ComputerVisionTopics

Version 2017 by MVPLAB

Topics by CV Society

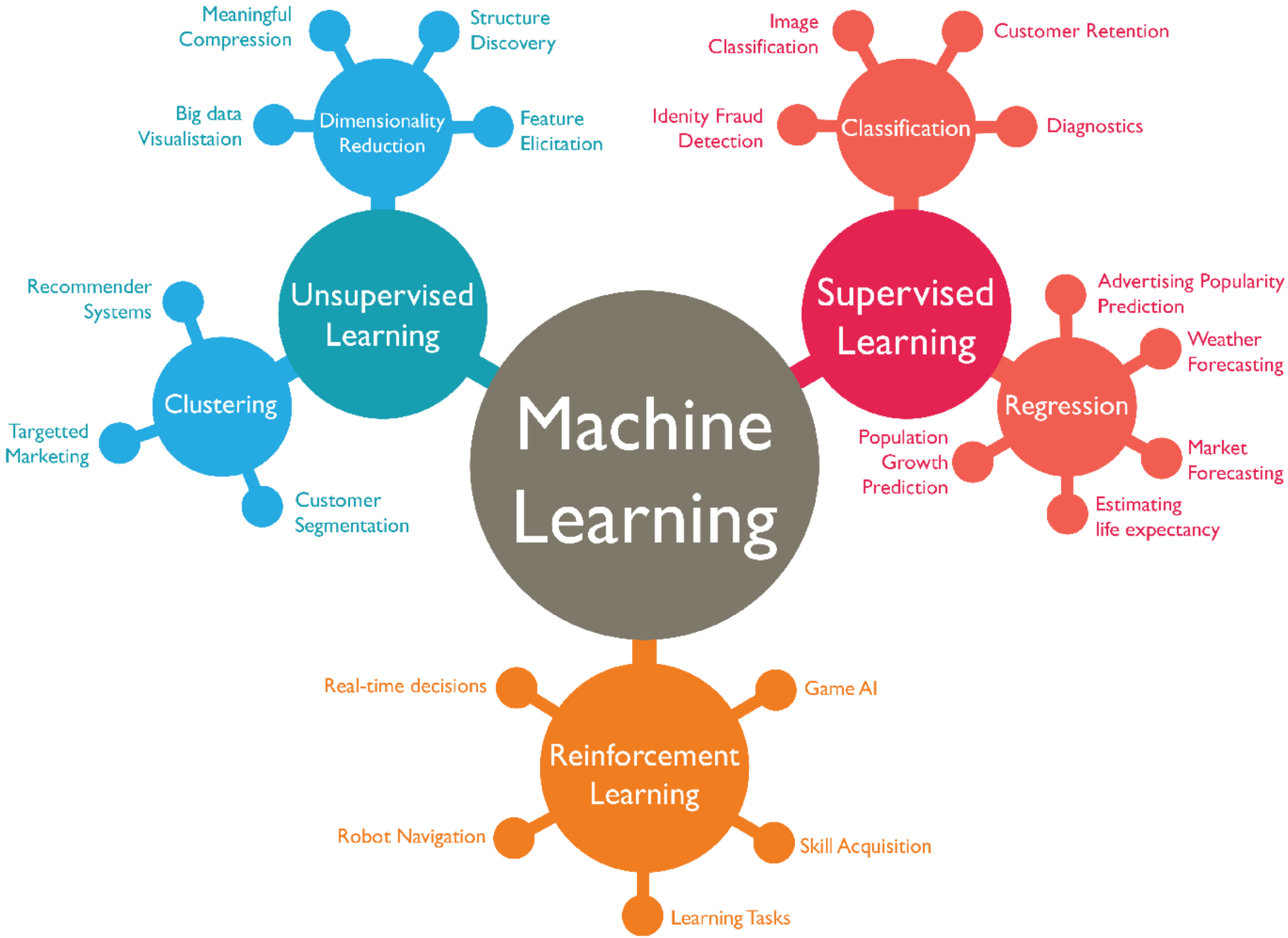
1. Low Level Vision
   - Filtering / Grouping / Enhancement...
2. High Level Vision
   - Detection / Recognition / Understanding...
3. Grahpics
   - Color / Style / Editing / Rendering...

Contents

1. Machine Learning
2. Restoration/Generation
3. Enhancement
4. Segmentation
5. 3D Vision
6. Recognition/Detection/Retrieval
7. Tracking/Motion/Action
8. Understanding
9. Vision + Language
10. Graphics

Today, We Introduce 63 Papers

Machine Learning


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Big data Visualistaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Idenity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Population Growth Prediction
Market Forecasting
Estimating life expectancy
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

Supervised Learning

Regression

- From Training Data, Predict Real-Value
- Linear Regression / ARMA / SVR / GP

Classification

- From Training Data, Predict Discrete-Value
- Naïve Bayes / Logistic Regression
- SVM / Random Forests / Neural Networks

Generative Model = Probabilistic Model

- Learn P(x, y) → Learn P(y | x)
- Naïve Bayes, VAE, GAN

Discriminative Model = Function Fitting

- Learn P(y | x) Directly
- Logistic Regression, Neural Networks

Discriminant Function

- SVM

Unsupervised Learning

Dimension Reduction

- High Dimension Data → Low Dimension Data
- Linear: PCA / LDA
- Manifold: ISOMAP / LLE / t-SNE

Clustering

- Cluster Un-labeled Data
- K-means / GMM / HMM

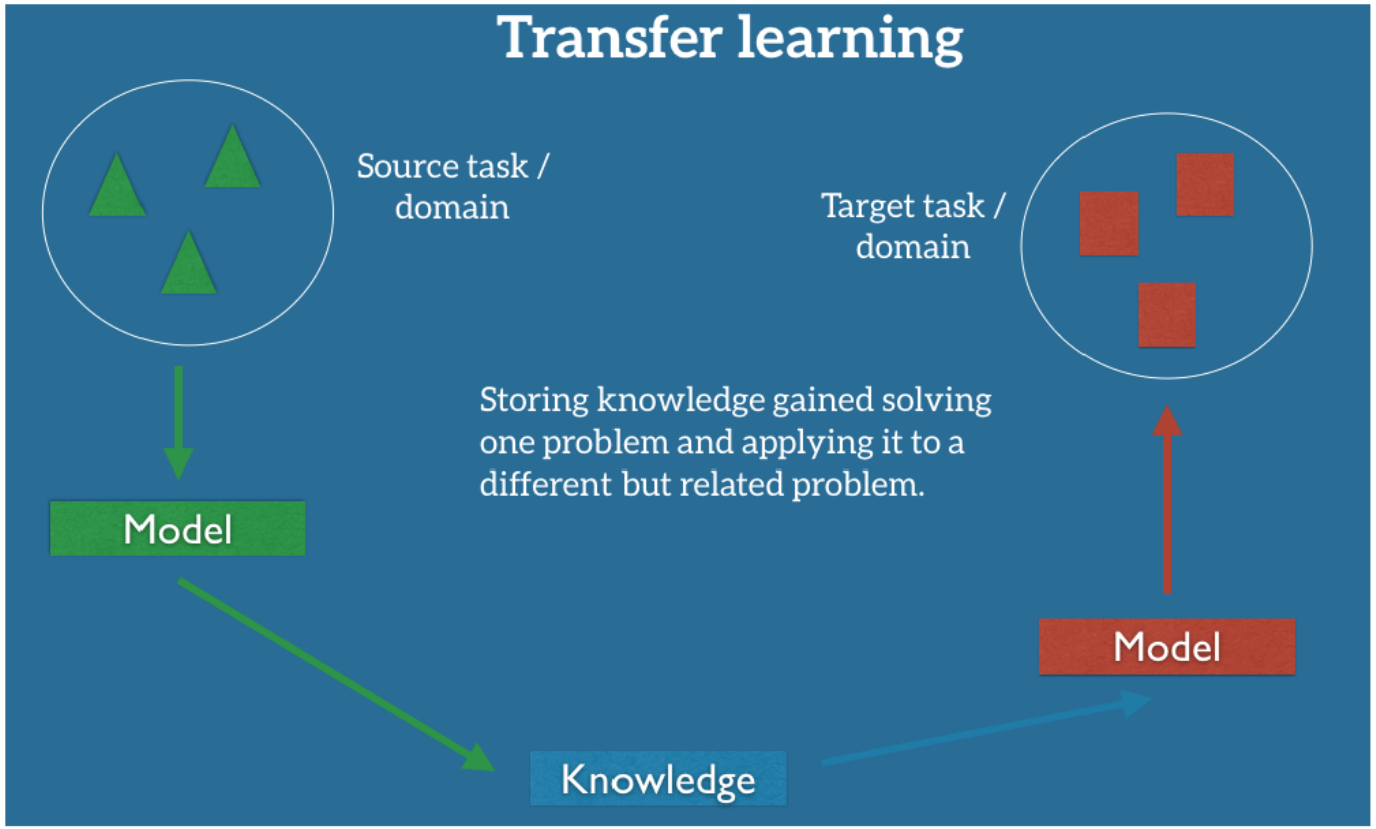
Unsupervised Learning

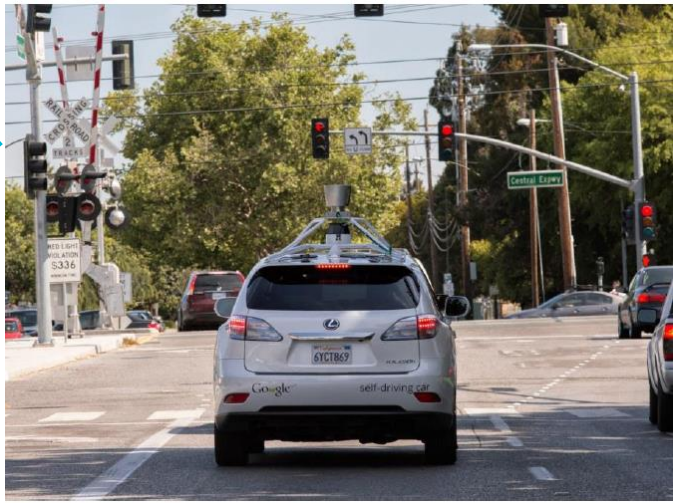
Feature Learning

- Learning Features from Training Data
- Also Called Pre-training
- Autoencoder / RBM
- VAE / GAN / CNN
- Semi-supervised Learning
- Weakly-supervised Learning

Transfer Learning

- Train on A, Prediction on B





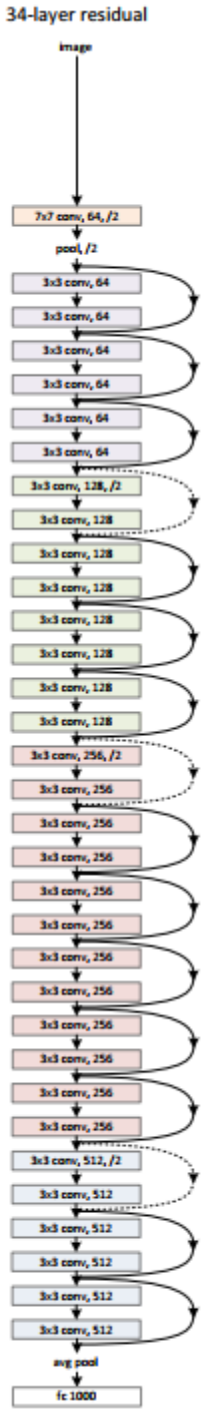
Reinforcement Learning

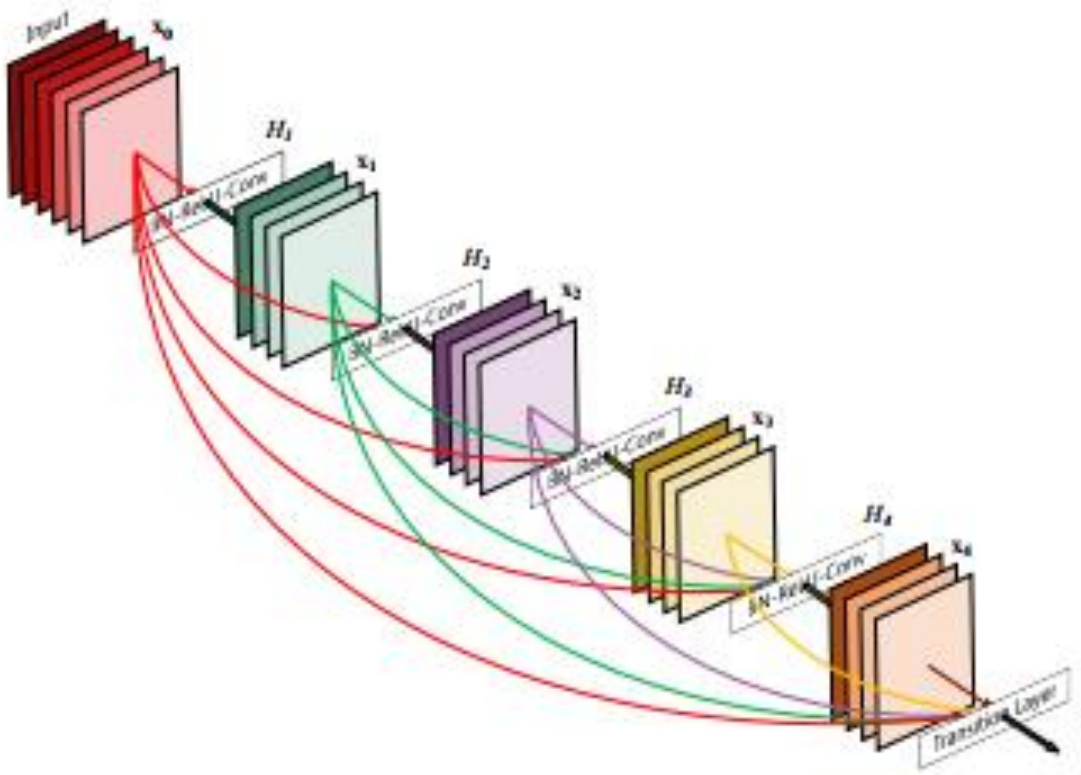
Learning from Actions & Rewards

- Dynamic Programming
- Deep Q Learning
- Policy Gradients
- Asynchronous Advantage Actor-Critic

CNN

ResNet CVPR 2016
DenseNet CVPR 2017



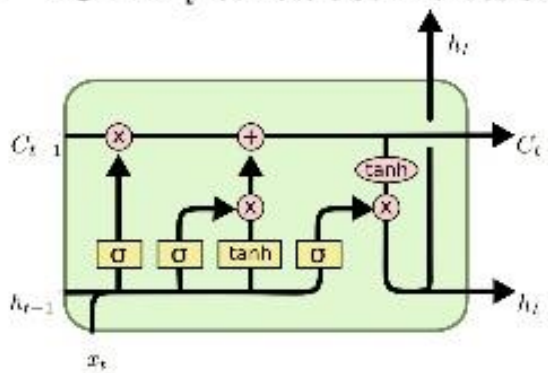


RNN

LSTM **NeuralComputation 1997**
GRU **Arxiv 2014**

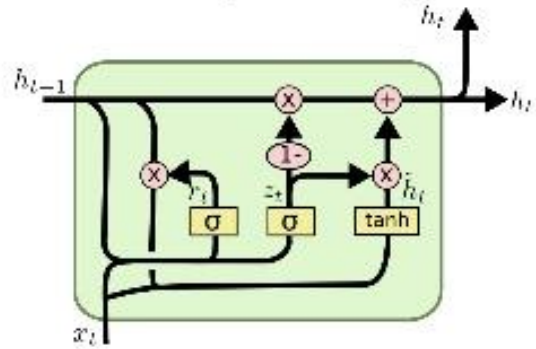
LSTM and GRU

- LSTM [Hochreiter&Schmidhuber97]



$$f_t = \sigma\left(W_f \cdot [h_{t-1}, x_t] + b_f\right)$$
$$i_t = \sigma\left(W_i \cdot [h_{t-1}, x_t] + b_i\right)$$
$$\tilde{C}_t = \tanh(W_C \cdot [h_{t-1}, x_t] + b_C)$$
$$C_t = f_t * C_{t-1} + i_t * \tilde{C}_t$$
$$o_t = \sigma\left(W_o [h_{t-1}, x_t] + b_o\right)$$
$$h_t = o_t * \tanh\left(C_t\right)$$

- GRU [Cho+14]

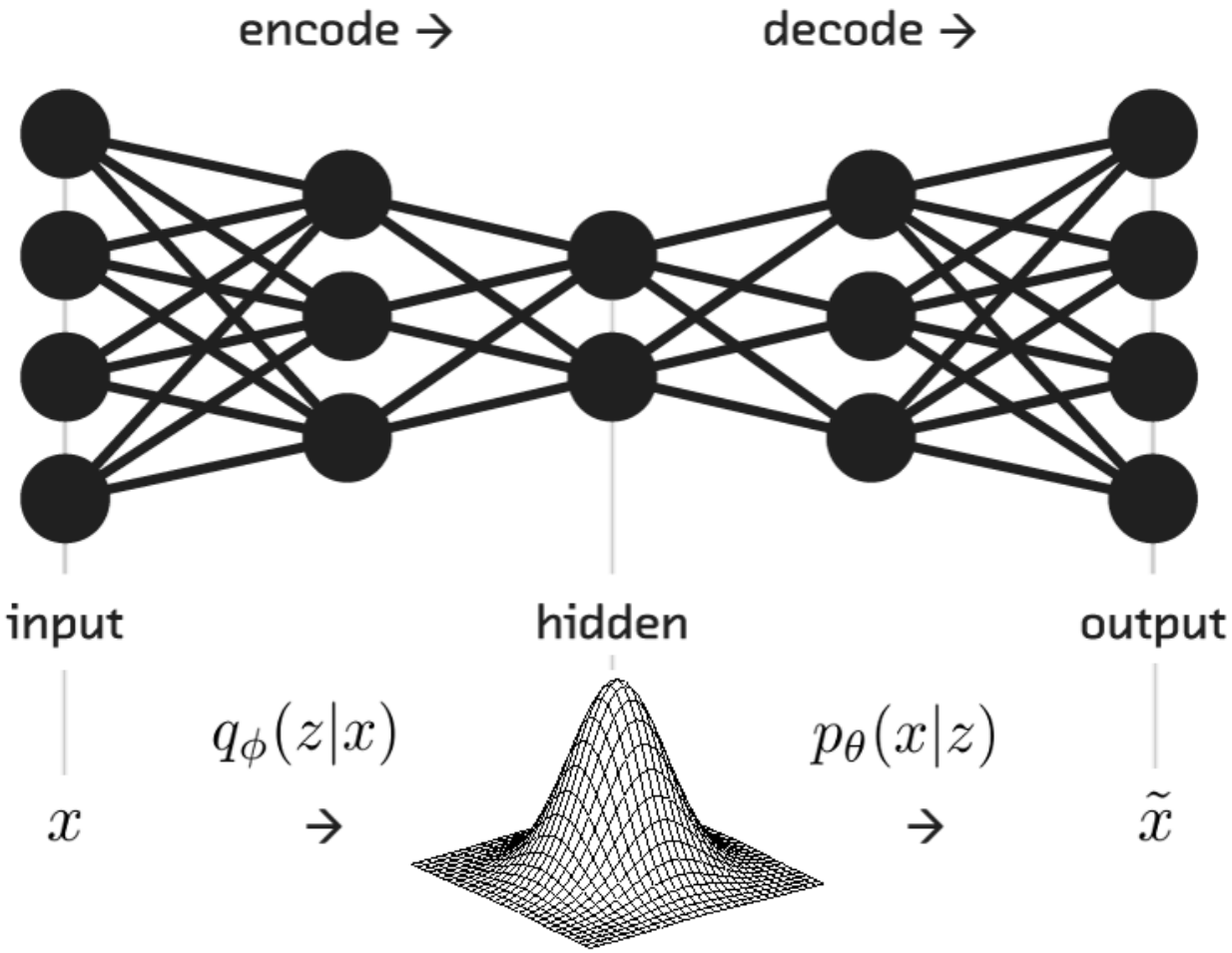


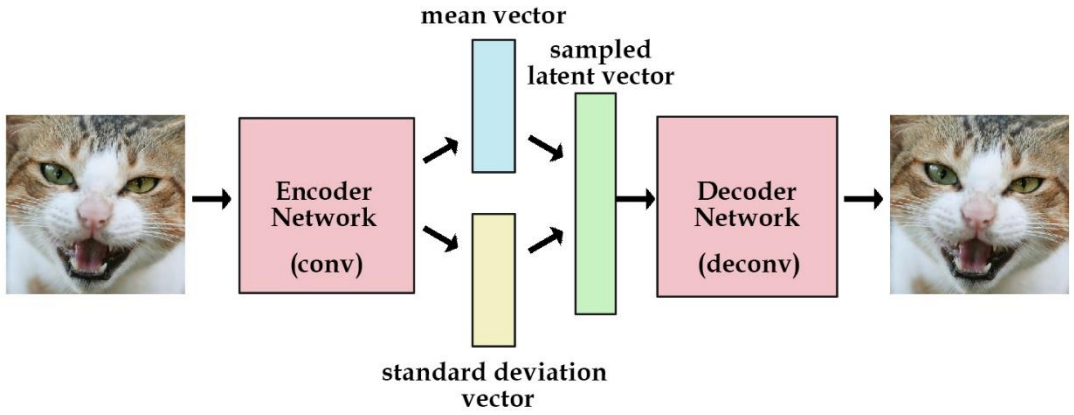
$$z_t = \sigma\left(W_z \cdot [h_{t-1}, x_t]\right)$$
$$r_t = \sigma\left(W_r \cdot [h_{t-1}, x_t]\right)$$
$$\tilde{h}_t = \tanh\left(W \cdot [r_t * h_{t-1}, x_t]\right)$$
$$h_t = (1 - z_t) * h_{t-1} + z_t * \tilde{h}_t$$

(Biases are omitted.)

