Machine Learning and its Applications

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Syllabus

Introduction: Theory and practices in machine learning

Supervised Learning: Decision trees, Bayesian Decision theory, Parametric Methods, Multivariate methods, Dimensionality Reduction

Unsupervised Learning: Clustering, Non parametric Methods, Linear models for regression, Linear models for classification

Kernel Methods: Support Vector Machine, Sparse kernel machines, Graphical Models, Mixture models and EM, Approximate Inference, Sampling Methods.

Reinforcement learning: Q Learning, Non deterministic rewards and Actions.

Evolutionary computing: Genetic Algorithms, Genetic Programming

Evaluation Techniques: The PAC and mistake bound learning frame work VC dimension, Minimum description length principle.

Books

1. C. Bishop, Pattern Recognition and Machine Learning, Springer

2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification and Scene Analysis, Wiley

3. Kishan Mehrotra, Chilukuri Mohan and Sanjay Ranka, Elements of Artificial Neural Networks, Penram International

4. Tom Mitchell, Machine Learning, TMH

5. Rajjan Shinghal, Pattern Recognition, Techniques and Applications, OXFORD

6. Athem Ealpaydin, Introduction to Machine Learning, PHI

Books

7. Computational Intelligence-An Introduction, by Andries P. Engelbrecht, Wiley Publication.

8. Computational Intelligence - Principles, Techniques and Applications, Amit Konar, Springer.

Course Site

https://sites.google.com/a/nirmauni.ac.in/ce623--machine-learning/eventerm

Teaching & Evaluation Scheme

Teaching Scheme:

Theory	Tutorial	Practical	Credits
3	1	0	4

Evaluation Methodology:

	SEE	CE
Exam Duration	3.0 Hrs.	Continuous Evaluation
Component Weightage	0.4	0.6

Teaching & Evaluation Scheme

Breakup of CE

	Unit 1	Unit 2	Unit 3
Exam	Class Test	Sessional Exam	Project
Inter Component Weightage	0.3	0.4	0.3
Numbers	1	1	1
Marks of Each	30	40	30

