Fashion2Events: A clothes recommendation method for social events

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Outline

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Introduction

- Deep Learning have been applied with great results to the fashion field
  - Progress in CV techniques
  - High availability of data
- Fashion companies see in these emerging methods new opportunities to attract the customer
- Shift from academic research works to commercial applications
  - Retrieval of similar clothes and recommendation systems
  - Analysis and predicition of fashion trends
  - Automatic generation of new clothes from existing ones

Introduction - Fashion2Events

Project Goal
Study a recommendation method based on deep learning techniques that suggests at which type of social event it is most appropriate to wear a certain garment

Decomposition of the problem into **two separated tasks**:

- Detection and instance segmentation of clothes in an image
- Classification of the social event from the image of a single isolated garment

Datasets

Two different datasets, one for each task:

- **DeepFashion2** for the detection and segmentation of clothes
- **USED** for the social events classification

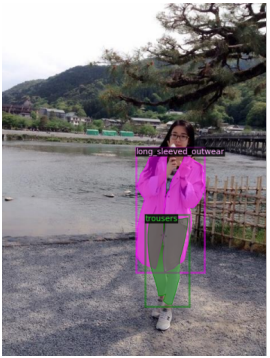
Datasets - DeepFashion2

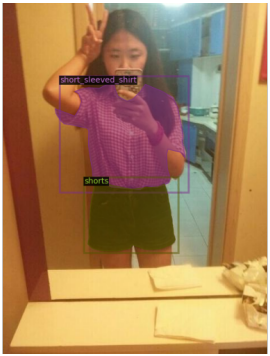
- Published in 2019 by Ge et al. with the aim to provide a unified benchmark for clothes detection, segmentation, retrieval and landmark prediction
- About **491K images** of clothes belonging to **13 classes**
- Large variation in style, pose, colour, scale, occlusion and viewing angle between items

Datasets - DeepFashion2

- It comes already split into train/validation/test:
  - **Train set**: 391K (only **192K publicly available**)
  - **Validation set: 34K**
  - **Test set**: 67K (labels **not publicly available**)
- We used the official **validation set as the test set**
  - The authors provided their best results on it to use as a comparison
- Further split the train set to use about 15% of the images (29K) as our validation set

Datasets - DeepFashion2





Datasets - USED

- About **525K images** of people attending to **14 different types of social events** (e.g. graduation, wedding, sport event)
  - Train set: 361K
  - Test set: 164K
- Large variations of image quality, illumination, places and number of people

Datasets - USED

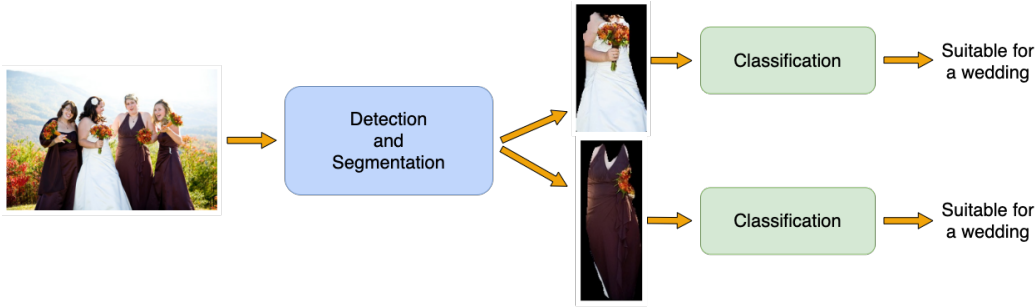
Class: Graduation

Class: Picnic

Class: Sport

Class: Concert

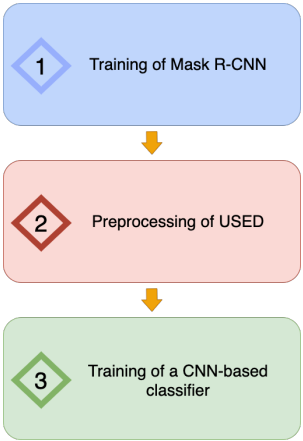
Proposed Method



Proposed Method - Training Pipeline

To build the recommendation system we performed **3 main steps**:

- Training of a detector/segmentator model (Mask R-CNN)
- Building of a new dataset made of images of single clothes using Mask R-CNN and USED
- Training of a CNN-based classifier of social events on the new dataset

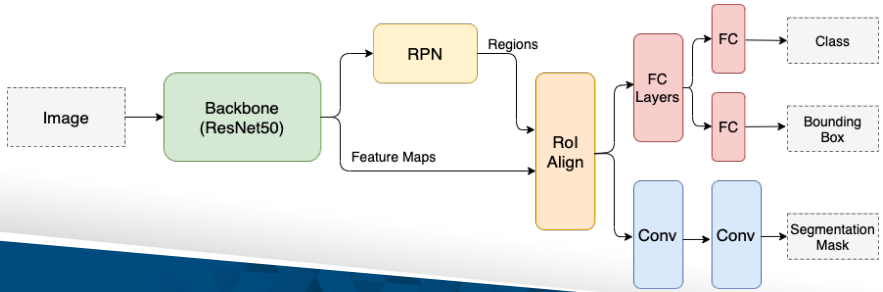


Step 1 - Mask R-CNN

- The authors of DeepFashion2 also proposed a deep learning model for fashion tasks: **Match R-CNN**
  - It solves the detection, segmentation, landmark estimation and retrieval tasks
  - Currently the best performing method on DeepFashion2
  - **An adaptation of Mask R-CNN** to include retrieval
- For detection and segmentation only the Mask R-CNN part is used

