

# Embedded Multi-Person Pedestrian Tracking and Detection

MSCV19 Capstone Project, Internal(CMU)

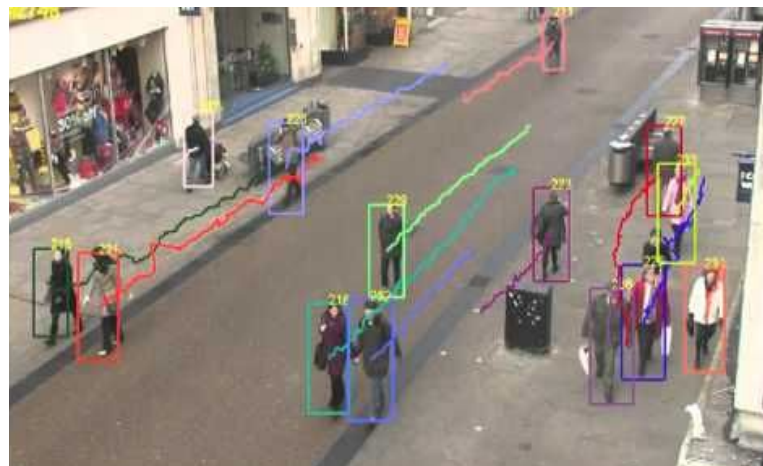
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Advisor: Dr. Kris Kitani

05/03/2019

# Introduction

- Motivation
  - Multi-person pedestrian tracking
  - Real-time performance on embedded system
  - Visual analysis, automatic driving, robotics
- Problem
  - Detect and track multiple people
  - Deal with new object, out-of-view objects, occlusion, large appearance changes
- Solution
  - Track by detection - SiameseRPN (Single Object)
  - Multiple object extension



# Past, Present, Future



## Past:

### January:

- Start From Single Obejct SiamRPN

### March:

- Train/Finetune Single Obejct SiamRPN on VOT dataset

### April:

- Single Obejct SiamRPN with ROI Align
- Multi Object SiamRPN Baseline

## Present:

- Single-Obejct SiameseRPN with Region of Interest (Rol) Align
- Multi Object SiamRPN Distractor

## Future:

### September 15:

- Finish Rol Align verification
- Merge Multi-Object SiamRPN with Rol Align

### October 15:

- Data Association & NMS

### October 31:

- Integrate object detection to handle new objects

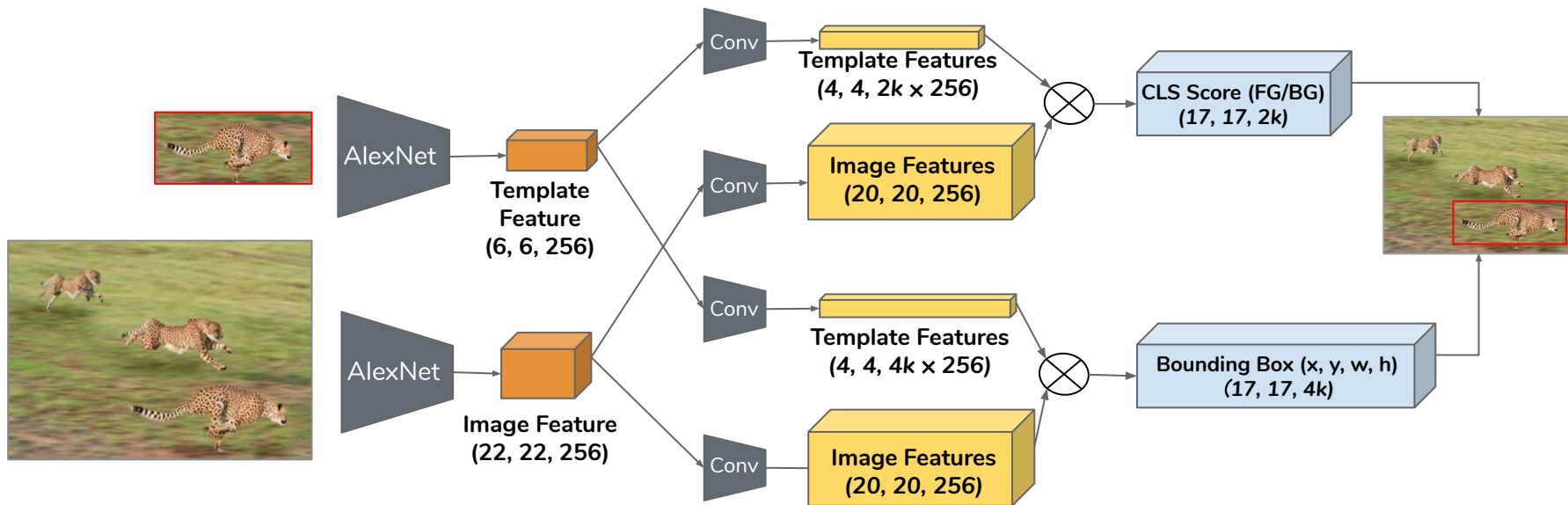
### December 15:

- Optimize and deploy algorithm on NVIDIA Jetson Machine

Past  
Present  
Future

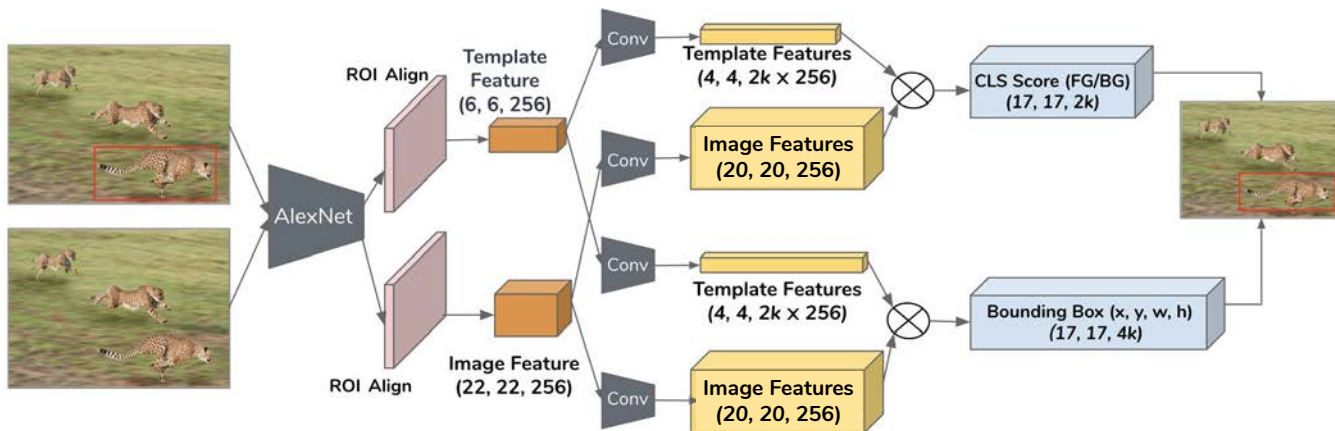
- Single Object SiamRPN
  - Implement Train Code & Verify
  - Fintune on VOT
- ROI Align For Single Object SiamRPN
  - Implement Code
  - Train and Verify on VOT
- Multi Object SiamRPN
  - Baseline Model
  - Multi Object Evaluatoin Code

# Past: Single Object SiamRPN



# Past: Single Object SiamRPN

- Re-implementing trainign code Siamese RPN (training & testing)
  - Official repository only has testing code
  - Sanity check of training process
    - Finetuned from pretrained model (trained with VID) on VOT dataset
- RoI Align for Single Object SiamRPN - Need for SPEED



# Past: Single Object SiamRPN

Model	Pretrained	Finetune	Test Data	EAO $\uparrow$
DaSiamRPN (Official, SOTA)	YoutubeBB + ImageNet VID	-	VOT 2015	0.446
SiamRPN	ImageNet VID	VOT 2015 (First 40 sequences)	VOT 2015 (First 40 sequences)	0.5240
SiamRPN Rol	ImageNet VID	VOT 2015 (First 40 sequences)	VOT 2015 (First 40 sequences)	0.6045
SiamRPN (with location & size penalty)	ImageNet VID	-	VOT 2015	0.3426
SiamRPN	ImageNet VID	-	VOT 2015	0.2647
SiamRPN	-	-	VOT 2015	IP
SiamRPN Rol	-	-	VOT 2015	IP

# Past: Single Object SiamRPN



Red - SiamRPN (finetuned)  
Blue - SiamRPN Rol (finetuned)