VAE

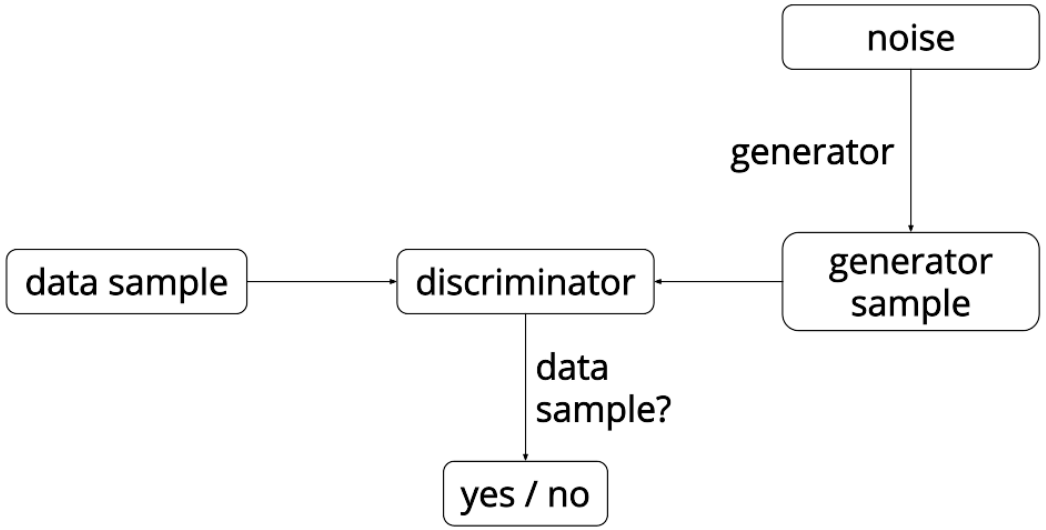
Auto Encoding Variational Bayes **Arxiv 2013**

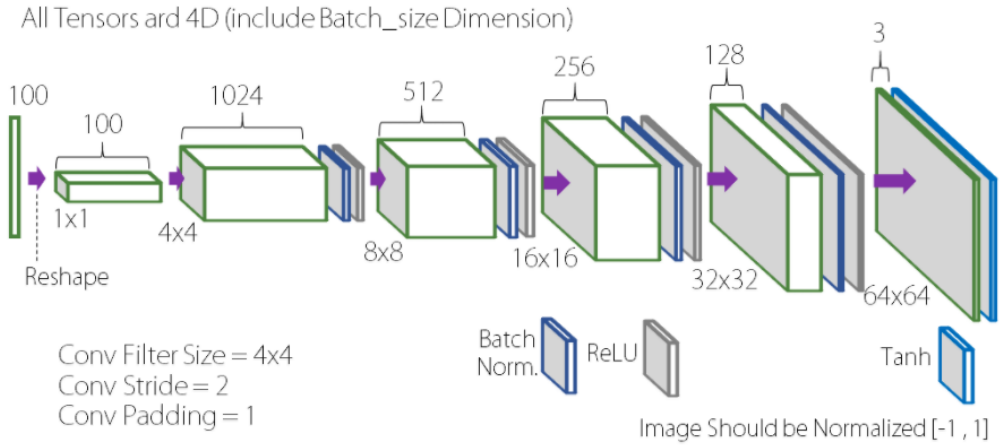


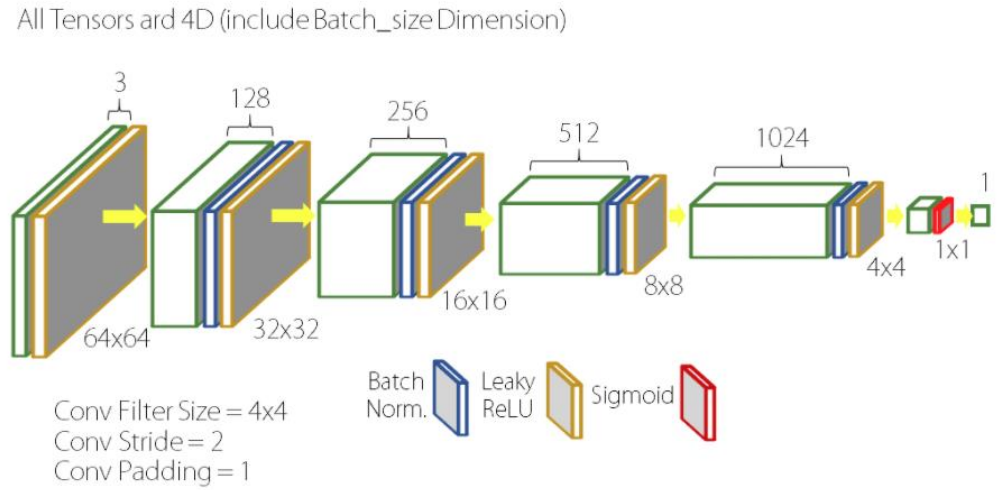


GAN

Generative Adversarial Nets **NIPS 2014**
DCGAN **Arxiv 2015**

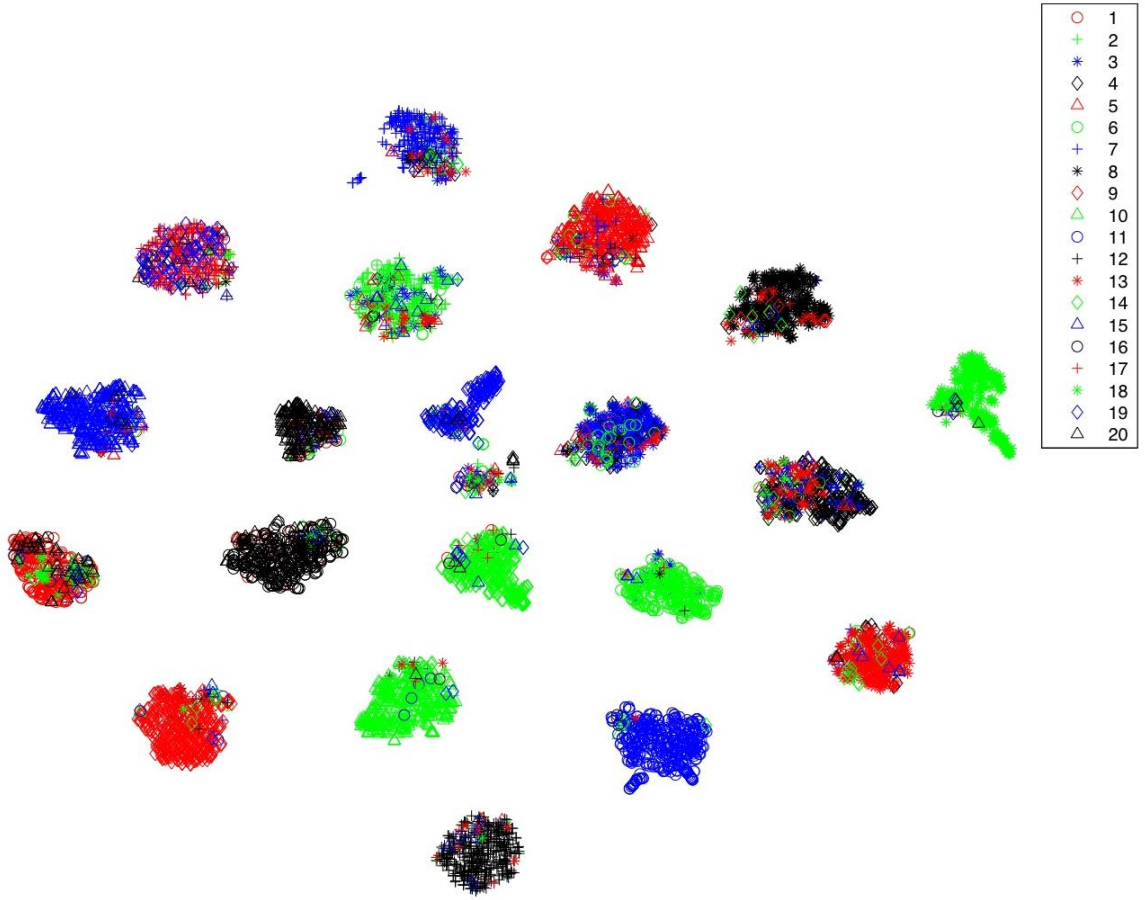






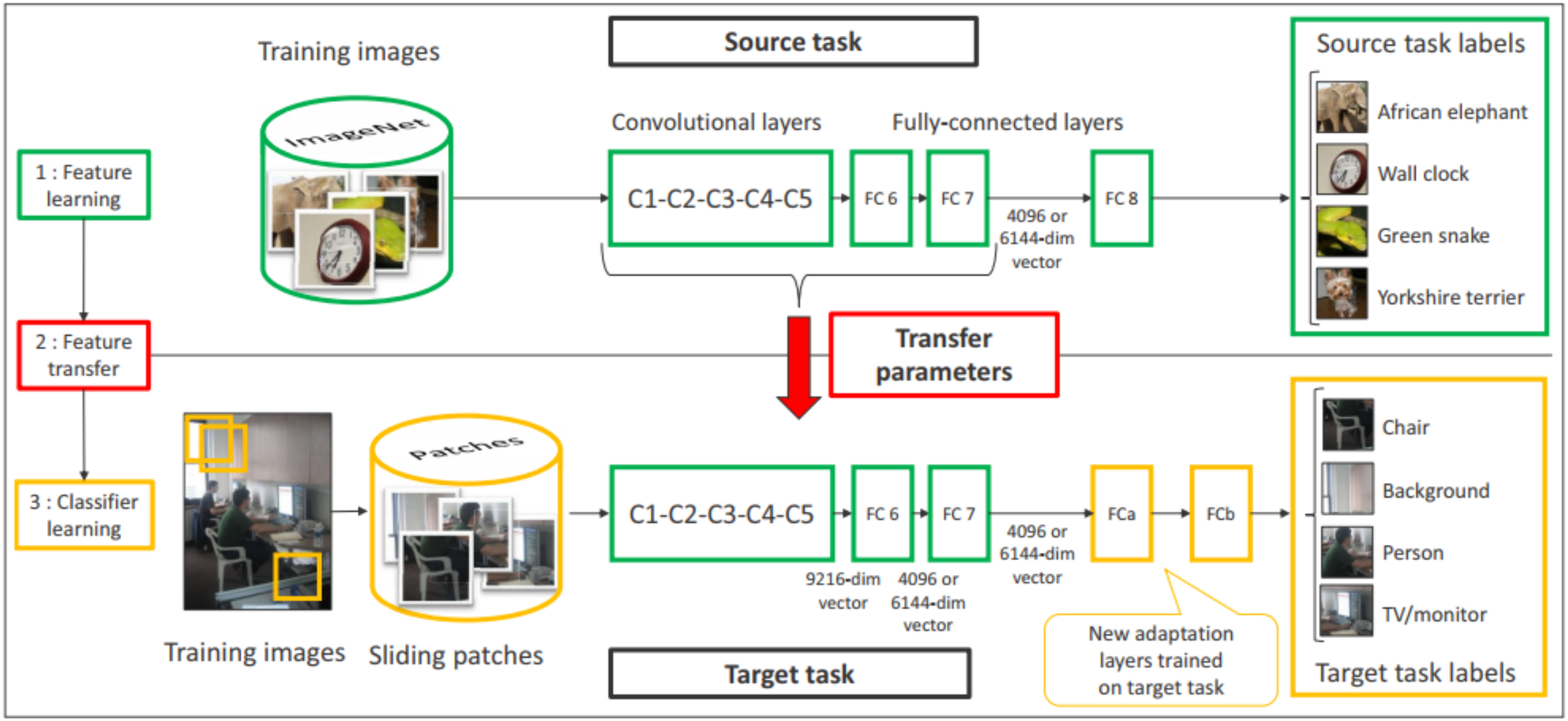
Dimension Reduction

Visualization Data using t-SNE **JMLR 2008**



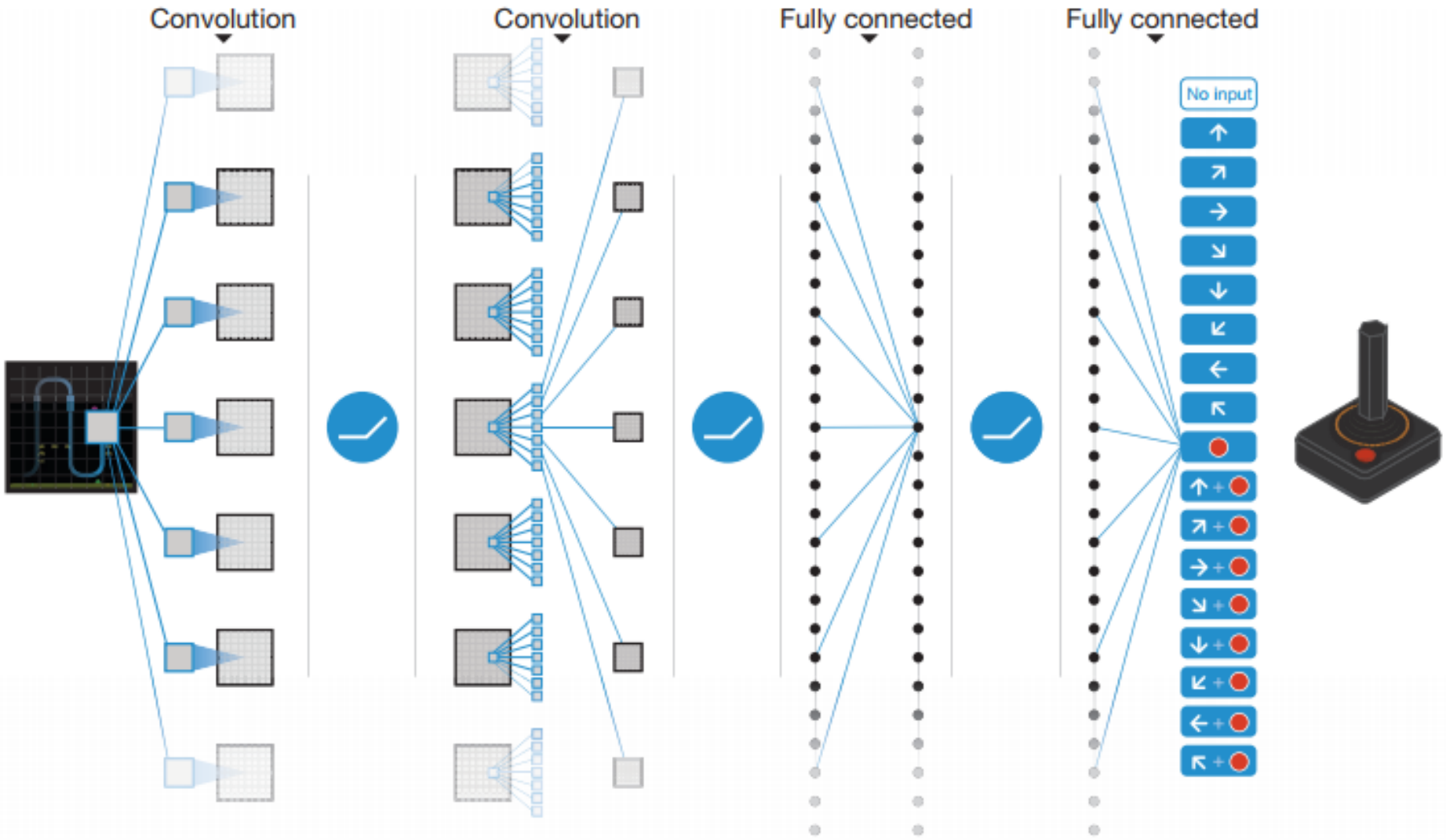
Transfer Learning

Learning and Transferring Mid-Level Image Representations using Convolutional Neural Networks **CVPR 2014**



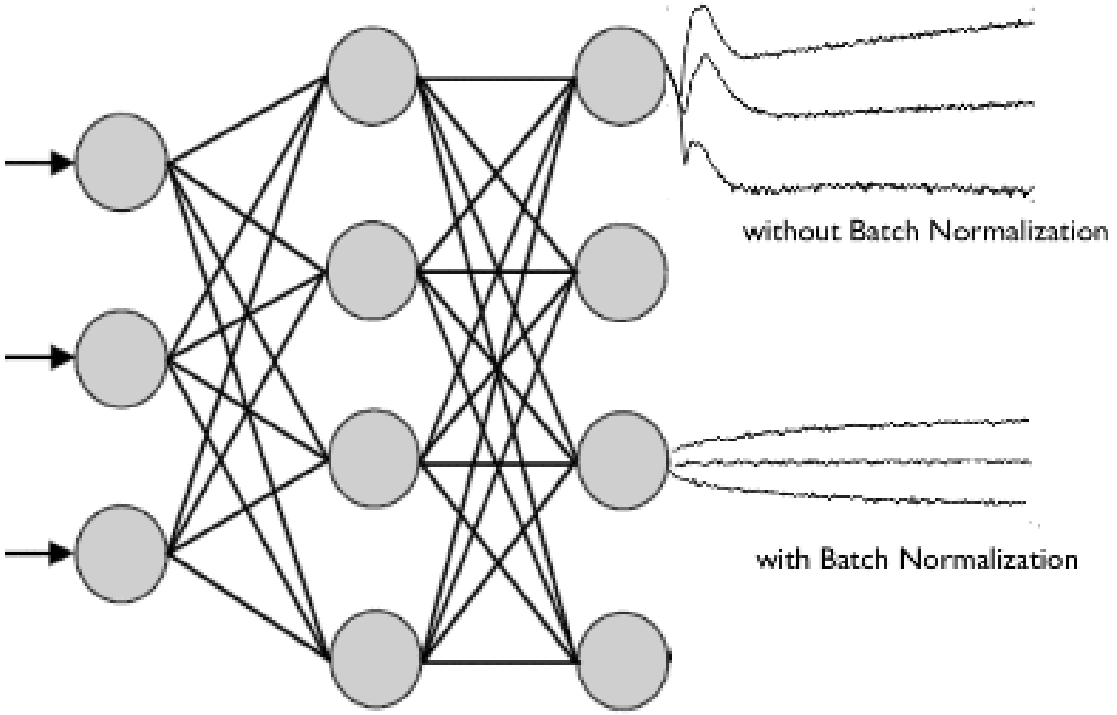
Reinforcement Learning

Human Level Control Through Deep Reinforcement Learning NATURE 2015



Training: Normalization

Batch Normalization JMLR 2015



Input: Values of x over a mini-batch: $\mathcal{B} = \{x_{1...m}\}$;
Parameters to be learned: γ, β

Output: $\{y_i = \mathrm{BN}_{\gamma,\beta}(x_i)\}$

$$\mu_{\mathcal{B}} \leftarrow \frac{1}{m}\sum_{i=1}^{m} x_i \qquad \text{// mini-batch mean}$$

$$\sigma^2_{\mathcal{B}} \leftarrow \frac{1}{m}\sum_{i=1}^{m}(x_i - \mu_{\mathcal{B}})^2 \qquad \text{// mini-batch variance}$$

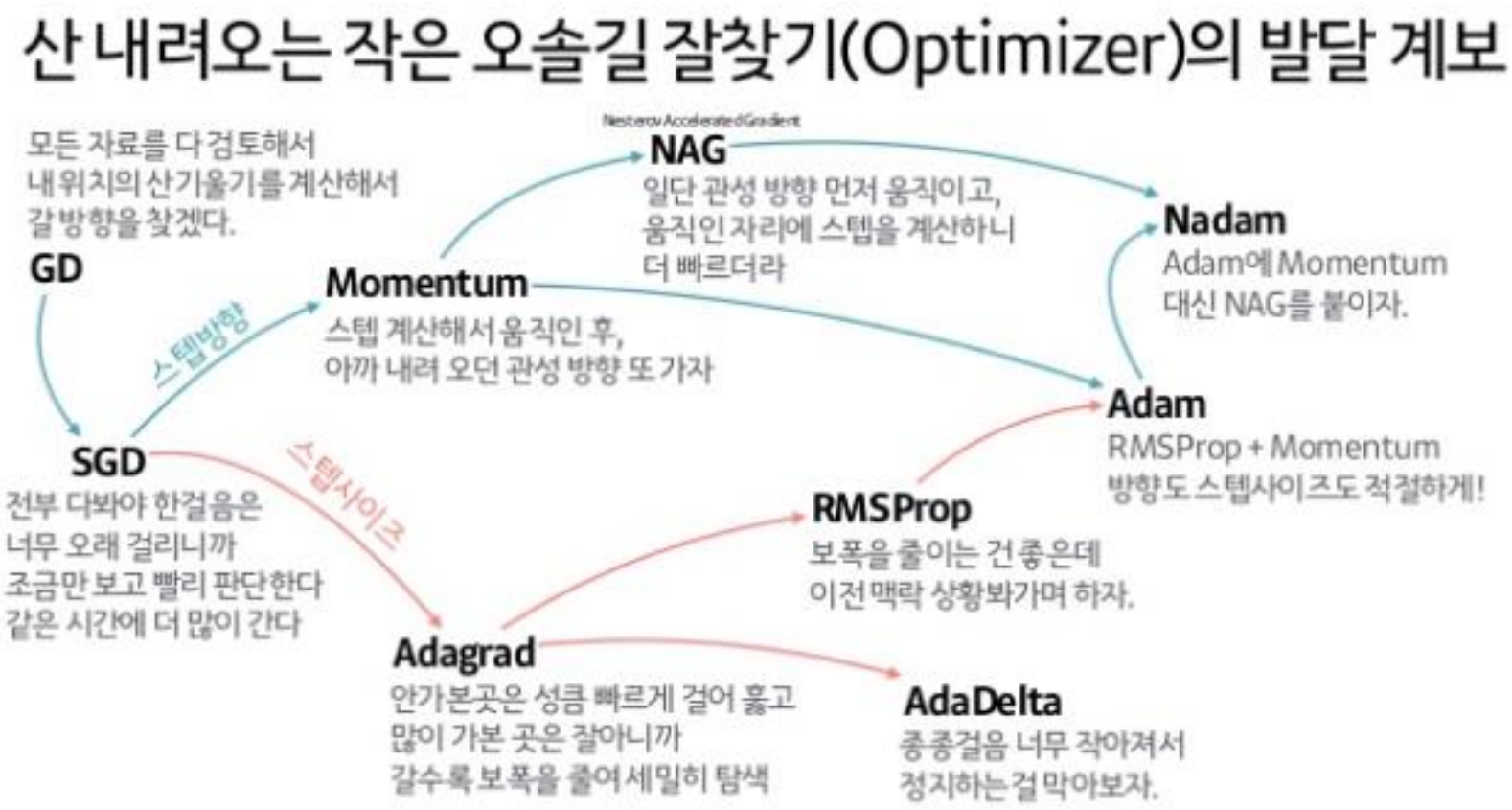
$$\widehat{x}_i \leftarrow \frac{x_i - \mu_{\mathcal{B}}}{\sqrt{\sigma^2_{\mathcal{B}} + \epsilon}} \qquad \text{// normalize}$$

$$y_i \leftarrow \gamma \widehat{x}_i + \beta \equiv \mathrm{BN}_{\gamma,\beta}(x_i) \qquad \text{// scale and shift}$$

Algorithm 1: Batch Normalizing Transform, applied to activation x over a mini-batch.

Training: Optimization

Adam: A Method for Stochastic Optimization **Arxiv 2014**



From Machine Learning to Computer Vision

1. **Define Problem**
2. Collect Data
3. Design Model
4. Training + Optimization + Regularization + ...
5. + Hand-crafted Network Components...

Restoration/Generation

Denoising, Deblurring, SuperResolution
Completion, Generation

Image Denoising

Non-local Color Image Denoising with Convolutional Neural Networks CVPR 2017

(a) (b)

Figure 1. Image denoising with the proposed deep non-local CNN model. (a) Noisy image corrupted with additive Gaussian noise ($\sigma = 25$) ; PSNR = 20.16 dB. (b) Denoised image using the 5-stage feed-forward network described in Sec. 3.3 ; PSNR = 29.53 dB.

