Digit recognition

Project Proposal

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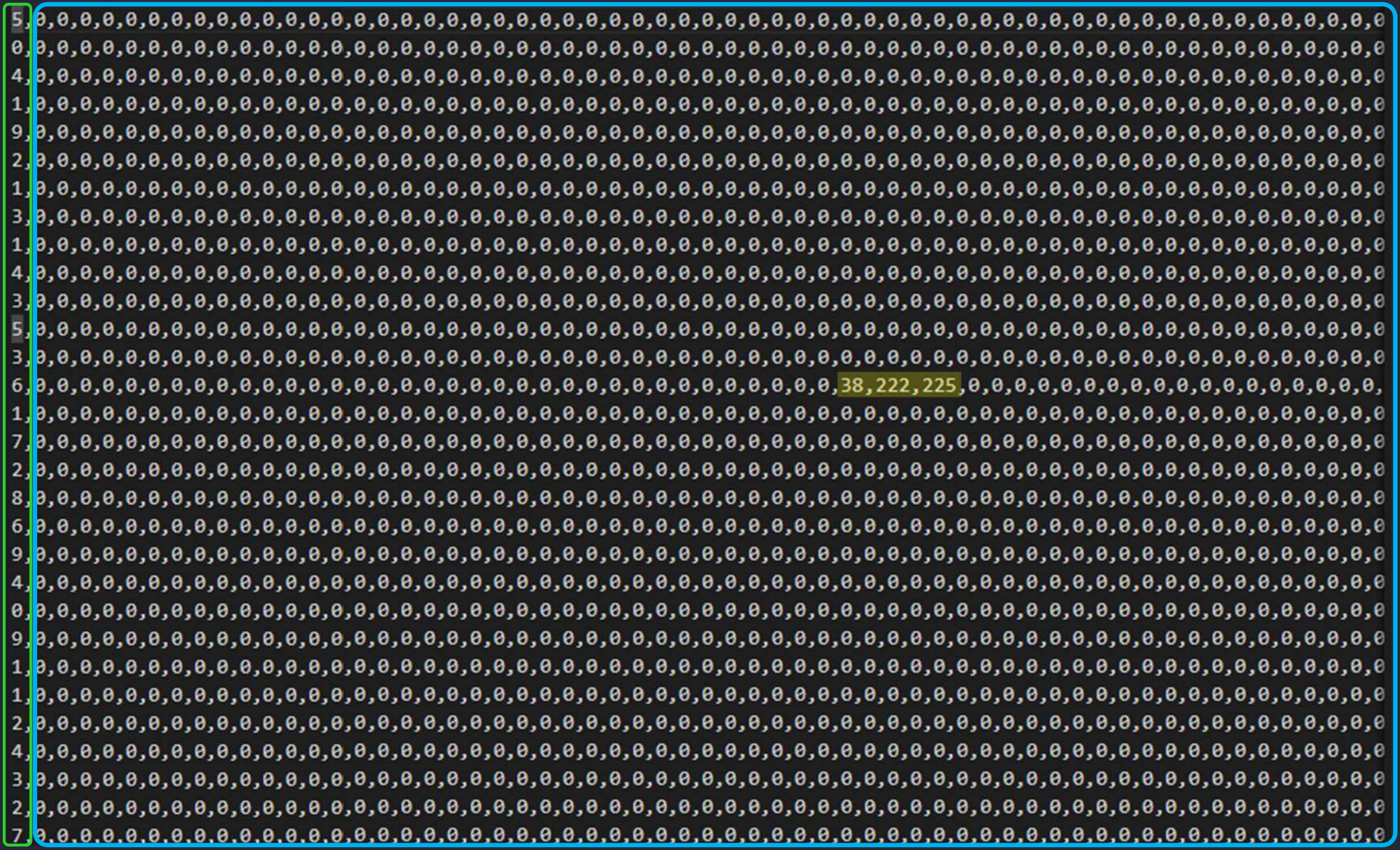
What is “Digit recognition”?