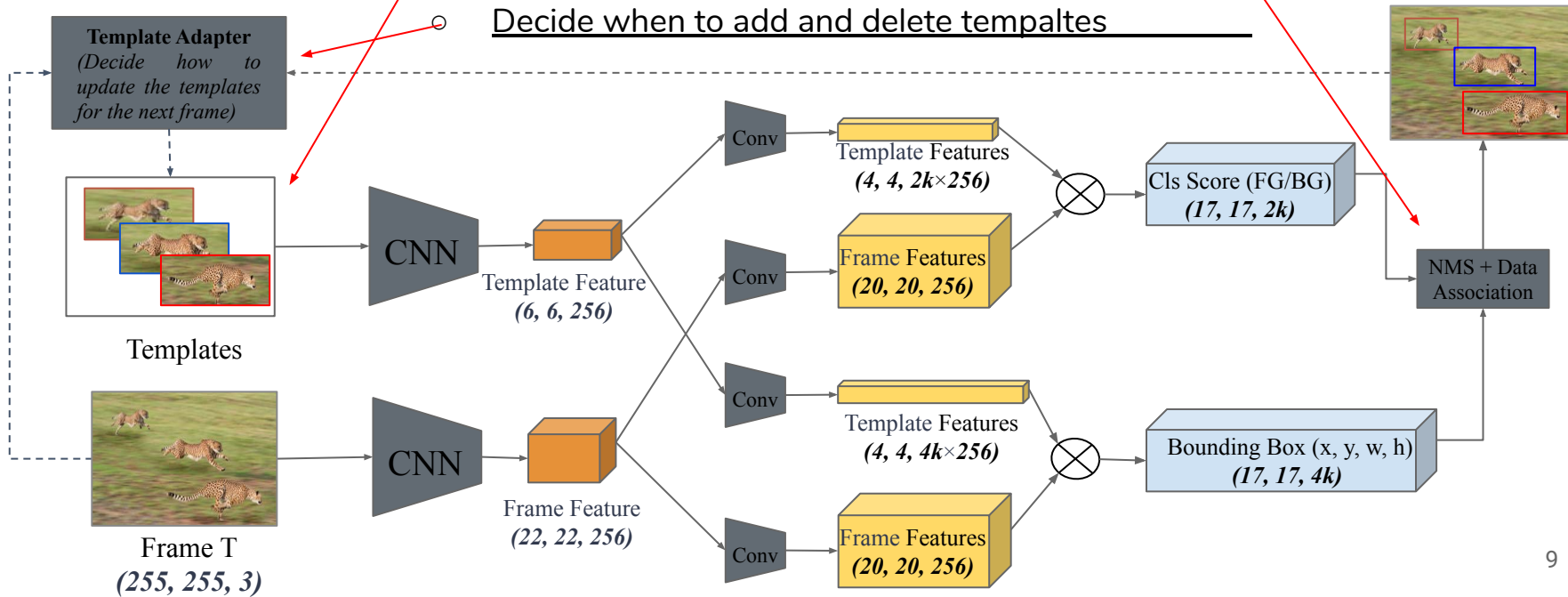
Black - DaSiameseRPN  
Green - Ground Truth