Introduction

➢ AI, ML and DL
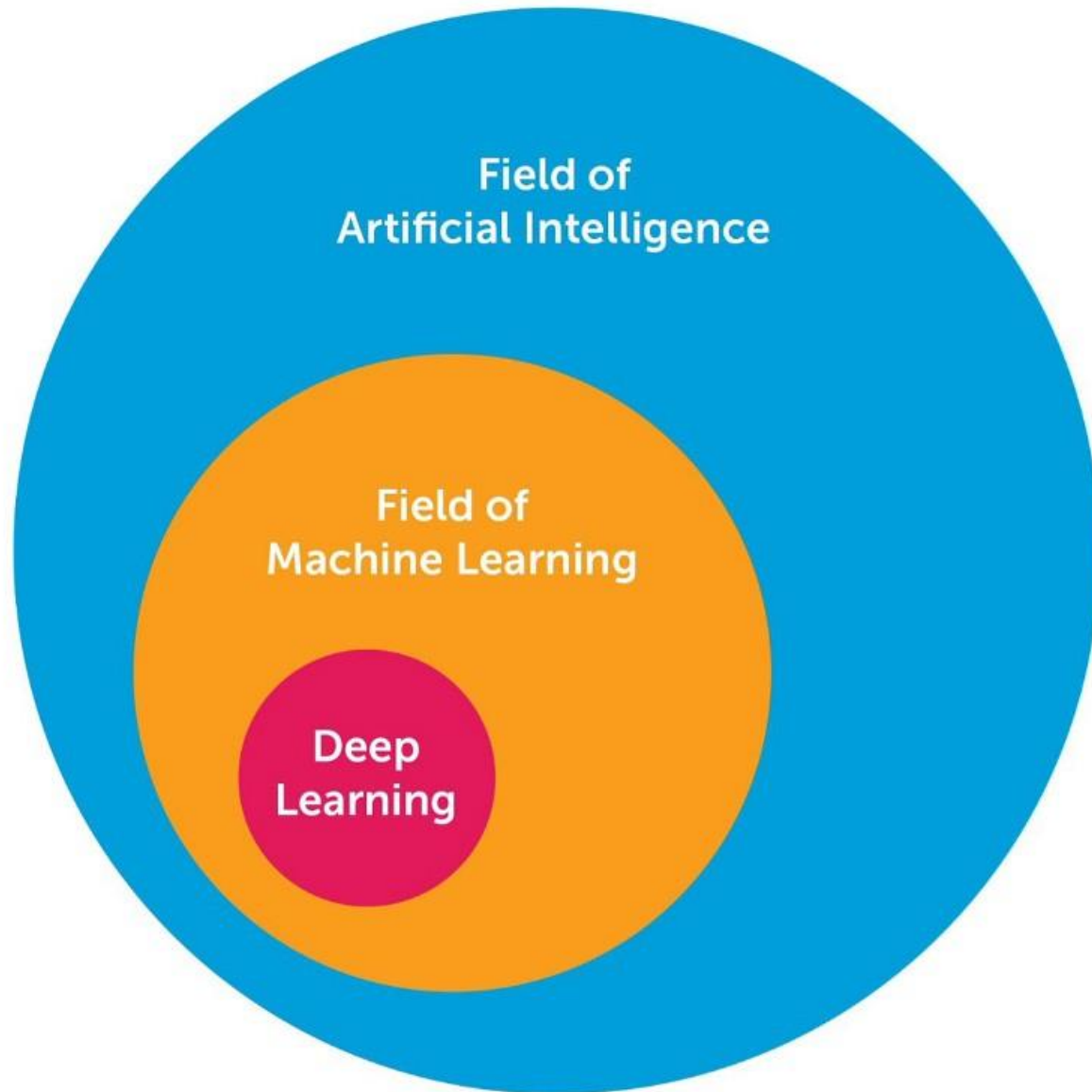
Introduction

➢ What is Machine Learning (ML)?

Introduction

➢ Flavors of Machine Learning

Introduction

➤ Flavors of Machine Learning

  ➤ Supervised Learning
  ➤ Unsupervised Learning
  ➤ Semi Supervised Learning
  ➤ Reinforcement Learning

Introduction

➢ Have you already been benefitted by ML?

  ➢ Google search and ranked pages
  ➢ Spam E-mail
  ➢ Recommendations on Amazon, Flipkart, Movielens
  ➢ Related advertisements on websites

Applications

- Natural Language Processing
  - Autonomous Tagging of Stackoverflow Questions
    - Make a multi-label classification system that automatically assigns tags for questions posted on a forum such as StackOverflow or Quora.
    - Dataset: StackLite or 10% sample

Applications

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  - Automated essay grading
    - The purpose of this project is to implement and train machine learning algorithms to automatically assess and grade essay responses.
    - Dataset: Essays with human graded scores

Applications

- ➢ Natural Language Processing
  - ➢ Autonomous Tagging of Stackoverflow Questions
    - ➢ Make a multi-label classification system that automatically assigns tags for questions posted on a forum such as StackOverflow or Quora.
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  - ➢ Automated essay grading
    - ➢ The purpose of this project is to implement and train machine learning algorithms to automatically assess and grade essay responses.
    - ➢ Dataset: Essays with human graded scores
  - ➢ Sentence to Sentence semantic similarity
    - ➢ Can you identify question pairs that have the same intent or meaning?
    - ➢ Dataset: Quora question pairs with similar questions marked

Applications

- Natural Language Processing
  - Fight online abuse
    - Can you confidently and accurately tell whether a particular comment is abusive?
    - Dataset: Toxic comments on Kaggle

Applications

➢ Natural Language Processing

    ➢ Fight online abuse

        ➢ Can you confidently and accurately tell whether a particular comment is abusive?

        ➢ Dataset: Toxic comments on Kaggle

    ➢ Open Domain question answering

        ➢ Can you build a bot which answers questions according to the student's age or her curriculum?

        ➢ Facebook's FAIR is built in a similar way for Wikipedia.