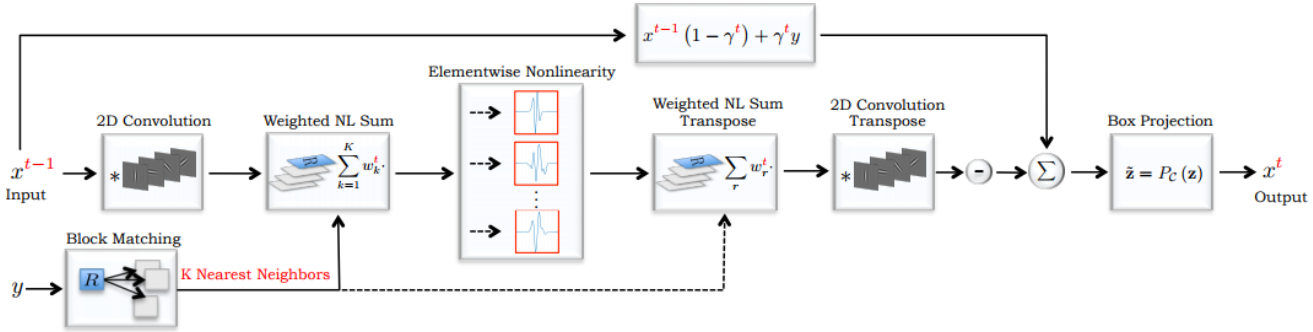


Image Deblurring

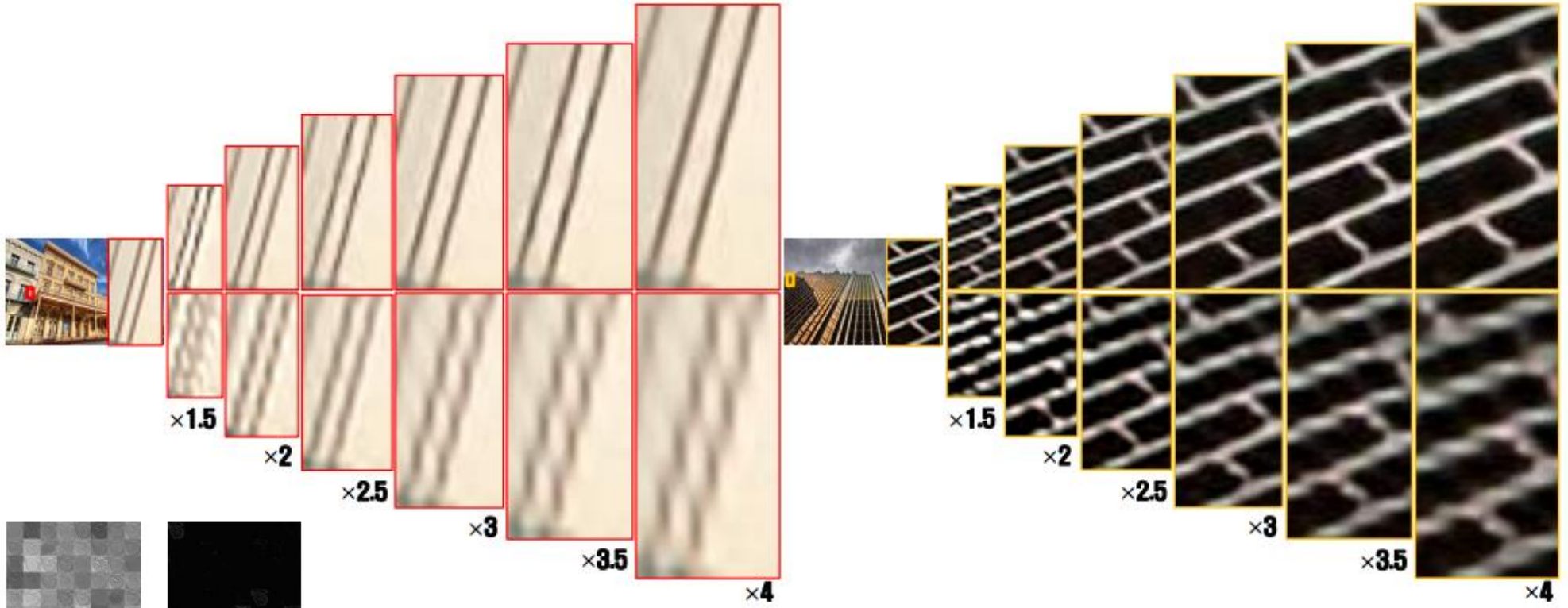
Self-paced Kernel Estimation for Robust Blind Image Deblurring **ICCV 2017**
Deep Video Deblurring for Hand-held Cameras **CVPR 2017**

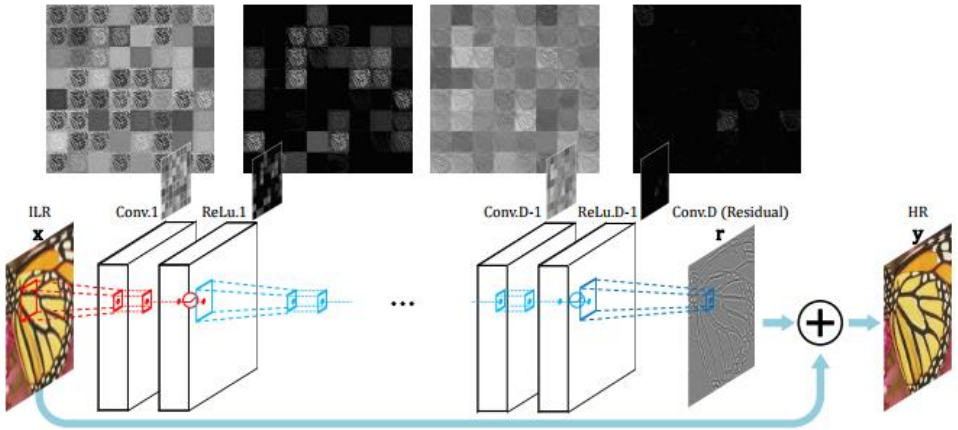
(a) Blurry image (b) Xu and Jia [37]

(c) Pan *et al.* [26] (d) Ours

Super Resolution

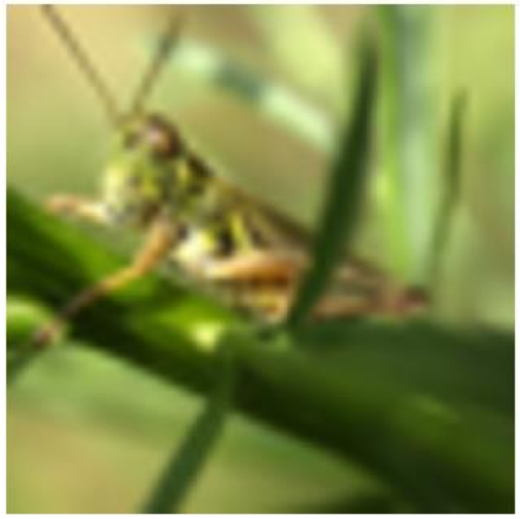
Accurate Image Super-Resolution Using Very Deep Convolutional Networks **CVPR 2016**



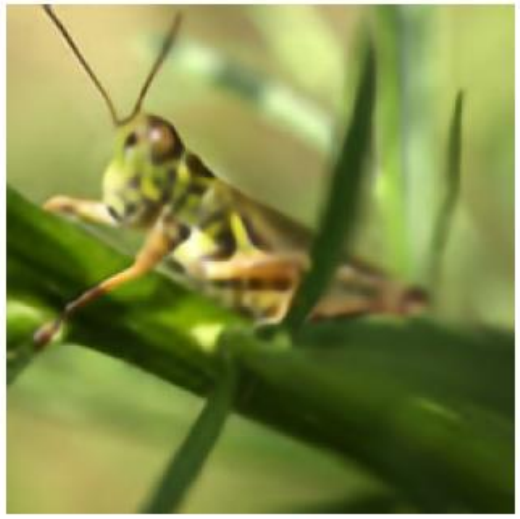


Super Resolution

EnhanceNet:Single Image Super-Resolution through Automated Texture Synthesis **ICCV 2017**



Bicubic



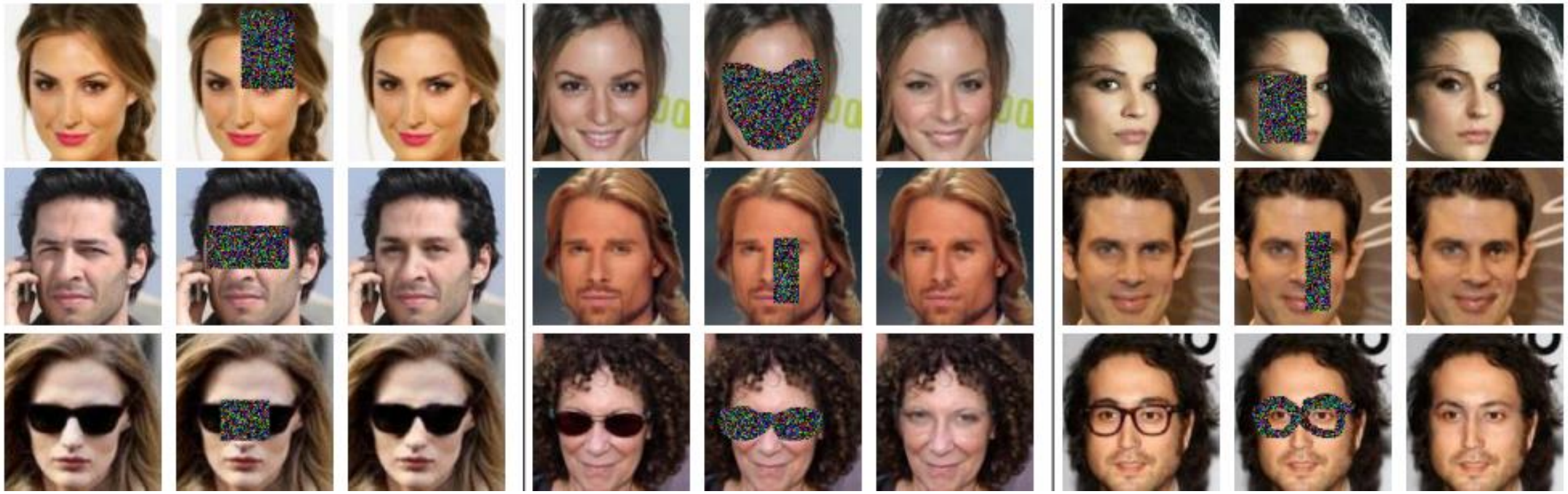
ENet-E

ENet-PAT

Ground Truth

Image Completion

Generative Face Completion CVPR 2017



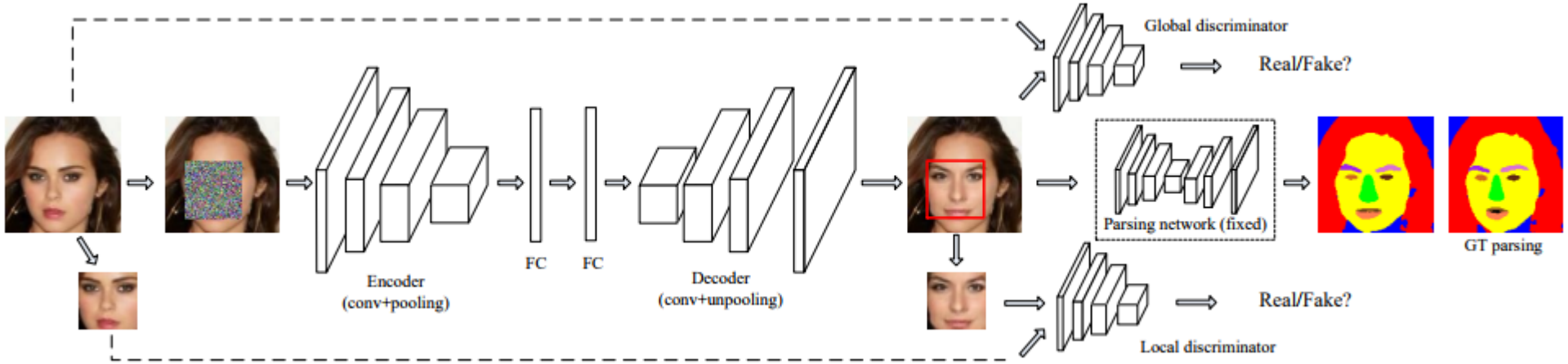


Image Completion

Pixel RNN **Arxiv 2016**

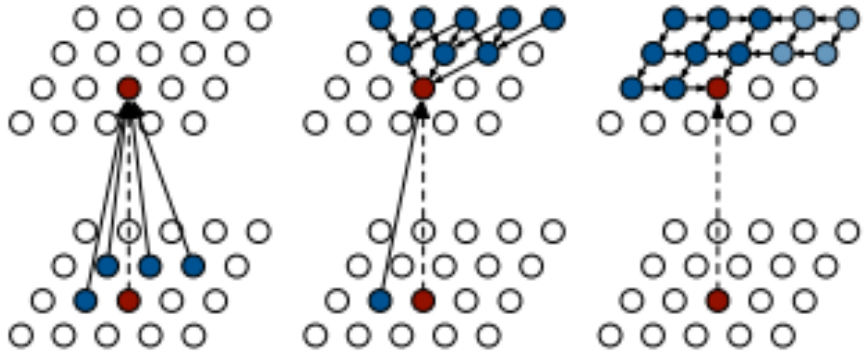


Figure 1. Image completions sampled from a PixelRNN.

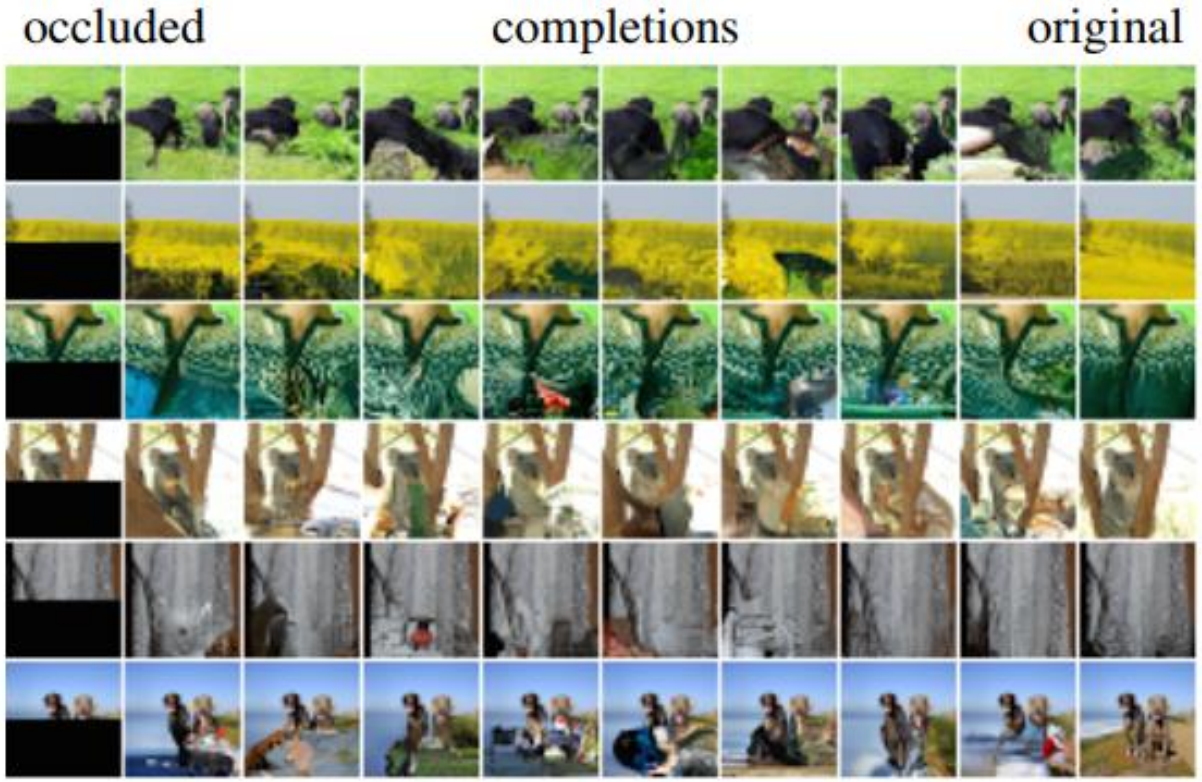
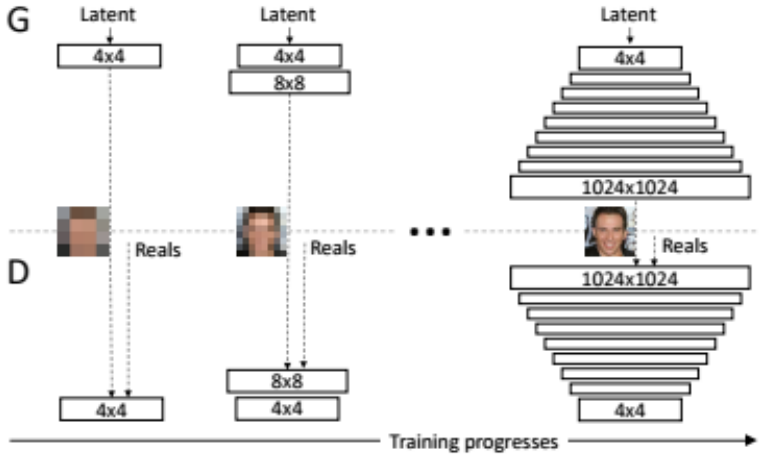


Image Generation

Progressive Growing of GANs for Improved Quality, Stability, and Variation **Arxiv 2017**



1024x1024

Gulrajani et al. (2017) (128 × 128)

Our (256 × 256)

Enhancement

Texture Removal, Depth Enhancement/SuperResolution
Contrast Enhancement, Quality Assessment

Texture Removal

Robust Guided Image Filtering Using Nonconvex Potentials IEEE TPAMI 2017

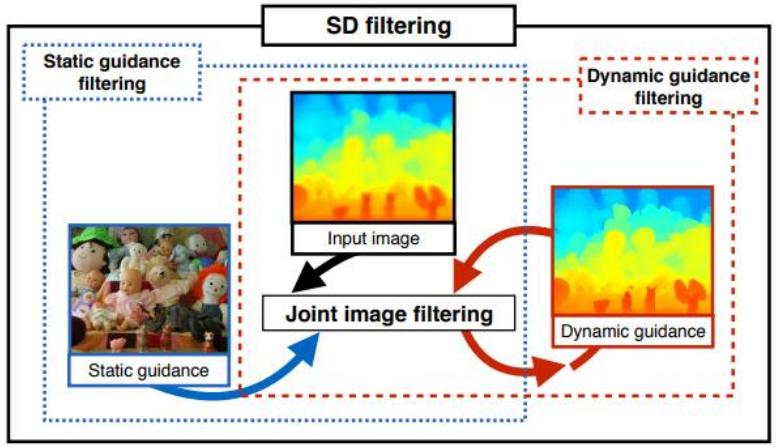
(a) WLS [23].

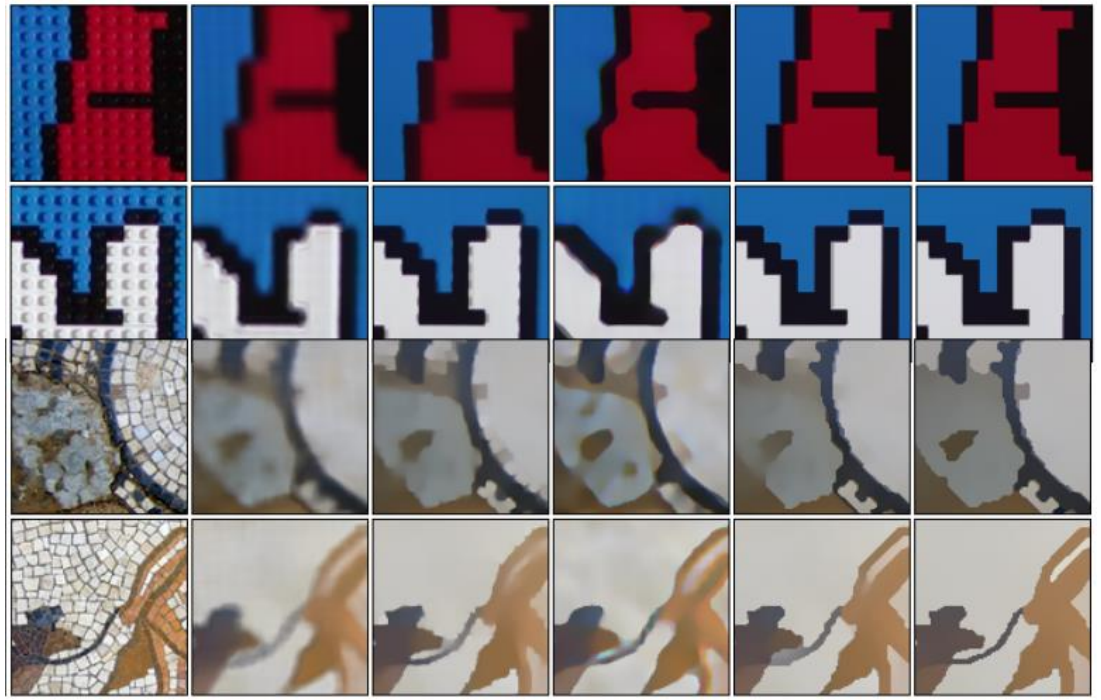
(b) WLS [23].

(c) RGF [16].

(d) SD filter ($\mathbf{u}^0 = \mathbf{u}_{l_2}$).

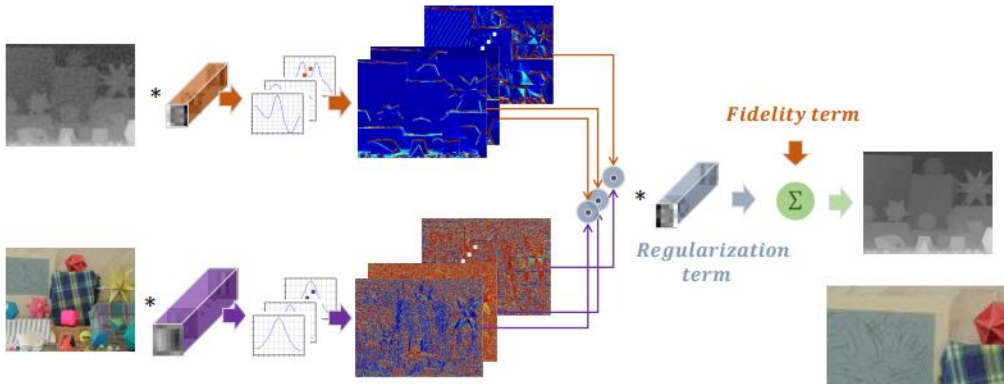
(e) SD filter ($\mathbf{u}^0 = \mathbf{u}_{l_1}$).

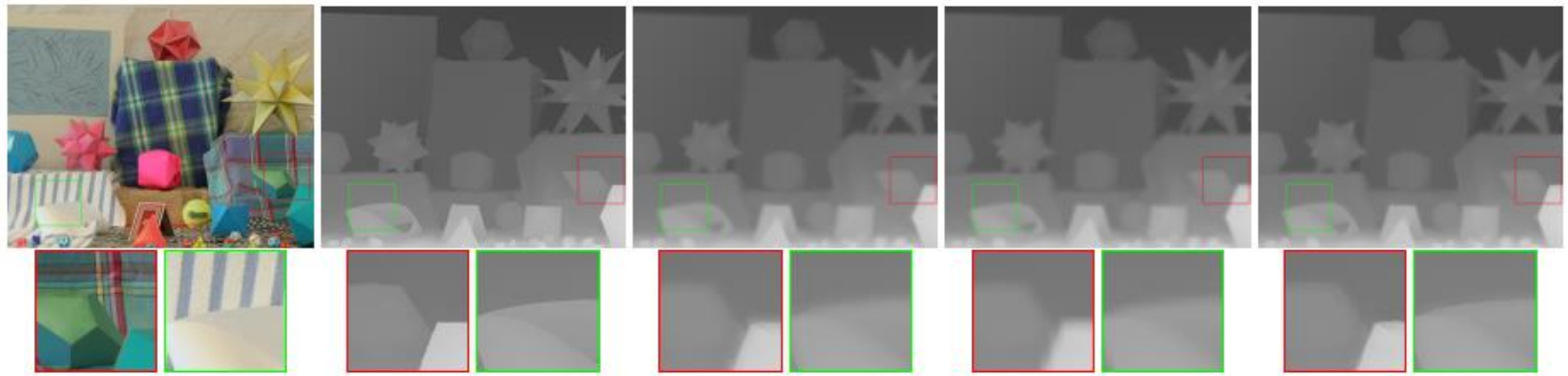




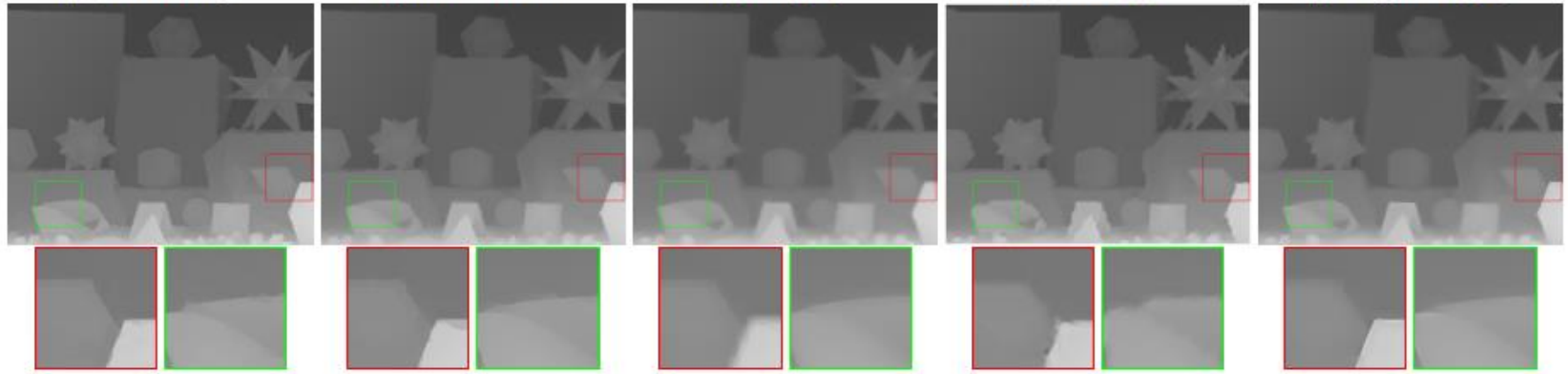
Depth Enhancement

Learning Dynamic Guidance for Depth Image Enhancement CVPR 2017





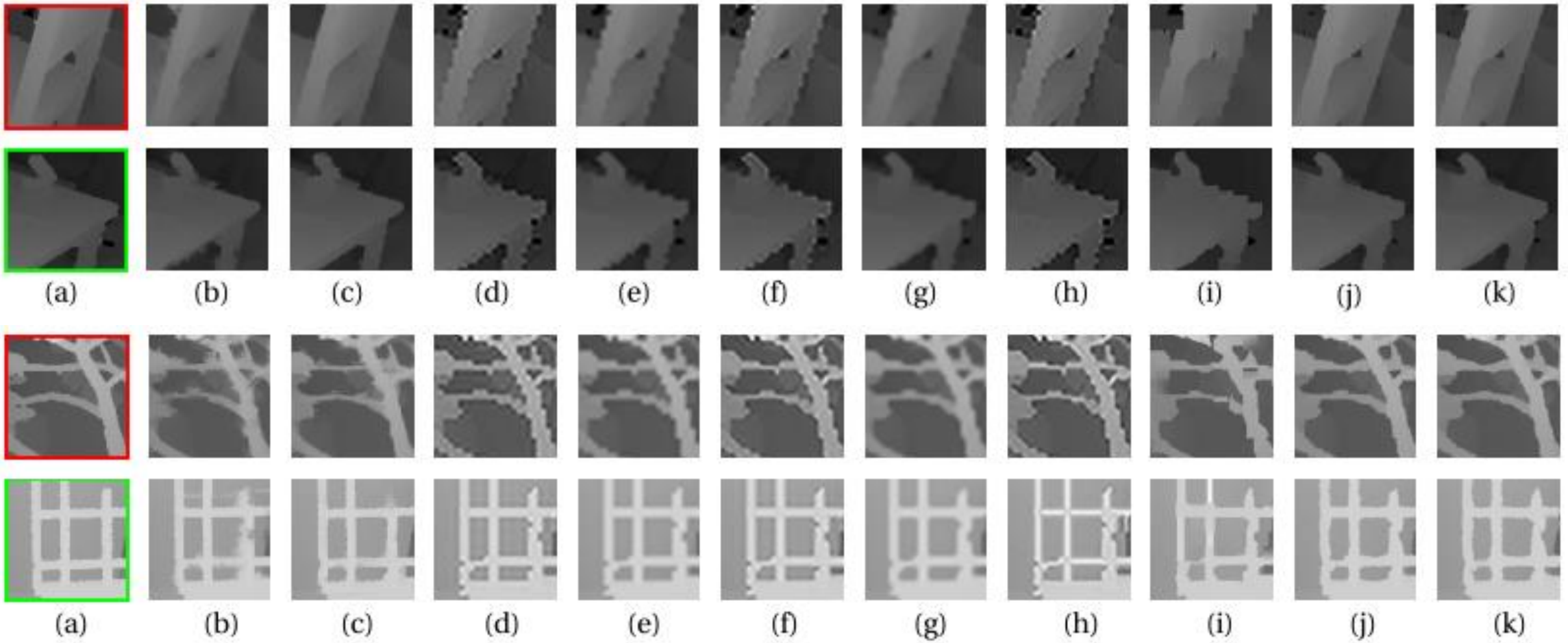
(a) Color Image (b) Ground Truth (c) GF [13] (d) MRF [4] (e) Yang et al. [37]



