Pattern Recognition

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Citations:

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3. https://www.technologyreview.com/the-download/608726/climate-change-research-is-getting-a-big-dose-of-ai/
4. http://bigthink.com/endless-innovation/humans-are-the-worlds-best-pattern-recognition-machines-but-for-how-long
5. https://chatbotslife.com/three-ways-big-data-and-machine-learning-revolutionize-drug-discovery-8d9d25b895f6
6. https://link.springer.com/chapter/10.1007/978-3-319-23117-4_37
7. https://www.datascience.com/blog/supervised-and-unsupervised-machine-learning-algorithms
8. http://ieeexplore.ieee.org/document/6061179/
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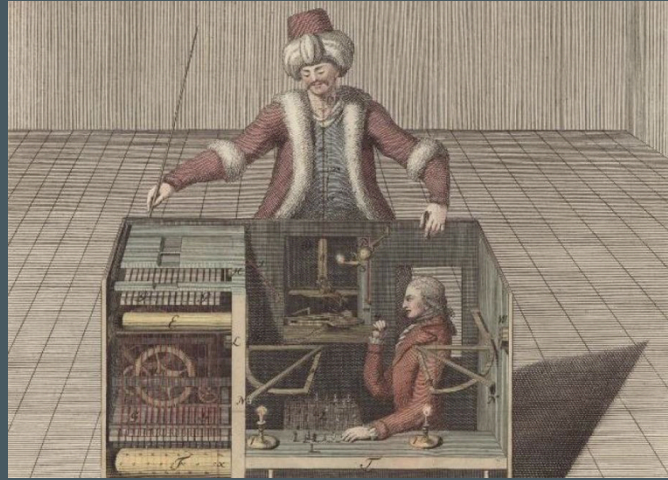
Outline

Overview of Pattern Recognition

What is Pattern Recognition?

Where do we use Pattern Recognition?

How are Patterns Discovered?

What are some approaches to pattern Recognition?

Applications of Pattern Recognition.

The
Turk

Motivation to explore patterns:

Once IBM could build machines that could recognize as many chessboard patterns as a chess grandmaster, the machines became "smarter" than humans.[4]

can be more accurate and cheaper.[1]

can be studied with pattern recognition and more concrete predictions can be made. [2]

and   can be much more successful with advent of pattern recognition based research.[3]

Pattern recognition can inevitably improve / revolutionize almost all fields that we care about today.
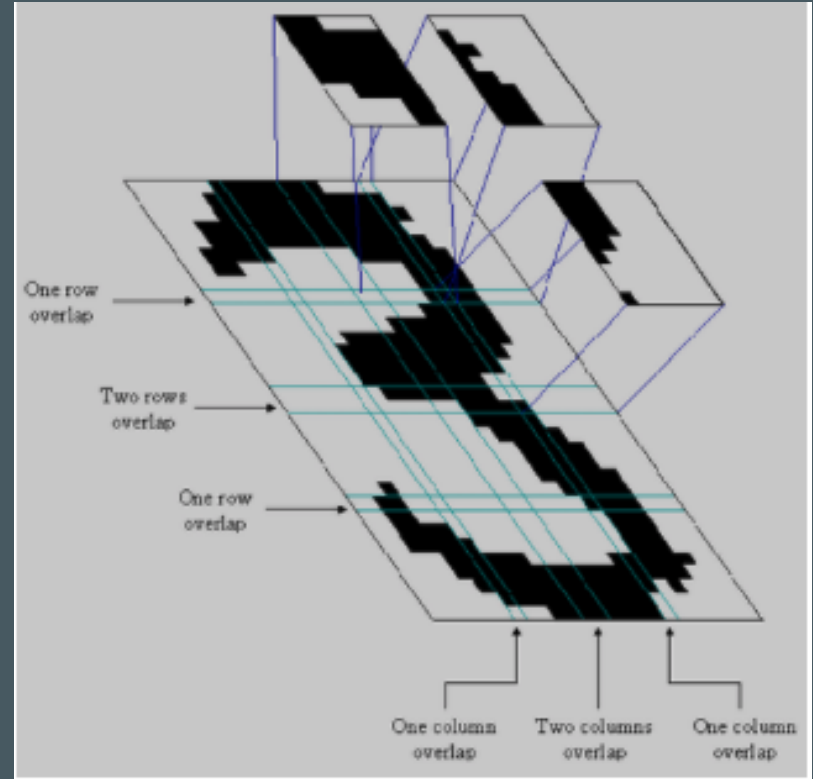
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What is a Pattern?