        ➢ Dataset: NCERT books for K-12/school students in India, NarrativeQA by Google DeepMind and SQuAD by Stanford

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    - Facebook's FAIR is built in a similar way for Wikipedia.
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  - Social Chat/Conversational Bots
    - Can you build a bot which talks to you just like people talk on social networking sites?
    - Reference: Chat-bot architecture
    - Dataset: Reddit Dataset

Applications

- Natural Language Processing
  - Copy-cat Bot
    - Generate plausible new text which looks like some other text
    - Obama Speeches? For instance, you can create a bot which writes some new speeches in Obama's style
    - Trump Bot? Or a Twitter bot which mimics @realDonaldTrump
    - Narendra Modi bot saying "doston"? Start by scrapping off his Hindi speeches from his personal website
    - Example Dataset: English Transcript of Modi speeches

Applications

➢ Applications that can't be programmed by hand

    ➢ Handwriting Recognition

Applications

- Applications that can't be programmed by hand
  - Natural Language Processing
    - Machine Translation

Applications

- Applications that can't be programmed by hand
  - Handwriting Recognition
  - Natural Language Processing
    - Machine Translation
    - Word Sense Disambiguation
      - "I am taking aspirin for my cold" the disease sense is intended
      - "Let's go inside, I'm cold" the temperature sensation sense is meant
      - "It's cold today, only 2 degrees", implies the environmental condition sense.

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      - "It's cold today, only 2 degrees", implies the environmental condition sense.
    - Part-of-Speech Tagging
      - "And now for something completely different"
      - [('And', 'CC'), ('now', 'RB'), ('for', 'IN'), ('something', 'NN'), ('completely', 'RB'), ('different', 'JJ')]
      - Here we see that and is CC, a coordinating conjunction; now and completely are RB, or adverbs; for is IN, a preposition; something is NN, a noun; and different is JJ, an adjective.

Applications

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    - Sentiment Analysis

Applications

- Applications that can't be programmed by hand
  - Natural Language Processing
    - Named-Entity Recognition
      - Teddy Roosevelt was a great president
      - Teddy bears are on sale

Applications

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    - Chatbot

Applications

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    - Speech Recognition, etc.
      - Speech recognition is the ability of a machine or program to identify words and phrases in spoken language and convert them to a machine-readable format.
      - The most frequent applications of speech recognition include voice dialling and voice search.

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    - Text Summarization
      - Extractive Summarization
      - Abstractive Summarization

Celebrities [2]
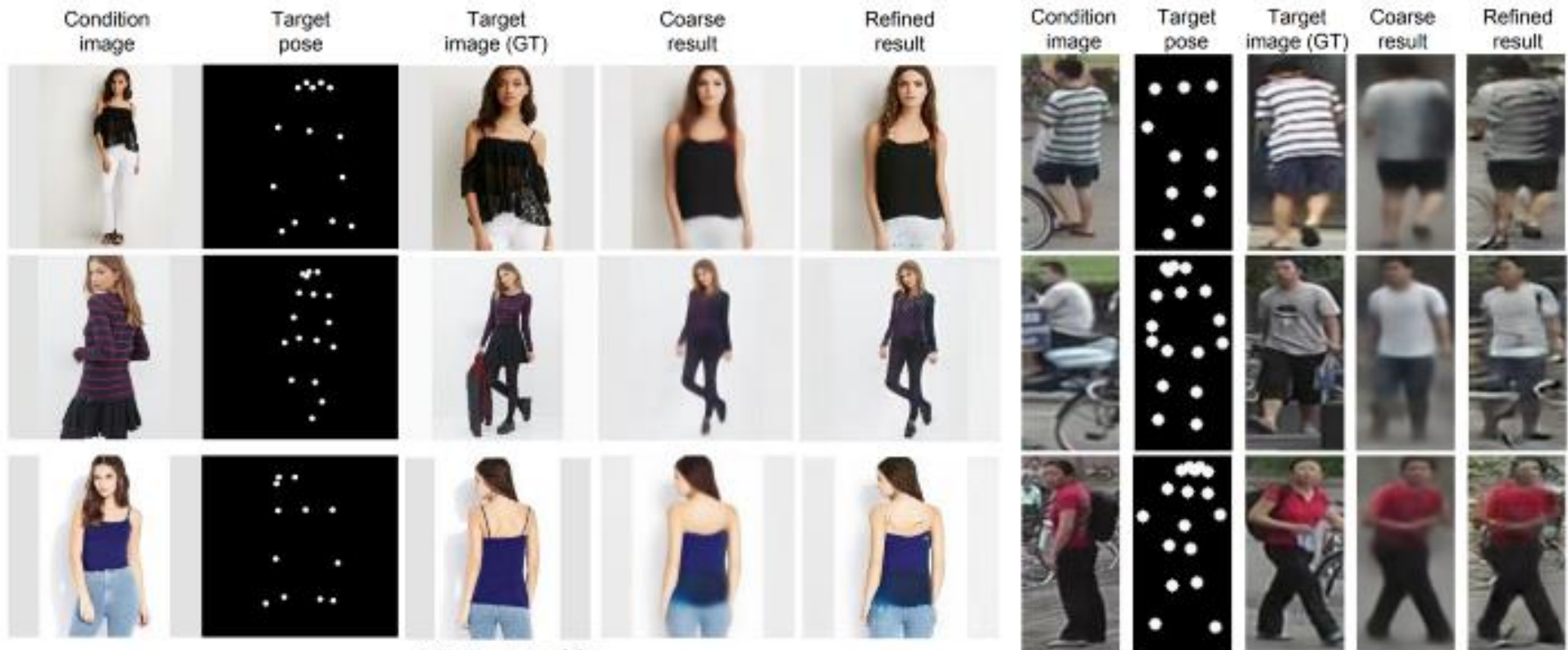
Pose Guided Person Image Generation [3]