(f) Park et al. [28] (g) TGV [6] (h) SDF [12] (i) DJF [22] (j) Ours

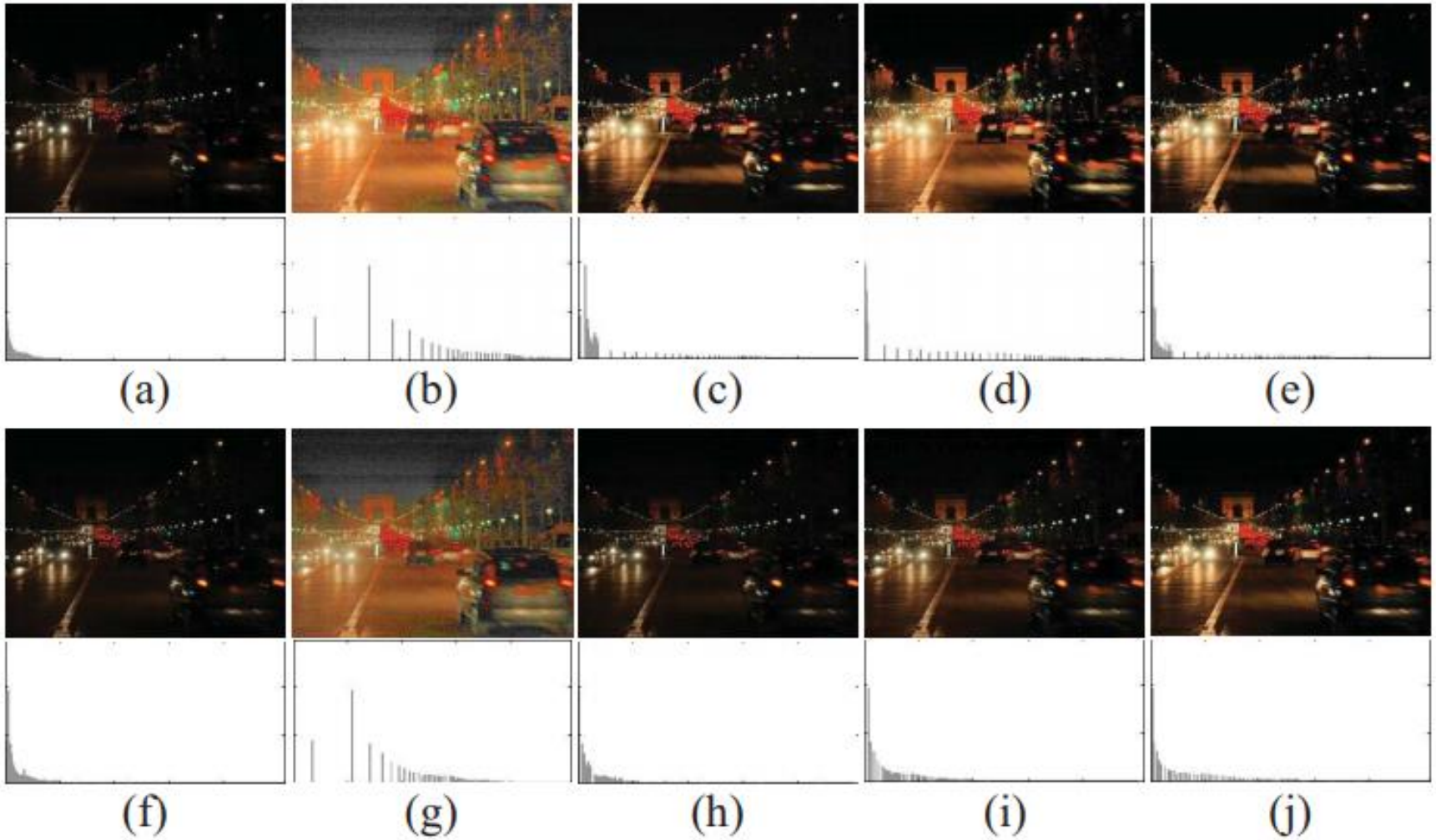
Depth Super Resolution

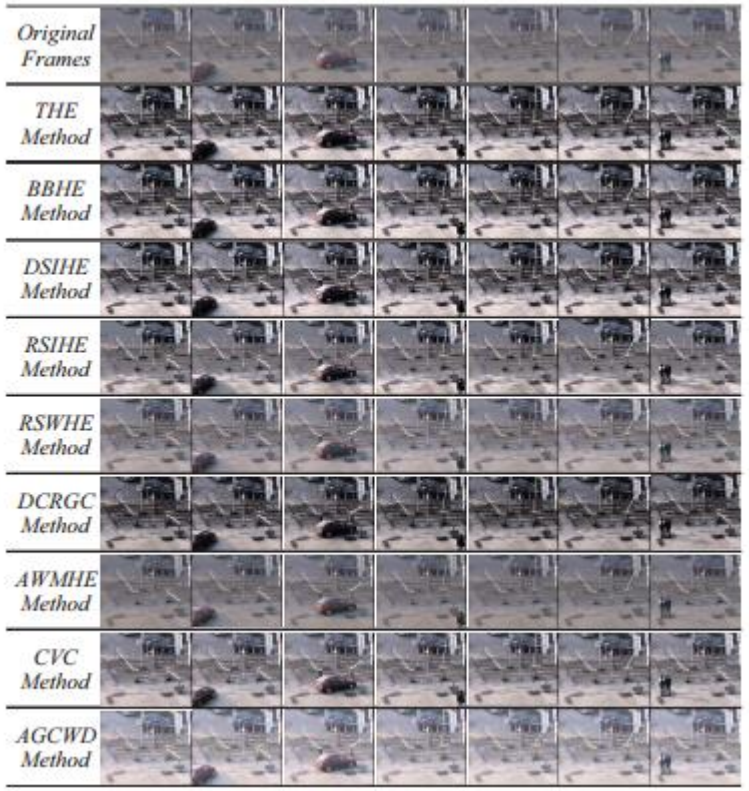
Edge-Guided Single Depth Image Super Resolution **IEEE TIP 2016**



Contrast Enhancement

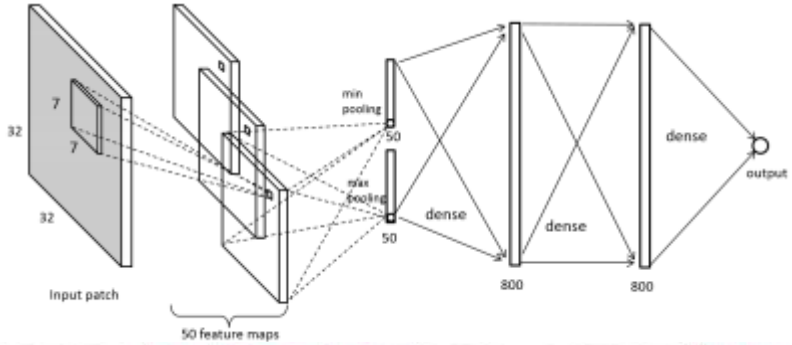
Efficient Contrast Enhancement Using Adaptive Gamma Correction With Weighting Distribution IEEE TIP 2013





Quality Assessment

Convolutional Neural Networks for No-Reference Image Quality Assessment CVPR 2014

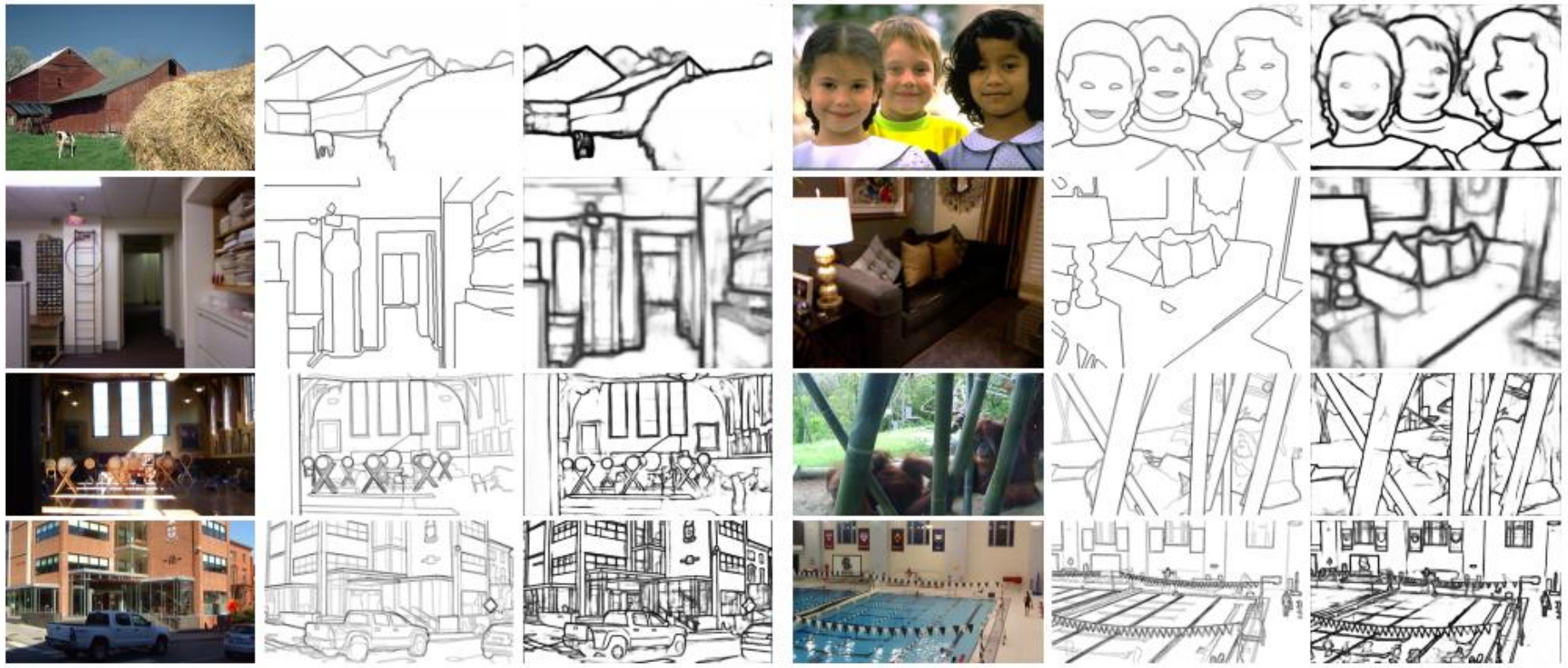


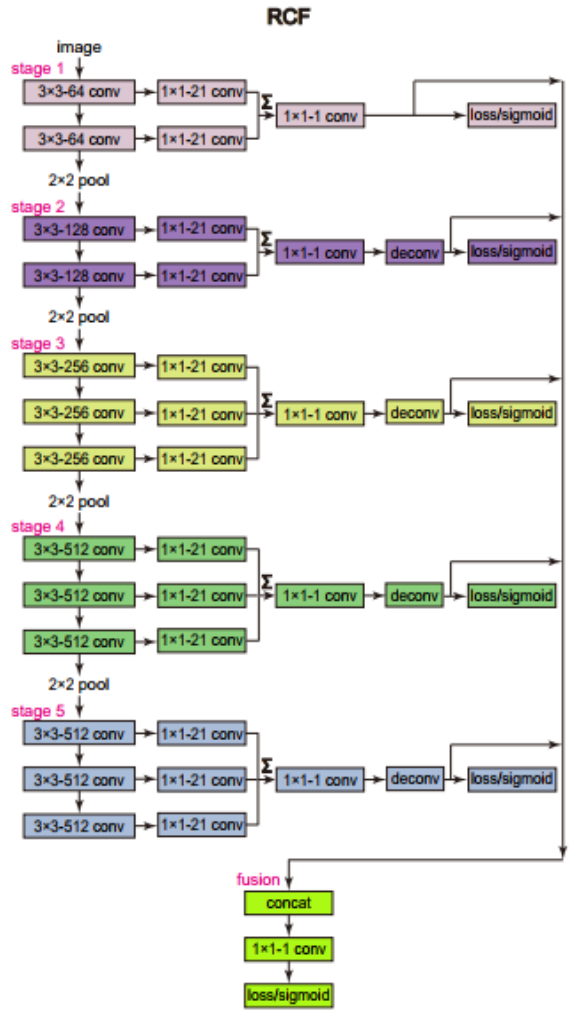
Segmentation

Edge Detection, Superpixels
Semantic Instance Segmentation, Video Segmentation

Edge Detection

Richer Convolutional Features For Edge Detection **CVPR 2017**

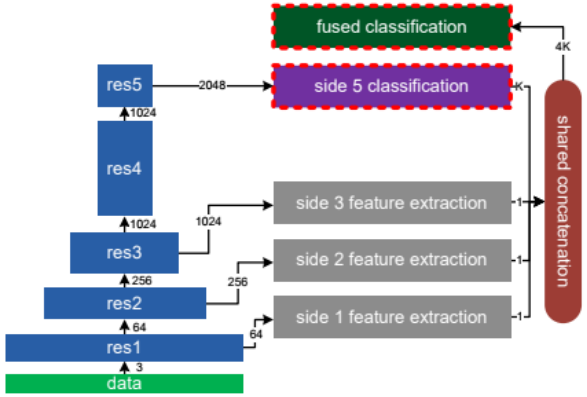




Semantic Edge Detection

CASENet: Deep Category-Aware Semantic Edge Detection CVPR 2017

(a) Input image



(c) CASENet

(b) Ground truth

(c) CASENet output

building+pole	road+sidewalk	road	sidewalk+building	building+traffic sign	building+car	road+car
building	building+vegetation	road+pole	building+sky	pole+car	building+person	pole+vegetation

Superpixels

Real-Time Coarse-to-fine Topologically Preserving Segmentation CVPR 2015

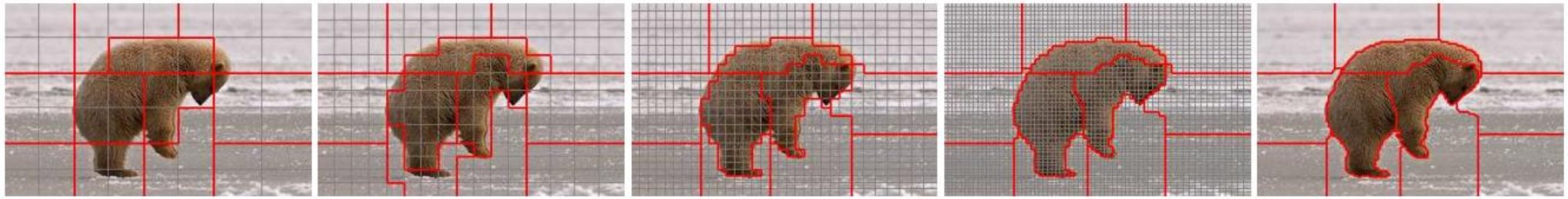


Figure 2. Coarse-to-fine boundary-level updates start at the coarse level (left) and proceeds to the finest level iteratively. The final result, defined on the finest (pixel) level, is shown on the right.

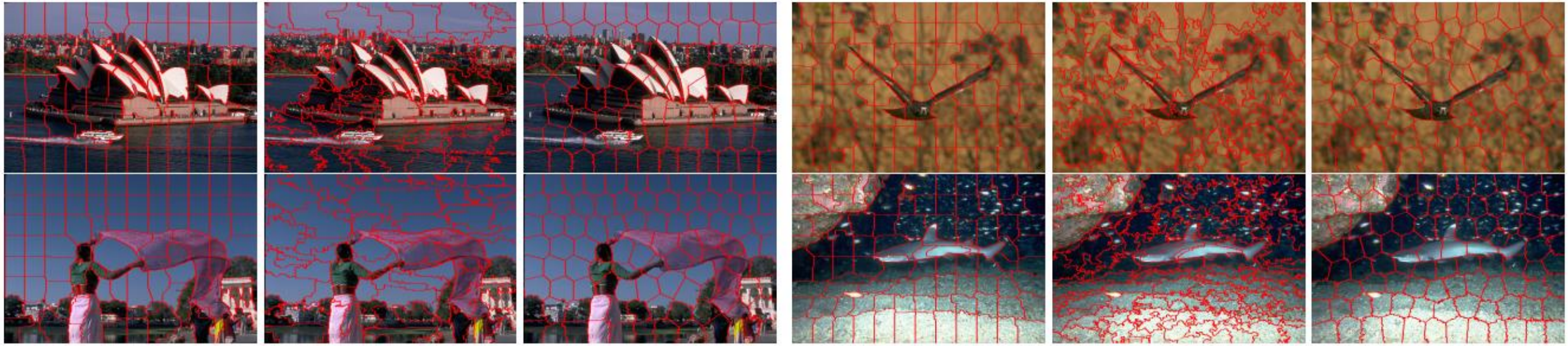
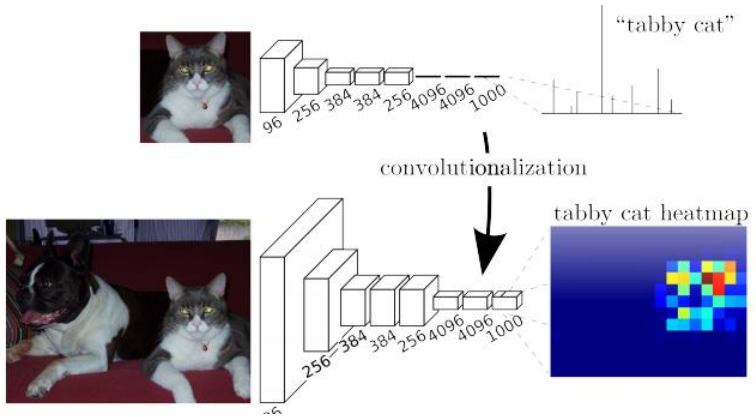


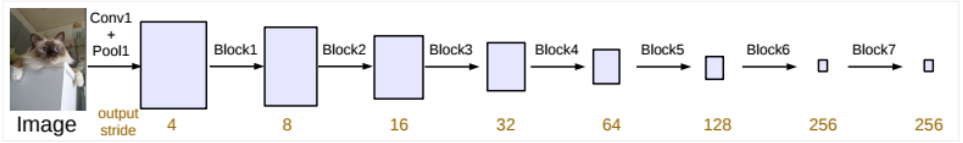
Figure 6. **BSD:** Qualitative results. Left to Right: Ours, SEEDS [7], SLIC [1]. Our approach better snaps to the image boundaries.

Semantic Segmentation

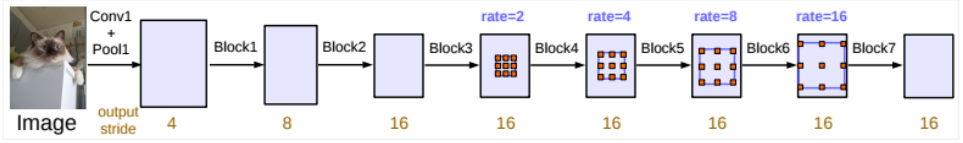
Rethinking Atrous Convolution for Semantic Image Segmentation (DeepLab-3)

Arxiv 2017



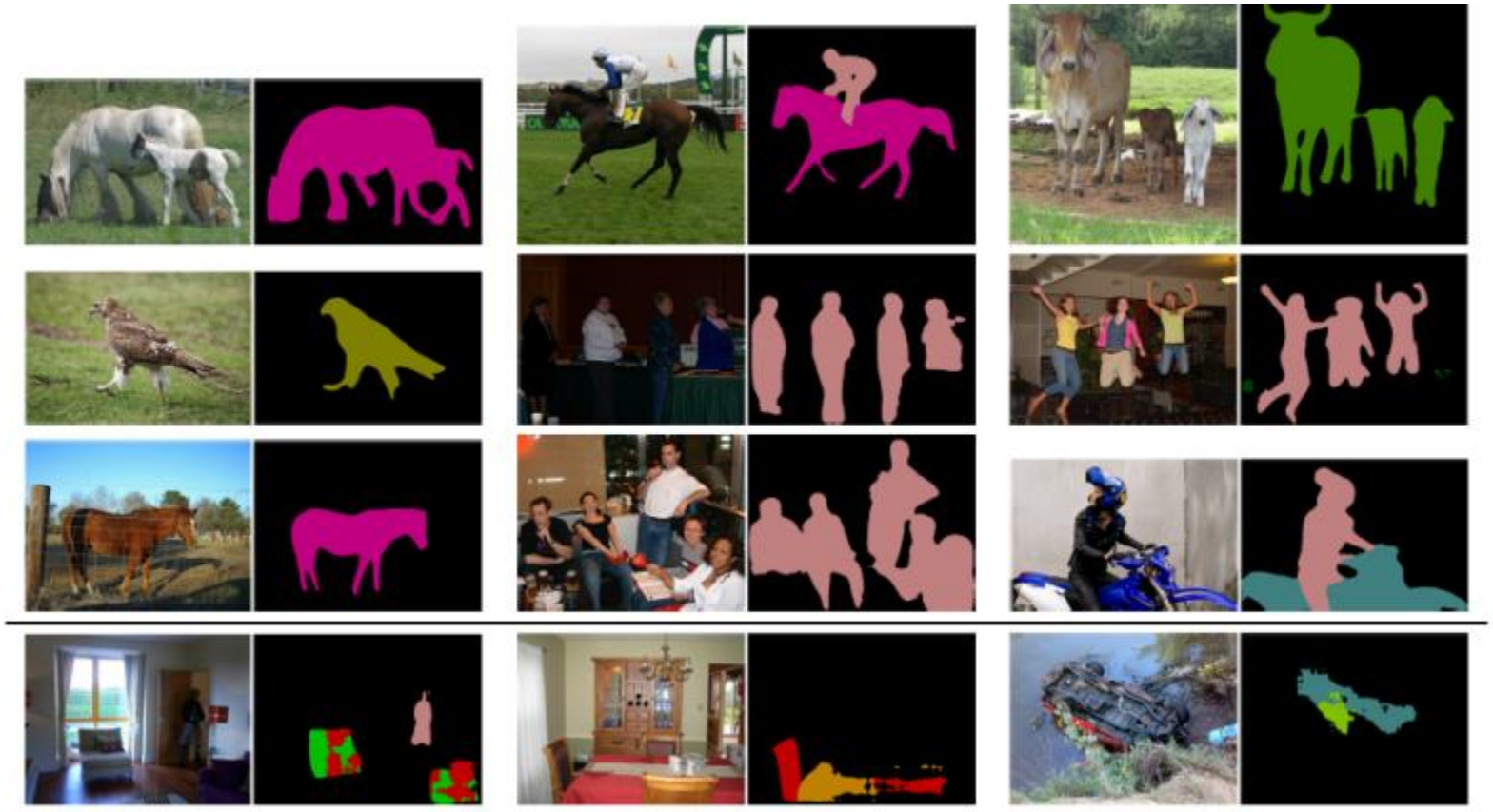


(a) Going deeper without atrous convolution.