A pattern is an entity, vaguely defined, that could be given a name, e.g. fingerprint image, handwritten word, human face, speech signal, DNA sequence.
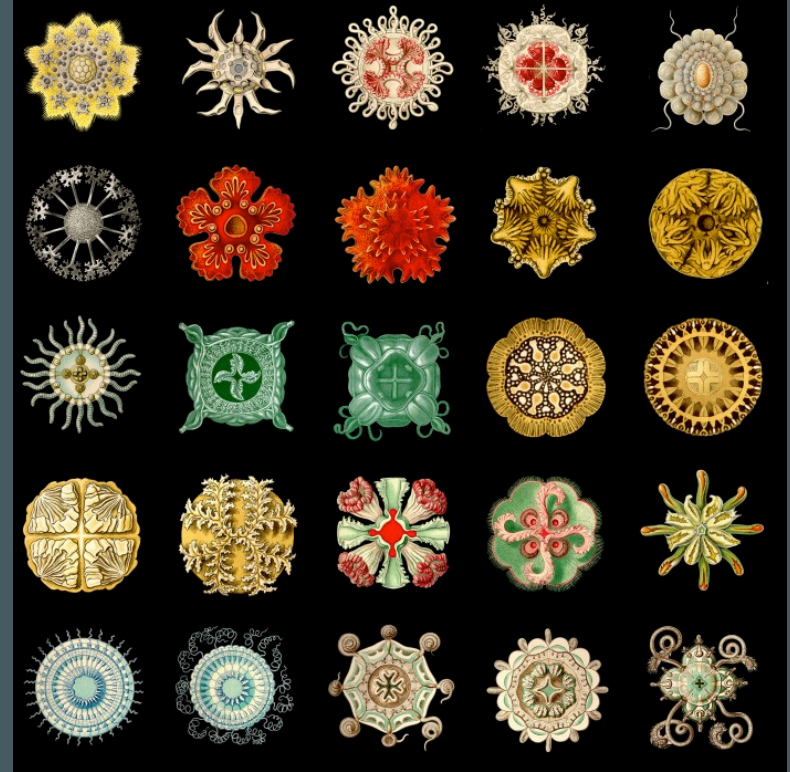
What is Pattern Recognition?

Pattern recognition involves finding the similarities or patterns among small, decomposed problems that can help us solve more complex problems.

One row overlap

Two rows overlap

One row overlap

One column overlap

Two columns overlap

One column overlap

Pattern Recognition versus AI

The most significant difference between AI and Pattern Recognition is that AI focuses on the reasoning part and Pattern Recognition on the observations derived from any data.

AI emphasizes primarily the modelling of human knowledge and reasoning and then it may adapt these models to observations whereas Pattern Recognition does not directly mimic knowledge and reasoning, but the handling of observations as they are given and then the observations have to be generalized and to be integrated with available knowledge.

Pattern Recognition and AI

The term artificial intelligence is applied when a machine mimics cognitive functions that humans associate with other human minds, such as learning and problem solving

Pattern Recognition is a subfield of AI and thus focuses on the recognition of patterns and regularities in data

Who is using it?

Google   (Google Analytics, Voice Search, Reverse Image Search)

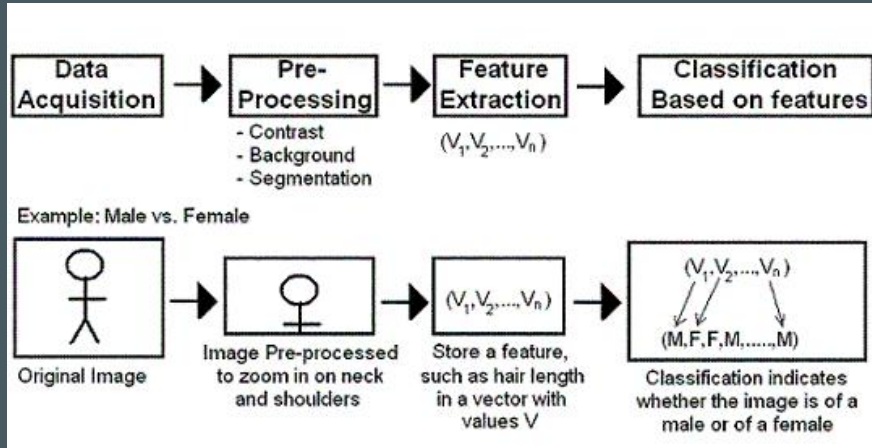Ada Health (The Amazon Alexa of Healthcare)

