

<http://artthatlearns.wordpress.com/>

What's machine learning?

Machine Learning – 10615/60411

Carlos Guestrin

Carnegie Mellon University

January 13th, 2009



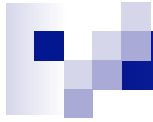
What is Machine Learning ?

Machine Learning



Study of algorithms that

- improve their performance
- at some task
- with experience



Classification

from data to discrete classes

Spam filtering

data

prediction

☆ **Osman Khan** to Carlos [show details](#) Jan 7 (6 days ago) [Reply](#) | ▾

sounds good
+ok

Carlos Guestrin wrote:
Let's try to chat on Friday a little to coordinate and more on Sunday in person?

Carlos

Welcome to New Media Installation: Art that Learns

☆ **Carlos Guestrin** to 10615-announce, Osman, Michel [show details](#) 3:15 PM (8 hours ago) [Reply](#) | ▾

Hi everyone,

Welcome to New Media Installation:Art that Learns

The class will start tomorrow.
Make sure you attend the first class, even if you are on the Wait List.
The classes are held in Doherty Hall C316, and will be Tue, Thu 01:30-4:20 PM.

By now, you should be subscribed to our course mailing list: 10615-announce@cs.cmu.edu.
You can contact the instructors by emailing: 10615-instructors@cs.cmu.edu

Natural_LoseWeight SuperFood Endorsed by Oprah Winfrey, Free Trial 1 bottle, pay only \$5.95 for shipping mfw rlk Spam | X

☆ **Jaquelyn Halley** to nherrlein, bcc: thehorney, bcc: ang [show details](#) 9:52 PM (1 hour ago) [Reply](#) | ▾

=== Natural WeightLOSS Solution ===

Vital Acai is a natural WeightLOSS product that Enables people to lose wieght and cleansing their bodies faster than most other products on the market.

Here are some of the benefits of Vital Acai that You might not be aware of. These benefits have helped people who have been using Vital Acai daily to Achieve goals and reach new heights in there dieting that they never thought they could.

- * Rapid WeightLOSS
- * Increased metabolism - BurnFat & calories easily!
- * Better Mood and Attitude
- * More Self Confidence
- * Cleanse and Detoxify Your Body
- * Much More Energy
- * BetterSexLife
- * A Natural Colon Cleanse

Text classification



→ Company home page

VS

Personal home page

VS

Univeristy home page

VS

...