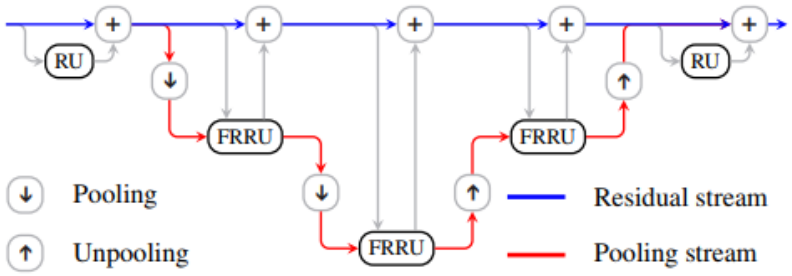
(b) Going deeper with atrous convolution. Atrous convolution with $rate > 1$ is applied after block3 when $output\_stride = 16$.

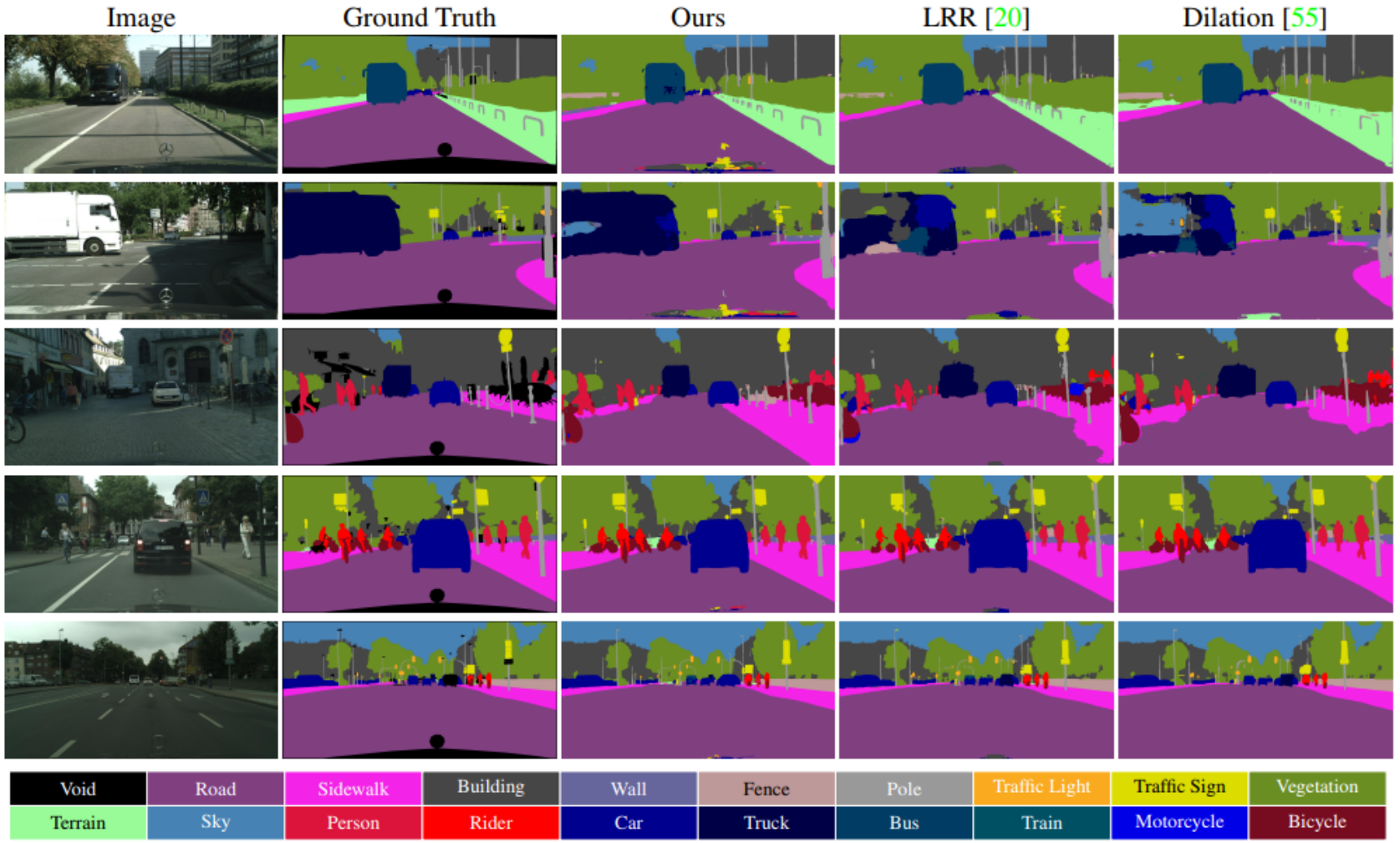
Figure 3. Cascaded modules without and with atrous convolution.



Semantic Segmentation

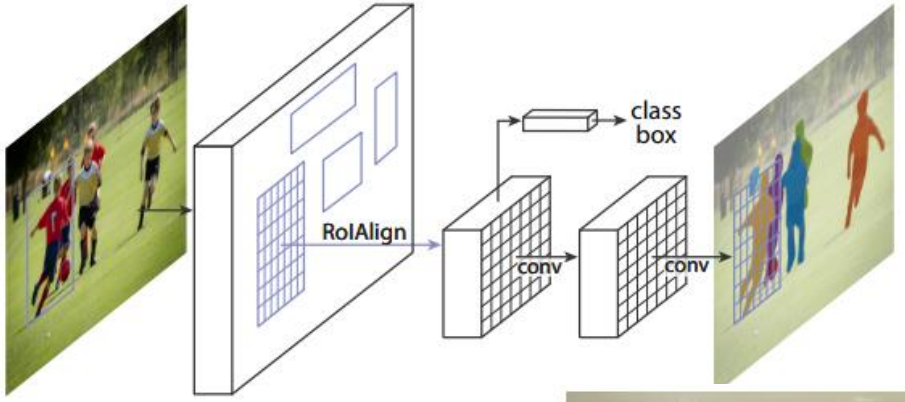
Full-Resolution Residual Networks for Semantic Segmentation in Street Scenes CVPR 2017





Instance Segmentation

Mask R-CNN ICCV 2017



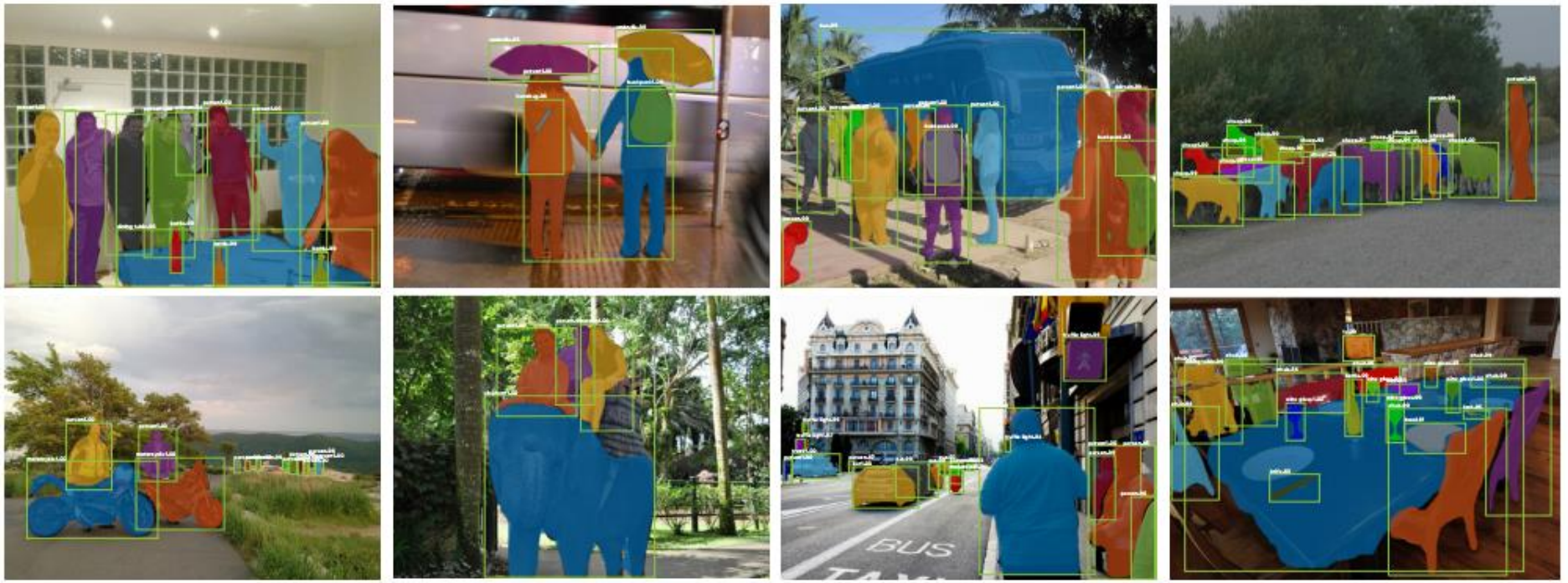
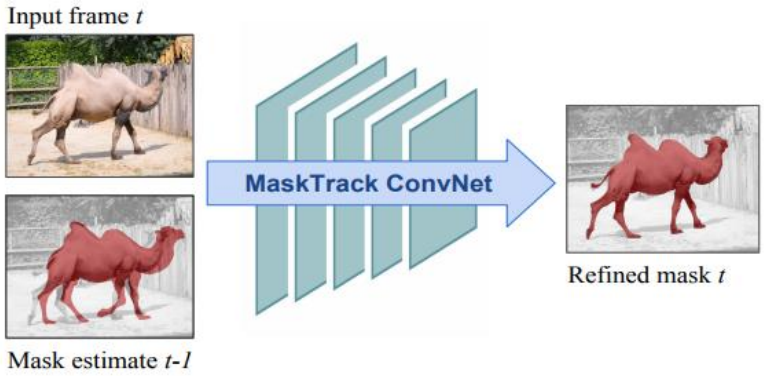
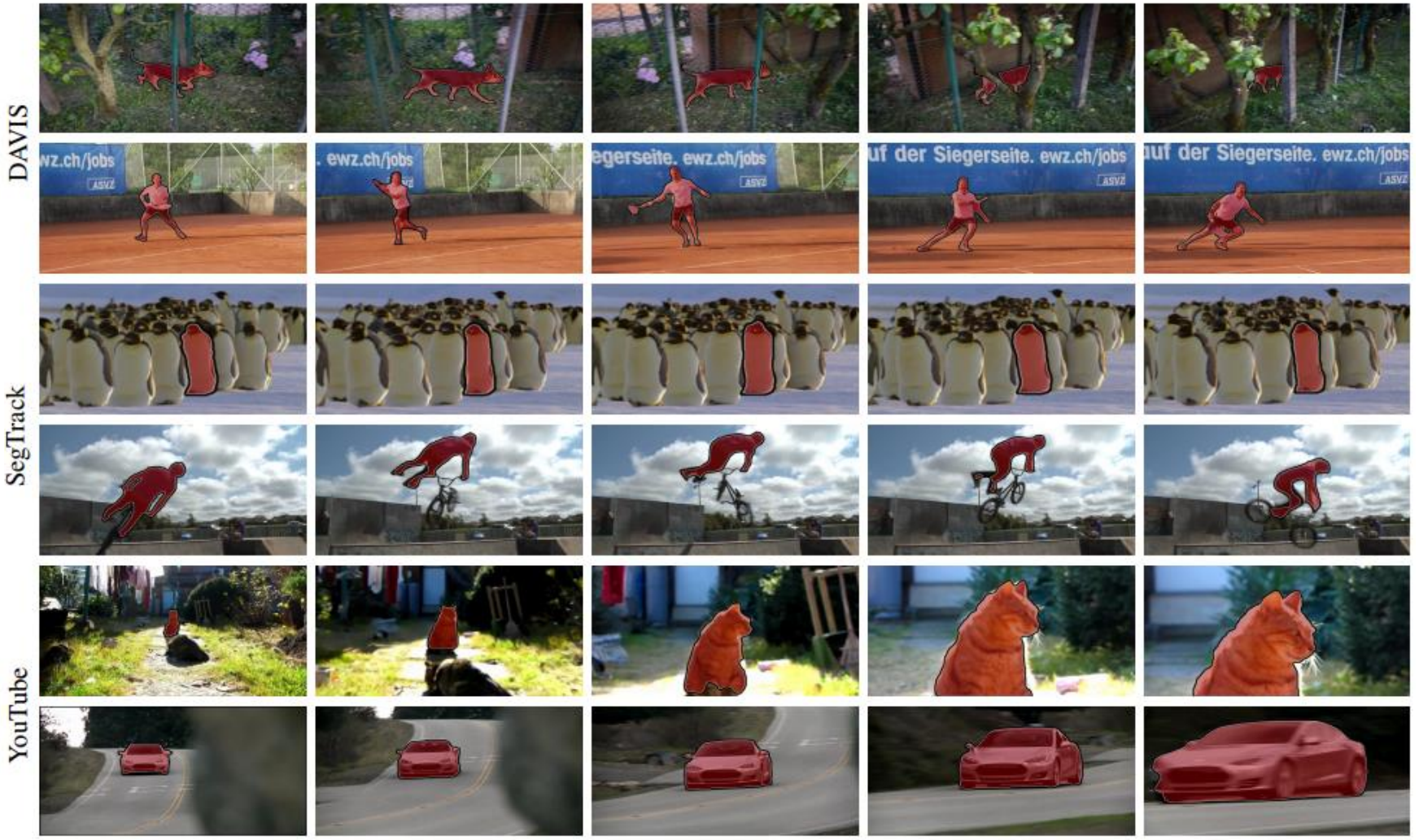


Figure 2. **Mask R-CNN** results on the COCO test set. These results are based on ResNet-101 [19], achieving a *mask* AP of 35.7 and running at 5 fps. Masks are shown in color, and bounding box, category, and confidences are also shown.

Video Segmentation

Learning Video Object Segmentation from Static Images CVPR 2017





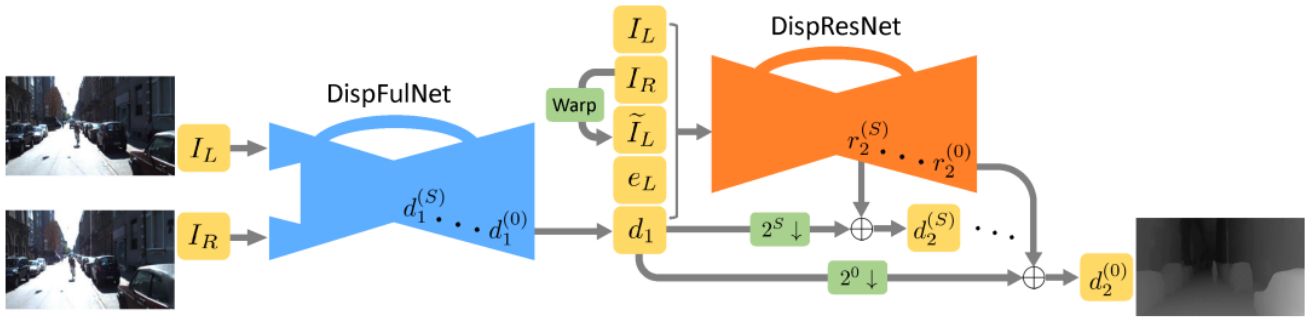
1st frame, GT segment Results with `MaskTrack`, the frames are chosen equally distant based on the video sequence length

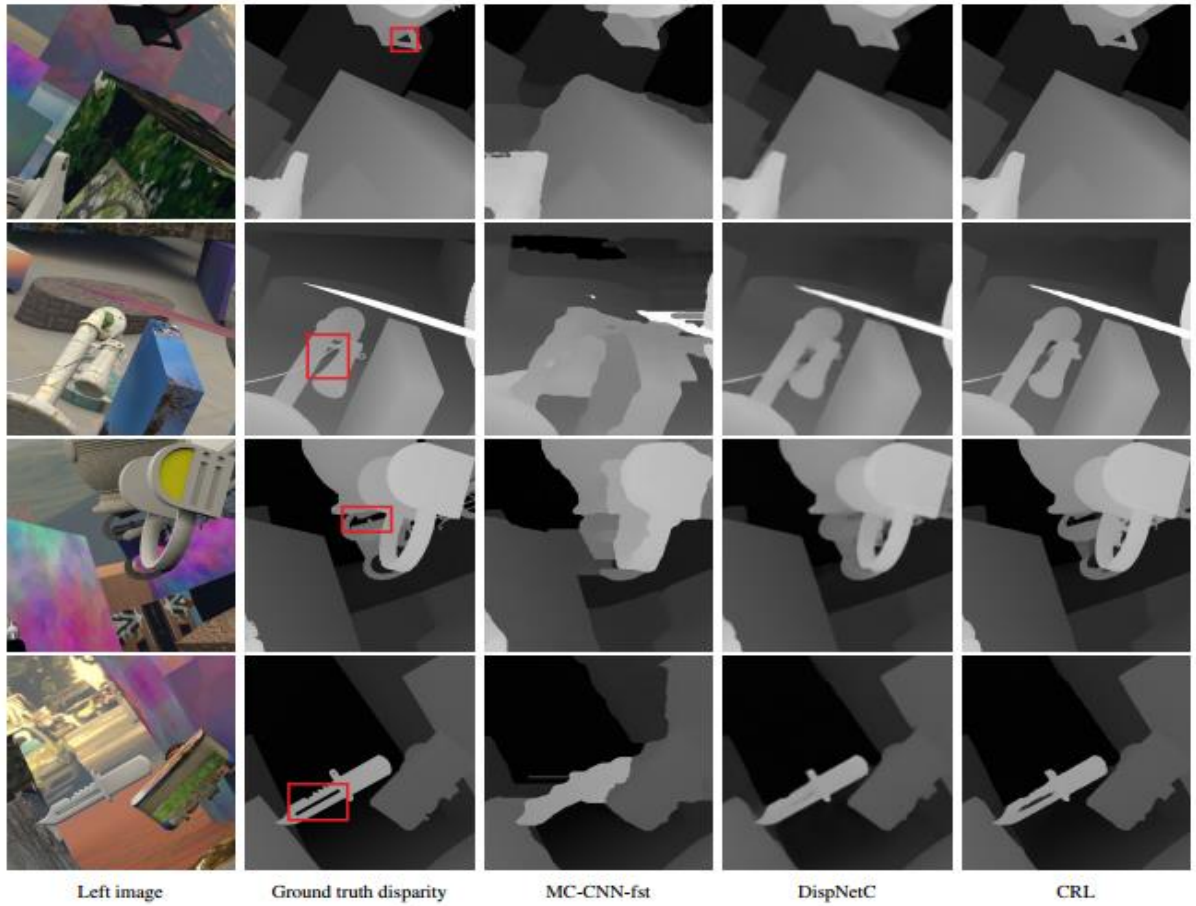
3D Vision

Stereo Matching, 2D to 3D
Instrinsic Image Decomposition, Visual SLAM

Stereo Matching

Cascade Residual Learning: A Two-stage Convolutional Neural Network for Stereo Matching **Arxiv 2017**