Ground truth

Generated

Pose Guided Person Image Generation [3]

(a) DeepFashion

(b) Market-1501

(c) Generating from a sequence of poses

34

CycleGAN [4]

Zebras ⟲ Horses
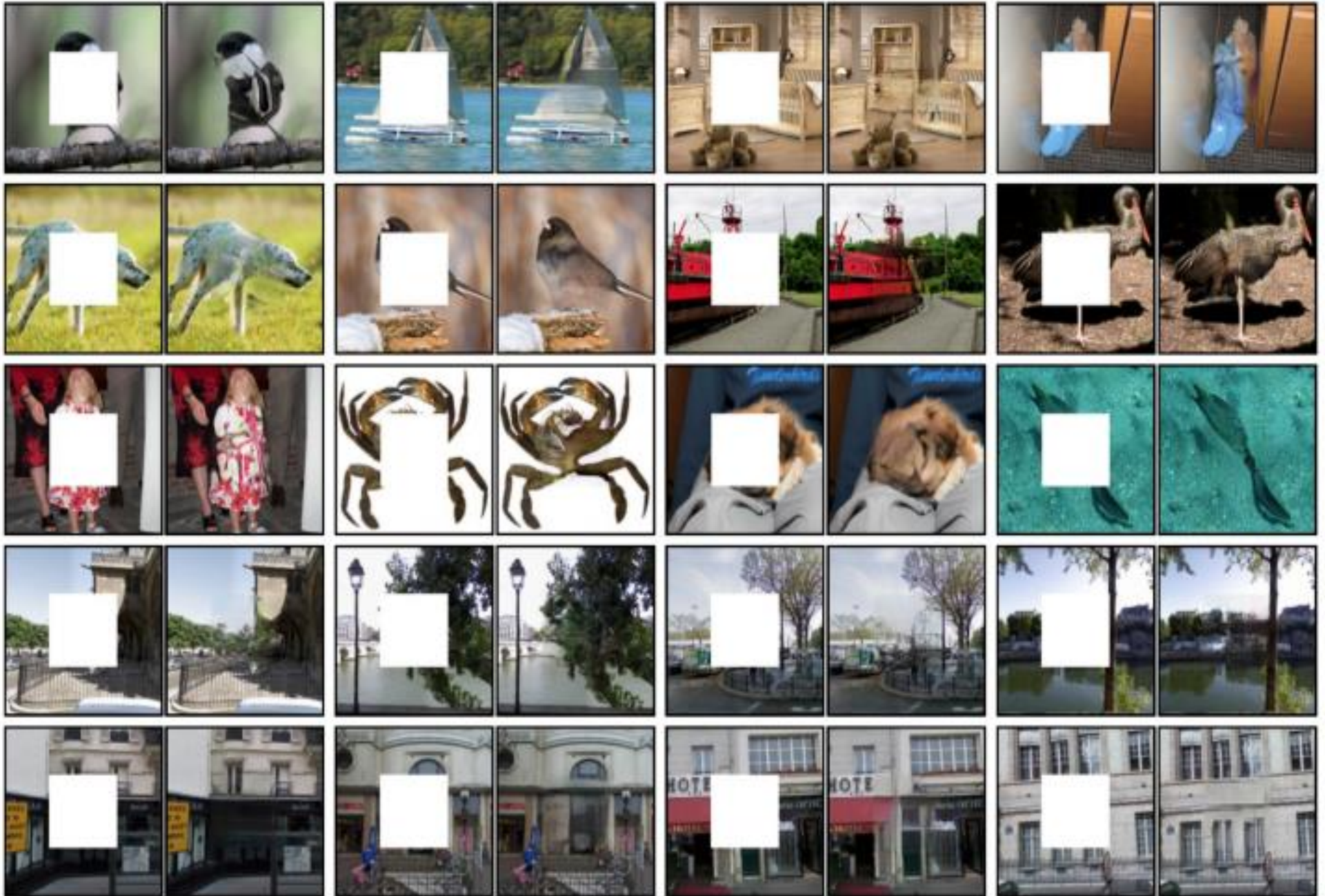

zebra ⟶ horse

horse ⟶ zebra

Text to Image [5]

Image Inpainting [6]

DiscoGAN [7]

(b) Handbag images (input) & **Generated** shoe images (output)

Pix2Pix [8]

Labels to Street Scene — input / output

Aerial to Map — input / output

Labels to Facade — input / output

Day to Night — input / output

BW to Color — input / output

Edges to Photo — input / output
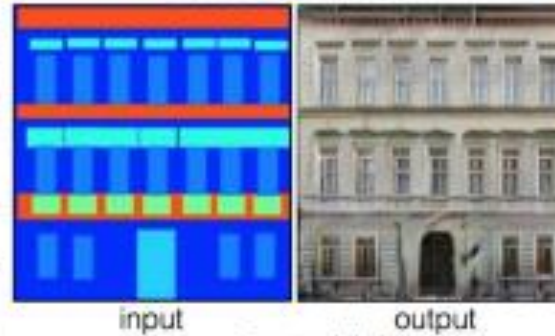
Face aging (Age-cGAN) [9]