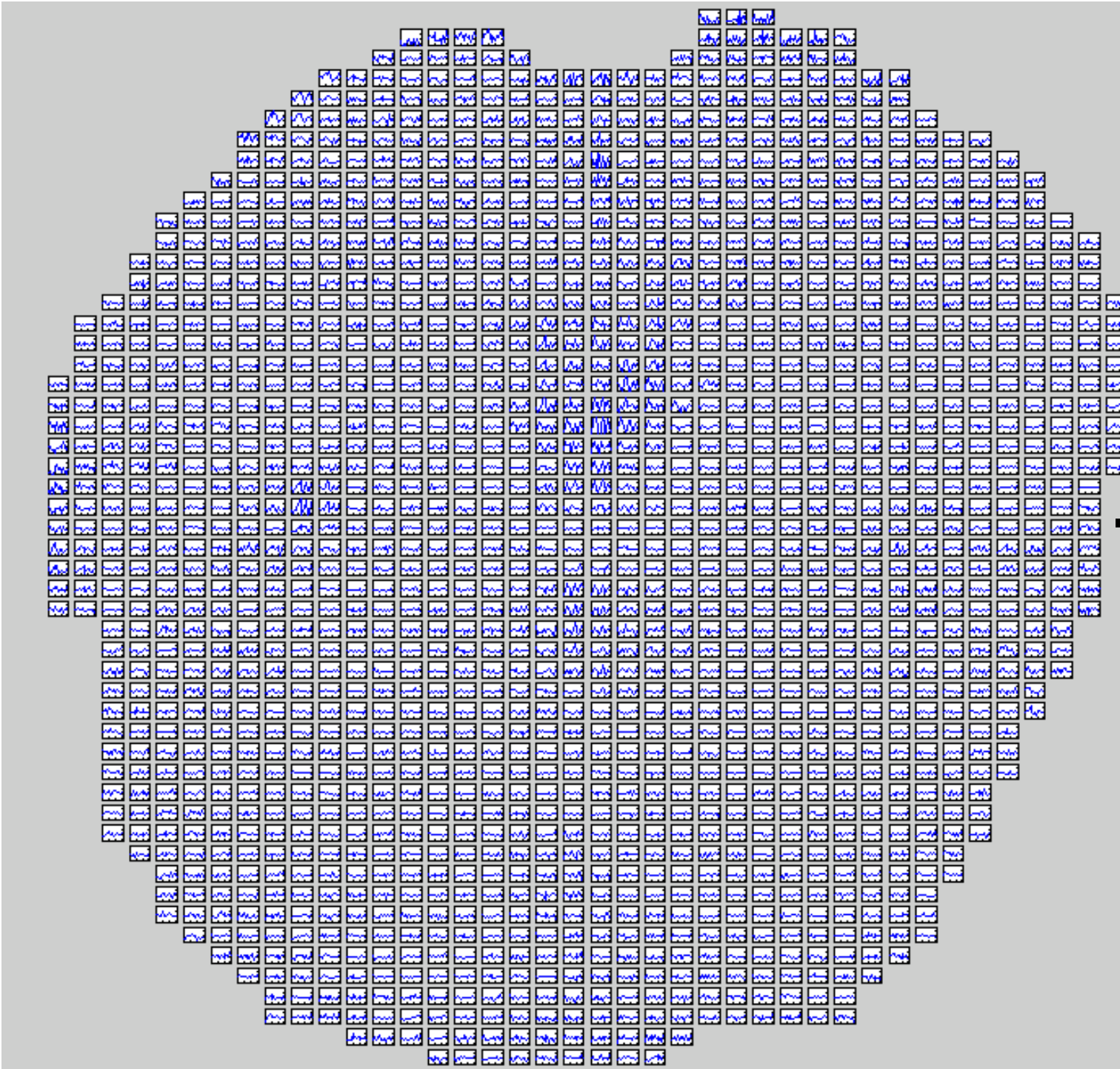
Object detection

(Prof. H. Schneiderman)



Example training images
for each orientation





Reading
a noun
(vs verb)

[Rustandi et al.,
2005]

The classification pipeline

Training

★ Osman Khan to Carlos [show details](#) Jan 7 (6 days ago) [Reply](#)

sounds good
+ok

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Natural LoseWeight SuperFood Endorsed by Oprah Winfrey, Free Trial 1 bottle, pay only \$5.95 for shipping mfw rik [Spam](#) [X](#)

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- * More Self Confidence
- * Cleanse and Detoxify Your Body
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- * BetterSexLife
- * A Natural Colon Cleanse

Testing

Welcome to New Media Installation: Art that Learns

★ Carlos Guestrin to 10615-announce, Osman, Miche [show details](#) 3:15 PM (8 hours ago) [Reply](#)

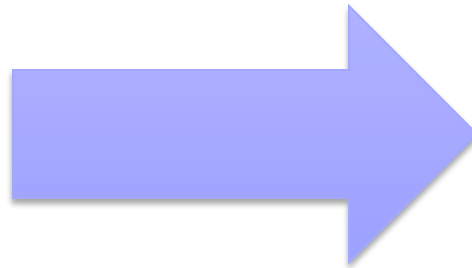
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Weather prediction





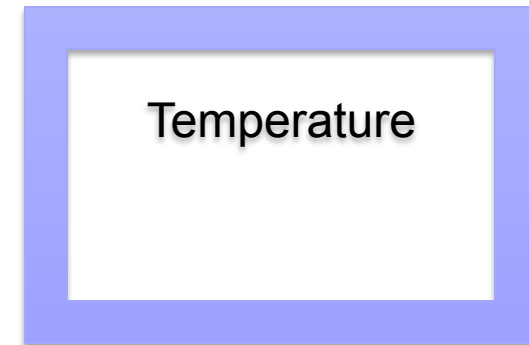
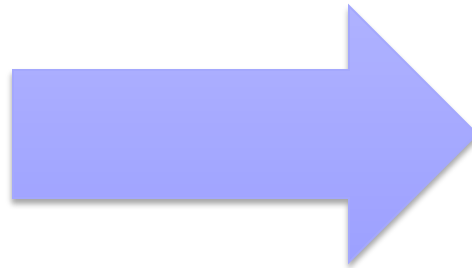
Regression