Amazon (Suggested Items)

Soundcloud (Music Discovery)

Pattern Recognition Process

A generic process of pattern recognition:

1. Data Acquisition and Collection
2. Feature extraction and Representation
3. Similarity Detection and Pattern Classifier Design
4. Performance Evaluation
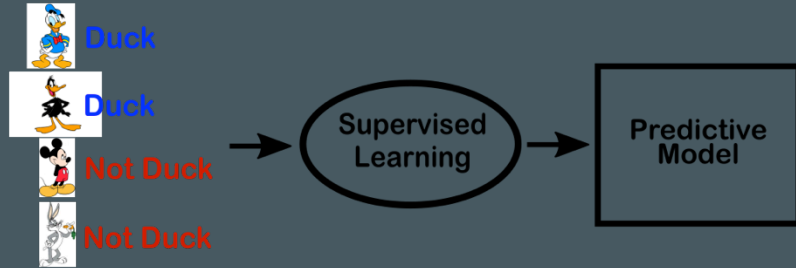
Classifications of Pattern Recognition

How Do We Do It?

Two methods of classifications have been developed: Supervised and Unsupervised learning.

Supervised Learning: Set of training data has to be provided and labeled with the correct output

Unsupervised Learning: training data is not labeled or there is no training data
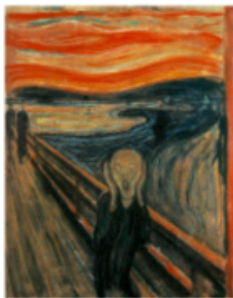
Supervised Classification

-Supervised pattern recognition creates classifiers using supervised learning algorithms to create classifiers from various object classes.

-Classifiers that are freshly created then accept input data and create new objects as well as class labels.
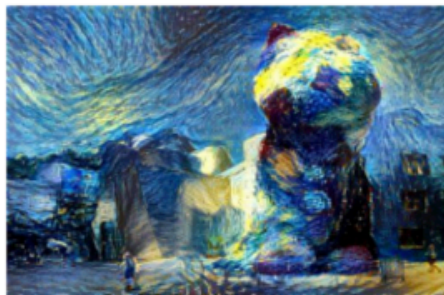
-These techniques are used in computer vision for many things including face detection/recognition, object detection, and optical recognition.
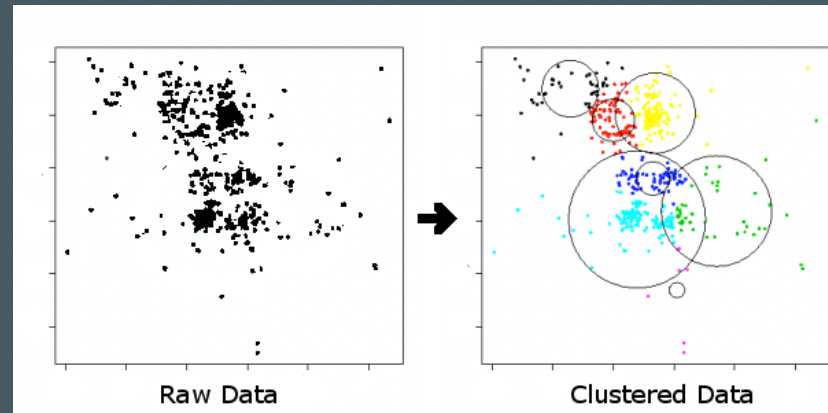
Input Image

