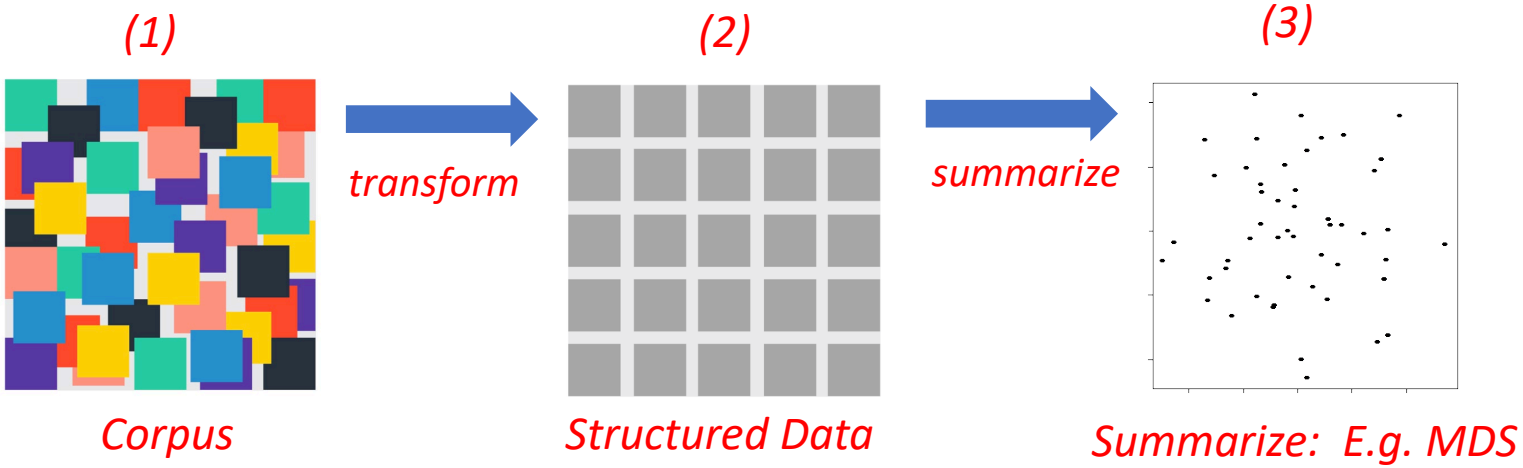
Review: Text Analytics

- Followed the data-insight pipeline
- Broadly,
    1. Define the corpus (i.e., the dataset)
    2. Transform documents into structured data
    3. Rely on visual and quantitative summaries to form insights from data