predicting a numeric value

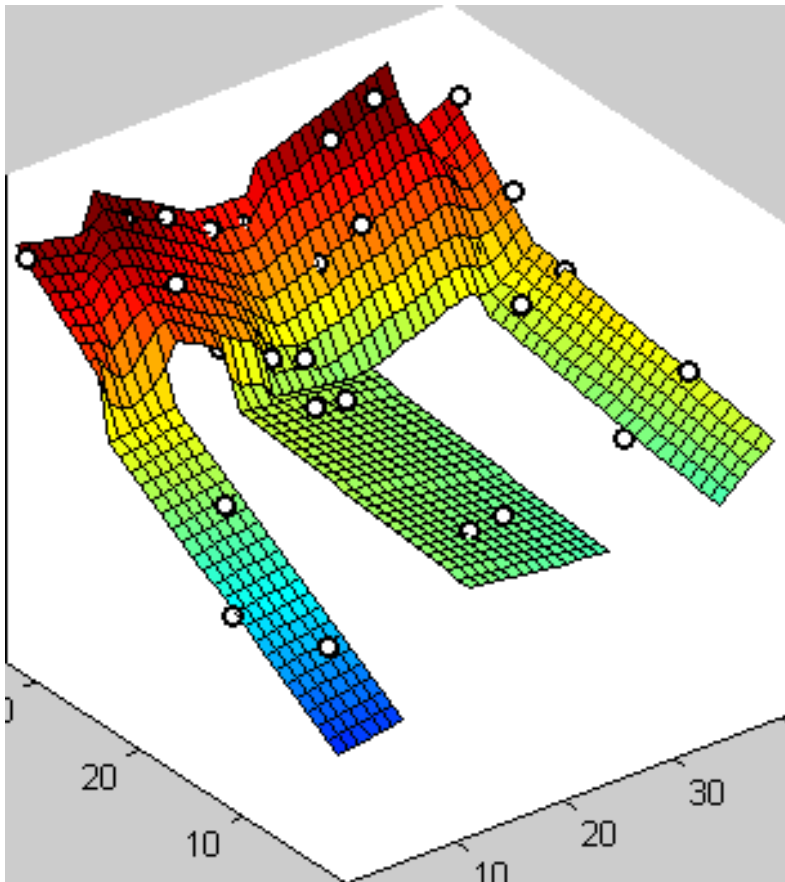
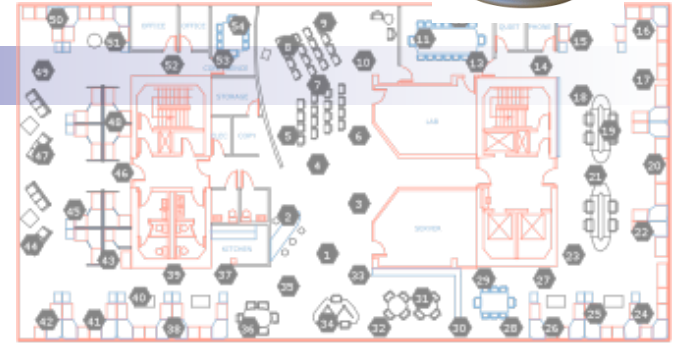
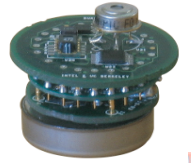
Stock market



Weather prediction revisited



Modeling sensor data



- Measure temperatures at some locations
- Predict temperatures throughout the environment

[Guestrin et al. '04]



Similarity

finding data

Given image, find similar images

1. Search mode: Theme
..... OR

2. Find similar by Color / Texture

1. Find similar by Theme
..... OR

2. Find similar by Color / Texture

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2. Search mode: Color / Texture

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2. Find similar by Color / Texture

THIS PHOTO IS CURRENTLY UNAVAILABLE.

flickr

1. Find similar by Theme
..... OR

2. Find similar by Color / Texture

1. Find similar by Theme
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Web

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[Rufus \(band\) - Wikipedia, the free encyclopedia](#)

Dec 20, 2008 ... Rufus. </gallery>. Background information. Also known as, Rufus featuring Chaka Khan Rufus & Chaka Rufus & Chaka Khan ...
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[Chaka Khan Music Website](#)

Always the most complete discography of Chaka Khan. Rufus, solo albums and contributions. Here you can find ckmw radio, concert updates, new releases and ...
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[Amazon.com: Funk This: Chaka Khan: Music](#)

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30. or. Sign in to turn on 1-Click ordering. ...
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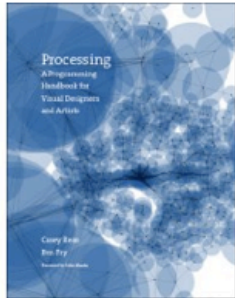
[Chaka Khan \(I\)](#)

Filmography at IMDb with actor, singer, and guest appearance credits.
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[Chaka Khan | Music Artist, Videos, Photos, News, Ringtones, Album ...](#)

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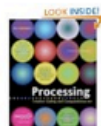
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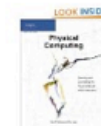
[Visualizing Data: Exploring and Explaining Data...](#) by Ben Fry

