



CS331.N11.KHTN – Advanced Computer Vision

Yoga Pose Classification with MoveNet

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Problem Introduction



Musculoskeletal Disorders (MSDs) are injuries and disorders that affect the human body's movement or musculoskeletal system.

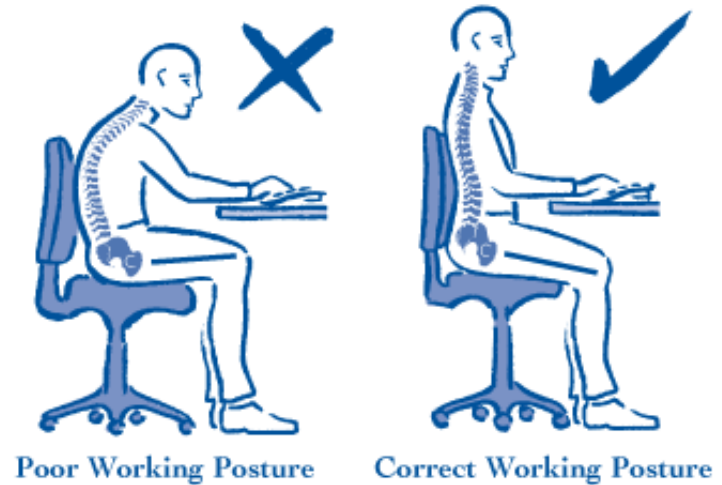




Problem Background



When a worker is exposed to MSD risk factors (bad posture, poor health habits, poor fitness,...), they begin to fatigue. When fatigue outruns their body's recovery system, they develop a musculoskeletal imbalance. Overtime, this develop MSD.





Problem Background



Yoga, which is a physical and spiritual exercise, have the ability to completely cure diseases without any medicines and improve physical and mental health.





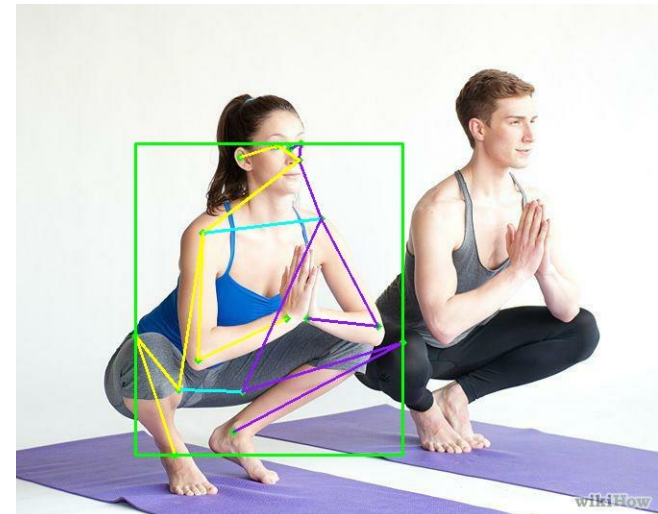
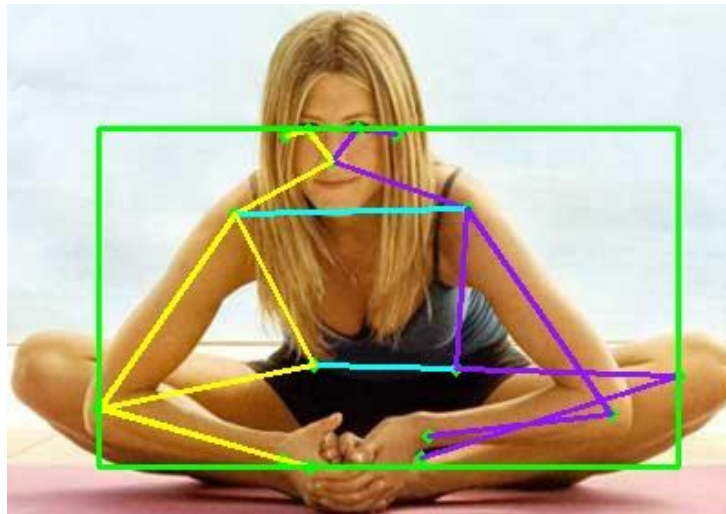
But what if practising yoga goes wrong? You could potentially harm yourself under these ways:

- Excessive pain
- Back pain and slip disc
- Stiff neck and sprain
- Muscle pulls
- Other major accidents



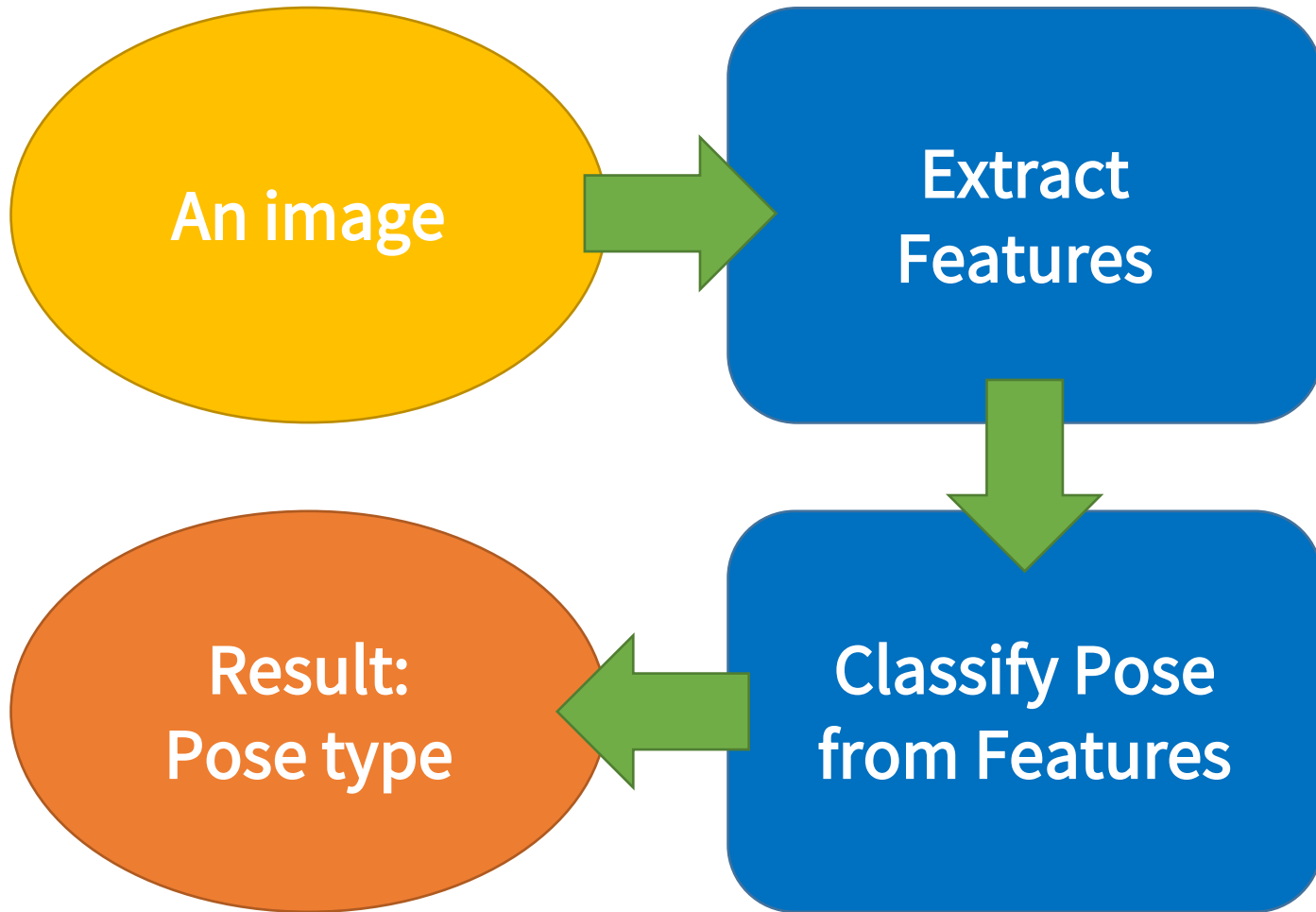


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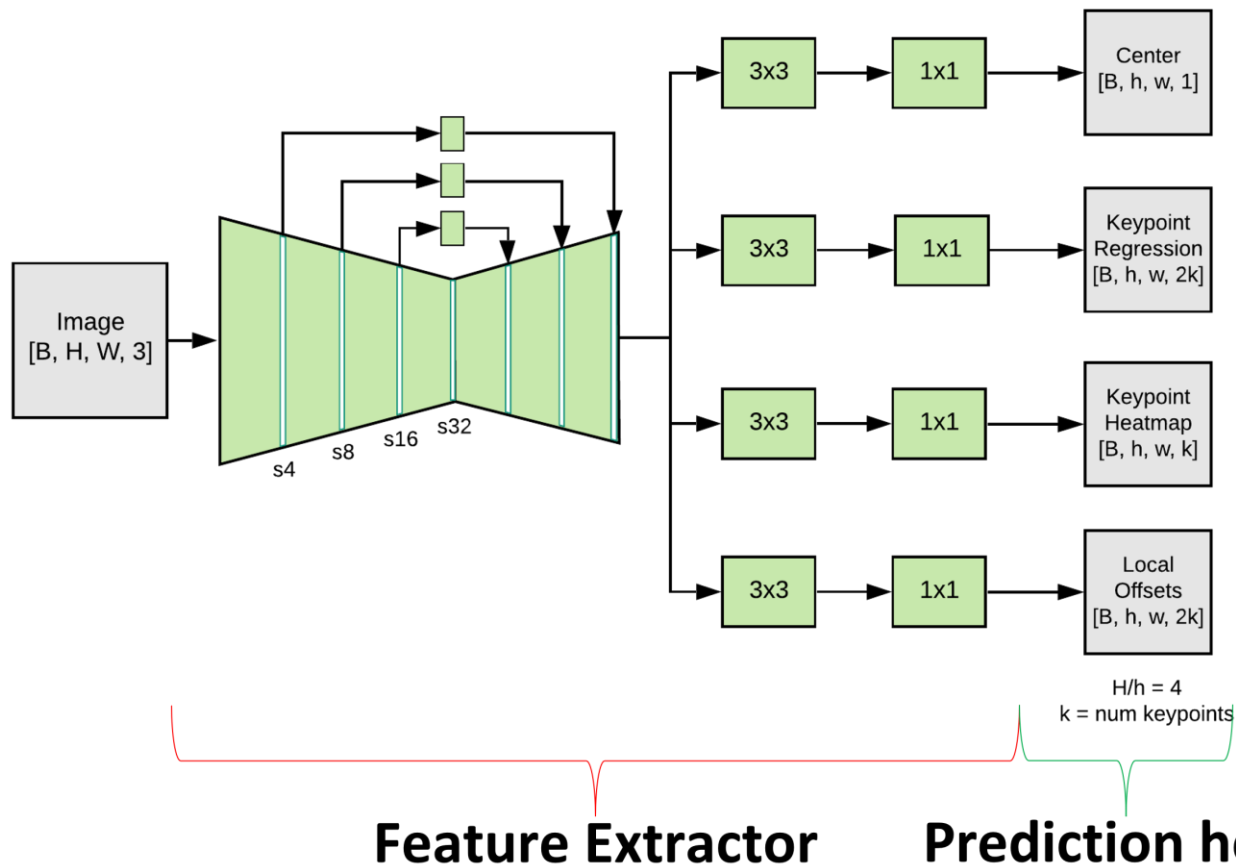