Don’t Forget: Critical Thinking

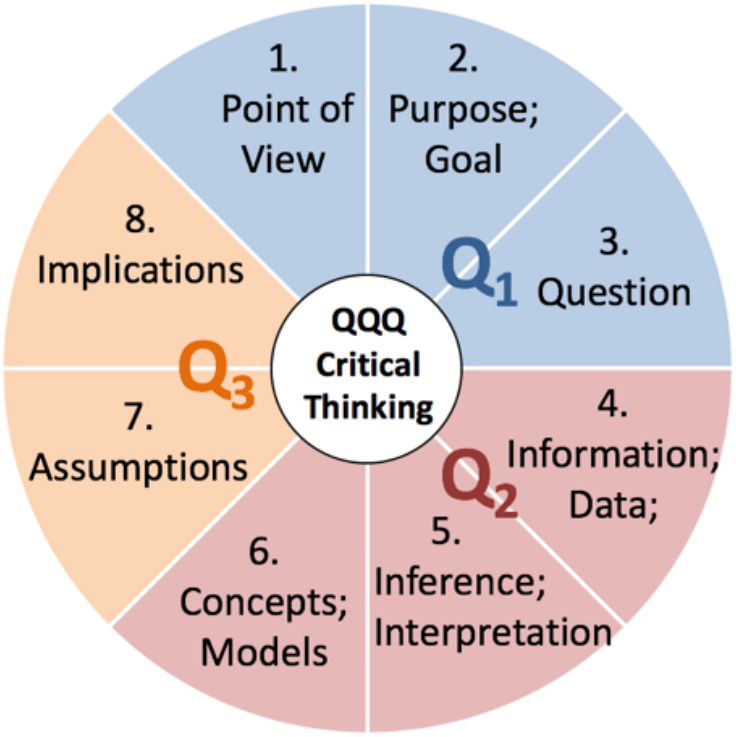
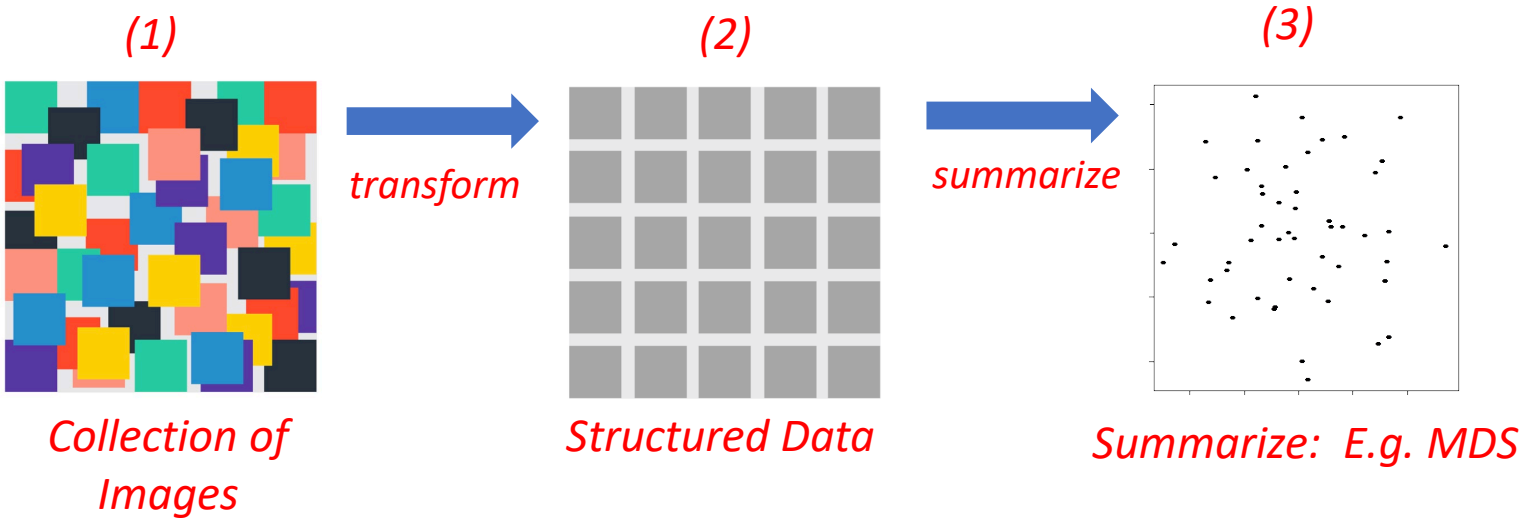


