Fashion Classification

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Fashion Classification Problem

- Task: Classify image data for accurate product representation
- Classes
  - Shirts (1322 images, 27%)
  - Pants (1139 images, 24%)
  - Shoes (1116 images, 23%)
  - Watches (1249 images, 26%)
- Characteristics
  - White background
  - Balanced
  - Variety of colors/patterns
  - Objects of interest are in the center
  - 2-5 KB
  - 60 x 80 pixels
  - Resolution: 96 dpi

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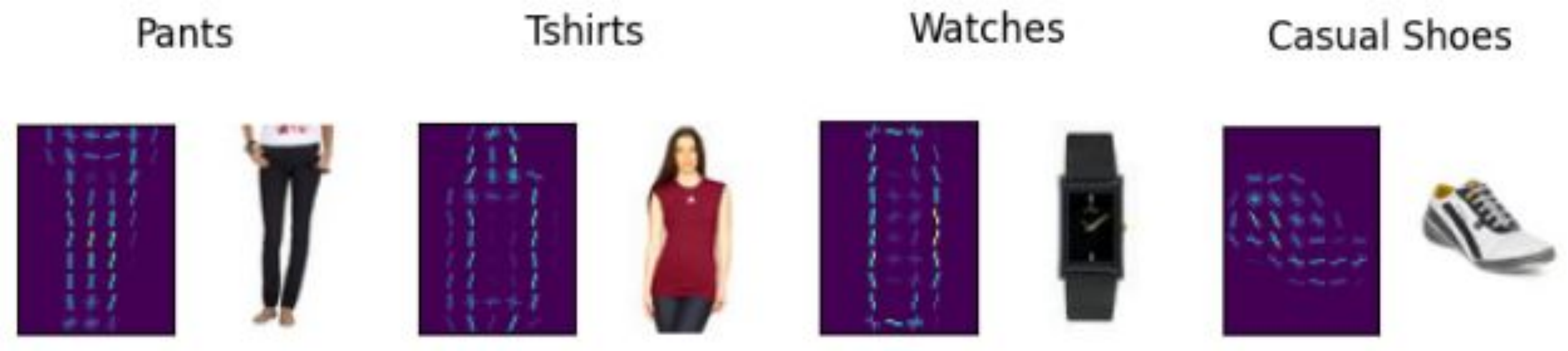
Preprocessing

- Resized images
- Images already centered
- PCA or UMAP transformation
- Train, test, validation (70%, 20%, 10%)
- Explored grayscale vs 3-channel RGB images

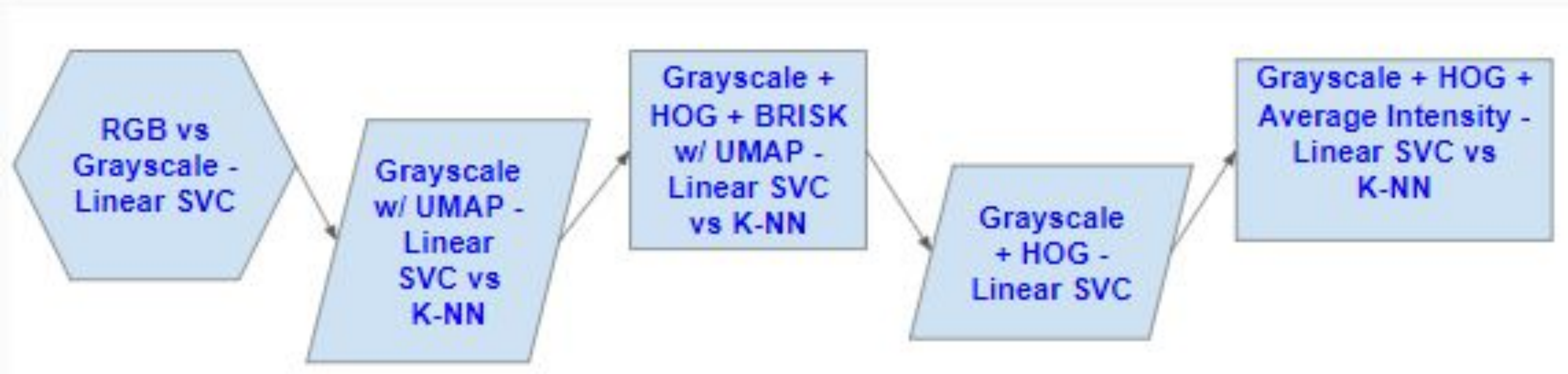
Feature Selection - Prelim Logit

Feature	Accuracy
HOG*	97.1%
HSV (Value) Histogram	45.3%
Harris Corner	55.7%
SIFT with BOVW	68.8%
BRISK*	47%
RGB Histogram	51%
ResNet101*	79%