# Past: Multi Object Tracking

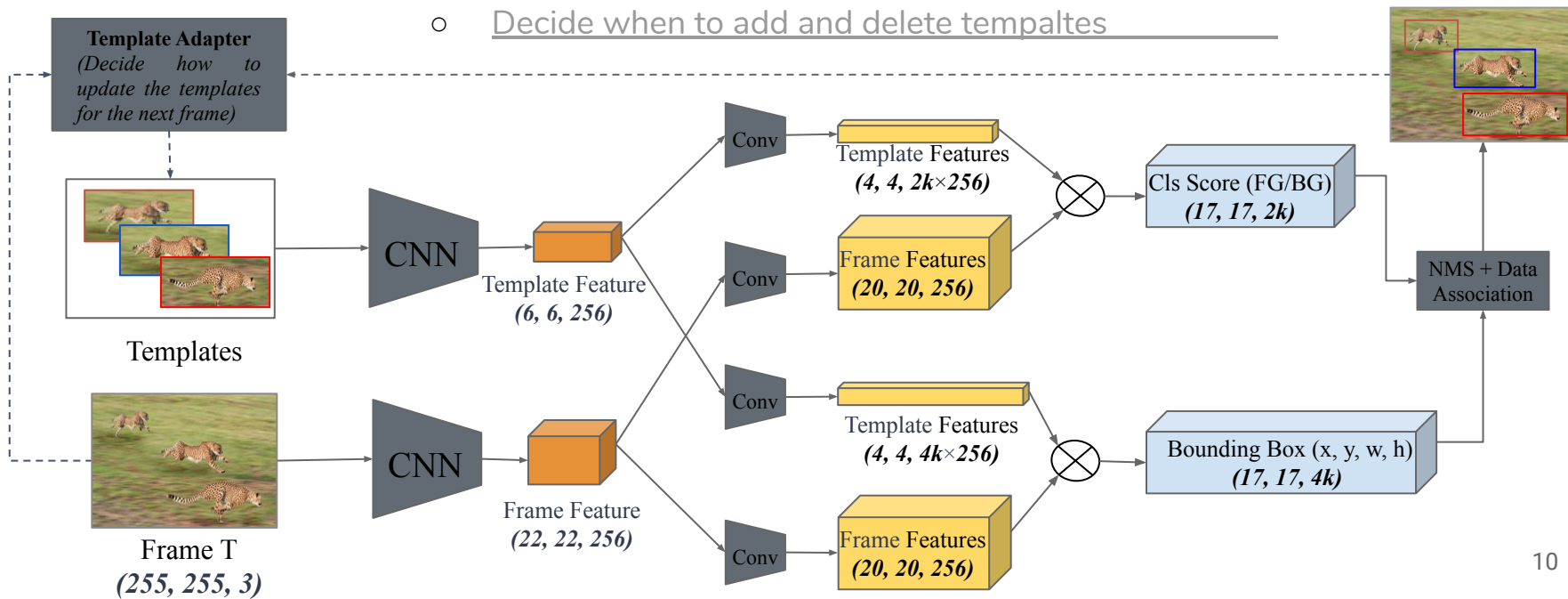
- From Single Object Tracking to Multiple Object Tracking:

- A network that can handle several templates
- NMS & Data Association for matching labels
- Decide when to add and delete templates



# Past: Multi Object SiamRPN

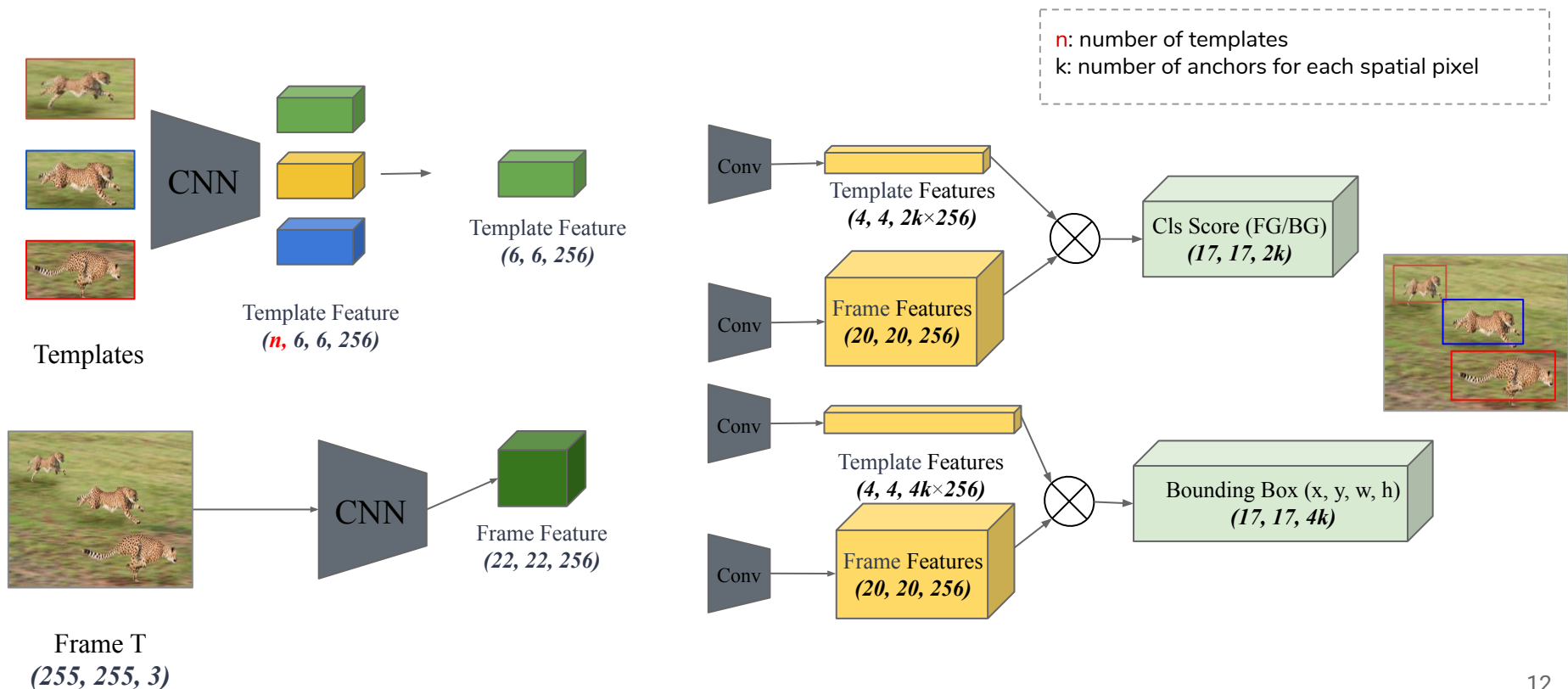
- From Single Object Tracking to Multiple Object Tracking:
  - A network that can handle several templates
  - NMS & Data Association for matching labels
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# Past: Multi Object Extension