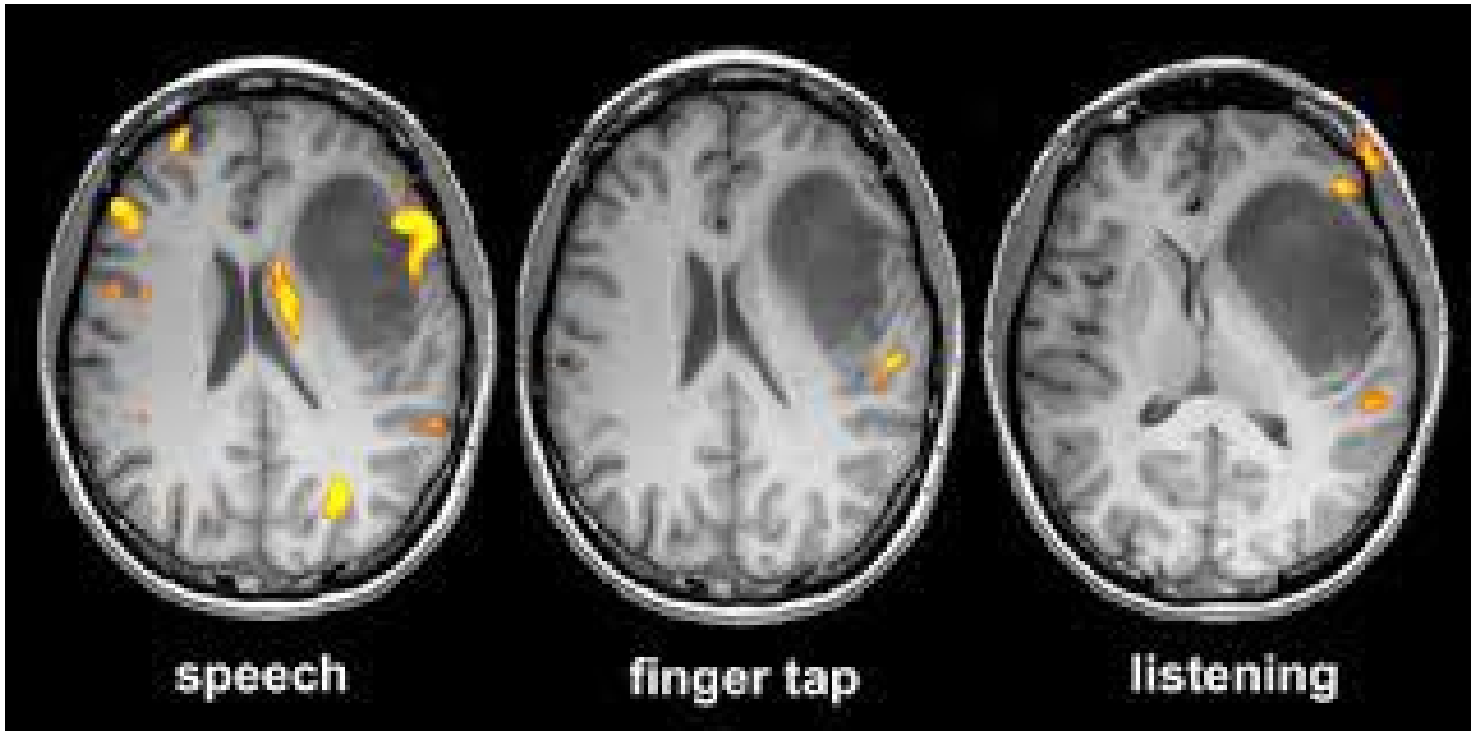
Image Analytics

- Similar process as Text Analytics
- Rather than corpus, now have collection of images
- Images, including videos, are unstructured observations
- Rely on critical thinking to transform and summarize