HOG - Best Feature



Classification



RGB vs Grayscale - Linear SVC

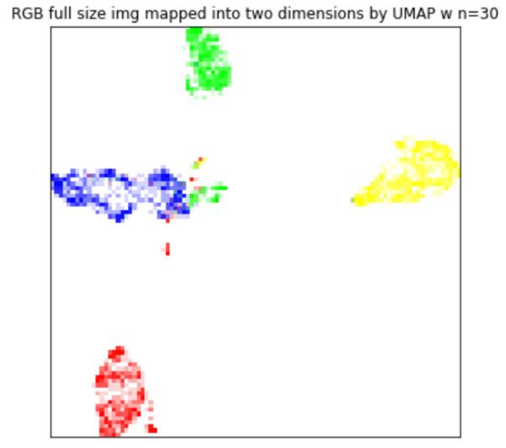
Grayscale w/ UMAP - Linear SVC vs K-NN

Grayscale + HOG + BRISK w/ UMAP - Linear SVC vs K-NN

Grayscale + HOG - Linear SVC

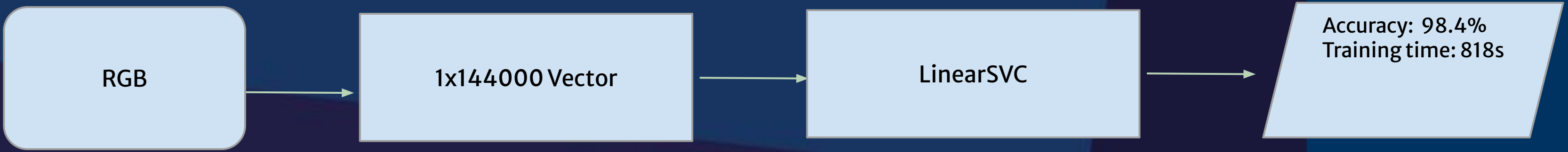
Grayscale + HOG + Average Intensity - Linear SVC vs K-NN