Face Aging

| 0-18 | 19-29 | 30-39 | 40-49 | 50-59 | 60+ |
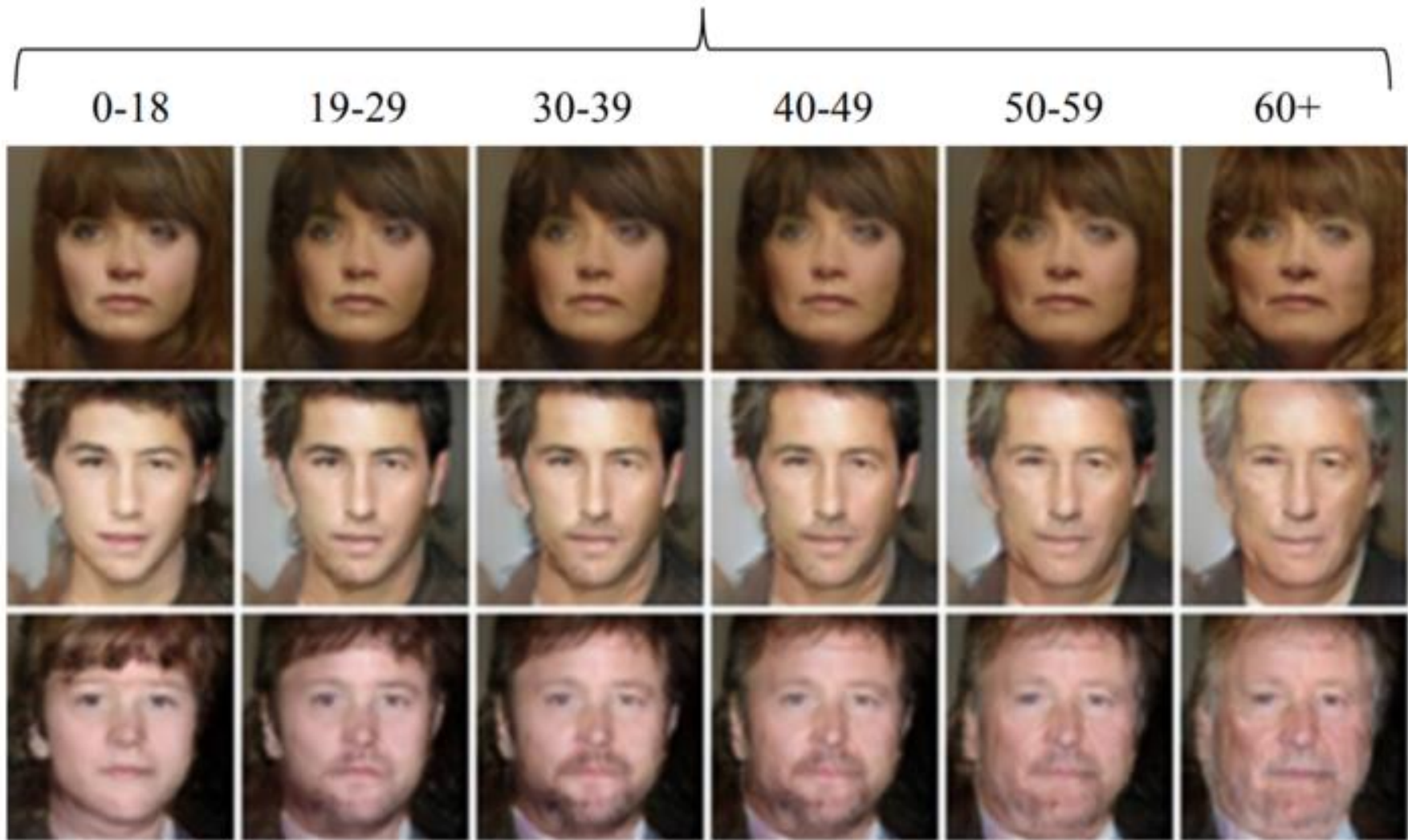
Unsupervised Domain Adaptation by Backpropagation [10, 11]

➤ Learning a discriminative classifier or other predictor in the presence of a shift between training and test distributions is known as domain adaptation (DA).

Figure 2. Examples of domain pairs used in the experiments. See Section 4.1 for details.

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition

Applications

- Applications that can't be programmed by hand
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    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
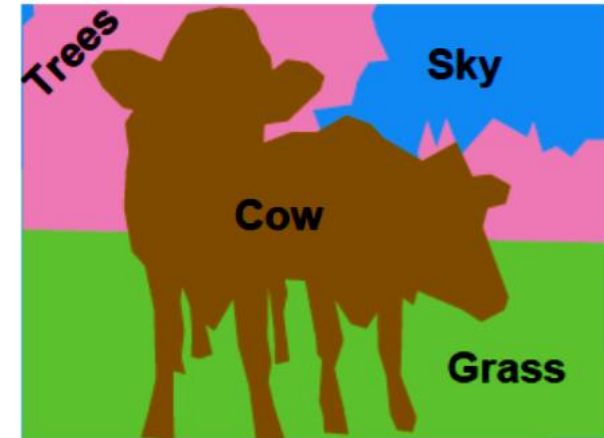   - Age Prediction
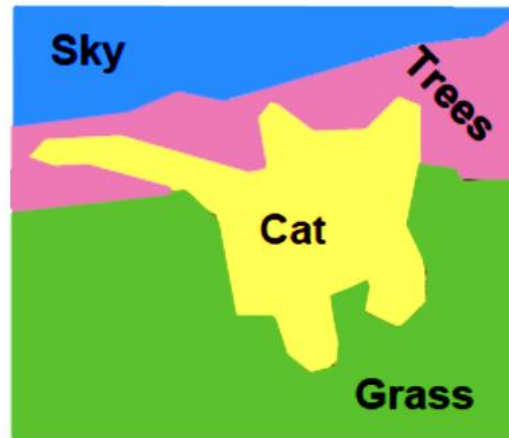
Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
    - Age Prediction
    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))