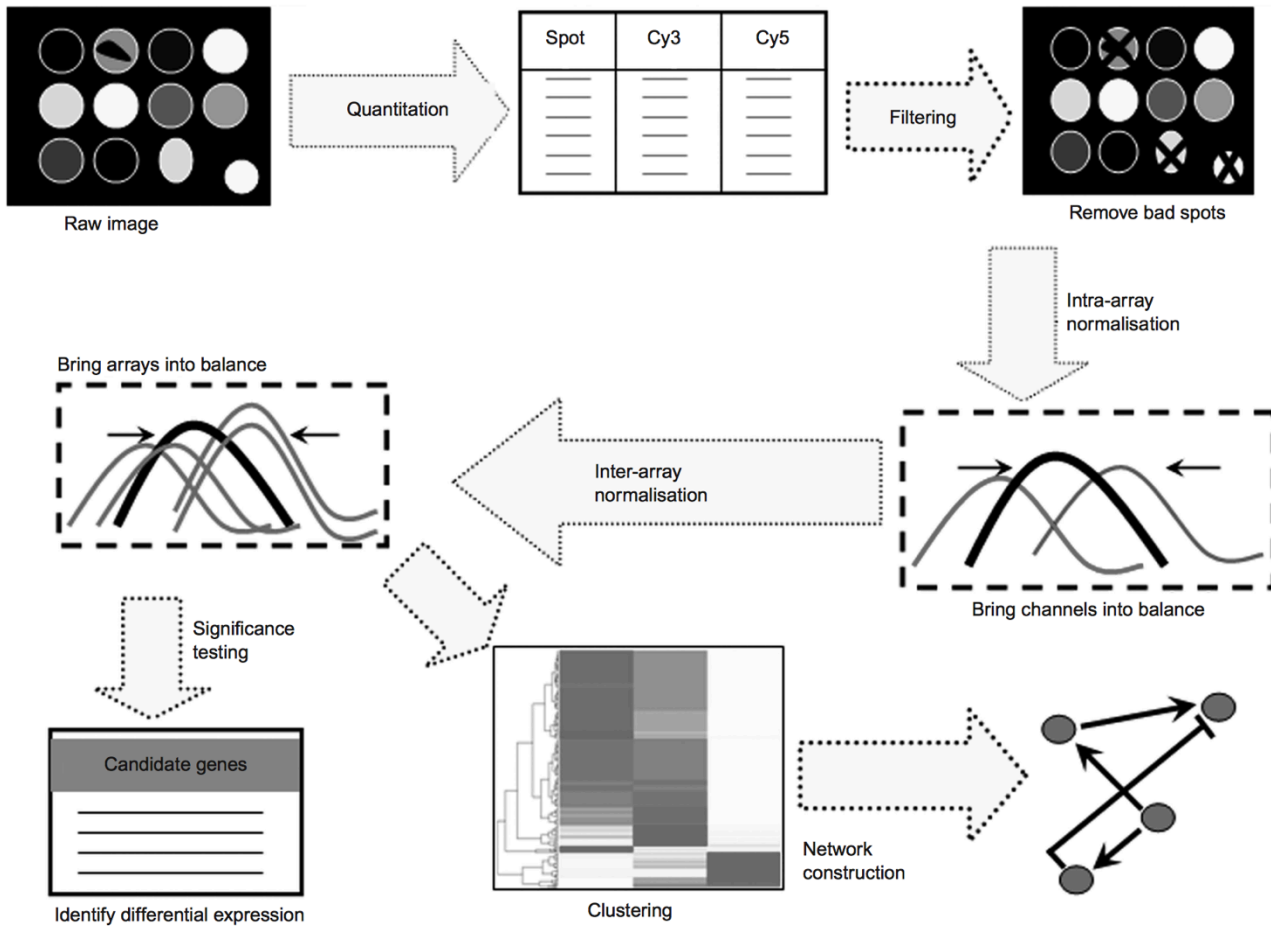**Training Set - Examples**

Result

Unsupervised Classification

Unsupervised classification finds hidden features in unlabeled data using clustering or data segmentation techniques.

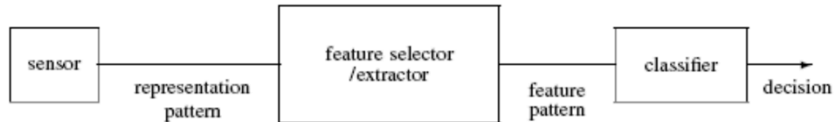Gaussian Mixture Models, Hidden Markov Model, and K- clustering.