Classification RGB Image



RGB full size img mapped into two dimensions by UMAP w n=30

UMAP mapping of RGB train images to 2 dimensions



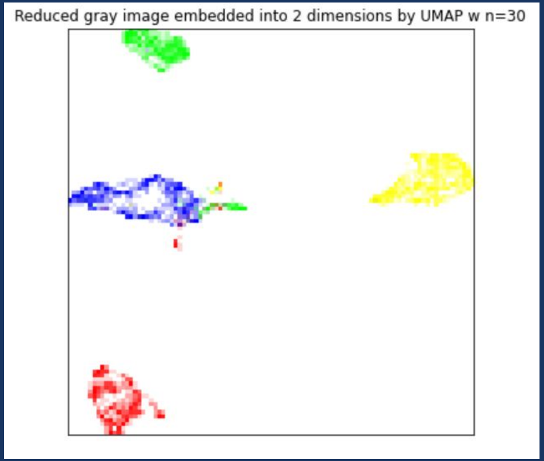
RGB

1x144000 Vector

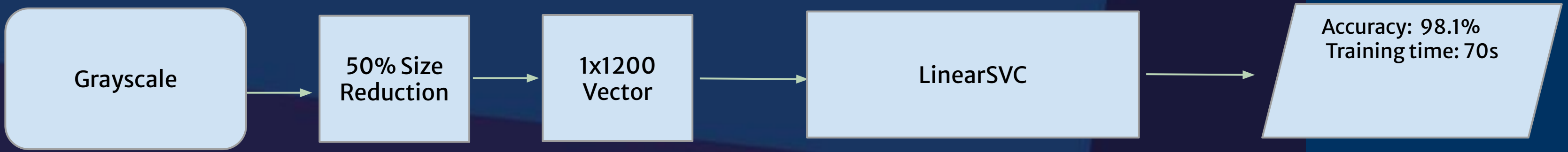
LinearSVC

Accuracy: 98.4%
Training time: 818s

Classification Grayscale img



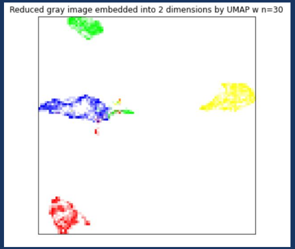
UMAP mapping of Grayscale train images to 2 dimensions



Accuracy: 98.1%
Training time: 70s

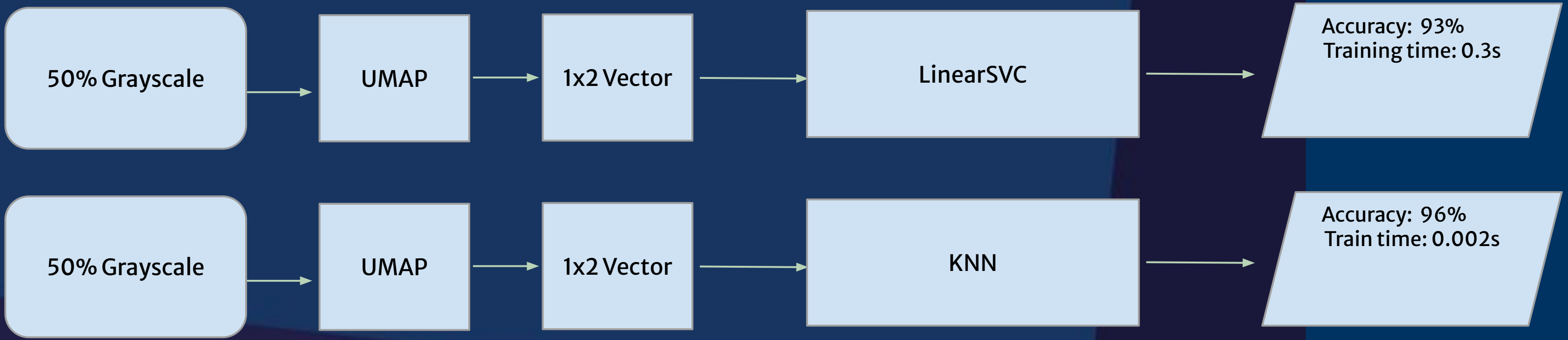
Moving forward we use reduced Grayscale images →

Classification



Reduced gray image embedded into 2 dimensions by UMAP w n=30

What if we could use the UMAP mapping for the training
Output is size 2 vector
UMAP learned architecture on Train data alone – Save it
Load saved model, transform Test data on UMAP model