Semantic Segmentation

Semantic Segmentation

Label each pixel in the image with a category label

Don't differentiate instances, only care about pixels
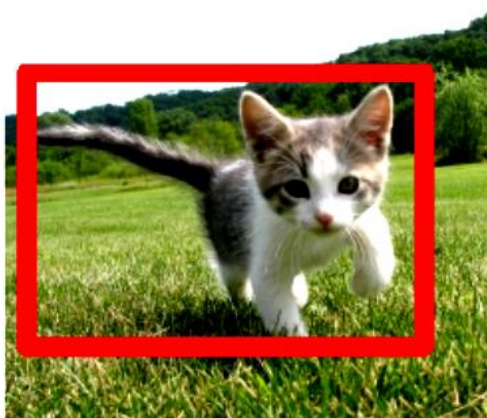
Instance Segmentation

Semantic Segmentation	Classification + Localization	Object Detection	Instance Segmentation
GRASS, CAT, TREE, SKY	CAT	DOG, DOG, CAT	DOG, DOG, CAT
No objects, just pixels	Single Object	Multiple Object	

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
    - Age Prediction
    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    - Object Detection

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
    - Age Prediction
    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    - Object Detection
    - Semantic Segmentation

Applications

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    - Autonomous Vehicle
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    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    - Object Detection
    - Semantic Segmentation
    - Instance Segmentation

Applications

➢ Applications that can't be programmed by hand
  ➢ Computer Vision
    ➢ Security and Surveillance
    ➢ Age Invariant Face Recognition
    ➢ Gesture Analysis
    ➢ Autonomous Vehicle
    ➢ Gender Recognition
    ➢ Emotion Recognition
    ➢ Age Prediction
    ➢ Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    ➢ Object Detection
    ➢ Semantic Segmentation
    ➢ Instance Segmentation
    ➢ Image and Video Captioning

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
    - Age Prediction
    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    - Object Detection
    - Semantic Segmentation
    - Instance Segmentation
    - Image and Video Captioning
    - Video Summarization

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
    - Age Prediction
    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    - Object Detection
    - Semantic Segmentation
    - Instance Segmentation
    - Image and Video Captioning
    - Video Summarization
    - CBIR (three variants)

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Security and Surveillance
    - Age Invariant Face Recognition
    - Gesture Analysis
    - Autonomous Vehicle
    - Gender Recognition
    - Emotion Recognition
    - Age Prediction
    - Image Classification (ImageNet Large Scale Visual Recognition Competition (ILSVRC))
    - Object Detection
    - Semantic Segmentation
    - Instance Segmentation
    - Image and Video Captioning
    - Video Summarization
    - CBIR (three variants)
    - Driver's Drowsiness Detection

Applications

- Applications that can't be programmed by hand
  - Computer Vision
    - Emojinator (Emoji Classifier)

Applications

➢ Personalized Websites

Applications

- Personalized Websites
- Medical Domain
  - Lung Cancer Detection (Nodules form CT Scan Images)
  - Bone X-ray

Applications

➢ Personalized Websites
➢ Medical Domain
➢ Finance

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System

Applications

➢ Personalized Websites
➢ Medical Domain
➢ Finance
➢ Intrusion Detection System
➢ Optimized Routing in IP Networks

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation
- Tag Recommendation

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation
- Tag Recommendation
- Solar Intensity Prediction

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation
- Tag Recommendation
- Solar Intensity Prediction
- Weather Prediction

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation
- Tag Recommendation
- Solar Intensity Prediction
- Weather Prediction
- Soil Moisture Estimation

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation
- Tag Recommendation
- Solar Intensity Prediction
- Weather Prediction
- Soil Moisture Estimation
- Oil Spill Detection

Applications

➢ Personalized Websites
➢ Medical Domain
➢ Finance
➢ Intrusion Detection System
➢ Optimized Routing in IP Networks
➢ Wireless Sensor Network
➢ Friend Recommendation
➢ Tag Recommendation
➢ Solar Intensity Prediction
➢ Weather Prediction
➢ Soil Moisture Estimation
➢ Oil Spill Detection
➢ Land Classification