2D to 3D

KillingFusion: Non-rigid 3D Reconstruction without Correspondences CVPR 2017

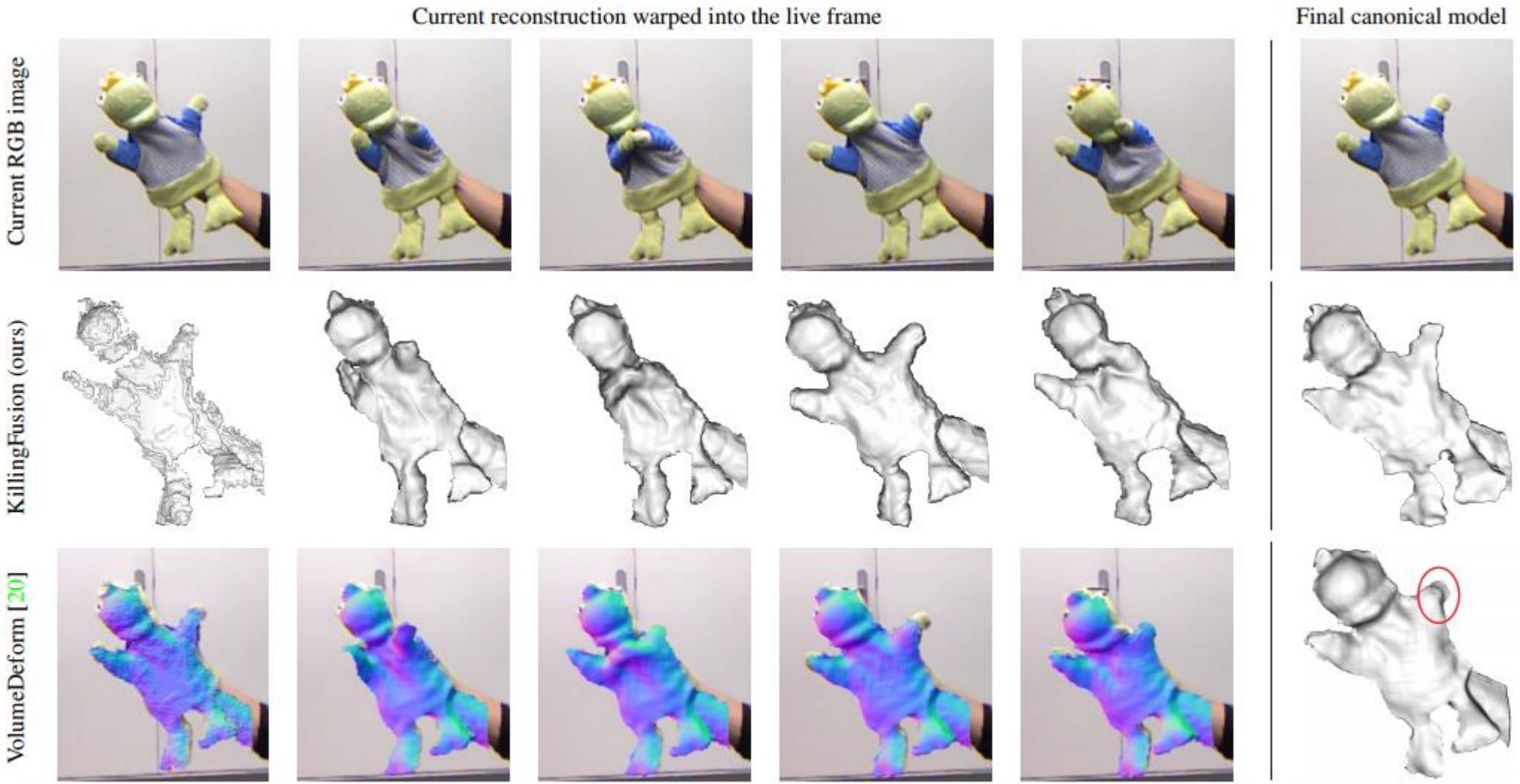
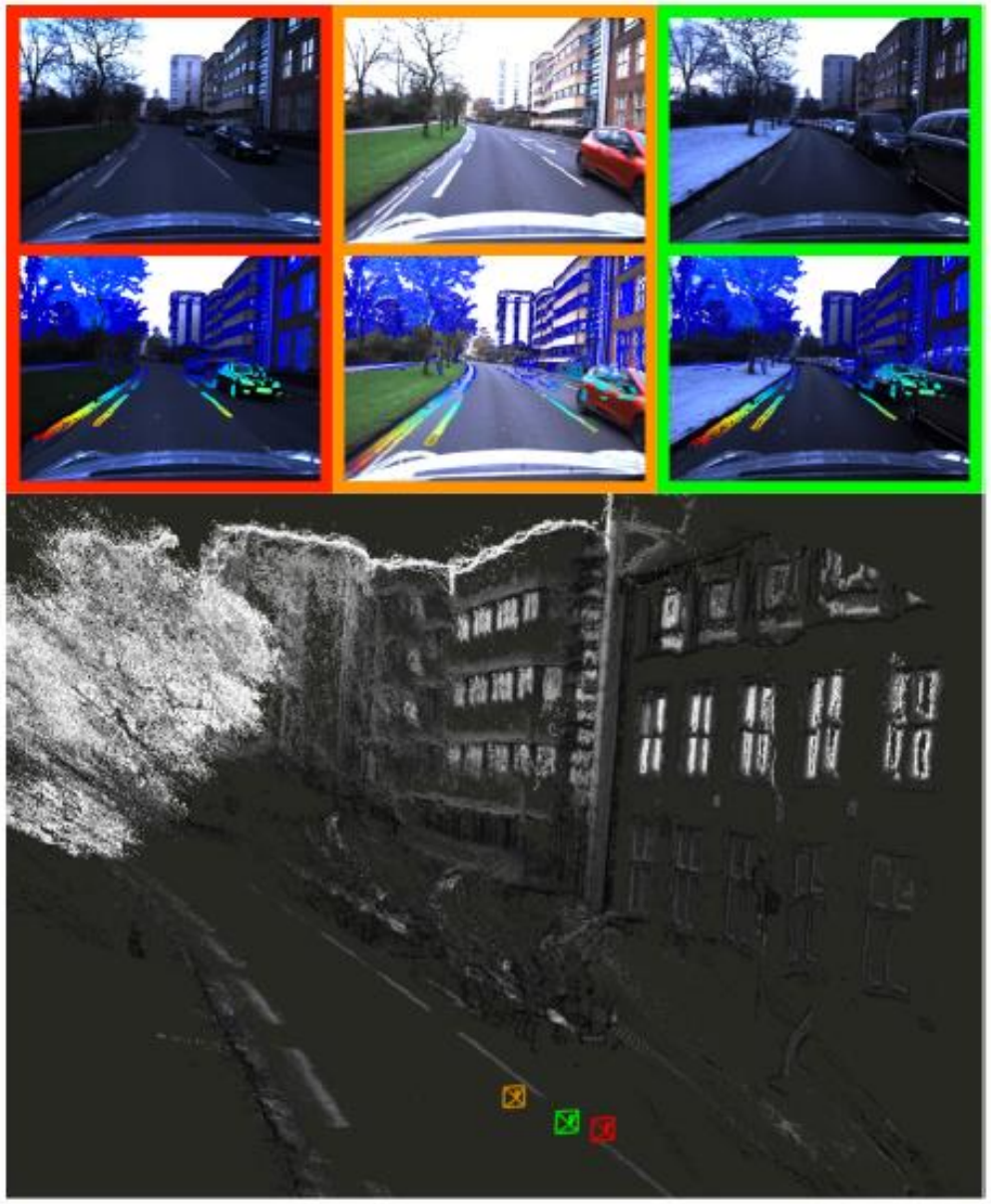
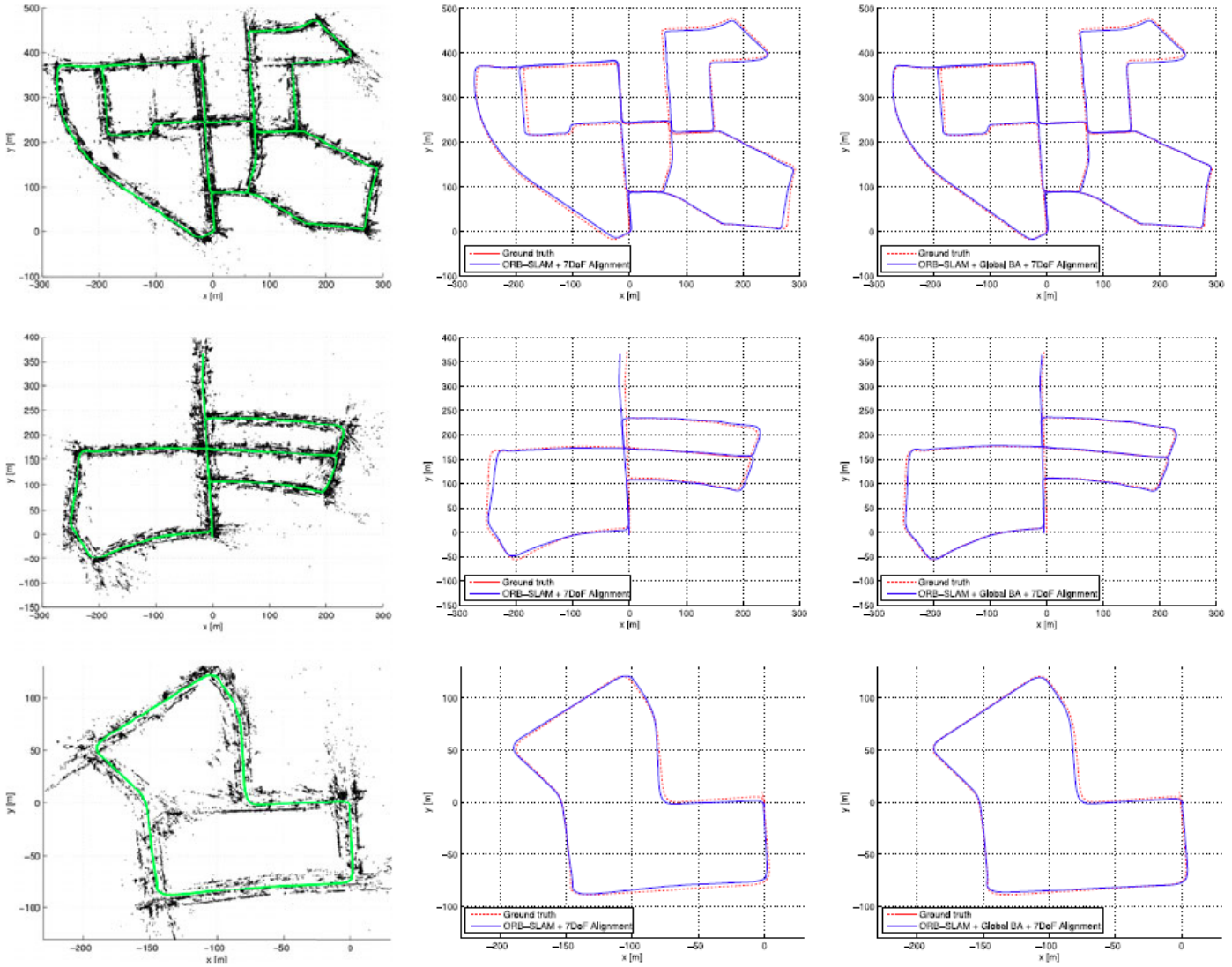


Figure 3. Comparison under **topological changes**. Our level-set-based KillingFusion fully evolves into the correct geometric shape between frames, while VolumeDeform [20] does so only partially (3rd and 5th live frames), which is reflected as artifacts in the final reconstruction.

Visual SLAM

ORB-SLAM **IROS 2015**
NID-SLAM **CVPR 2017**





Intrinsic Image Decomposition

DARN: a Deep Adversial Residual Network for Intrinsic Image Decomposition **Arxiv 2016**

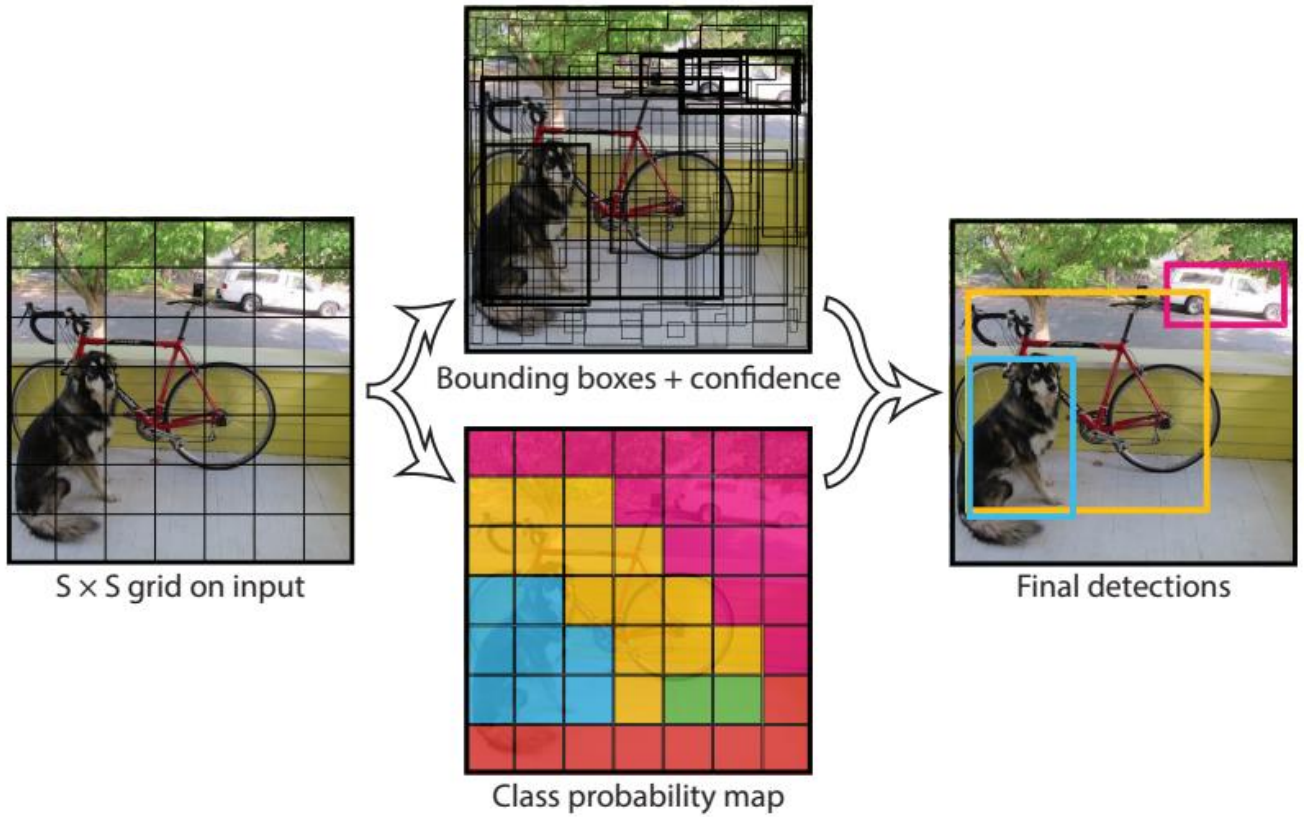
Recognition/Detection/Retrieval

Object/Face Detection, Fine Grained Recognition
Pose Estimation, Keypoint/Landmark Detection
Retrieval

Object Detection

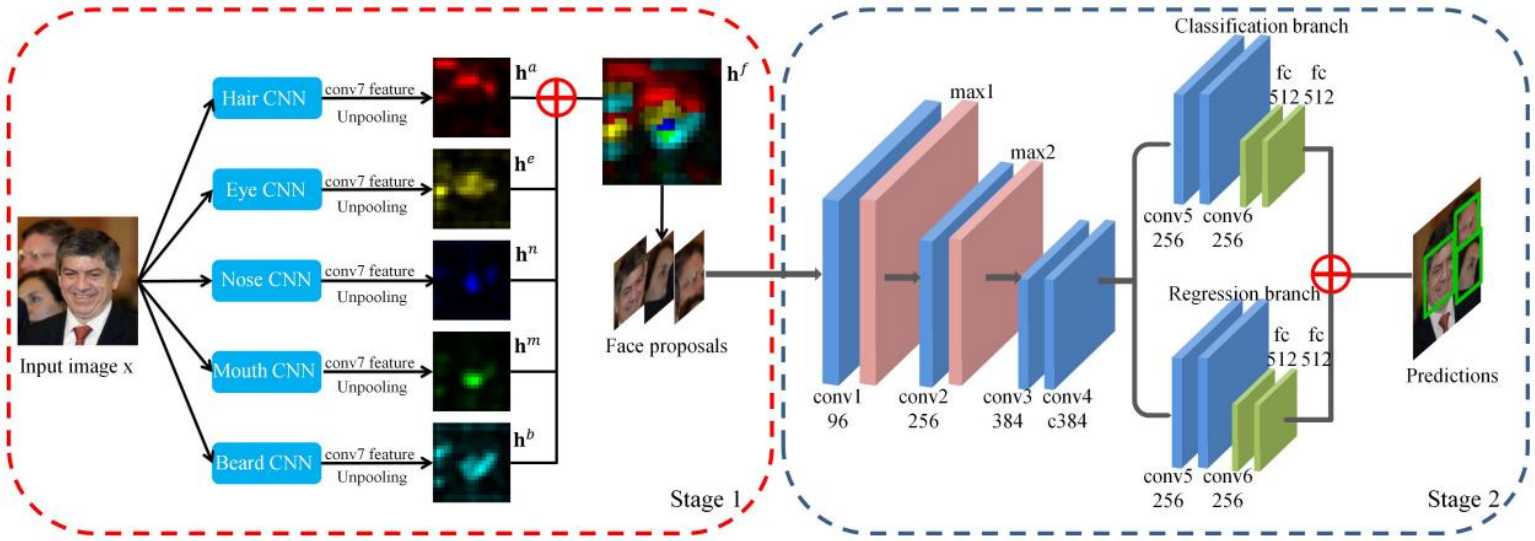
YOLO 9000: Better, Faster, Stronger **CVPR 2017**

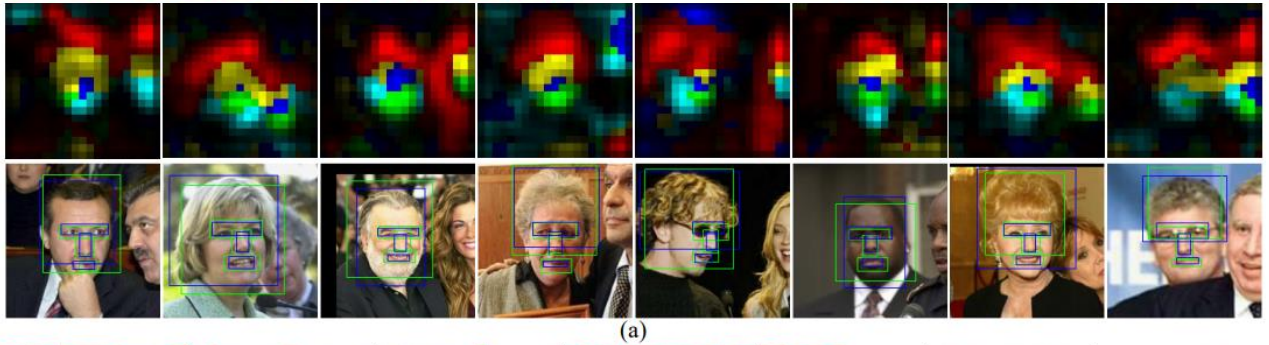
https://www.youtube.com/watch?v=VOC3huqHrss



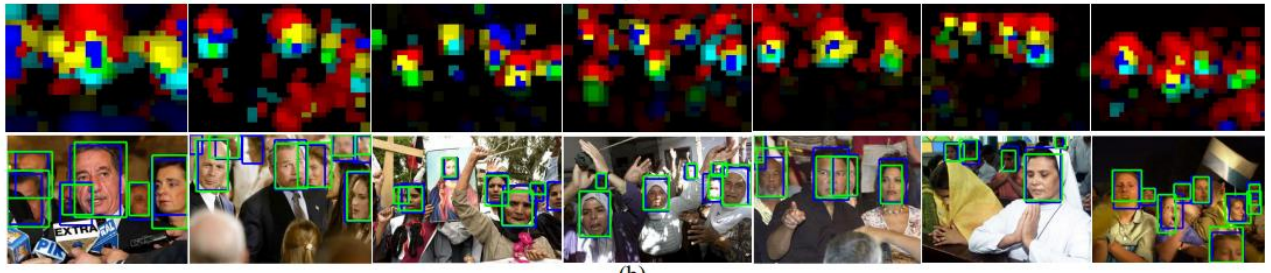
Face Detection

Faceness-Net: Face Detection through Deep Facial Part Responses Arxiv 2017





(a)



(b)

Hair Eye Nose Mouth Beard

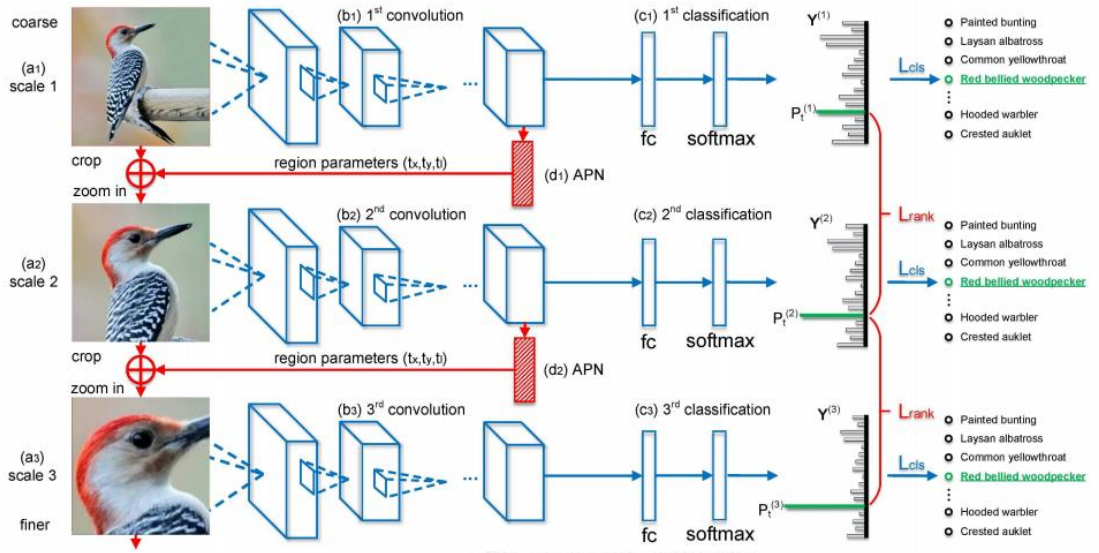
Face Recognition

FaceNet: A Unified Embedding for Face Recognition and Clustering **CVPR 2015**

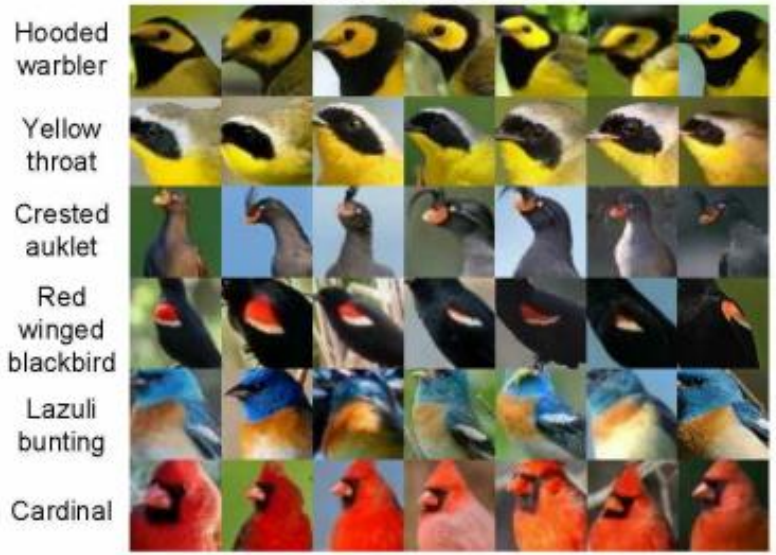
Fine-Grained Recognition

Look Closer to See Better: Recurrent Attention Convolutional Neural Network for Fine-grained Image Recognition

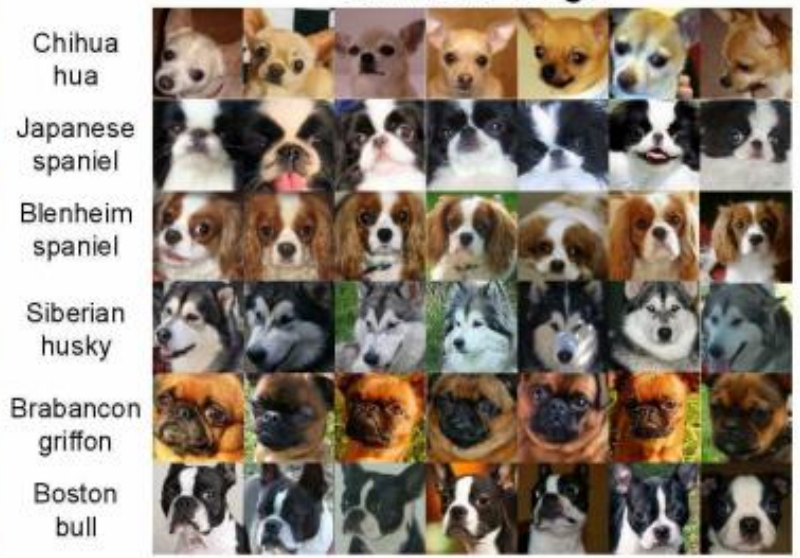
CVPR 2017



CUB-200-2011



Stanford Dogs

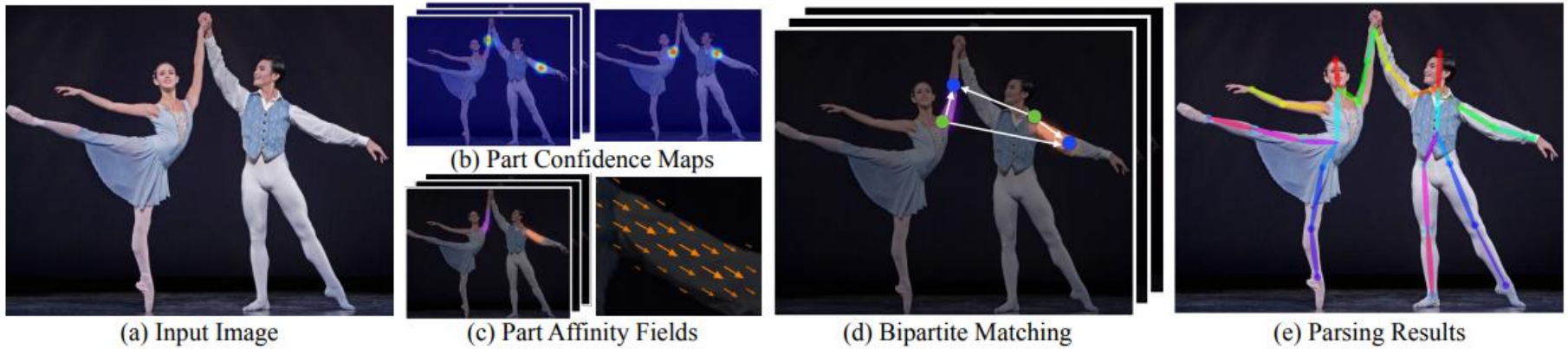


Stanford Cars

Pose Estimation

Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields **CVPR 2017**

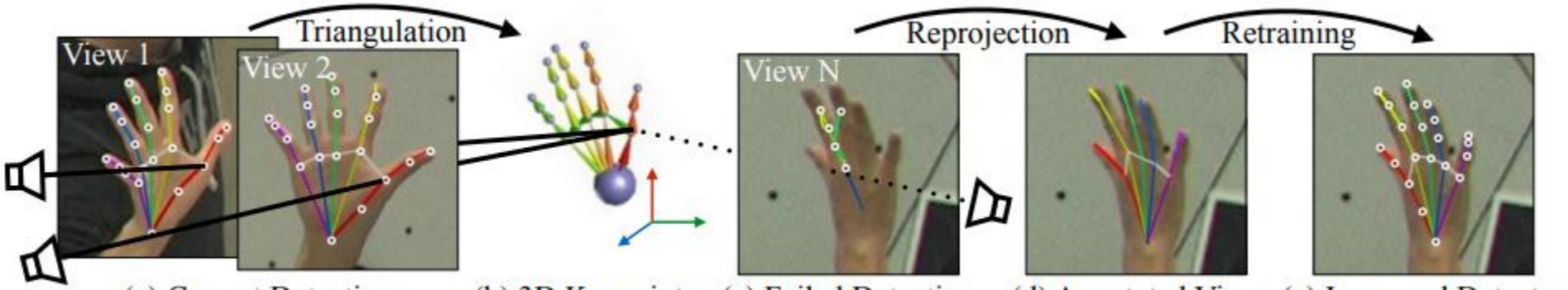
https://www.youtube.com/watch?v=pW6nZXeWlGM



Hand Keypoints Detection

Hand Keypoint Detection in Single Images using Multiview Bootstrapping **CVPR 2017**

https://www.youtube.com/watch?v=q4xbmEQp3VE



(a) Correct Detections (b) 3D Keypoints (c) Failed Detection (d) Annotated View (e) Improved Detector