50% Grayscale → UMAP → 1x2 Vector → LinearSVC →

Accuracy: 93%
Training time: 0.3s

50% Grayscale → UMAP → 1x2 Vector → KNN →

Accuracy: 96%
Train time: 0.002s

Want to use K Classifier and UMAP →only need accuracy to go up

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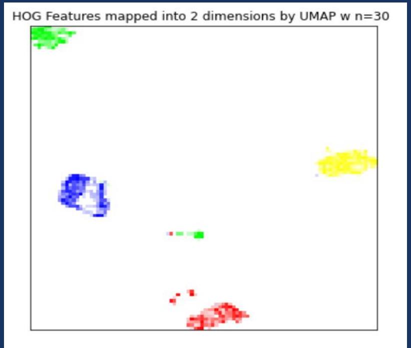
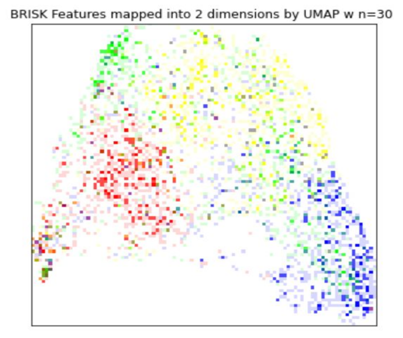
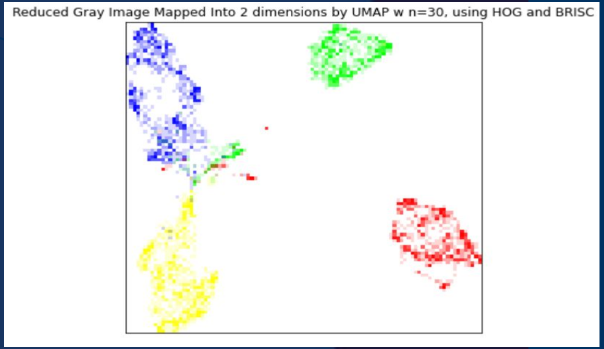
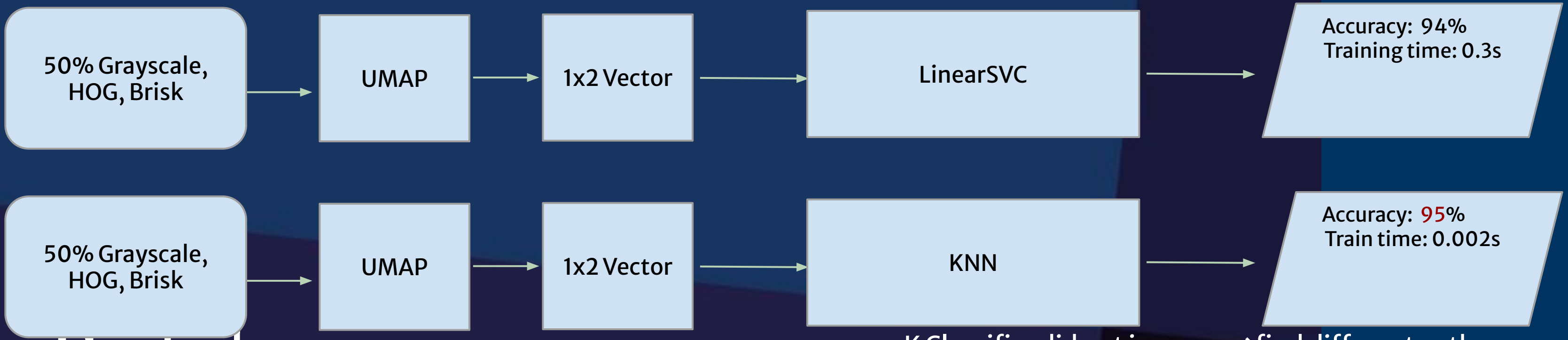
UMAP Visualizations + Classifier