★★★★★ (11) \$26.39



[Making Things Talk: Practical Methods for Conne...](#) by Tom Igoe

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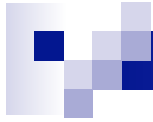
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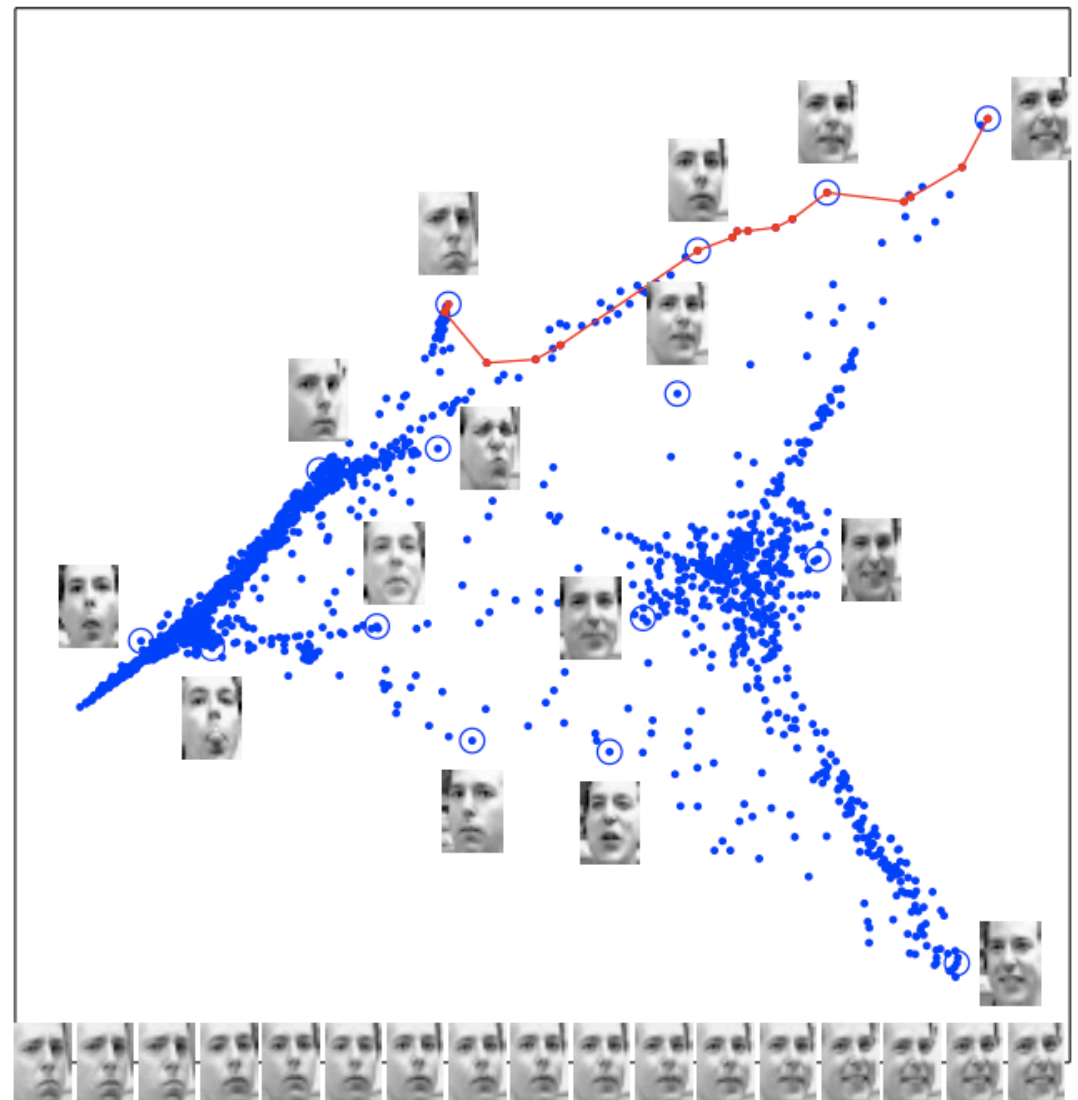
Embedding

visualizing data

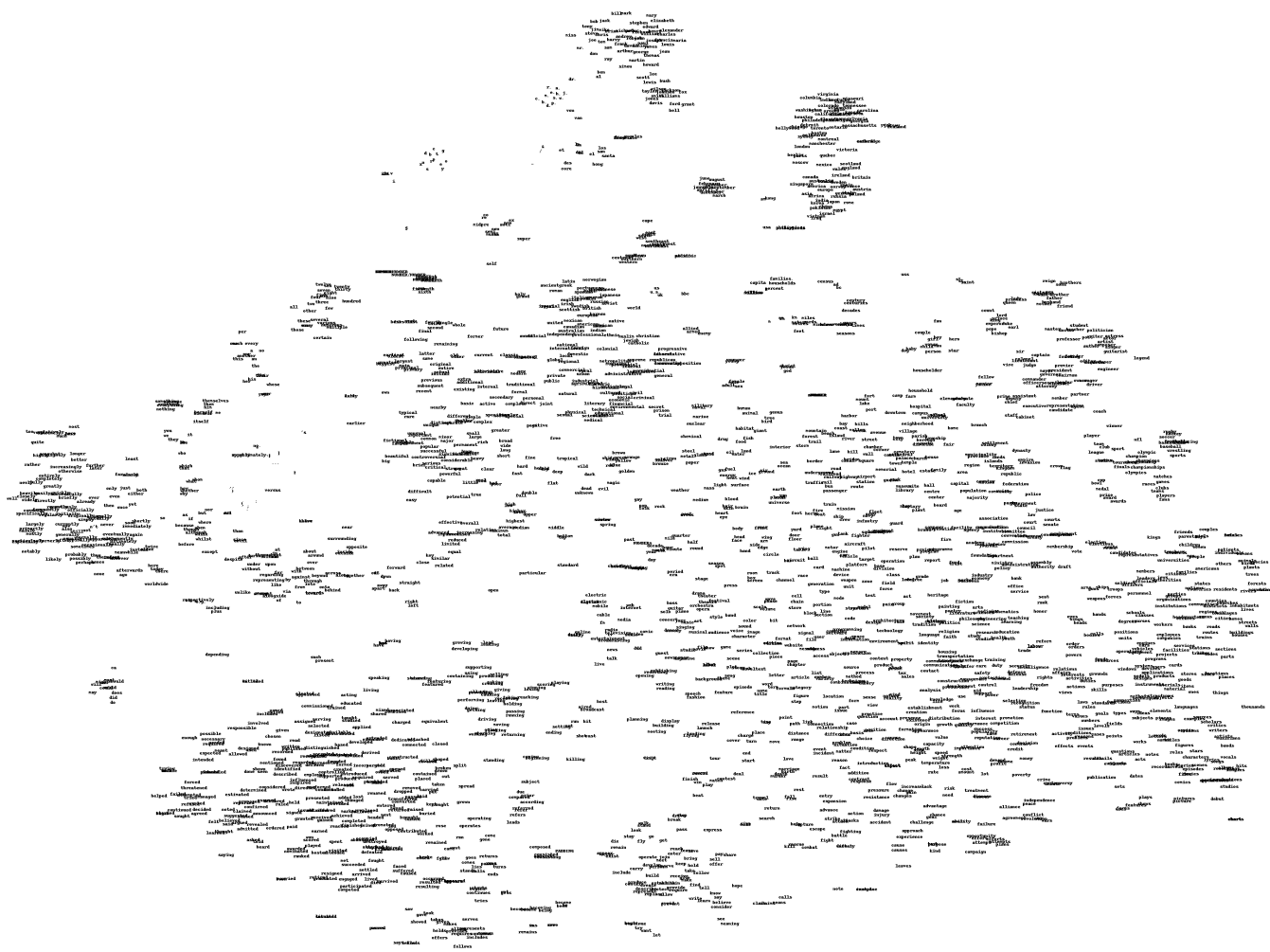
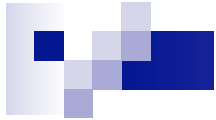
Embedding images