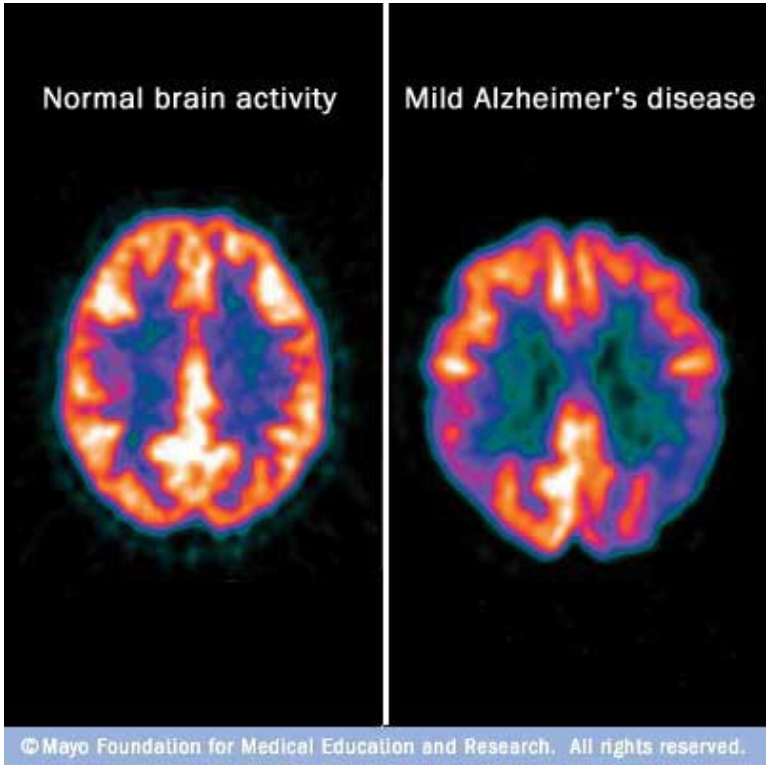
Examples of Image Analytics

- Topics in Health: E.g., in functional MRIs, brain areas "light-up" when performing certain tasks.



- Use image analytics to detect/compare yellow regions quantitatively across images