Method



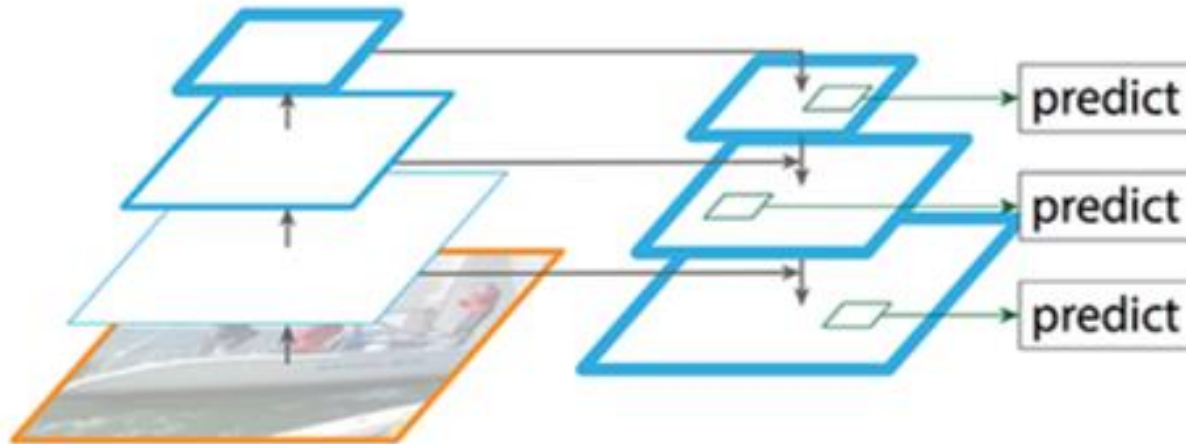


- **MoveNet** is a bottom-up estimation model, using heatmaps to accurately localize human keypoints.



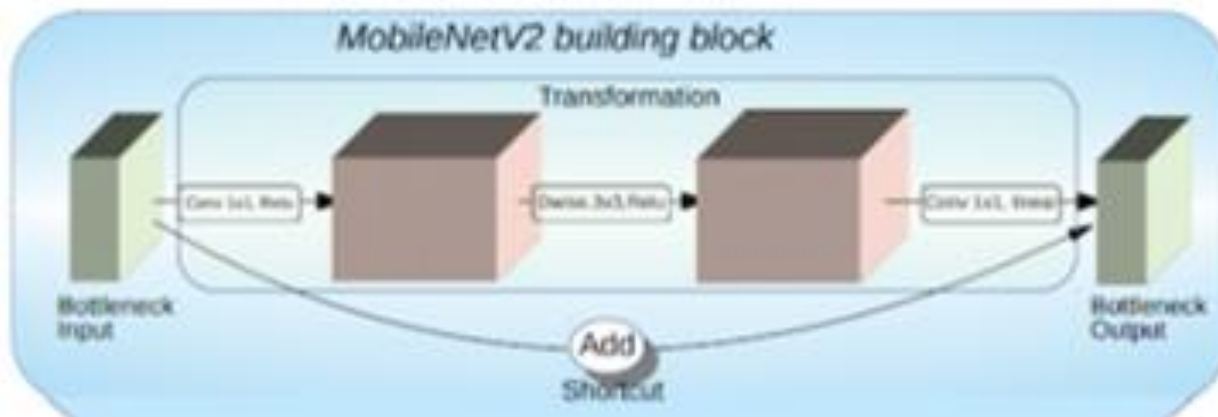
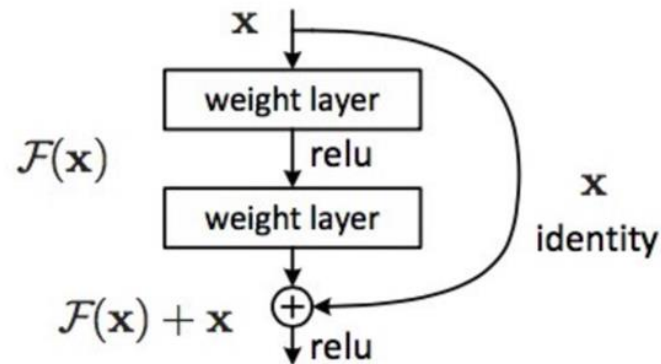


The feature extractor in MoveNet is MobileNetV2 with an attached feature pyramid network (FPN), which allows for a high resolution, semantically rich feature map output.





MobileNetV2





There are four prediction heads attached to the feature extractor, responsible for densely predicting:



Step 1

Person Center
Heatmap



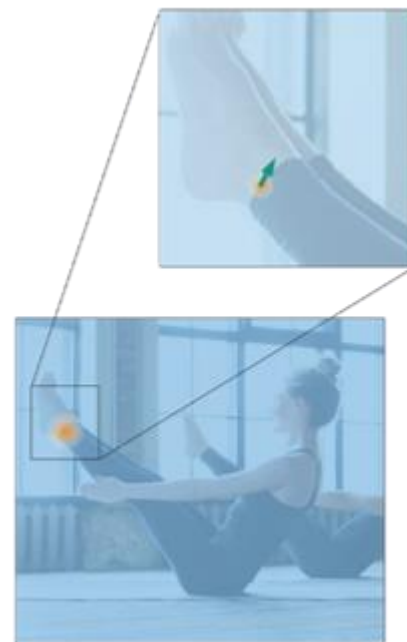
Step 2

Keypoint
regression field



Step 3

Person keypoint
heatmap



Step 4

2D per-keypoint
offset field



Experiments



Dataset: Yoga-82 (Customized)