HOG Features mapped into 2 dimensions by UMAP w n=30


BRISK Features mapped into 2 dimensions by UMAP w n=30


Reduced Gray Image Mapped Into 2 dimensions by UMAP w n=30, using HOG and BRISC


50% Grayscale, HOG, Brisk

UMAP

1x2 Vector

LinearSVC

Accuracy: 94%
Training time: 0.3s

50% Grayscale, HOG, Brisk

UMAP

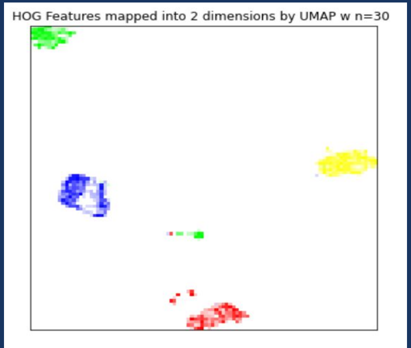
1x2 Vector

KNN

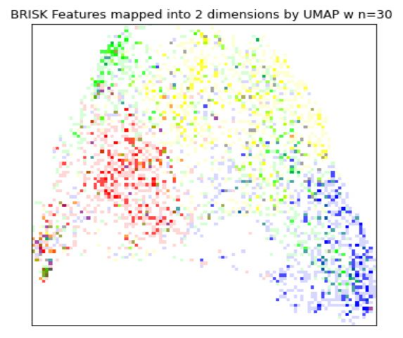
Accuracy: 95%
Train time: 0.002s

K Classifier did not improve →find different path

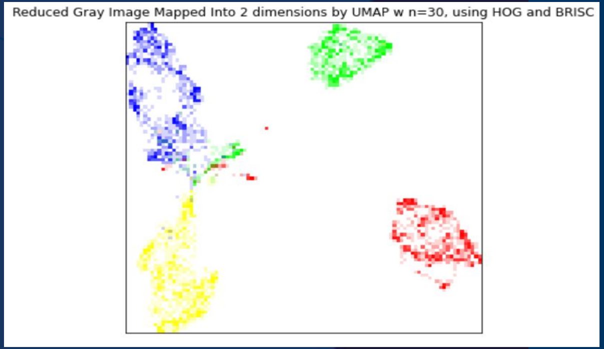
UMAP + Features



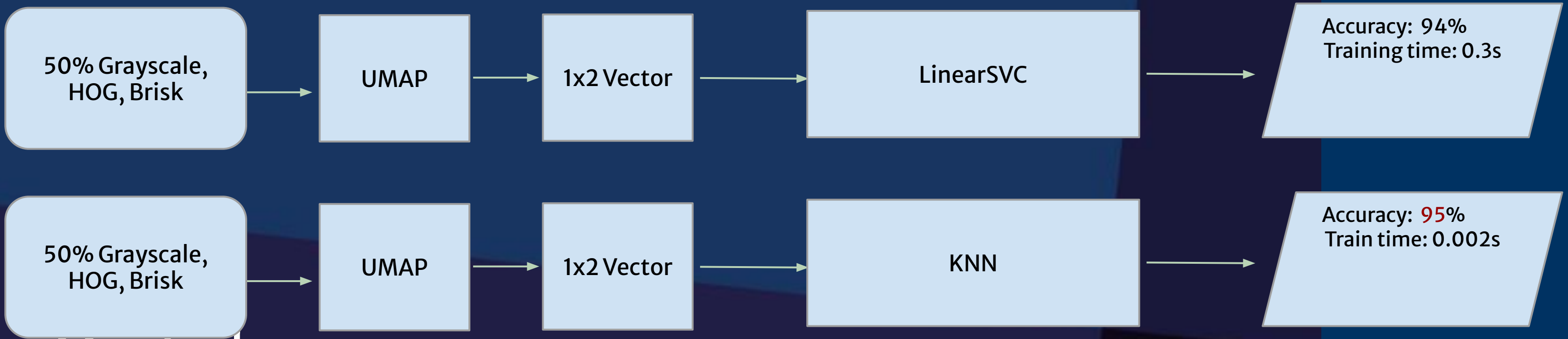
HOG Features mapped into 2 dimensions by UMAP w n=30



BRISK Features mapped into 2 dimensions by UMAP w n=30



Reduced Gray Image Mapped Into 2 dimensions by UMAP w n=30, using HOG and BRISC



50% Grayscale, HOG, Brisk → UMAP → 1x2 Vector → LinearSVC → Accuracy: 94% Training time: 0.3s

50% Grayscale, HOG, Brisk → UMAP → 1x2 Vector → KNN → Accuracy: 95% Train time: 0.002s

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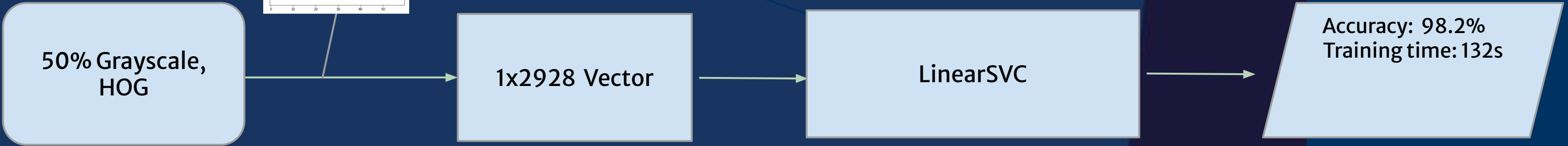
Gray and Hog