- Baseline Idea:
  - Pre-compute correlation filters for each template
  - All templates share the RPN network to do tracking independently
- Introduce Communication among templates (1)
  - Concatenate all correlation filters as a bigger filter
  - Re-train RPN network to perform multi-object classification
- Introduce Communication among templates (2)
  - Add Distractor-aware loss and fine-tune RPN

# Network 0: Baseline (Pretrained Weight)

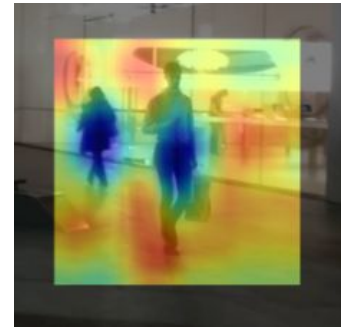
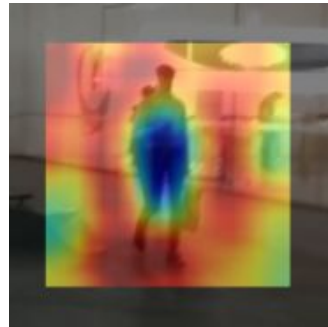
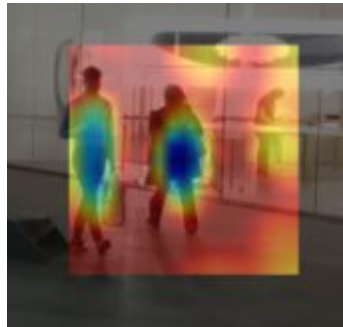


# Visualization Results (MOT Dataset)

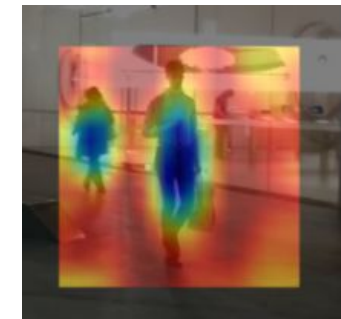
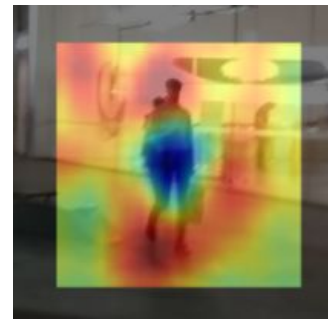
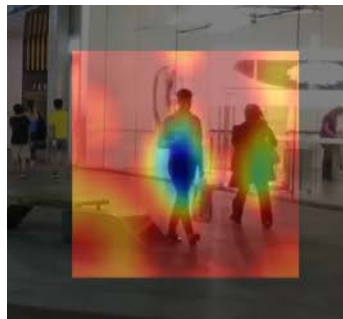
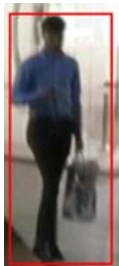


# Visualization Response

Template:



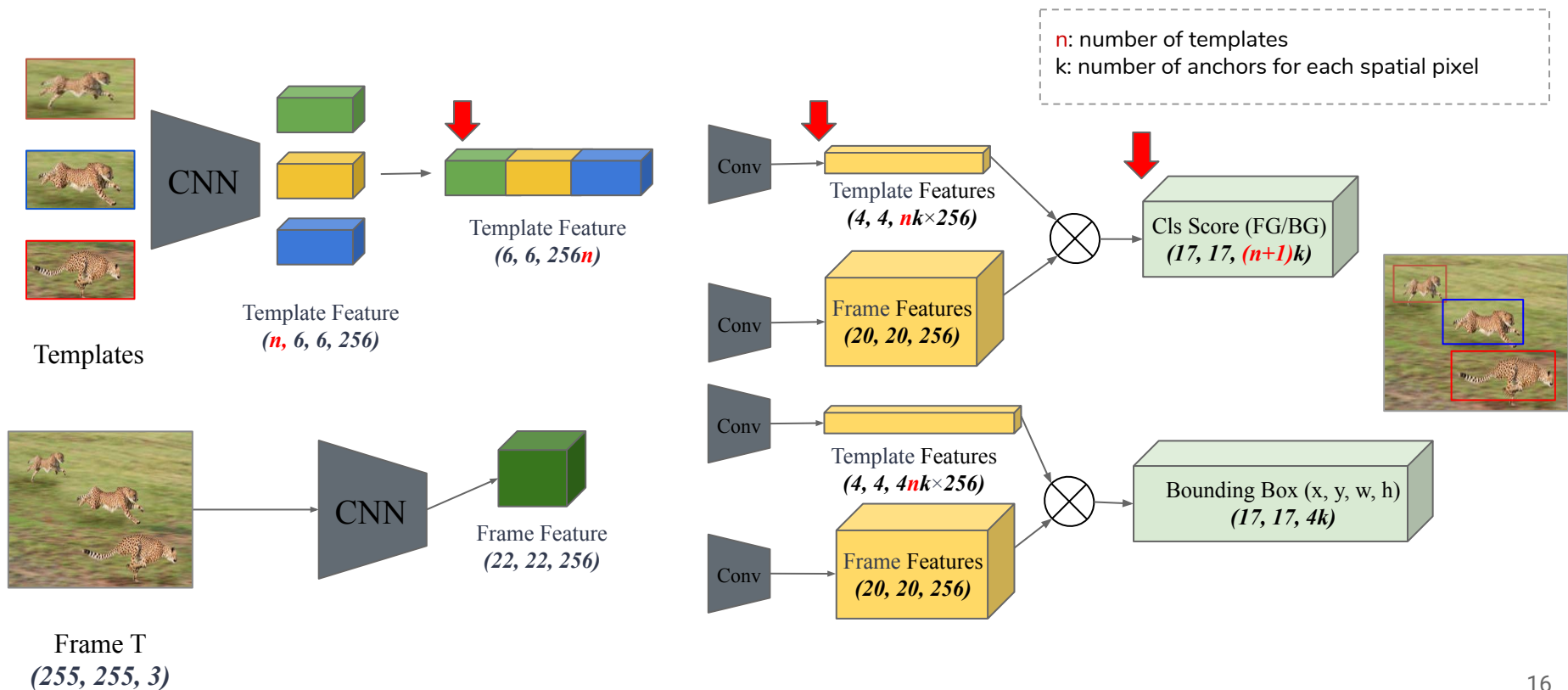
Template:



# Past: Multi Object SiamRPN

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# Network 1: Abandoned





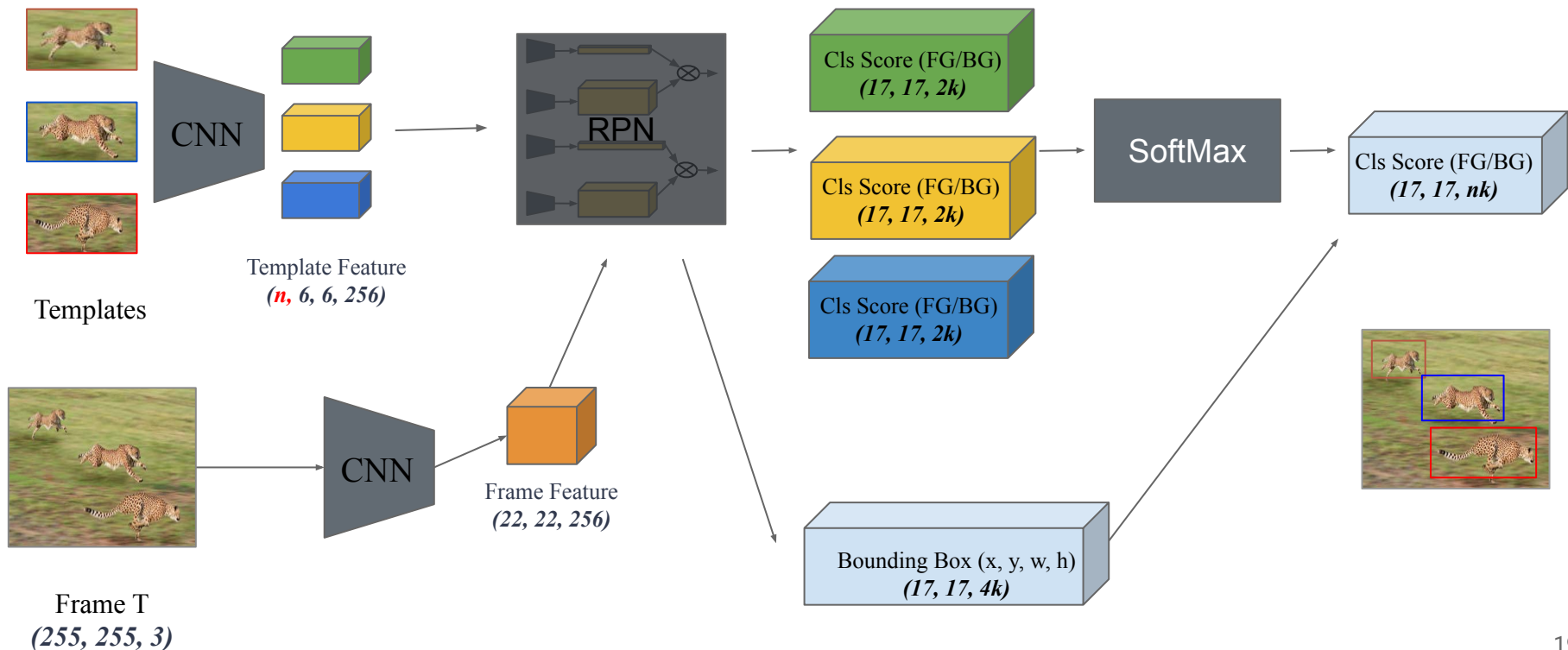
Past  
Present  
Future

- Single Object SiamRPN
  - Training from scratch
  - Verifying Effect of RoI
- Multi Object SiamRPN
  - Try to fix Distractor Issue

# Present: Multi Object SiamRPN

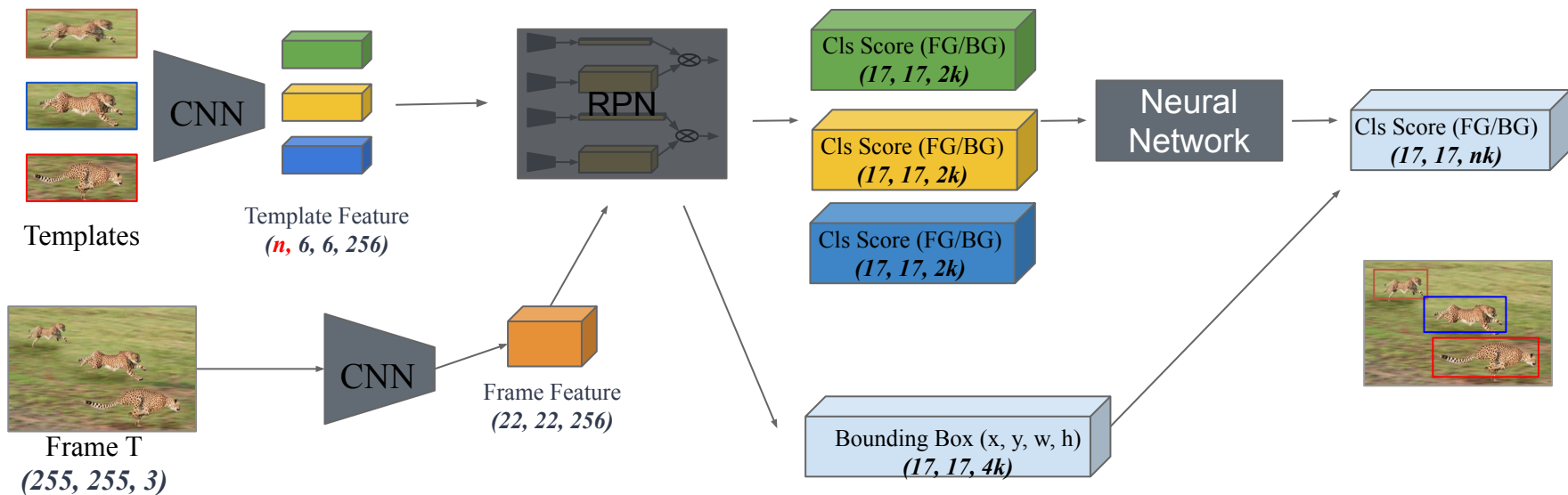
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# Network 2: Softmax (Pretrained Weight)