Applications

- Personalized Websites
- Medical Domain
- Finance
- Intrusion Detection System
- Optimized Routing in IP Networks
- Wireless Sensor Network
- Friend Recommendation
- Tag Recommendation
- Solar Intensity Prediction
- Weather Prediction
- Soil Moisture Estimation
- Oil Spill Detection
- Land use Land Cover Classification
- Cyclone Path Prediction

Applications

- Personalized Websites
- Medical Domain
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- Weather Prediction
- Soil Moisture Estimation
- Oil Spill Detection
- Land use Land Cover Classification
- Cyclone Path Prediction
- Robotics

Applications

➢ Music Recommender System

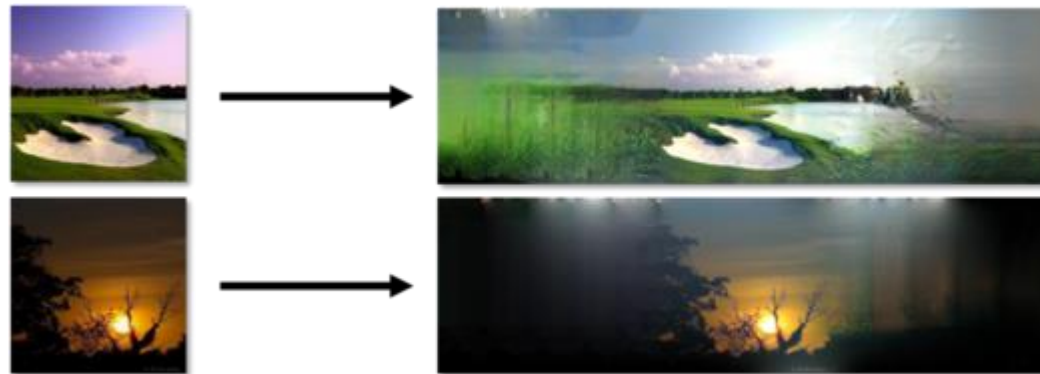# Applications

- Music Recommender System
- LipNet

Applications

- Music Recommender System
- LipNet
- Image Enlarging

| 8×8 input | 32×32 samples | ground truth |

Applications

➤ Music Recommender System

➤ LipNet

➤ Image Enlarging

➤ Image Outpainting

    ➤ Imagine you have a half image of a scene and you wanted the full scenery, well that's what image outpainting can do

Applications

➢ Music Recommender System
➢ LipNet
➢ Image Enlarging
➢ Image Outpainting
➢ Audio Visual Scene Aware Dialog (DSTC)
  ➢ The goal is to generate a complete and natural response to a question about a scene, given video and audio of the scene and the history of previous turns in the dialog.
  ➢ To answer successfully, agents must ground concepts from the question in the video while leveraging contextual cues from the dialog history.

References

1.	https://towardsdatascience.com/the-10-deep-learning-methods-ai-practitioners-need-to-apply-885259f402c1

2. Progressive Growing of GANs for Improved Quality, Stability, and Variation

3. Ma, Liqian, et al. "Pose guided person image generation." Advances in Neural Information Processing Systems. 2017.

4. https://github.com/junyanz/CycleGAN

5. https://github.com/hanzhanggit/StackGAN

6. https://github.com/pathak22/context-encoder

7. https://github.com/carpedm20/DiscoGAN-pytorch

8. https://github.com/phillipi/pix2pix

9. Antipov, Grigory, Moez Baccouche, and Jean-Luc Dugelay. "Face aging with conditional generative adversarial networks." Image Processing (ICIP), 2017 IEEE International Conference on. IEEE, 2017.

10.	https://pdfs.semanticscholar.org/presentation/f4af/de757b9dfc697 d149 e 95cb193aa4749530e2.pdf

11. Ganin, Yaroslav, and Victor Lempitsky. "Unsupervised domain adaptation by backpropagation." arXiv preprint arXiv:1409.7495 (2014).

Disclaimer

➢ Content of this presentation is not original and it has been prepared from various sources for teaching purpose.