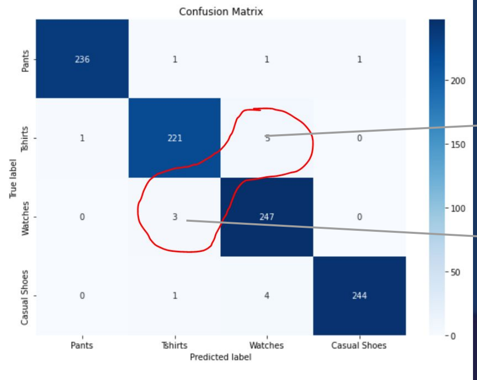
Item of Class: 'Tshirts' Labeled As 'Watches'


50% Grayscale, HOG

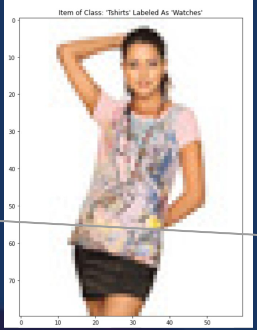
1x2928 Vector

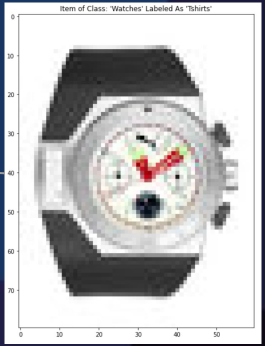
LinearSVC

Accuracy: 98.2%
Training time: 132s

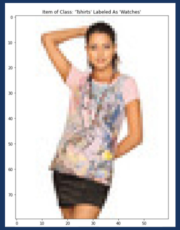

Confusion Matrix

True label \ Predicted label	Pants	Tshirts	Watches	Casual Shoes
Pants	236	1	1	1
Tshirts	1	221	5	0
Watches	0	3	247	0
Casual Shoes	0	1	4	244

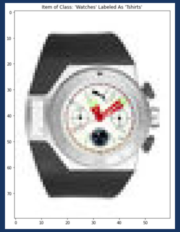

Item of Class: 'Tshirts' Labeled As 'Watches'


Item of Class: 'Watches' Labeled As 'Tshirts'

Gray and Hog



Item of Class: 'Tshirts' Labeled As 'Watches'

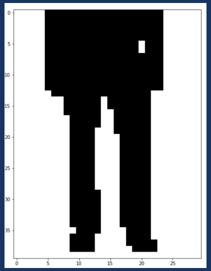


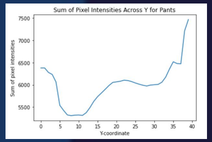
Item of Class: 'Watches' Labeled As 'Tshirts'

Considered face det, but..

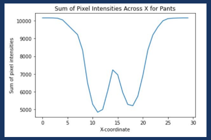
Top edge differentiates some Tshirts from some Watches.

Not being taken account of.