- Divided into train/test sections with test ratio of 20%
- Only 20 poses (treated as classes) are chosen due to resources limitation. Each class having around 200 – 400 images of a person doing that pose
- Input of this problem will be an image from now on (may expand to realtime video in the future if possible)

System: Google Colab (Free Edition)



Dataset source: <https://sites.google.com/view/yoga-82/home>



MoveNet - Thunder

Classification Report:

	precision	recall	f1-score	support
Bound_Angle	0.94	0.96	0.95	46
Cat_Cow	1.00	0.99	0.99	74
Child	0.87	0.87	0.87	53
Crane	0.98	1.00	0.99	49
Eagle	1.00	0.96	0.98	49
Fish	0.87	0.87	0.87	47
Forward_Bend	0.93	0.93	0.93	43
Garland	0.97	0.83	0.90	36
Legs_Up_The_Wall	0.88	0.91	0.90	33
Revolved_Triangle	0.97	0.98	0.97	94
Scorpion	0.85	1.00	0.92	33
Side_Angle	0.97	0.94	0.95	96
Split	1.00	0.96	0.98	52
Supported_Headstand	0.96	0.92	0.94	49
Supported_Shoulderstand	0.94	0.84	0.89	38
Supta	0.90	0.87	0.89	54
Tree	0.88	0.96	0.92	47
Upward_Bow	0.88	0.91	0.90	47
Virasana	0.93	0.98	0.96	57
Warrior_II	0.96	1.00	0.98	47
accuracy			0.94	1044
macro avg	0.93	0.93	0.93	1044
weighted avg	0.94	0.94	0.94	1044



MoveNet - Lightning

Classification Report:

	precision	recall	f1-score	support
Bound_Angle	0.89	0.98	0.93	43
Cat_Cow	0.97	0.96	0.97	74
Child	0.90	0.79	0.84	56
Crane	0.91	1.00	0.95	51
Eagle	0.96	0.96	0.96	51
Fish	0.89	0.85	0.87	46
Forward_Bend	0.95	0.93	0.94	45
Garland	0.79	0.89	0.84	38
Legs_Up_The_Wall	0.83	0.86	0.85	35
Revolved_Triangle	0.93	0.99	0.96	94
Scorpion	0.91	0.89	0.90	36
Side_Angle	0.96	0.93	0.94	98
Split	0.98	0.94	0.96	52
Supported_Headstand	0.98	0.90	0.94	51
Supported_Shoulderstand	0.86	0.84	0.85	44
Supta	0.91	0.84	0.88	58
Tree	0.98	0.96	0.97	46
Upward_Bow	0.89	0.92	0.91	52
Virasana	0.93	0.98	0.96	55
Warrior_II	0.98	1.00	0.99	47
accuracy			0.93	1072
macro avg	0.92	0.92	0.92	1072
weighted avg	0.93	0.93	0.93	1072



Compare with other solutions



Model	Accuracy
MoveNet – Thunder + Custom Keras Model	0.94
MoveNet – Lightning + Custom Keras Model	0.93
VGG16	0.623
VGG19	0.621
ResNet50	0.327
ResNet152	0.313



- Insufficient target size
- Tough angles, under/over-exposed images
- Resources demanding



- <https://ergo-plus.com/musculoskeletal-disorders-msd/>
- <https://www.news18.com/news/lifestyle/yoga-side-effects-myupchar-2727181.html>
- <https://phamdinhhkhanh.github.io/2020/09/19/MobileNet.html>
- <https://blog.tensorflow.org/2021/05/next-generation-pose-detection-with-movenet-and-tensorflowjs.html>
- <https://arxiv.org/abs/1801.04381.pdf>
- <https://sites.google.com/view/yoga-82/home?pli=1>
- <https://www.kaggle.com/code/jyothijyothiii/vgg19multiclassclassification>
- <https://medium.com/axinc-ai/movenet-pose-estimation-for-video-with-intense-motion-2b92f53f3c8>