Lecture 7 : Image & Recognition (3)

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Statistical IR Approach (StatIR)

- Assume a satistical basis.
- Approach:
  - Representation: vector space
  - Generalization: rules & concepts
  - Evaluation: accurate & trustworthy estimates
- Procedure:
  i. Determine **feature vector** x
  ii. Train system
  iii. Classify patterns.

Syntactic IP Approach (StyntIR)

- **Structural information**
- Quantify and extract **structural** information and to assess structural similarity of patterns.
- Formulate **hierarchical** descriptions of complex patterns built up from simpler **sub-patterns**.
- **Quantify** Structure:
    i. Formal grammars (Parsing)
    ii. Relational descriptions (Relational Graph Matching)

Neural Networks IR Approach

- Architecture
- Training or Learning
- Activation Function

ANN (Artificial Neural Networoks)

ANN Characterized by:

1. Pattern of **connections**
2. Method of determining the **weights**
3. **Activation** Function

Back-Propagation (BP)

- Gradient descent method to minimize the total squared error.
- Balance between the ability to respond correctly to the **input patterns** that are used for **training** and the ability to give reasonable responses to **input** that is **similar**.
- 3 Stages:
    i. **Feed-forward** of the input training pattern
    ii. Calculation & **back-propagation** of the associated **error**
    iii. **Adjustment** of the weights

Deep Learning

Machine Learning vs Deep Learning

Machine Learning: ability of machines; Feature extraction by human.

Deep learning: a series of algorithms; Feature extraction by neural network.

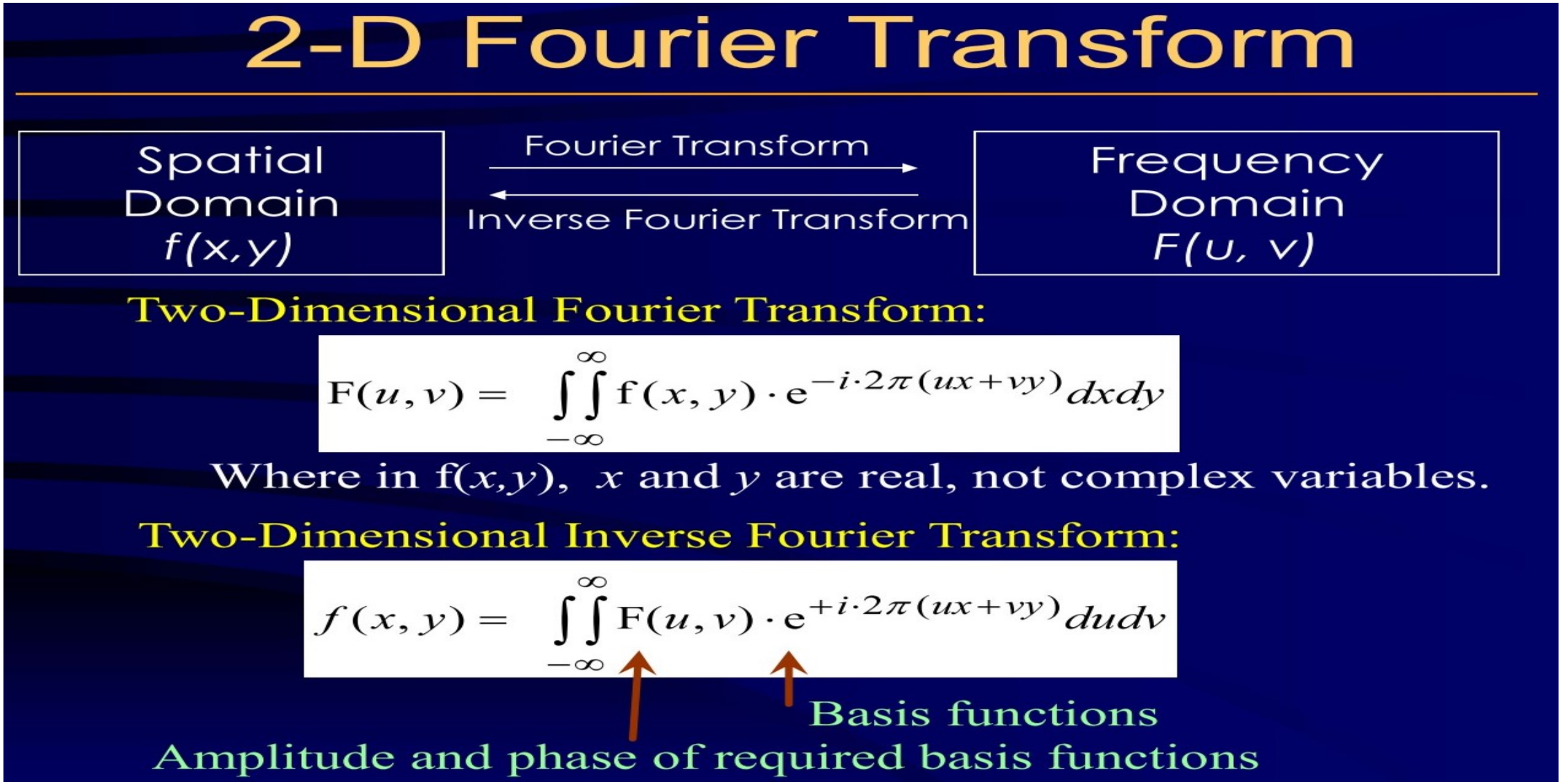
Layer of Deep Learning

1. Convolutional layers: filters. Result of one filter: *feature map* (FM).
2. Subsampling layers: reduce the **size** of input.

Feature Extraction from Frequency Domain

- Time domain: respect to time
- Frequency domain: respect to frequency.
    - In 2D cases, frequency domain is the space defined by values of the *Fourier transform* and its frequency variables.
    - How much the signal lies wthin each given frequency band.
    - Decompose a function into frequencies, with more than one sine wave.

2-D Fourier Transform



- Center dot: DC component.
- **Far** away: **Higher** frequency.
- More **contract**, **wider** spectrum.
- The image rotated, the specturm will rotate in the same direction.

2D FT: Applications

- High-pass filter: Sharpen (high frequency)
- Low-pass filter: Blur (low frequency)

Gabor Filters

- Band-pass filters.
- Optimal **space freqeuncy resolution** (the best joint space-frequency localization)

Gabor Filters Applications

1. Fingerprint identification: image enhancement. (Orientation and freqeuncy for each cell)
2. Fingerprint verification: texture analysis
3. Palmprint identification: texture analysis
4. Iris identification: texture coding
5. Face recognition: Gaborface