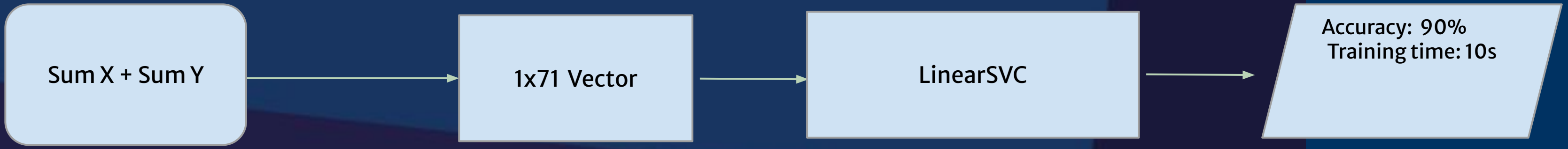


Sum of Pixel Intensities Across Y for Pants



Sum of Pixel Intensities Across X for Pants

Turned images to b&w
Sum of Y vector
Sum of X vector



Sum X + Sum Y

1x71 Vector

LinearSVC

Accuracy: 90%
Training time: 10s

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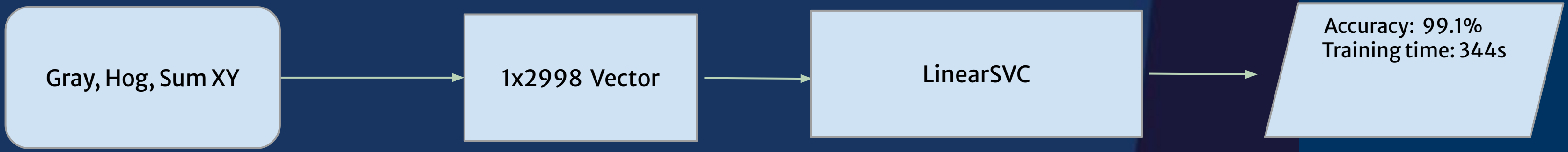
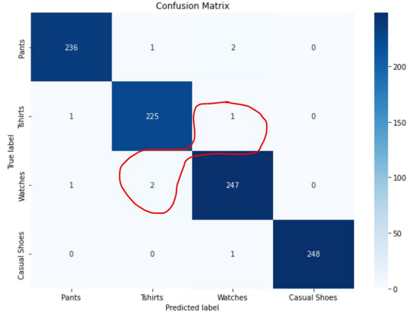
Gray and Hog and Axis Intensity

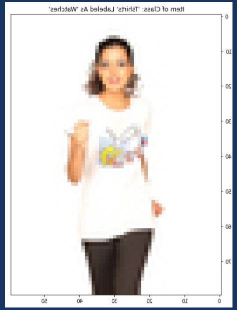


Gray, Hog, Sum XY → 1x2998 Vector → LinearSVC → Accuracy: 99.1% Training time: 344s

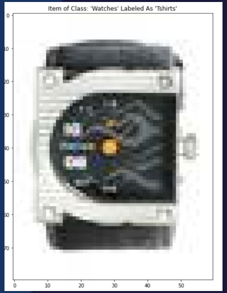


Confusion Matrix

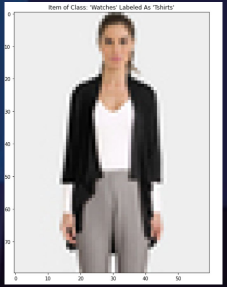
True label \ Predicted label	Pants	Tshirts	Watches	Casual Shoes
Pants	236	1	2	0
Tshirts	1	225	1	0
Watches	1	2	247	0
Casual Shoes	0	0	1	248



Fails because of white Tshirt



Failure unknown



Mislabeled picture.

Labeled as Watch

Classifier identified as Tshirt

This is our best model →

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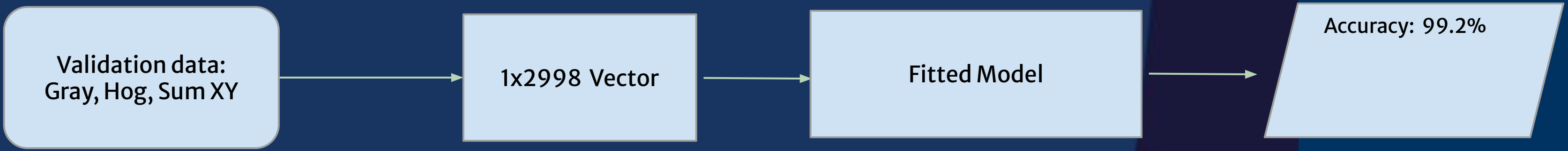
Model on Validation

