLU neural networks
    - This lecture presented the deep connections between linear finite element functions and the deep ReLU neural network functions.
- Lecture 3: Approximation and representation of ReLU^k NNs
    - This lecture showed the approximation and representation power of ReLU and ReLU^k neural functions from the viewpoint of hierarchical basis and global polynomials.
- Lecture 4: Iterative methods and frequency principles
    - This lecture presented the basic properties of iterative methods in numerical PDEs and then proved the frequency principles in training ReLU NNs or Hat NNs.
- Lecture 5: Multigrid methods and subspace correction
    - This lecture gave a fundamental introduction to multigrid methods and methods of subspace correction and then applied them to the federated learning problems.
- Lecture 6: Logistic regression
    - This lecture gave a new (more geometric and intuitive) perspective on understanding the Logistic regression model.
- Lecture 7: Convolutional neural networks (CNN) and image classification
    - This lecture introduced some basic aspects of convolutional neural networks and standard models for image classification.
- Lecture 8: MgNet
    - This lecture presented a unified framework for multigrid and CNN, known as MgNet, and introduced the contained linear model as the underlying mechanism to interpret both MgNet and ResNet.
- Lecture 9: Finite neuron method
    - This lecture introduced the finite neuron method for numerical PDEs with rigorous error analysis and convergent algorithms.
- Lecture 10: Approximation properties of shallow neural networks
    - This lecture presented the optimal approximation theory for shallow neural networks using the tool of dictionaries and variation spaces.