“Digit recognition is the ability of computers to recognize human handwritten digits”

(data-flair.training)

Pixel Values

L
a
b
e
l



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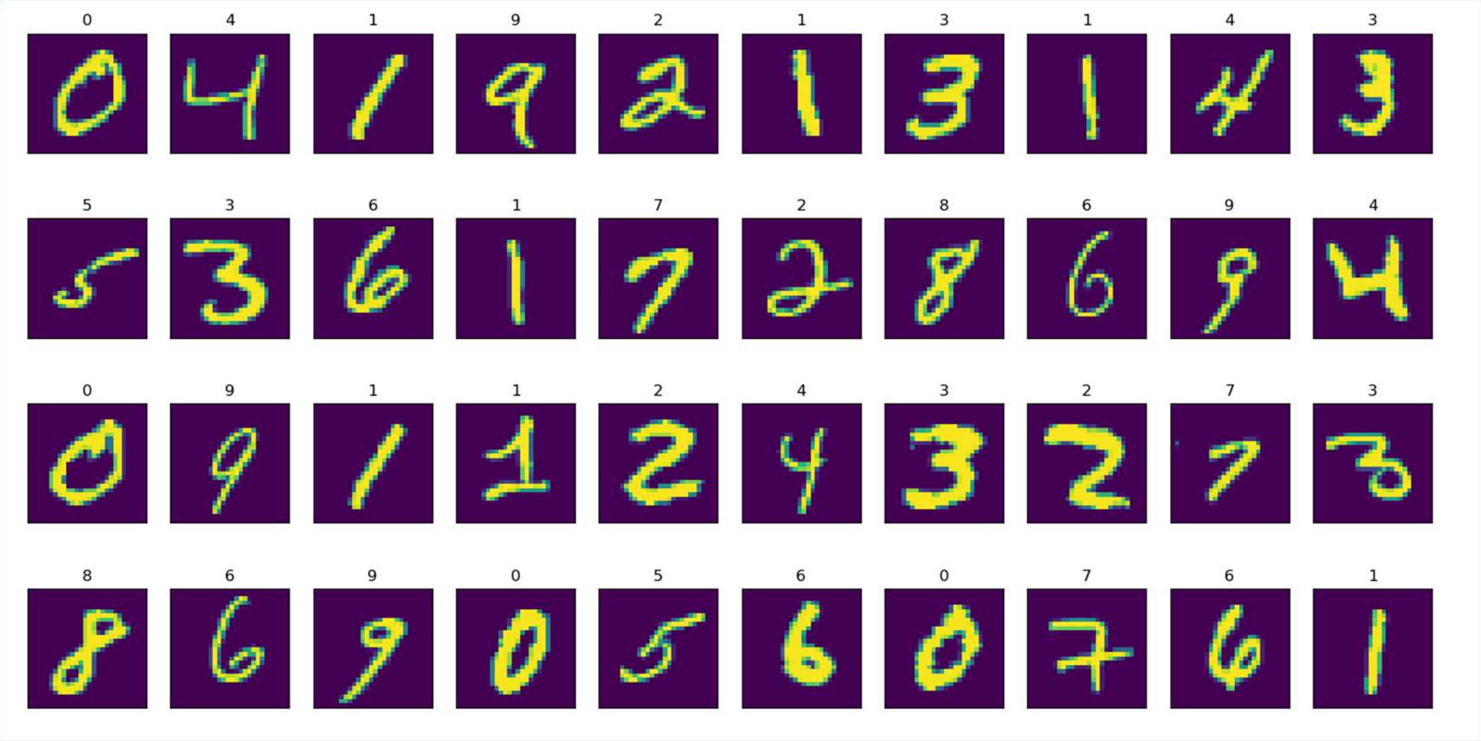
Conversion with matplotlib