(a) Realtime 2D Hand Detection on YouTube and Webcam Videos

(b) 3D Hand Motion Capture by Triangulating Multiple 2D Detections

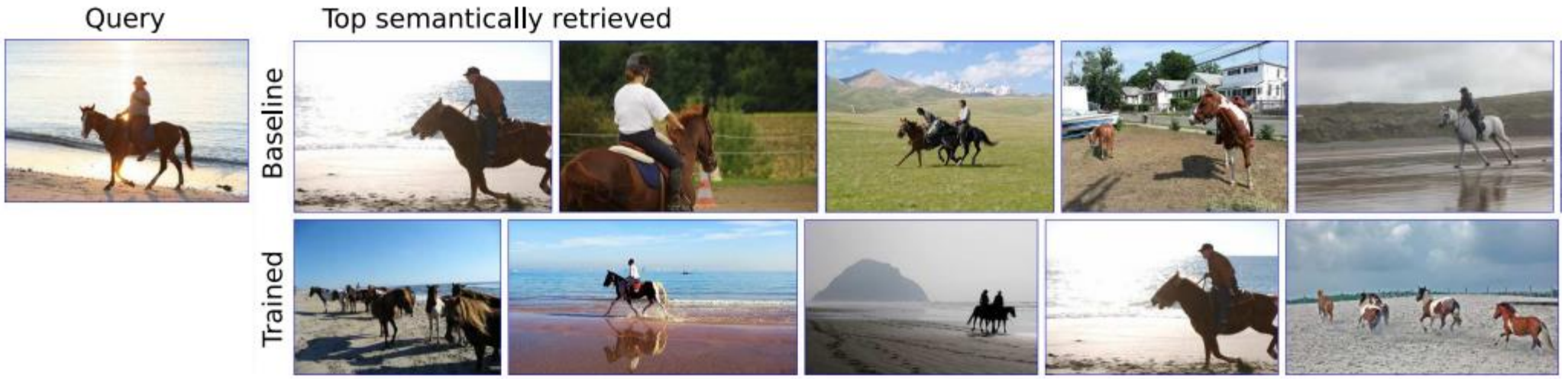
Facial Landmark Detection

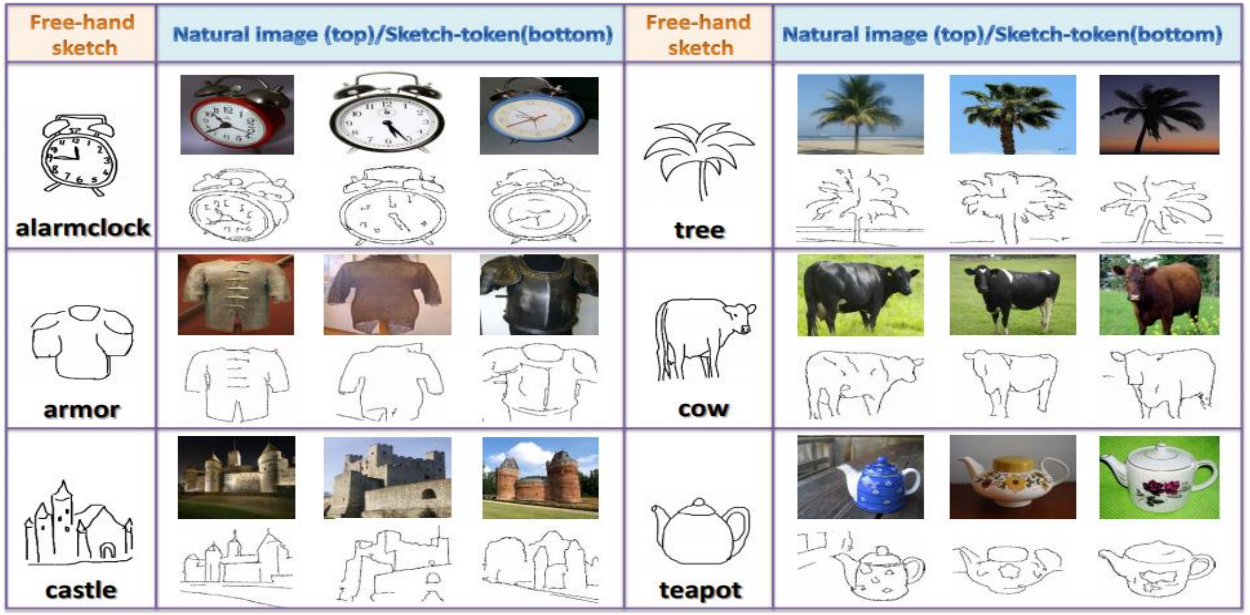
Binarized Convolutional Landmark Localizers for Human Pose Estimation and Face Alignment with Limited Resources

ICCV 2017

Retrieval

Leveraging captions to learn a global visual representation for semantic retrieval CVPR 2017
Deep Sketch Hashing: Fast Free-hand Sketch-Based Image Retrieval CVPR 2017



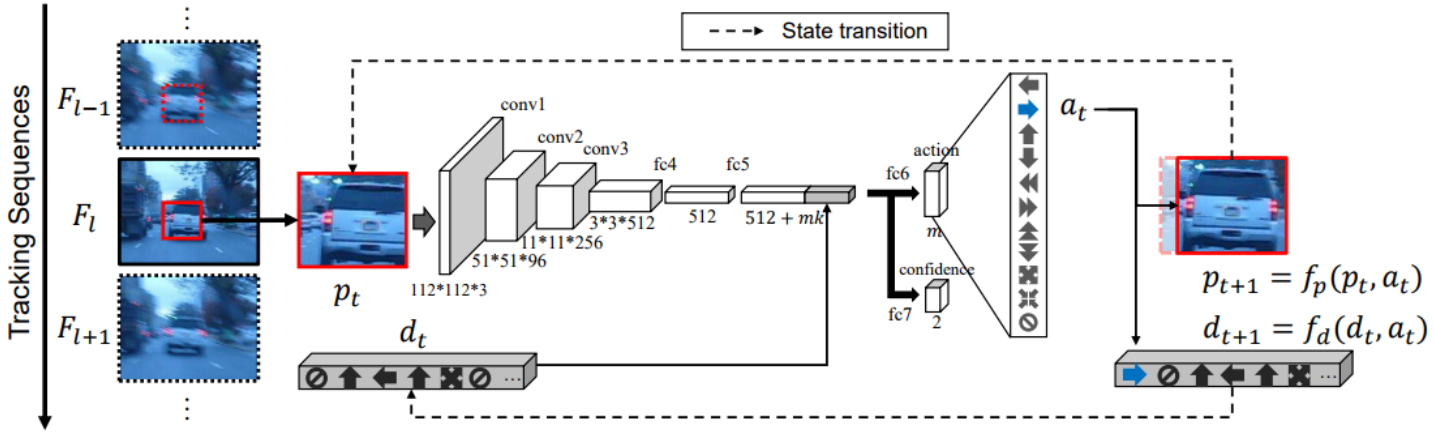


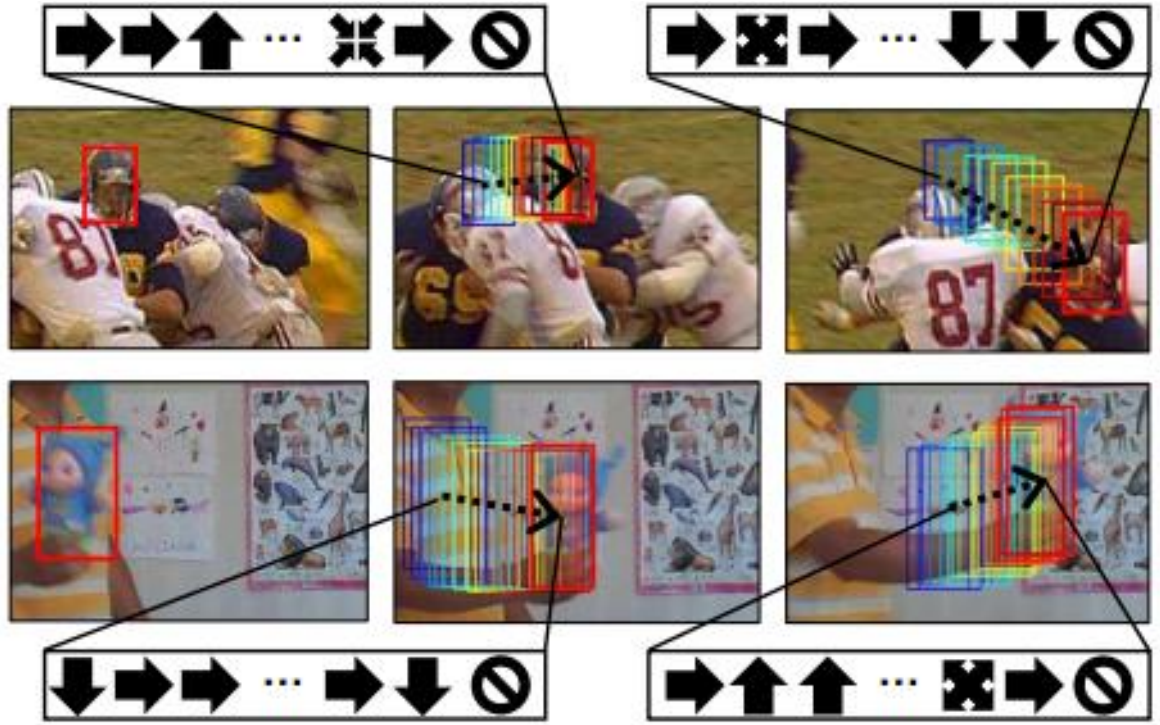
Tracking/Motion/Action

Tracking, Optical Flow, Prediction
Gesture Recognition, Action Recognition

Tracking

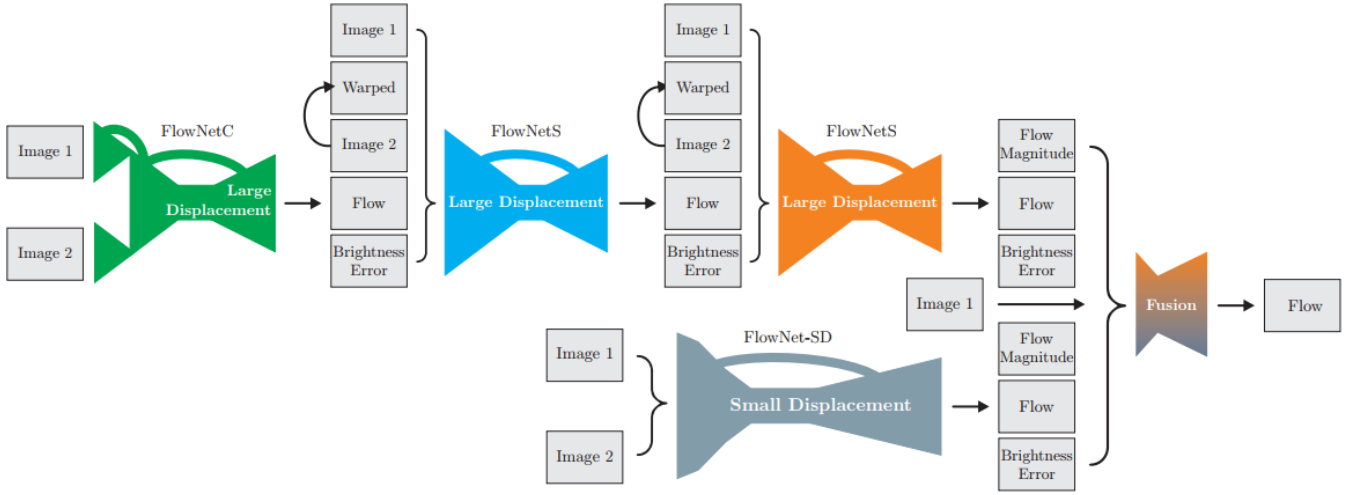
Action-Decision Networks for Visual Tracking With Deep Reinforcement Learning CVPR 2017

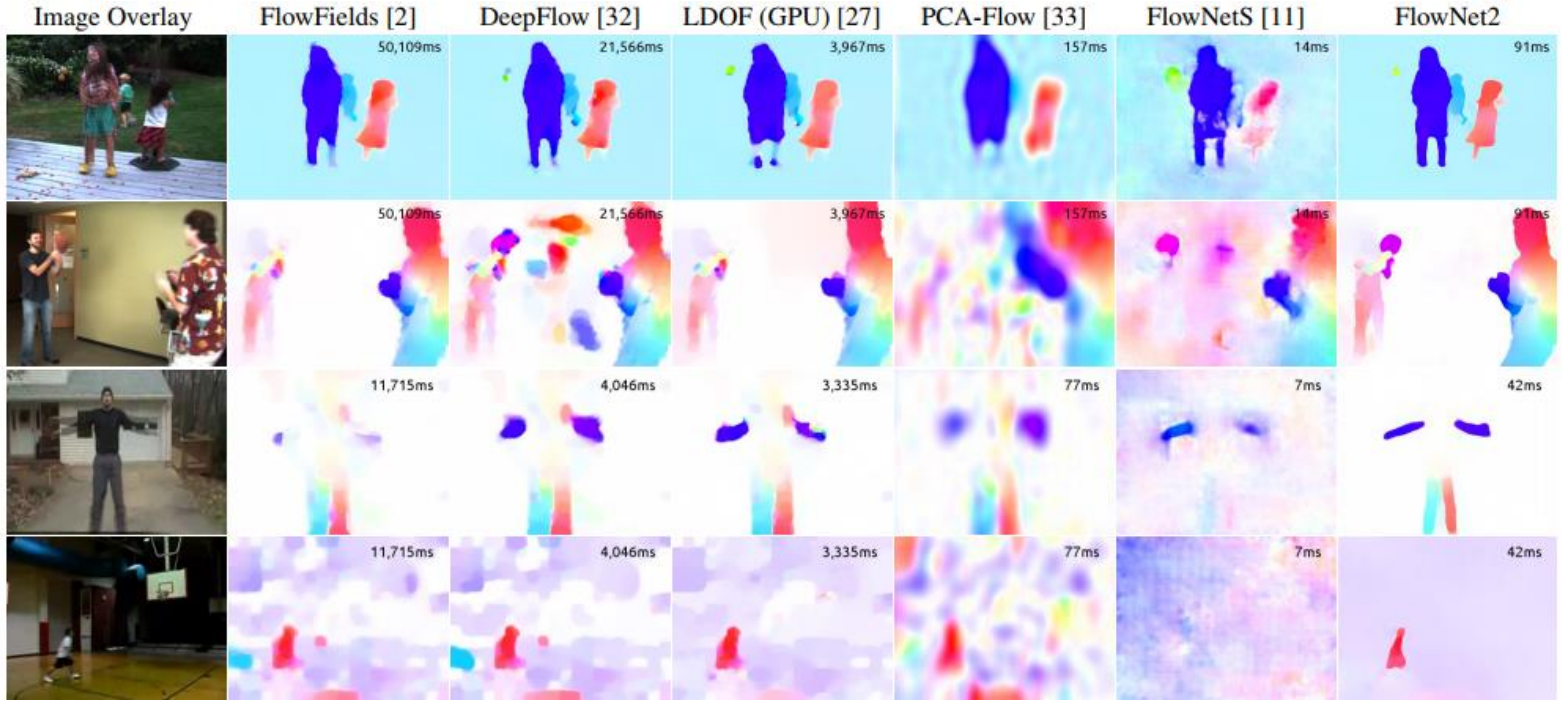




Optical Flow

FlowNet 2.0 **CVPR 2017**





Optical Flow

MirrorFlow: Exploiting Symmetries in Joint Optical Flow and Occlusion Estimation ICCV 2017

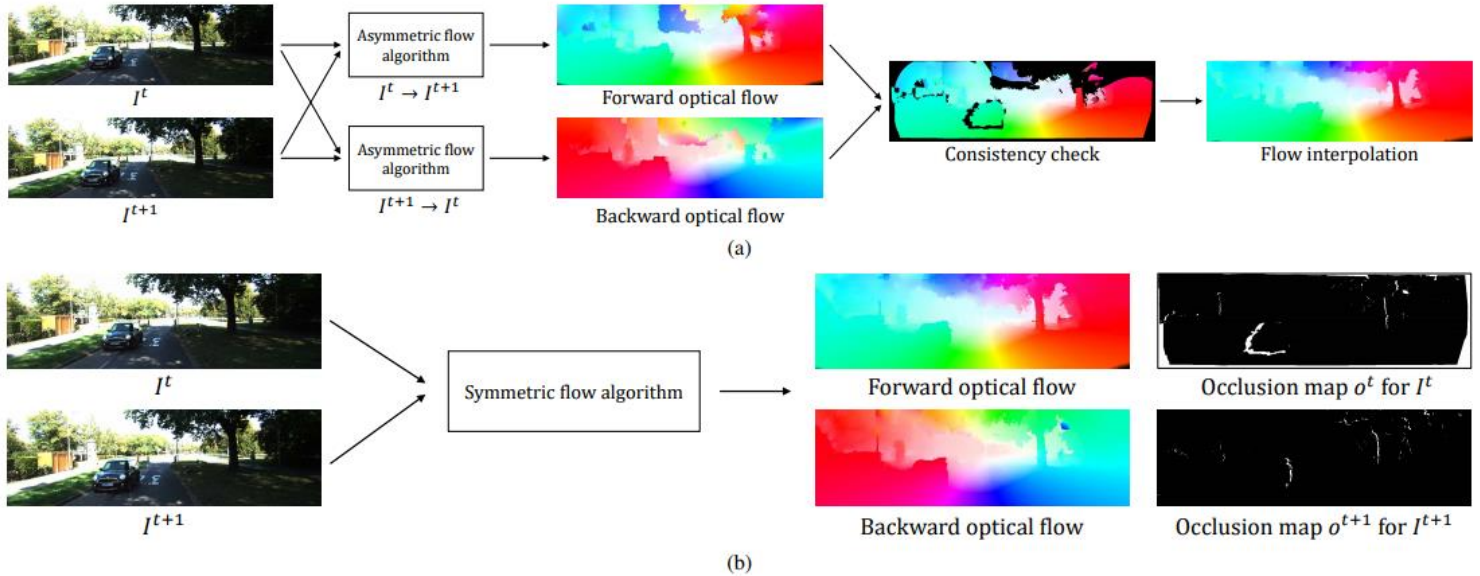
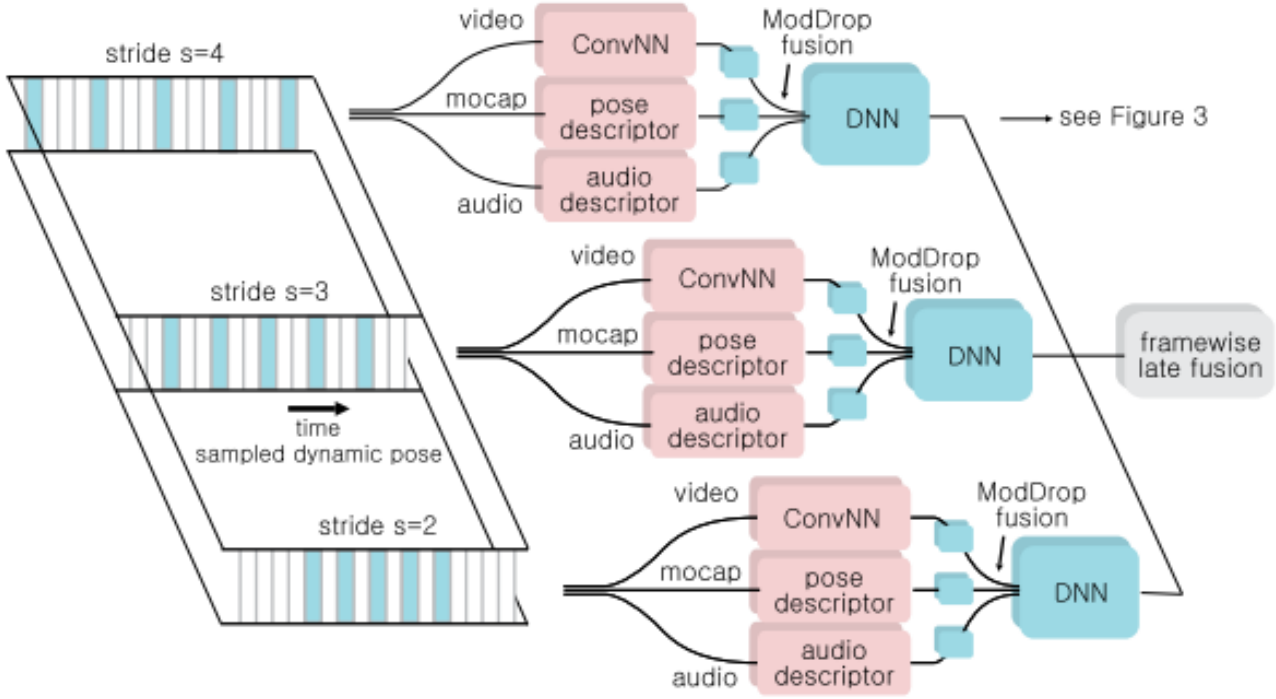


Figure 2. *(a)* A conventional asymmetric approach that requires post-processing. *(b)* Our integrative, symmetric approach.

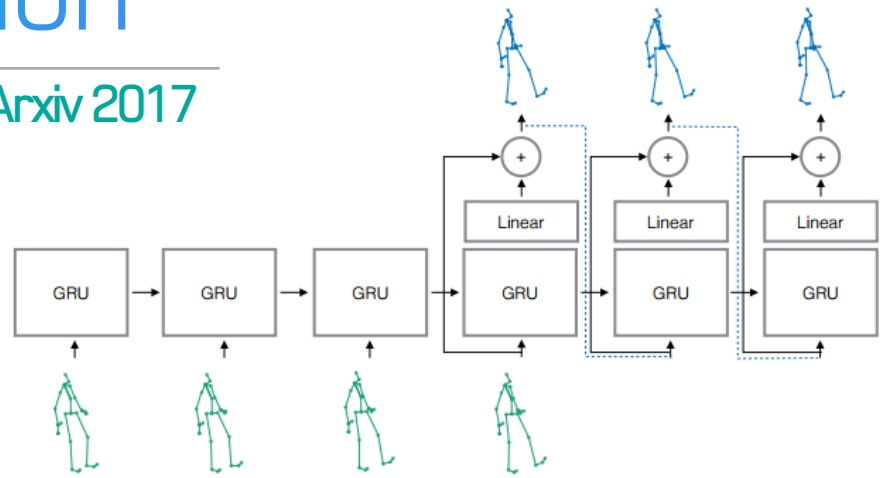
Gesture Recognition

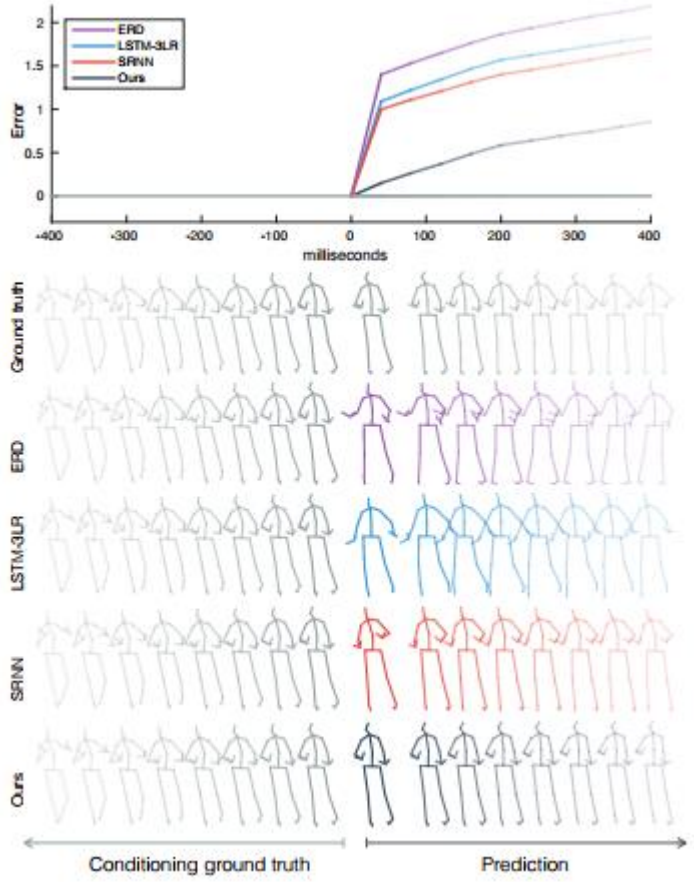
ModDrop: Adaptive Multi-Modal Gesture Recognition PAMI 2016