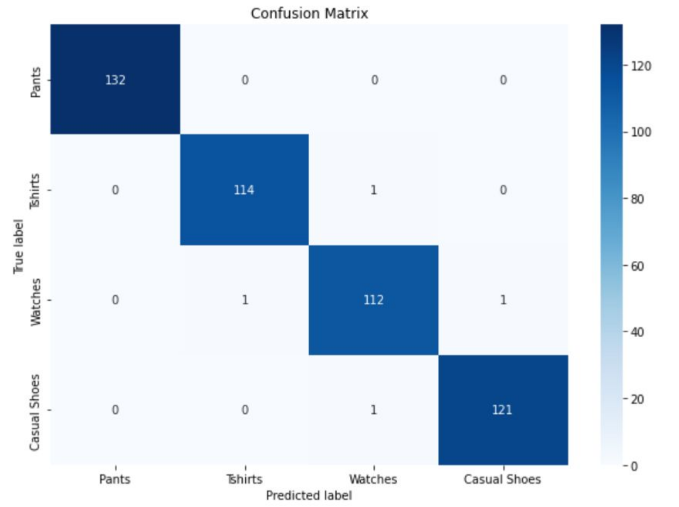


Validation data: Gray, Hog, Sum XY

1x2998 Vector

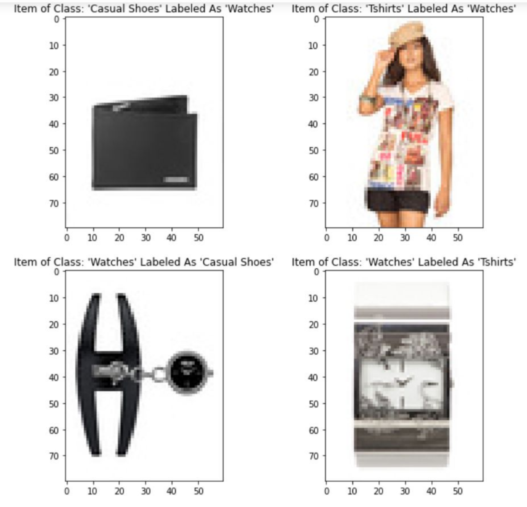
Fitted Model

Accuracy: 99.2%



Confusion Matrix

True label \ Predicted label	Pants	Tshirts	Watches	Casual Shoes
Pants	132	0	0	0
Tshirts	0	114	1	0
Watches	0	1	112	1
Casual Shoes	0	0	1	121



Item of Class: 'Casual Shoes' Labeled As 'Watches'
Item of Class: 'Tshirts' Labeled As 'Watches'
Item of Class: 'Watches' Labeled As 'Casual Shoes'
Item of Class: 'Watches' Labeled As 'Tshirts'
0
10
20
30
40
50
60
70

Classification Approach

Grayscale	UMAP	Features	Model	Accuracy
No	No	None	Linear SVC	98%
Yes	No	None	Linear SVC	98%
Yes	Yes	None	Linear SVC	93%
Yes	Yes	None	K-NN	96%
Yes	Yes	HOG, BRISK	Linear SVC	94%
Yes	Yes	HOG, BRISK	K-NN	95%
Yes	No	HOG	Linear SVC	98%
Yes	No	HOG, Avg Intensity	Linear SVC	99%
Yes	Yes	HOG, Avg Intensity	K-NN	25%

Classification Approach - Hyperparameter Tuning w/ GridSearchCV

From C = 0.00001 to 100000:

Grayscale	UMAP	Features	Model	Accuracy	Best Hyperparameters	Training Time	Prediction Time
Yes	No	HOG, Axis Intensity	Linear SVC	99.1%	C=1xe-5	6.73 s	0.025 s

The hyperparameter C in a LinearSVC model controls the trade-off between the margin size and the misclassification error. A larger C means that the model will try to find a smaller margin, but it may also overfit the training data and perform poorly on new data.

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Conclusion

Grayscale	UMAP	Features	Model	Accuracy	Hyperparameter	Training Time	Prediction Time
Yes	No	HOG, Axis Intensity	Linear SVC	99.1%	C=1xe-5	6.73 s	0.025 s

RGB	UMAP	Features	Model	Accuracy	Hyperparameter	Training Time	Prediction Time
Yes	No	RGB	Linear SVC	98%	C=1xe-5	121 s	0.82 s

Conclusion

- Increased accuracy
- Reduced file size
- Improved performance
- Intuitive Approach
- For future experiment more with UMAP

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Appendix: Class. Approach 2

- Collab/Google computing
- Hyperparameter tuning with PCA Transformed HOG and RestNet101 with models Logistic Regression and Linear SVC

Features	Model	Accuracy	Best Hyperparameters	Training Time	Prediction Time
HOG	Logistic Regression	98%	C=100, Penalty=L1, Solver=Saga	4.62 s	0.016 s
HOG	Linear SVC	98%	C=10, Gamma=0.01, Kernel=RBF	0.26 s	0.23 s
HOG + ResNet101	Linear SVC	97.8%	C=10, Gamma=auto, Kernel=RBF	0.21 s	0.11 s