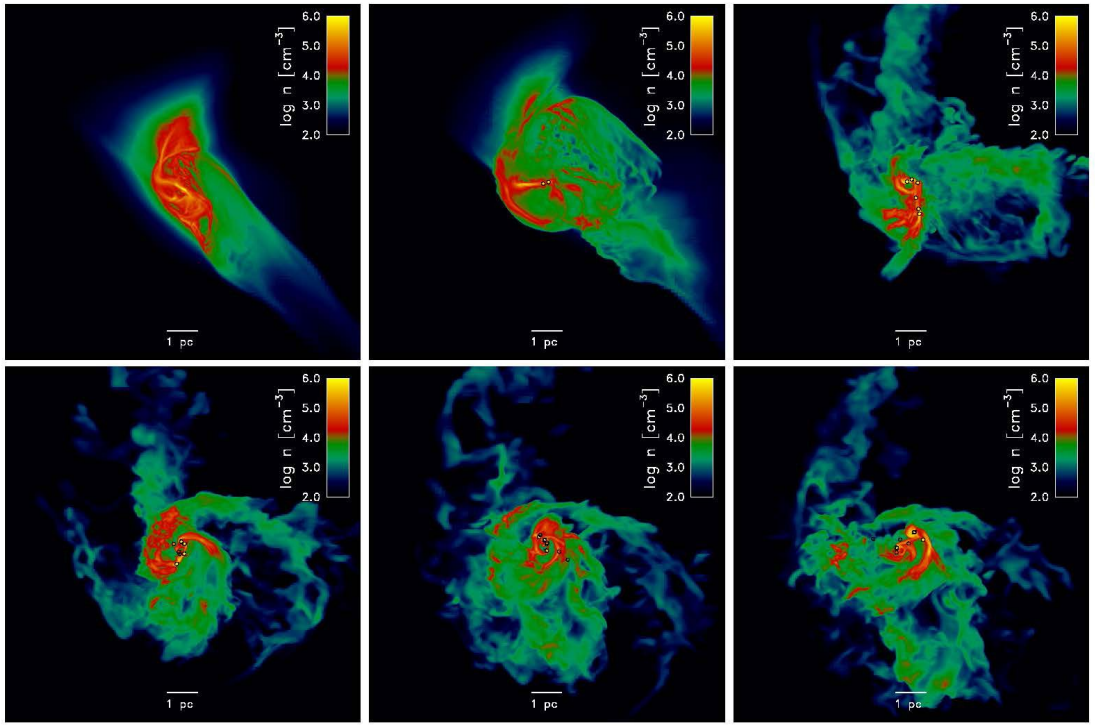
Health: More brain images



- Consider multiple colors
- Consider methods to define regions

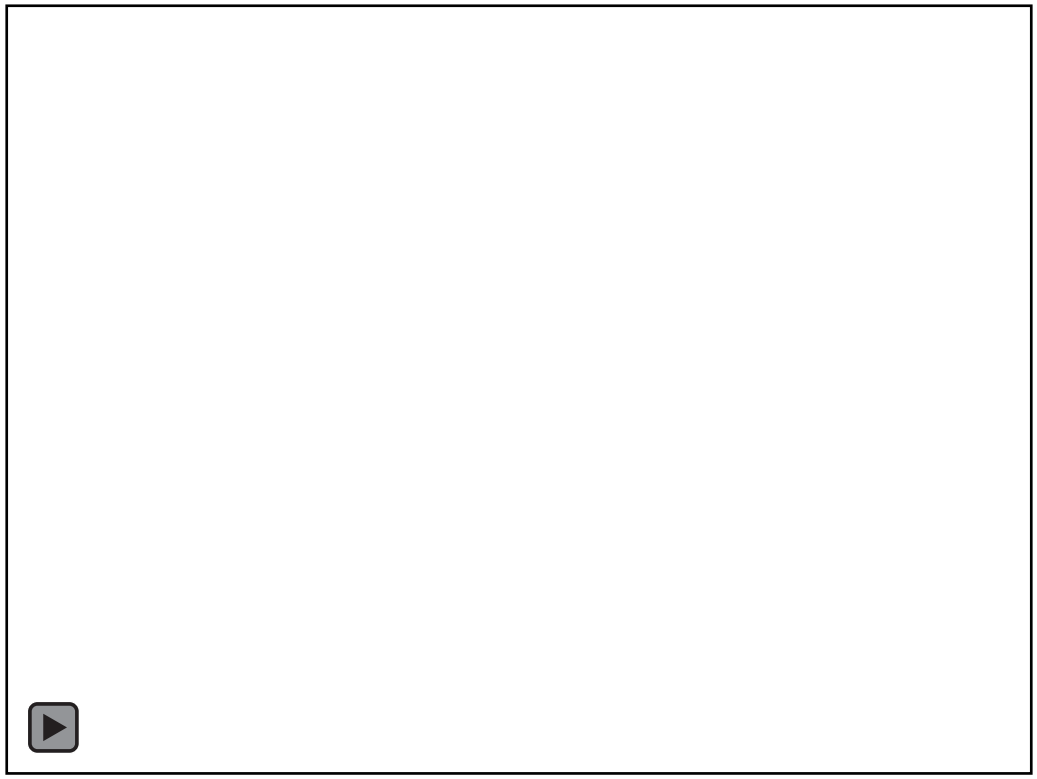
Astronomy; e.g., galaxies

- Simulation images of stars exploding to predict galaxy formation



- Use image analytics to explain/compare formations quantitatively

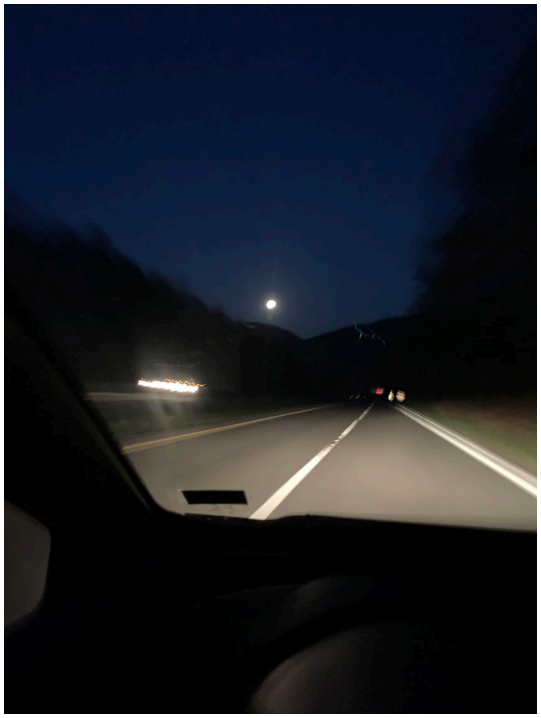
Astronomy; e.g., colliding stars



- https://youtu.be/8vikrAy9Dnc
- Use image analytics to explain/compare formations quantitatively from videos too!