List of planned analysis steps

Principal Component Analysis (PCA)

- Z-transform, covariance, eigenvalues and -vectors

K-Nearest Neighbour (KNN)

- Euclidian distance, distance sorting, most common neighbours, prediction of class

Evaluation

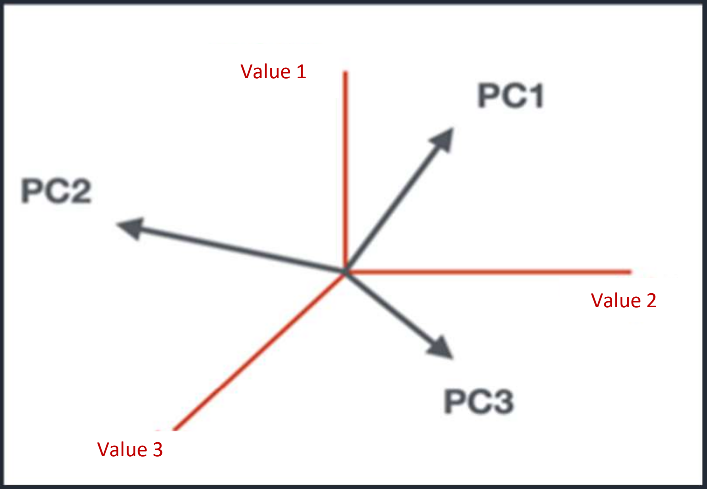
- Accuracy, optimizing PC/K-value, error analysis

Additional:

- Implementation of a neural network / comparing outcomes

Principal Component Analysis (PCA)

60.000 dimensions ⟶ n principal components (reduction of dimensions)



Principal Component Analysis (PCA)

1. Import libraries and dataset

2. z-transform

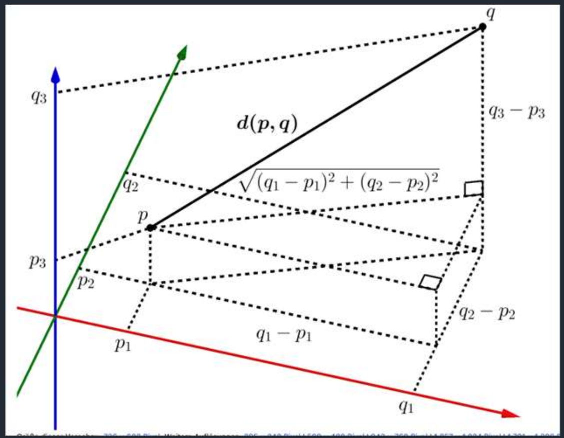
$$z = \frac{x - \mu}{\sigma}$$

3. Implement PCA

- Covariance
- Eigenvalues and -vectors

$$X\underset{\substack{\uparrow\\ \text{eigenvector}\\ \text{of X}}}{v} = \underset{\substack{\uparrow\\ \text{eigenvalue}\\ \text{of X}}}{\lambda} v$$