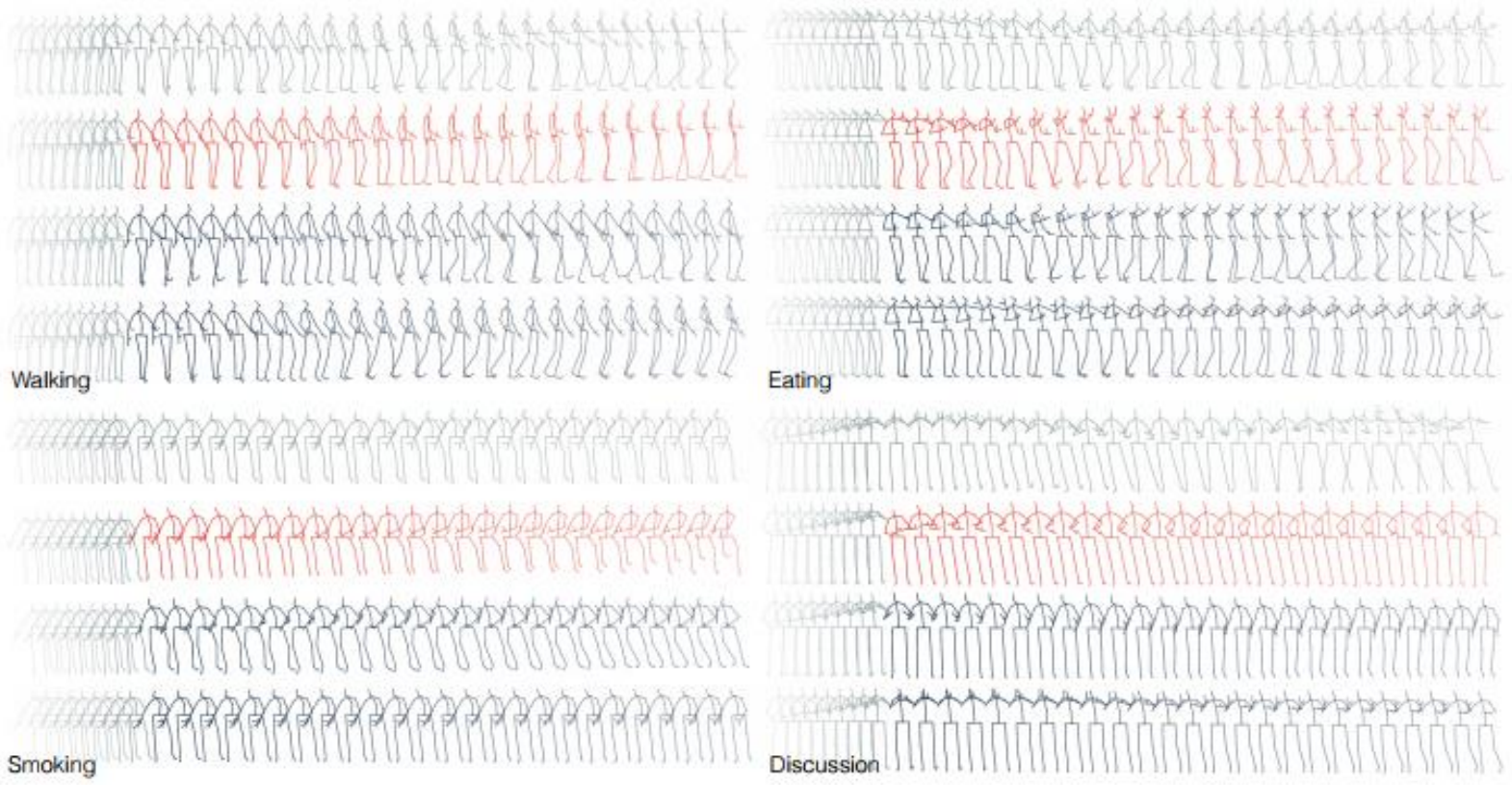


Action Recognition

On Human Motion Prediction using RNNs **Arxiv 2017**







Understanding

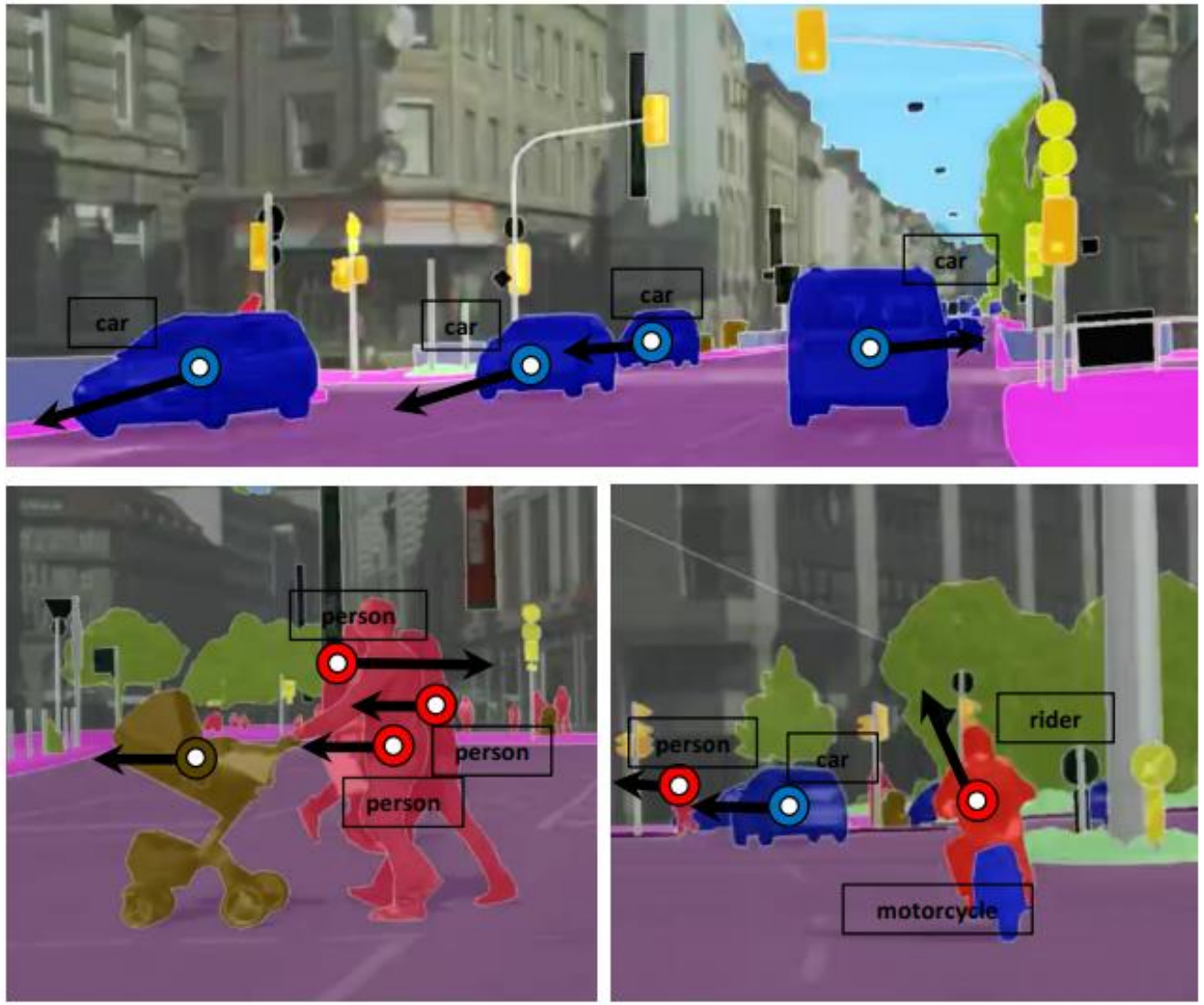
Semantic Matching, Future Prediction, Video Modeling

Semantic Flow

Proposal Flow: Semantic Correspondences from Object Proposals **PAMI 2017**

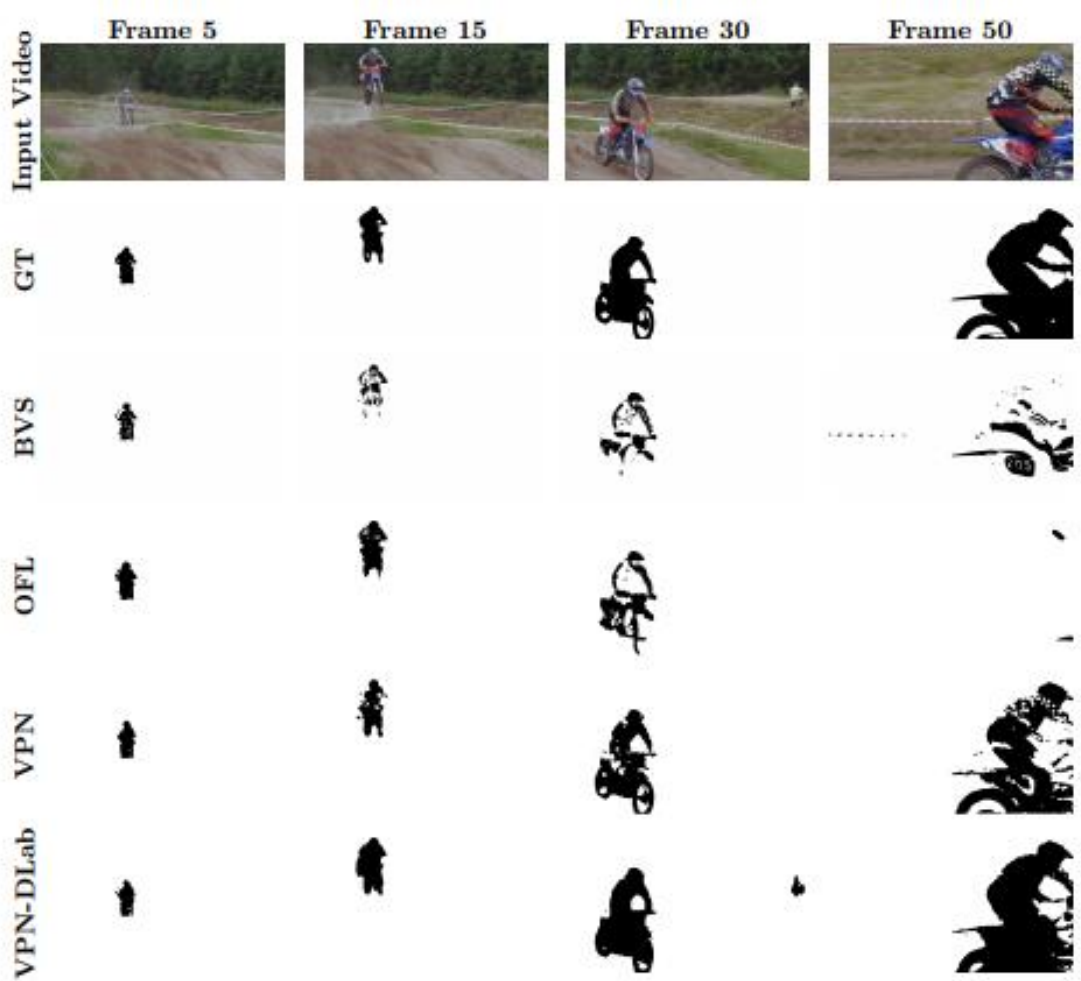
Future Prediction

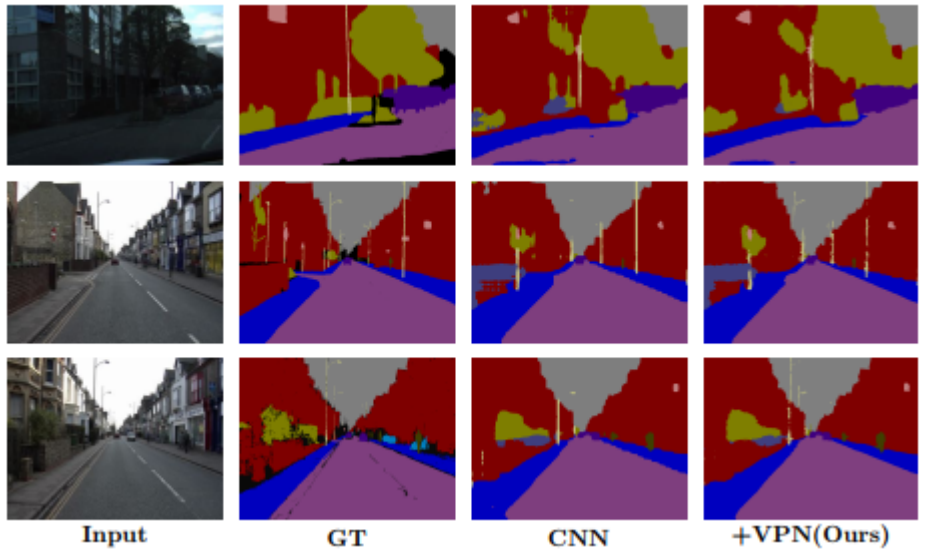
Predicting Deeper into the Future of Semantic Segmentation ICCV 2017



Video Modeling

Video Propagation Networks CVPR 2017



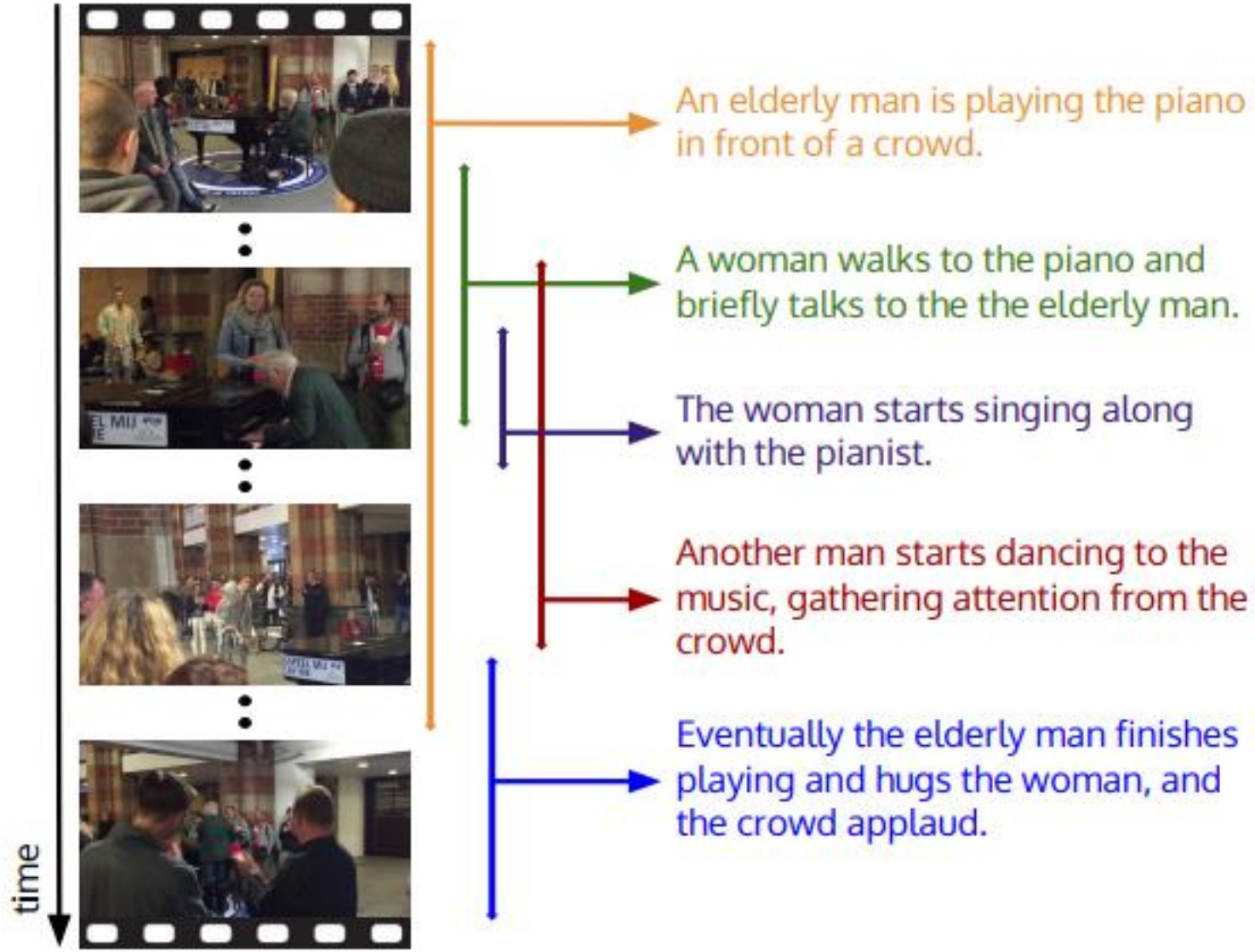


Vision + Language

Captioning, Q&A, Reasoning, Text to Image

Captioning

Dense-Captioning Events in Videos **ICCV 2017**



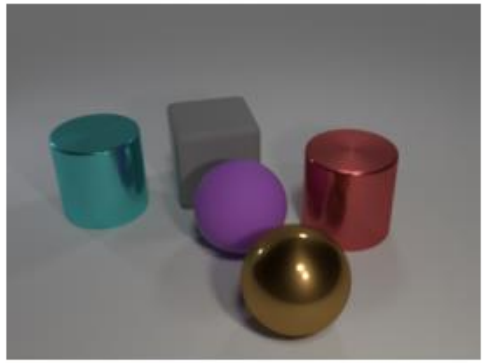
Q&A / Reasoning

Inferring and Executing Programs for Visual Reasoning ICCV 2017

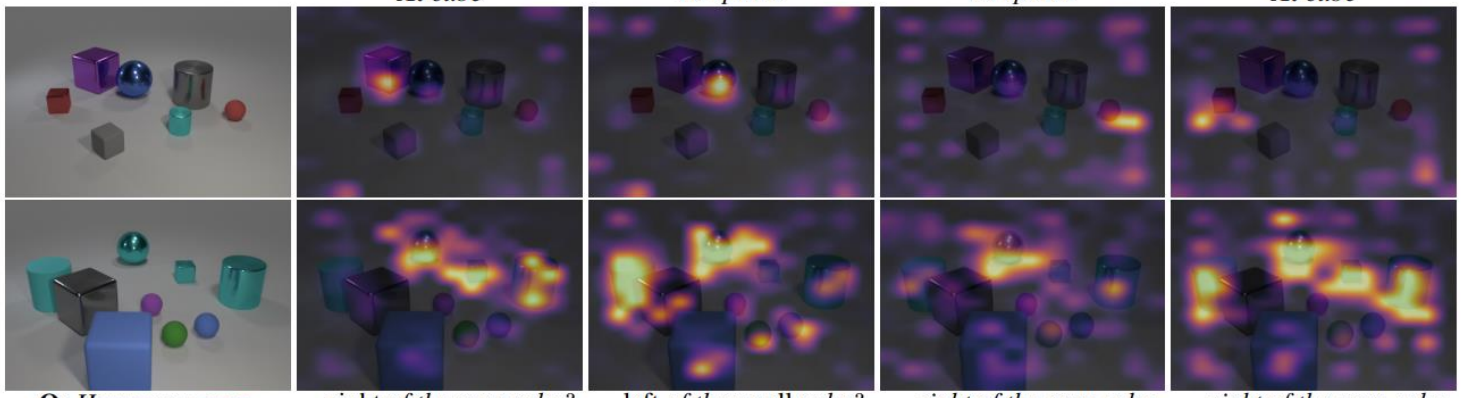
How many chairs are at the table?

Is there a pedestrian in my lane?

Is the person with the blue hat touching the bike in the back?



Is there a matte cube that has the same size as the red metal object?



Text to Image

StackGAN++: Realistic Image Synthesis with Stacked Generative Adversarial Networks **Arxiv 2017**

Text description	A couple of men riding horses on top of a green field	A train coming to a stop on the tracks out side	A big airplane flying in the big blue sky	A group of boats on a body of water	Two public transit buses parted in a lot	The white kitchen features very contemporary cabinet arrangements	The man is standing in the water holding his surfboard
Stage-II images							
Text description	A big building with a parking lot in front of it	There is a lot of electrical sitting on the table	A couple of computer screens sitting on a desk	Three zeebras standing in a grassy field walking	A herd of cows standing on a grass covered field	A group of people standing around and posing for a picture	People who are dressed for skiing standing in the snow
Stage-II images							

Graphics

Image Translation, Style Transfer, Attribute Transfer, Matting

Image Translation

CycleGAN **ICCV 2017**
DiscoGAN **ICML 2017**

apple → orange

orange → apple

summer → winter

winter → summer

horse → zebra

zebra → horse

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

(c) Shoe images (input) & **Generated** handbag images (output)

Style Transfer

Deep Photo-Style Transfer **CVPR 2017**
Real-Time Neural Style Transfer for Videos **CVPR 2017**

(a) Input image (b) Reference style image (c) Reinhard et al. [12] (d) Pitié et al. [11] (e) Our result

Attribute Transfer

Neural Color Transfer Between Images **Arxiv 2017**

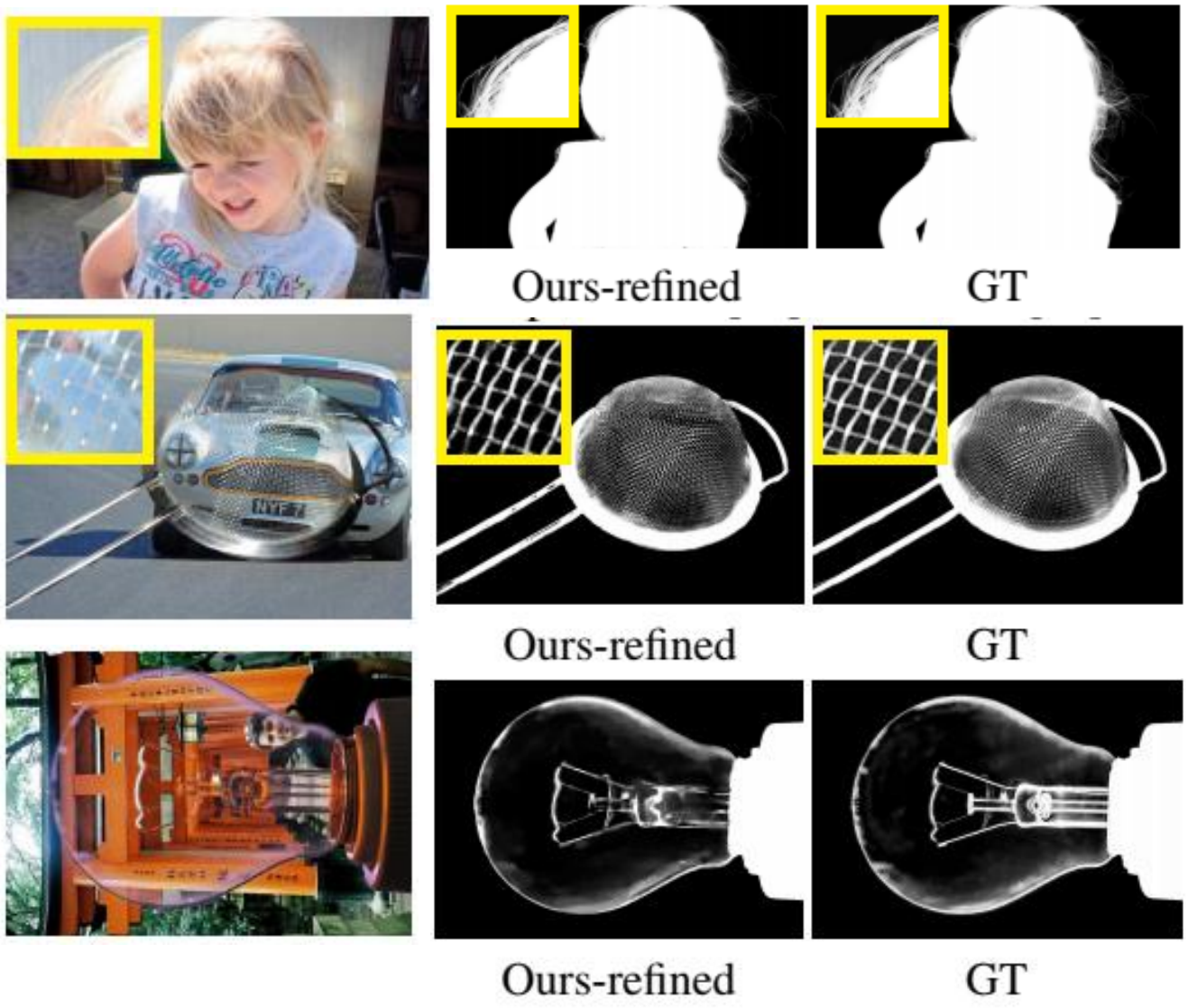
Source | Reference | Reinhard et al. [2001] | Pitié et al. [2005] | Ours

Source | Reference | Shih et al. [2014] | Ours

Source | Reference | Tong et al. [2007] | Ours

Matting

Deep Image Matting **CVPR 2017**



Thank You

MVPLAB