Artificial Intelligence: E.g., visual perception

- Robots: Detect people, lights, signs, roads, etc.
- Homeland Security: Facial recognition



Purposes of Image Analytics

- Similar purposes as any data analytics
- E.g, Contrast images
  - Responses to change in treatments
  - Compare before and after events
- E.g., Identify features in images
  - Faces: noses, eyes, face vs background, specific people
  - Street Signs: E.g., to program self driving cars
  - Colors: E.g., heat maps, medical images
- E.g., Group like images
  - Cluster: E.g., cluster faces, signs, subjects
  - Classify: E.g., Diagnose disease, objects for robots,

Video: What CAN be done

- Deep Learning, which *we* won't do… but you could with more advanced class…

Transforming Images to Structured Data

- *Leanna* defines two approaches as
  - "feature": high level, big picture, dimension-reduction
  - "pixel": low level, detailed
- Feature approach:
  - Consider a list of all features that *could* be in images
    - E.g., Tree, Beach, Animal, Human, House, Flower, etc…
    - E.g., faces turned up, down, left, right.
  - Humans go through images, 1 by 1, to tag images by features
  - Thus, image analyses are based on feature lists
  - Analogy:
    - Subjective lexicon is to Text Analytics *as* Feature list is to Image Analytics

Transforming Images (cont.)

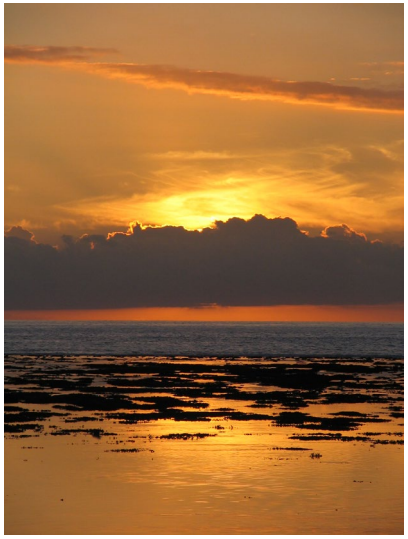
- Two approaches: “feature” vs “pixel” approaches
- Pixel approach:
  - Def: A pixel is a ``minute area of illumination on a display screen''
  - Computers encode images pixel by pixel.
    - E.g., numeric representations of color for each pixel in an image
  - Automate image processing to structure data via pixel data
- Combine the two (beyond scope of this class):
  - Automate feature identification using pixel data
  - Analyze images based on automatically-discovered features.

Transform via feature approach (lab on Wed)