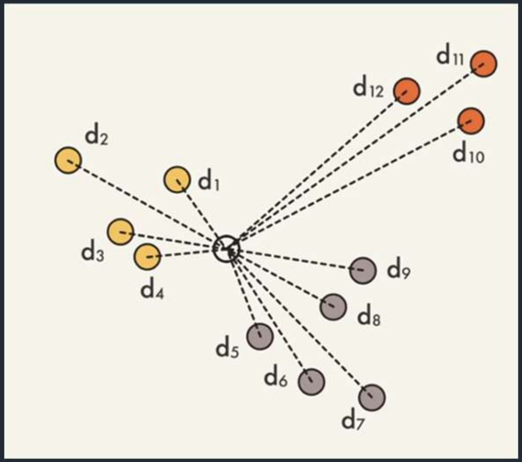
K-Nearest Neighbour (KNN) algorithm



https://de.wikipedia.org/wiki/Euklidischer_Abstand

Euclidean distance

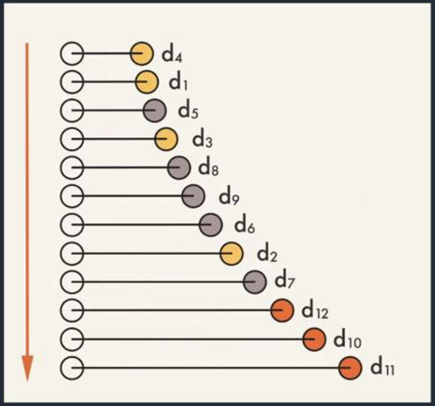
- length of line segment between two points
- $d(p,q) = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$

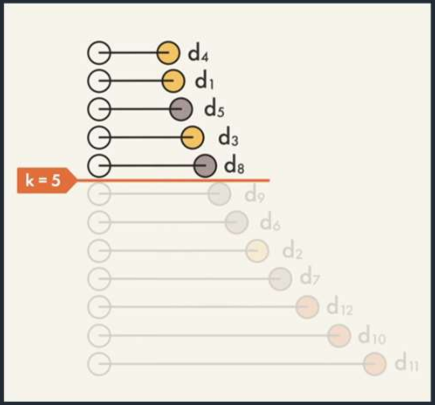


https://youtu.be/0p0o5cmgLdE

- calculating distance between test data image and train data images
- Euclidean distance: square of the differences between their coordinates in n-dimensional space (set by PCA)

K-Nearest Neighbour (KNN) algorithm





https://youtu.be/0p0o5cmgLdE

Sort distances in ascending order

- sorting labeled neighbors (train data points) by ascending distance
- Get the k nearest neighbors by taking top k rows from sorted array

Most common neighbours

- select the most common labels (digits) for these rows by majority vote
- predicting class of new data point

Evaluation

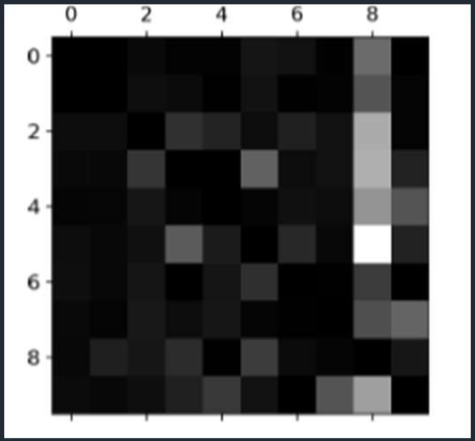
- computing mean accuracy

Problem Nr.1

1. Some numbers are difficult to distinguish

1 or 7?

→ Estimating error frequency with e.g. confusion matrix

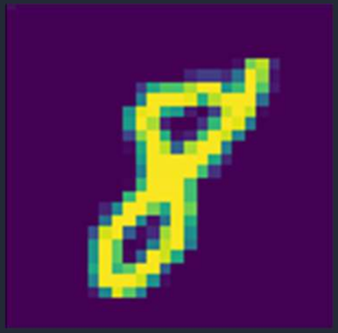


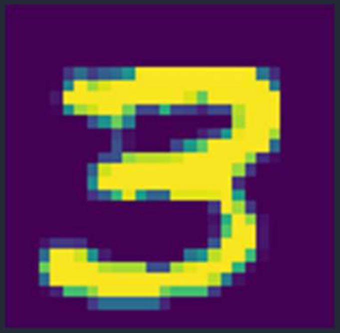
Géron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow (Sebastopol, CA: O'Reilly Media).