Example of K-clustering

Raw Data → Clustered Data

Raw image → Quantitation → (Spot | Cy3 | Cy5) → Filtering → **Remove bad spots** → Intra-array normalisation → **Bring channels into balance** → Inter-array normalisation → **Bring arrays into balance** → Significance testing → **Identify differential expression**; Clustering → Network construction

How are Patterns Discovered?

Patterns can be found by identifying similarities between objects that are the same or very close to each other. Sometimes not properties are found we is also a useful result

sensor → representation pattern → feature selector /extractor → feature pattern → classifier → decision

Pattern classifier

What are some approaches to pattern Recognition?

Some Techniques:

Template Matching: *Quality Control*

Statistical Pattern Recognition:
Recognition of ships

Artificial Neural Networks:
Stock Market Prediction

Syntactic pattern recognition:
Syntactic pattern recognition

Applications of Pattern Recognition

Climate change and pattern recognition

Contemporary climate archives are approximately 5PB (1000 terabytes) in size[6].

Being, perhaps, one of the most important topics of 21st century, scientists are using several mechanisms to make sense of the patterns of climate change.

Big data and climate change:
https://www.datasciencecentral.com/profiles/blogs/big-data-plays-surprising-role-in-fight-against-climate-change

Detection of extreme climate events using neural networks and patterns:
https://arxiv.org/pdf/1605.01156.pdf

Deep Convolutional Neural Network

Problem:

There is no universally accepted sets of criteria for what defines a tropical cyclone. The "Low" Pressure and "Warm" Temperature are interpreted differently among climate scientists, therefore different thresholds are used to characterize them.

Solution:

Formulate the problem of detecting extreme climate events as classic visual pattern recognition problem.

89% to 99% accuracy in detecting extreme events. [11]
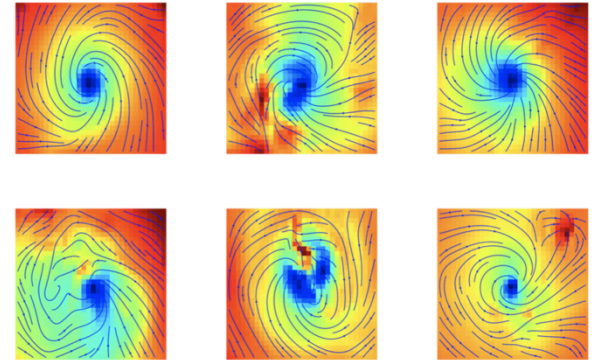
Biometrics and Pattern Recognition

1. Biometrics refers to the automatic recognition of an individual by using anatomical or behavioral traits associated with that person by using the concept of pattern recognition techniques.
2. Biometric Technology is used in fingerprint scanners, facial recognition systems, voice recognition systems, etc.
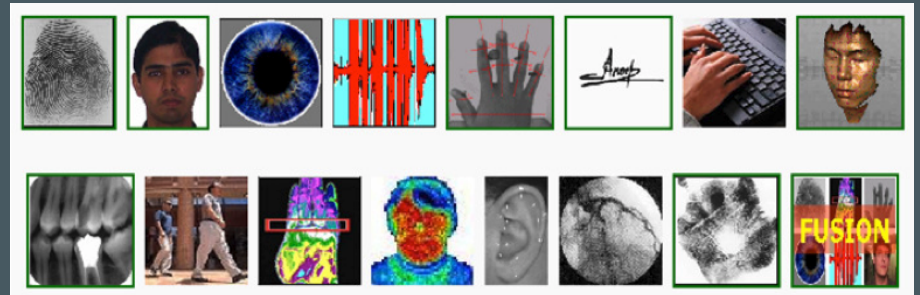
Bioinformatics and Pattern Recognition
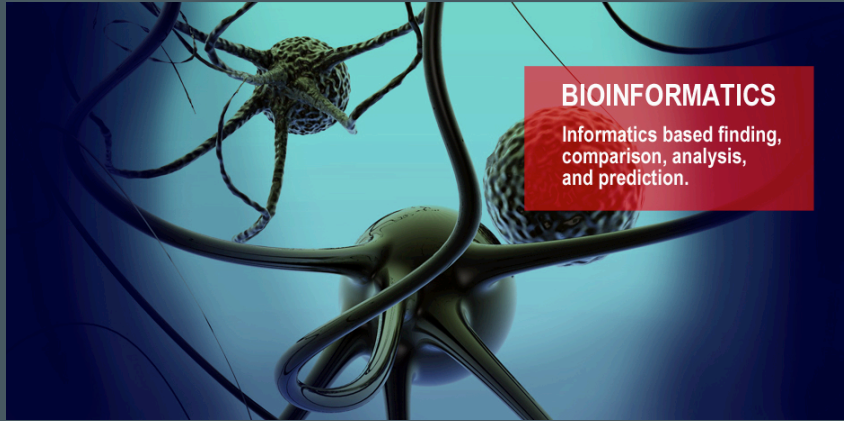
1. Bioinformatics deals with development of algorithms and software for understanding the biological data[10].
2. A particular field of bioinformatics uses the application of pattern recognition for protein classification : A good protein classification system must take into account the following elements namely, structure, sequence, biomolecular interaction and subcellular localization [9].