Images have thousands or millions of pixels.

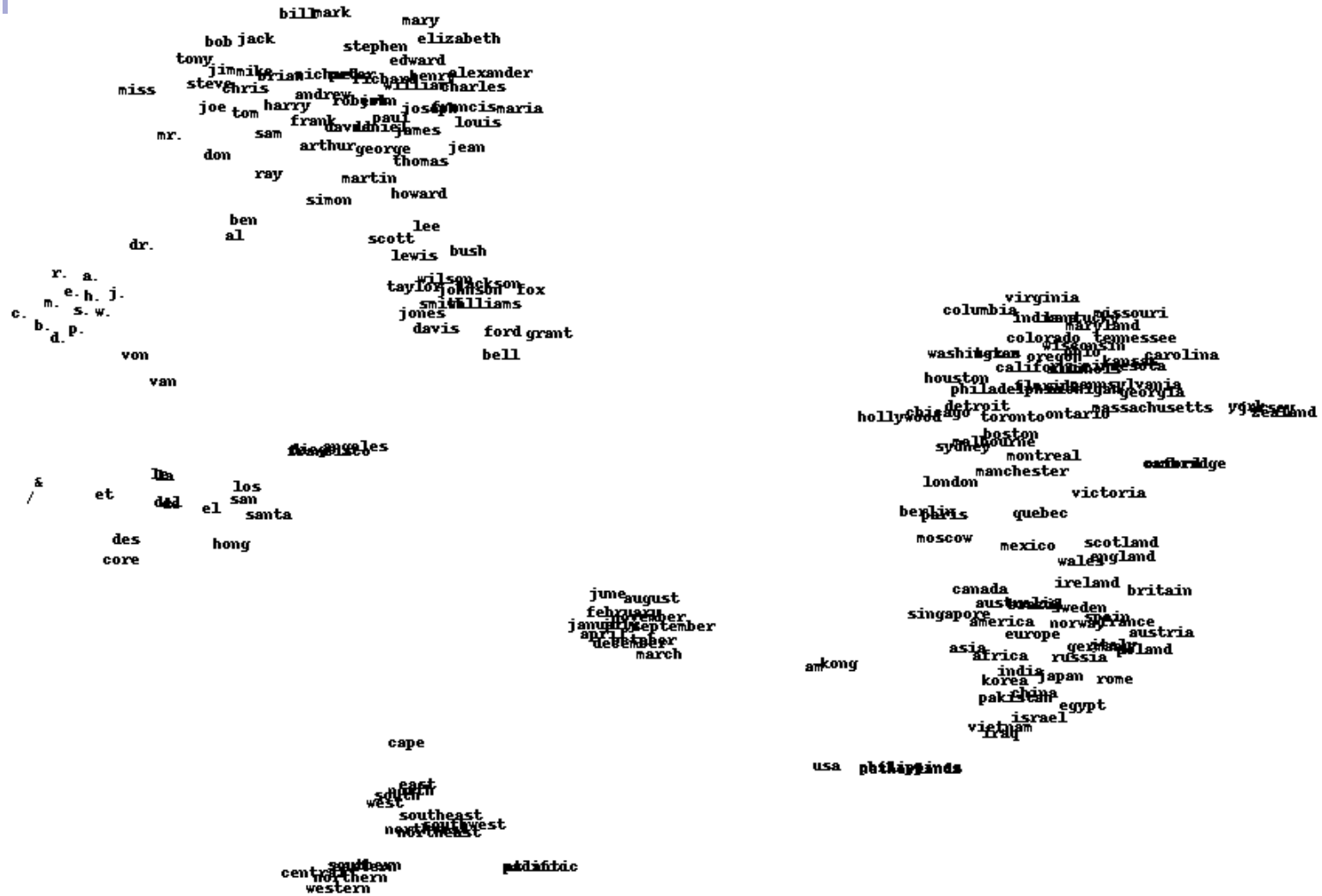
Can we give each image a coordinate, such that similar images are near each other?