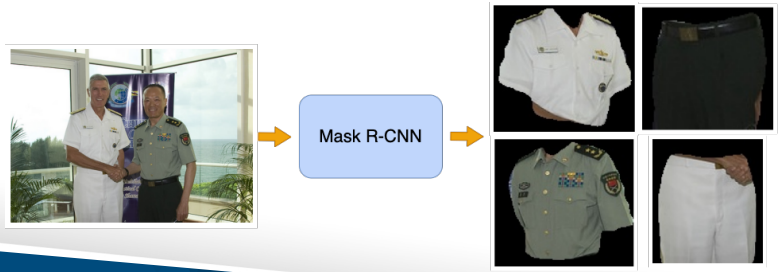
Step 1 - Mask R-CNN

- Based on Faster R-CNN
- **Three main parts**
- **Two parallel final branches** for classification + bounding box regression and segmentation



Step 2 - USED Preprocessing

- Use Mask R-CNN to make inference on all images of USED and create a new dataset
- For each detection create an image of the isolated (segmented) garment on a black background

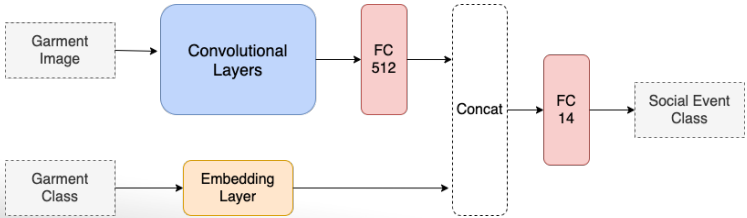


Step 3 - Events Classifier

- We used a **CNN-based classifier**
- We experimented with various architectures: VGG16, ResNet18 and **ResNet50** (the final choice)
- Final classifier part made of two fully-connected layers with 512 and 14 neurons respectively
- We started from a model pretrained on ImageNet, and we did a two-step training of **transfer learning + fine-tuning**

Step 3 - Events Classifier

- We built a second classifier using a **feature fusion approach**
  - The **garment class label** is sent as input to an **embedding layer**
  - The embedding layer output is concatenated to the image features from the convolutional part
- Additional info can improve the model performance



Experiments - Mask R-CNN Training

- We used **Detectron2** to build and train Mask R-CNN
- We replicated the training setup from the DeepFashion2 and Mask R-CNN papers
- Training took about 4 days on a Titan RTX GPU

Epochs	12
Batch Size	8
LR	$2 * 10^{-2}$ (*)
Optimizer	SGD (0.9 of momentum)
Weight Decay	10^{-5}

(*) Decreased by a factor of 10^{-1} at the 8^{th} and the 11^{th} epochs

Experiments - Mask R-CNN Results

- Model evaluated using the **COCO metrics**
- Our results were significantly lower than the DeepFashion2 authors
  - Authors trained on twice as many images
  - Training Match R-CNN could improve the detection and segmentation performance

	Detection		Segmentation	
	Ours	**Ge et al.**	Ours	**Ge et al.**
AP	0.48	**0.667**	0.466	**0.674**
AP50	0.63	**0.814**	0.625	**0.834**
AP75	0.565	**0.773**	0.551	**0.793**

Experiments - Events Classifier Training

Problems Faced

- Dataset heavily unbalanced
- Strong presence of overfitting after few epochs

Solution

- Weighted Random Sampler: oversampling of minority classes and undersampling of majority ones
- Data augmentation techniques
- Regularization

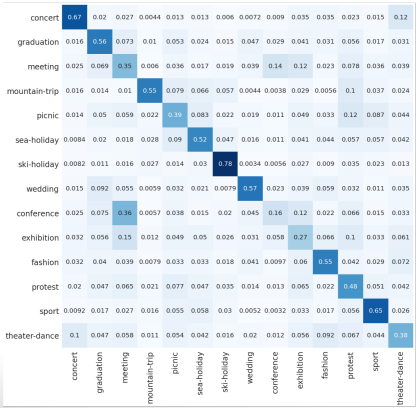
Experiments - Events Classifier Training

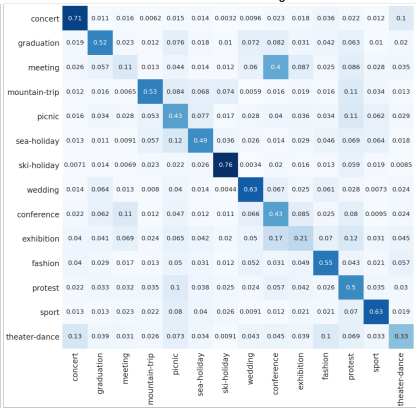
- Training the classifier keeping the pretrained ResNet50 part frozen
- Unfreeze of the last convolutional part of ResNet and fine-tuning
- Monitor the validation loss and save the best models

	Transfer Learning	Fine-Tuning
Epochs	32	32
Batch Size	64	64
LR	$5 * 10^{-4}$	$5 * 10^{-5}$
Optimizer	Adam	Adam
Weight Decay	$1 * 10{-}4$	$1 * 10{-}3$

Experiments - Events Classifier Results

	Accuracy
ResNet50	0.494
ResNet50 + Emb.	0.499





Application Example

Conclusions

- The proposed recommendation method gave good results and it is a good starting point for further research works
- Using images of single isolated garments could not give enough information to the network
- The embeddding layer did not bring sensible improvements. This can be related to the garment type distribution among the dataset
- Future works may consider additional information related to the garment image (e.g. other clothes found in the same context)

Thank you for your attention