Criminology and Pattern Recognition

1. The field of computational criminology involves using the pattern recognition technique to identify patterns and emerging patterns, crime generators and crime attractors, terrorism, organized crime and gang social and spatial networks as well as co-offending networks and cyber crime [8].
2. The most significant advantage of using Pattern Recognition in Criminology is that crime and terrorism are not random and thus follow a specific pattern or MO(modus operandi). Thus we can find criminals in huge populations.

Criminology and Pattern Recognition
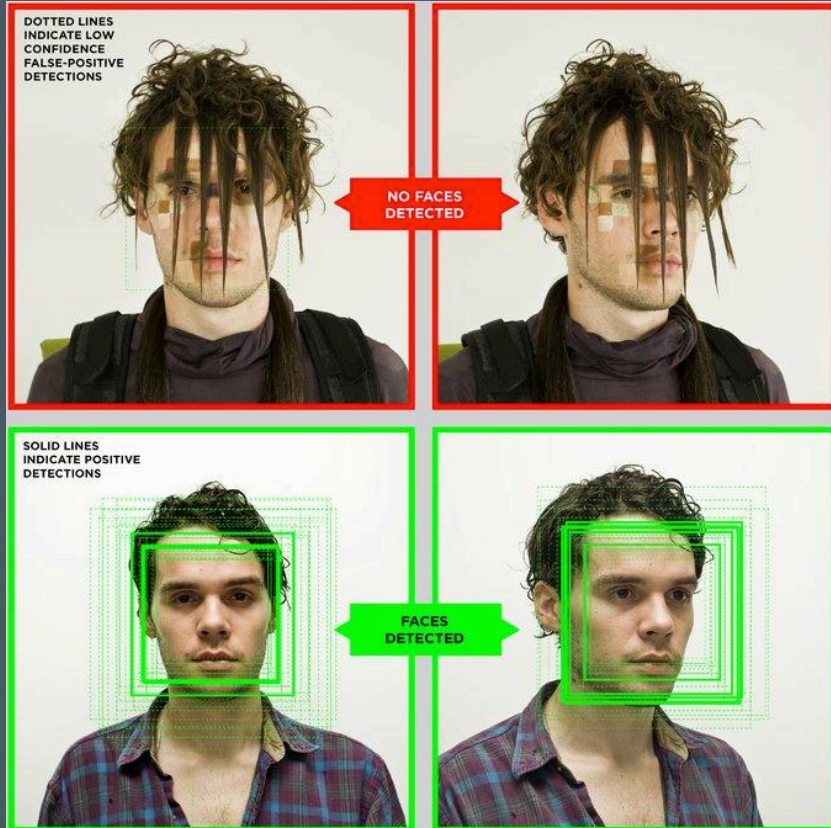
"Stealth Wear Aims to Make a Tech Fashion Statement" - The New York Times

Take home

Why AI still stinks at pattern recognition:

http://bigthink.com/laurie-vazquez/why-artificial-intelligence-still-stinks-at-pattern-recognition

Microsoft Researches Use Pattern Recognition to Generate a Rembrandt Painting

https://www.nextrembrandt.com