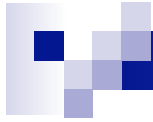


Embedding words



Embedding words (zoom in)

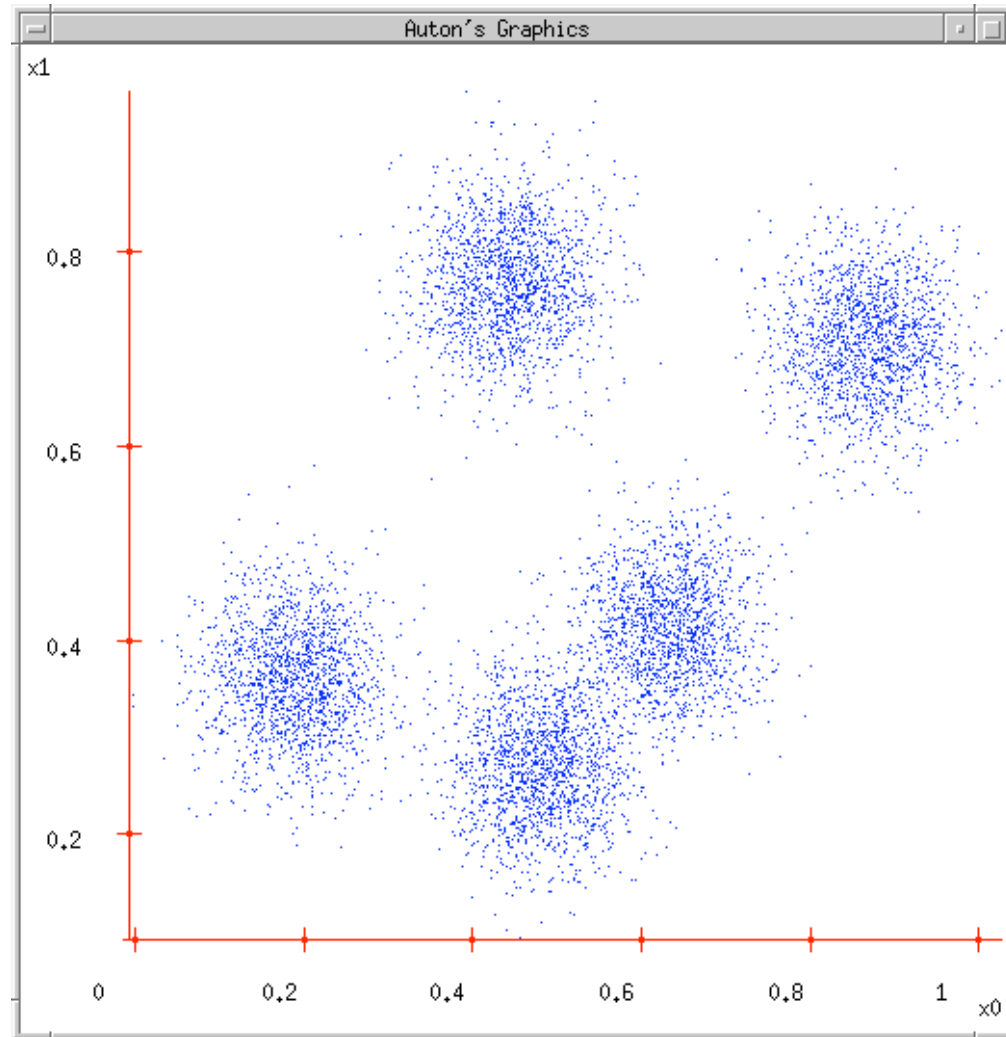




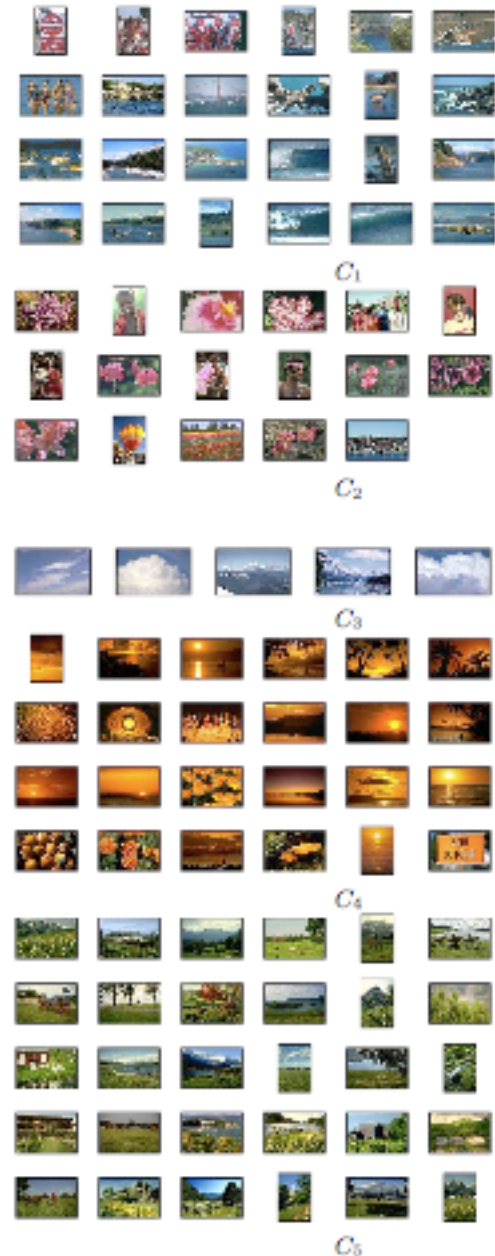
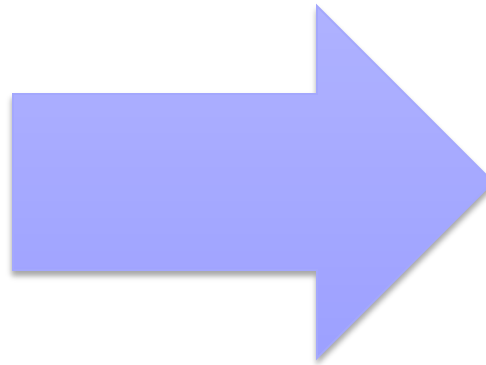
Clustering

discovering structure in data

Clustering Data: Group similar things



Clustering images



Clustering web search results

The screenshot shows the Clusty search engine interface. At the top, there is a navigation bar with links for 'web', 'news', 'images', 'wikipedia', 'blogs', 'jobs', and 'more'. The search bar contains the word 'race' and has a 'Search' button and a link to 'advanced preferences'. Below the search bar, there are tabs for 'clusters', 'sources', and 'sites'. The 'clusters' tab is active, showing a list of clusters on the left and search results on the right. The left sidebar lists clusters such as 'Car (28)', 'Race cars (7)', 'Photos, Races Scheduled (5)', 'Game (4)', 'Track (3)', 'Nascar (2)', 'Equipment And Safety (2)', 'Other Topics (7)', 'Photos (22)', 'Game (14)', 'Definition (13)', 'Team (18)', and 'Human (8)'. The 'Human (8)' cluster is selected, and its sub-clusters are 'Classification Of