Solution for Problem Nr.1

1. Some numbers are difficult to distinguish

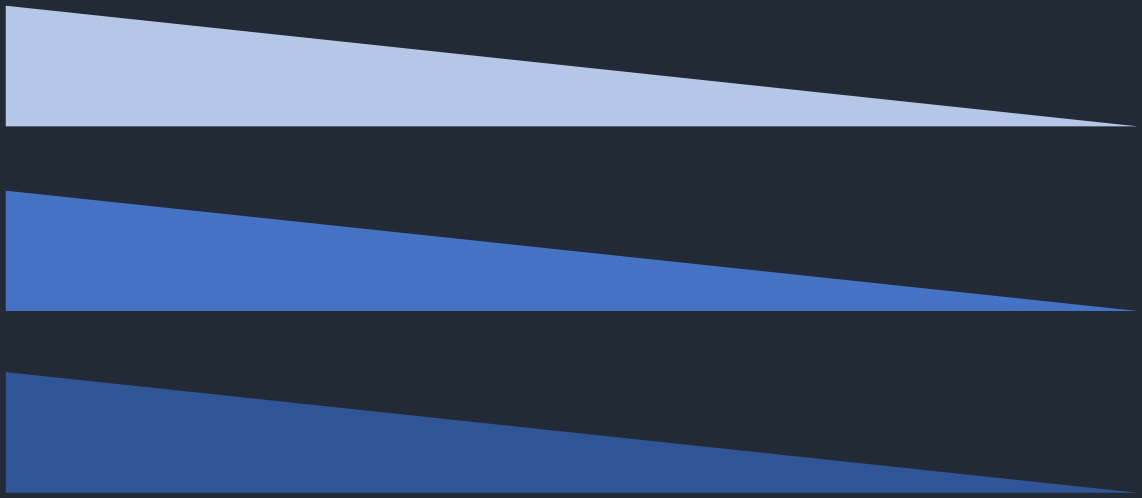
Solution: implementation of an algorithm that recognizes closed loops





Problem Nr. 2

2. Principal components: Tradeoff run-time vs. variance



many PCs — few PCs

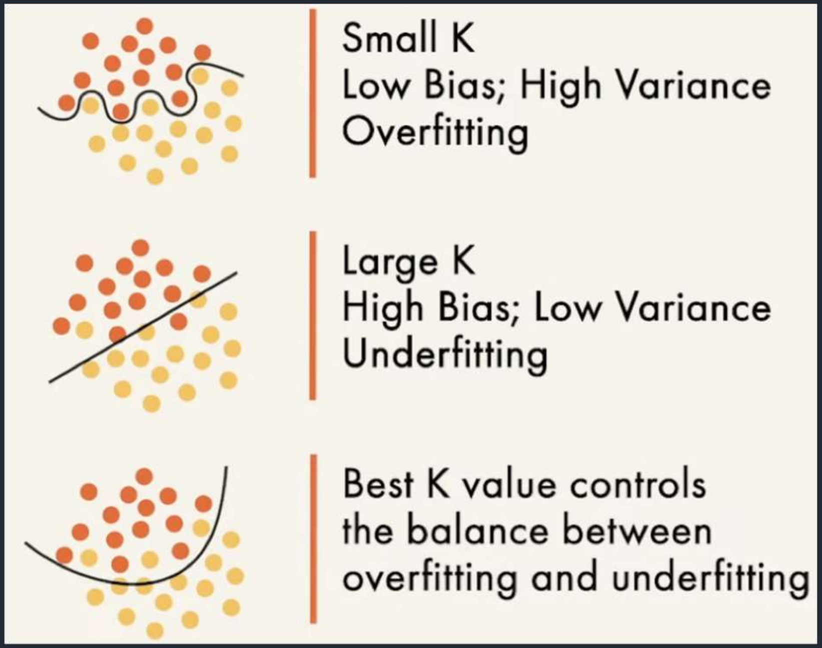
high explanation of variance — low explanation of variance