1

2

3



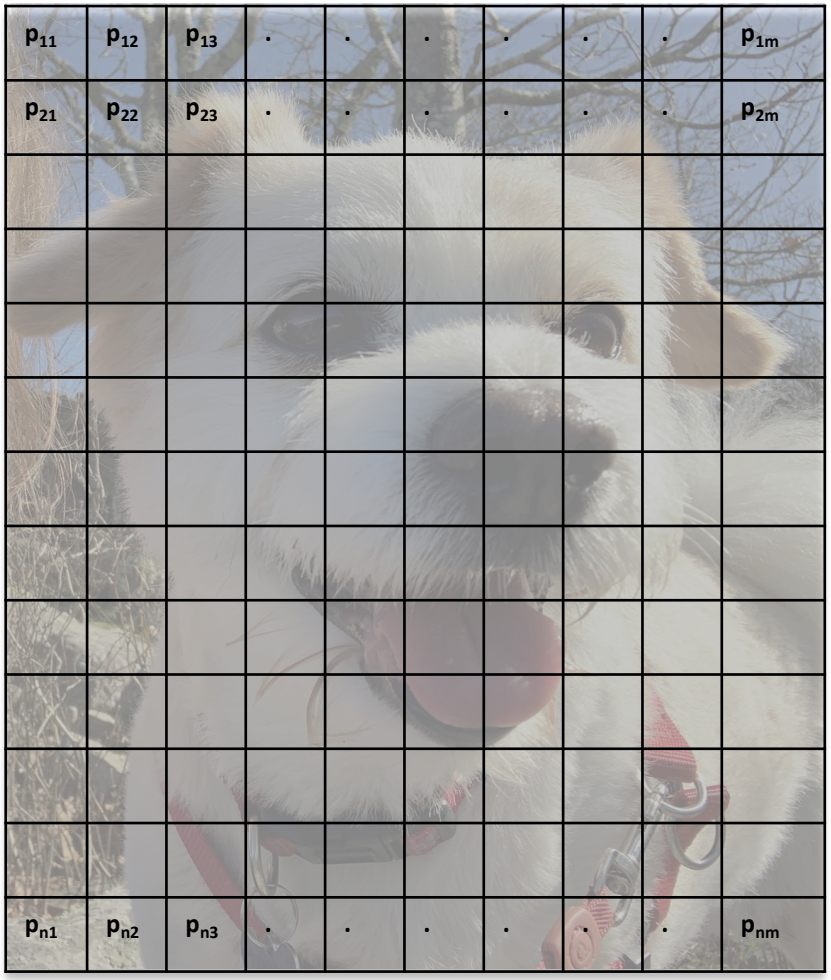
4

Image	Scenic	Clouds	Ocean	Sun	Tree
1	1	0	0	0	1
2	0	0	0	0	0
3	1	1	1	1	0
4					

Transform via pixel approach

- 1 image is n x m pixels
- Define the *amount* of color in each pixel:
  E.g., amount of red
- Pixel Matrix:

$$\begin{matrix} p_{11}\ p_{12} \cdots p_{1m} \\ p_{21}\ p_{22} \cdots p_{2m} \\ \cdots \\ p_{n1}\ p_{n2} \cdots p_{nm} \end{matrix}$$



- Vectorize: $[p_{11}, p_{12}, \ldots p_{1m}, p_{21}, p_{22}, \ldots, p_{2m} \ldots, p_{n1}, p_{n2}, \ldots . p_{nm}]$

Lab: High-level image analytics

Transform via pixel approach (cont)

- Structured data using pixel approach for collection
- This matrix would include *amount* of one color seen in each pixel of N images

Image	**P_{11}**	**P_{12}**	**…**	**P_{1m}**	**P_{21}**	**P_{22}**	**…**	**P_{2m}**	**…**	**…**	**P_{n1}**	**P_{n2}**	**…**	**P_{nm}**
1														
2														
3														
…														
N														

Anatomy of Images (pixel approach)

- Pixels: x-axis and y-axis
- Size
  - File size
  - Number of pixels
- Color Spectrum:
  - RGB: Red, Blue, Green (primary colors for light)
  - CMYK: Cyan, Magenta, Yellow, Black
  - Gray Scale
  - “Amount of each color”
- Depth
  - Static images = 1
  - Movie > 1

Example Color: RGB

- Observed colors are mixtures of primary colors

  Here, consider RGB as 3 primary colors
- A primary color is coded with 8 bits each,
  - So, there are 2^8=256 amounts of red
  - E.g., we code the amount of Red by [0,255]
- An observed, RGB color is defined by the amounts of red, green, and blue in it.
  - R=225, G=137, B=37 
  - R=255, G=126, B=121 
  - R=0, G=145, B=147 

RGB in R

- R scale primary color amounts from

  [0,255] to [0,1]

  - [0/255, 1/255, …., 255/255] -> [0, 0.00392, … 1]
- One image, has three color-matrices:
  - Red-matrix, Green-matrix, Blue-matrix
- Three matrices = An array

Arrays

- So, EACH pixel is described by R,G, AND B.
- Thus, arrays are used to store image data
- Vector:
- Matrix:
- Array:

Two lectures from now