Human (2)', 'Statement, Evolved (2)', and 'Other Topics (4)'. The main content area shows a list of 7 search results for the 'Human' cluster, each with a title, a brief description, and a URL. The results are: 1. 'Race (classification of human beings) - Wikipedia, the free ...', 2. 'Race - Wikipedia, the free encyclopedia', 3. 'Publications | Human Rights Watch', 4. 'Amazon.com: Race: The Reality Of Human Differences: Vincent Sarich ...', 5. 'AAPA Statement on Biological Aspects of Race', 6. 'race: Definition from Answers.com', and 7. 'Dopefish.com'.

web news images wikipedia blogs jobs more »

Clusty

race Search advanced preferences

clusters sources sites

All Results (238) remix

- Car (28)
 - Race cars (7)
 - Photos, Races Scheduled (5)
 - Game (4)
 - Track (3)
 - Nascar (2)
 - Equipment And Safety (2)
 - Other Topics (7)
- Photos (22)
- Game (14)
- Definition (13)
- Team (18)
- Human (8)**
 - Classification Of Human (2)
 - Statement, Evolved (2)
 - Other Topics (4)
- Weekend (8)
- Ethnicity And Race (7)
- Race for the Cure (8)
- Race Information (8)

more | all clusters

find in clusters: Find

Cluster Human contains 8 documents.