# Present: Deal with Distractor

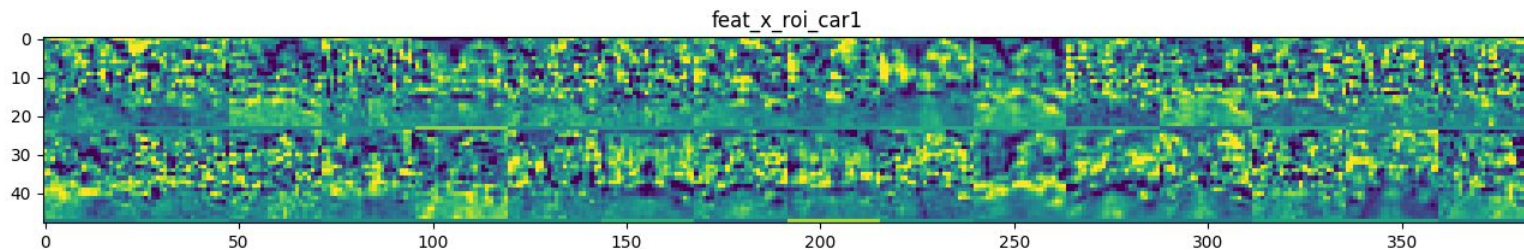
- Add a Layer to handle distractor-aware labelling
  - Freeze the SiamRPN, only train the Association Network
  - E.g. A fully connect network



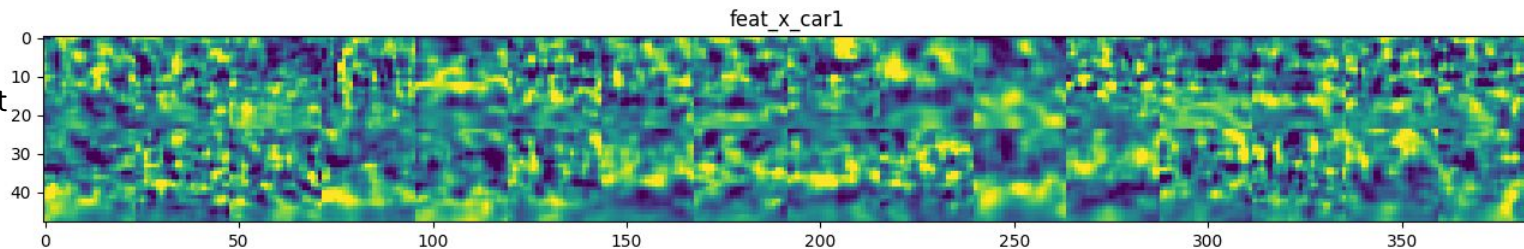
# Present: Single Object SiamRPN

- ROI Align: Quantitative and Qualitative Verification

Whole Image as Input  
Cropped Feature



Cropped Image as Input  
Whole Feature



# Past Present Future

- Finish Rol Align Verification for Single Object SiamRPN (September 15)
  - Achieve similar EAO as in SiamRPN paper
- Merge Multi Object SiamRPN with Rol Align (September 15)
  - Achieve similar performance as without Rol Align
- Data Association and NMS Network (October 15)
  - Assign correct ID to correct person
- Integrate Object Detection (October 31)
  - Learn a universal template that has high response on all pedestrians
- Test Speed and Deploy (December 15)

# Future: Detect New Objects



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# Future: Detect New Objects



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- Test Speed and Deploy (December 15)
  - Real-time performance on Nvidia Jeston tx2.

Thanks