high run-time — low run-time

Problem Nr. 3

3. over- and underfitting of k-value

→ write an algorithm which determines best k-value



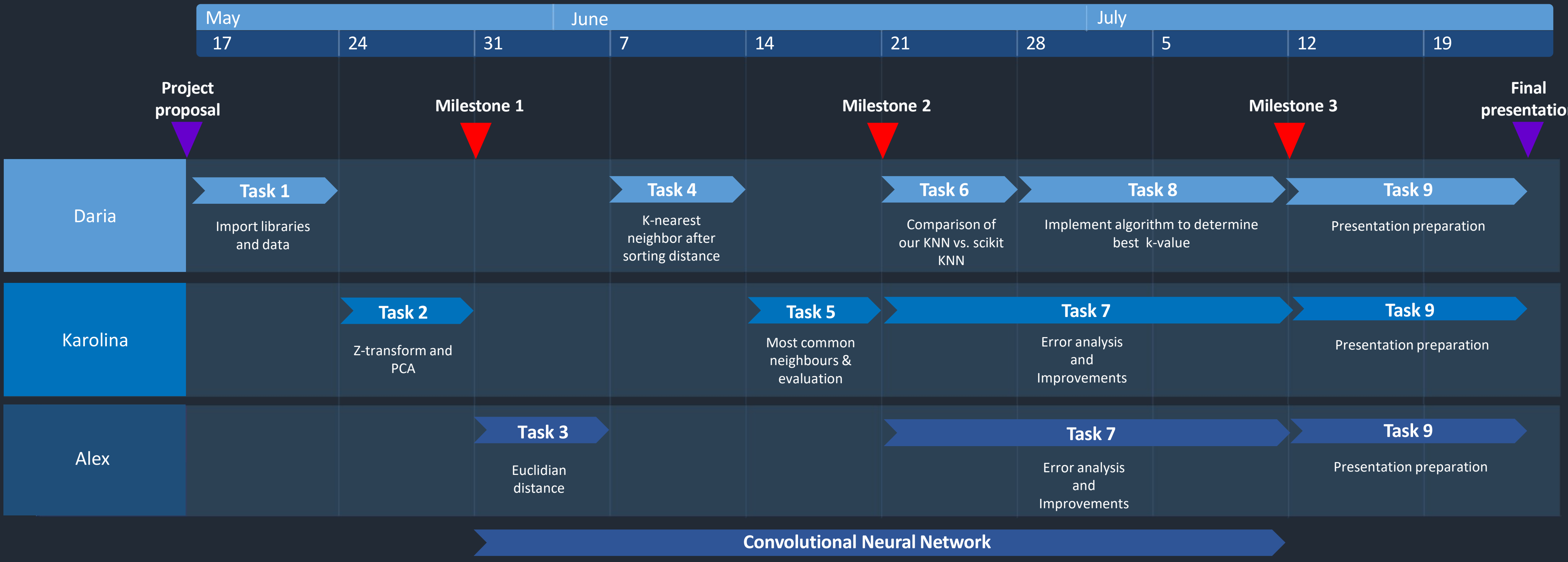
Small K
Low Bias; High Variance
Overfitting

Large K
High Bias; Low Variance
Underfitting

Best K value controls
the balance between
overfitting and underfitting

https://youtu.be/0p0o5cmgLdE

Approximate timetable



	May			June				July		
	17	24	31	7	14	21	28	5	12	19
	Project proposal		Milestone 1			Milestone 2			Milestone 3	Final presentation
Daria	Task 1 Import libraries and data			Task 4 K-nearest neighbor after sorting distance		Task 6 Comparison of our KNN vs. scikit KNN	Task 8 Implement algorithm to determine best k-value		Task 9 Presentation preparation	
Karolina		Task 2 Z-transform and PCA			Task 5 Most common neighbours & evaluation	Task 7 Error analysis and Improvements			Task 9 Presentation preparation	
Alex			Task 3 Euclidian distance			Task 7 Error analysis and Improvements			Task 9 Presentation preparation	
			Convolutional Neural Network							

Thank you for listening

Questions?