Search Results

- [Race \(classification of human beings\) - Wikipedia, the free ...](#)

The term **race** or racial group usually refers to the concept of dividing **humans** into populations or groups on the basis of various sets of characteristics. The most widely used **human** racial categories are based on visible traits (especially skin color, cranial or facial features and hair texture), and self-identification. Conceptions of **race**, as well as specific ways of grouping **races**, vary by culture and over time, and are often controversial for scientific as well as social and political reasons. History · Modern debates · Political and ...
[en.wikipedia.org/wiki/Race_\(classification_of_human_beings\)](http://en.wikipedia.org/wiki/Race_(classification_of_human_beings)) - [cache] - Live, Ask
- [Race - Wikipedia, the free encyclopedia](#)

General. **Racing** competitions The **Race** (yachting **race**), or La course du millénaire, a no-rules round-the-world sailing event; **Race** (biology), classification of flora and fauna; **Race** (classification of **human** beings) **Race** and ethnicity in the United States Census, official definitions of "**race**" used by the US Census Bureau; **Race** and genetics, notion of racial classifications based on genetics. Historical definitions of **race**; **Race** (bearing), the inner and outer rings of a rolling-element bearing. **RACE** in molecular biology "Rapid ... General · Surnames · Television · Music · Literature · Video games
en.wikipedia.org/wiki/Race - [cache] - Live, Ask
- [Publications | Human Rights Watch](#)

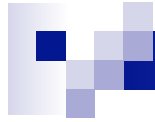
The use of torture, unlawful rendition, secret prisons, unfair trials, ... Risks to Migrants, Refugees, and Asylum Seekers in Egypt and Israel ... In the run-up to the Beijing Olympics in August 2008, ...
www.hrw.org/background/usa/race - [cache] - Ask
- [Amazon.com: Race: The Reality Of Human Differences: Vincent Sarich ...](#)

Amazon.com: **Race: The Reality Of Human Differences: Vincent Sarich, Frank Miele: Books ...** From Publishers Weekly Sarich, a Berkeley emeritus anthropologist, and Miele, an editor ...
www.amazon.com/Race-Reality-Differences-Vincent-Sarich/dp/0813340861 - [cache] - Live
- [AAPA Statement on Biological Aspects of Race](#)

AAPA Statement on Biological Aspects of **Race** ... Published in the American Journal of Physical Anthropology, vol. 101, pp 569-570, 1996 ... PREAMBLE As scientists who study **human** evolution and variation, ...
www.physanth.org/positions/race.html - [cache] - Ask
- [race: Definition from Answers.com](#)

race n. A local geographic or global **human** population distinguished as a more or less distinct group by genetically transmitted physical
www.answers.com/topic/race-1 - [cache] - Live
- [Dopefish.com](#)

Site for newbies as well as experienced Dopefish followers, chronicling the birth of the Dopefish, its numerous appearances in several computer games, and its eventual take-over of the **human race**. Maintained by Mr. Dopefish himself, Joe Siegler of Apogee Software.
www.dopefish.com - [cache] - Open Directory



Reinforcement Learning

training by feedback

Learning to act

- Reinforcement learning
- An agent
 - Makes sensor observations
 - Must select action
 - Receives rewards
 - positive for “good” states
 - negative for “bad” states



[Ng et al. '05]

Growth of Machine Learning



- Machine learning is preferred approach to
 - Speech recognition, Natural language processing
 - Computer vision
 - Medical outcomes analysis
 - Robot control
 - Computational biology
 - Sensor networks
 - ...
- This trend is accelerating
 - Improved machine learning algorithms
 - Improved data capture, networking, faster computers
 - Software too complex to write by hand
 - New sensors / IO devices
 - Demand for self-customization to user, environment



But what impact can Machine Learning have on Art ?

Syllabus & Structure

- ML concepts
 - Data, Patterns, Features, Similarity, Classification, Sorting, Unsupervised Learning, Clustering, Active Learning, Exploration/Exploitation, Reinforcement Learning,...
 - The What, but not The How
 - Will provide black boxes for many methods
 - Prior knowledge of ML not required
- Art concepts
 - Aesthetics, Conceptual Art, Installation, New Media, Process or Systems as Art, Information Visualization, Social/Cultural/Political implications to Art, Interactive/Participatory Art,...
- Invited speakers from Art & ML
- But this is a project class
 - Workshops to learn techniques
 - Programming required, there will be a workshop on topic
 - Main goal is for you to create visually interesting, thought-provoking Interpretations of *Art that Learns*
 - There will be critiques & discussions weekly

Exercises/Assignments

Important Dates

- Exercises
 - Try out techniques
 - Must still have a strong focus on concept
 - Individual
- Assignments/Key dates
 - Assignment 1 - Individual
 - Due this Thursday, 1/15
 - Assignment 2
 - Groups of about 3, must mix Art & “CS” students
 - **Visit the Children’s Museum during class on Thursday 1/29**
 - Displayed at Museum: **Sunday 2/22**
 - Data (canned or sensed), some machine learning technique, physical I/O, output
 - Assignment 3 – Final Project
 - Groups of about 3, must mix Art & “CS” students
 - Several Phases detailed in class blog
 - **Final Installation: 4/20-4/24**
 - **Presentation: Saturday 4/25 at Museum**
 - DNA Day
 - Data should change over time: either sensed data or streamed data, e.g., from web or camera, some machine learning technique, output

Logistics/Blog



- All work must be documented
 - Process
 - Concept
 - Execution
 - Code
 - With photos, videos,...

- All work posted to class blog:
 - <http://artthatlearns.wordpress.com/>
 - Will also find lecture notes, readings, points to applets and other cool sites on blog