Background and Motivation
Crack formations on art paintings, or craquelure, can reveal much about a painting’s history. Analyzing the craquelure of a painting can often predict its authenticity and geographic origin with reasonable confidence. If this process of craquelure analysis could be automated and perfected, then it is possible to discover correlations between craquelure and other parameters, such as paint material and conservation process, perhaps offering insight into what methods of conservation are in fact the most effective. Furthermore, the opportunity to create an open-source, easily-accessible version of this process would allow any curator or conservator to gain useful insight on the history of their paintings.

Overview
Much of the inspiration for this project comes from “The development of a diagnostic method for geographical and condition-based analysis of artworks using craquelure pattern recognition techniques,” written by M El-Youssef, S Bucklow and R Maev. At a high-level, the paper describes algorithms for the following:

1. Processing a high-resolution image of a painting and converting the crack-patterns into a binary image.
2. Constructing and analyzing a digital “crack network” based on binary crack-images.
First, I will implement and test the effectiveness of algorithm 1. This will likely involve some modifications and tweaking of the algorithm, because the paper is more high-level than it is technical, and does not offer much in the form of code or pseudocode. In order to construct the binary image, an image is treated with a series of processes, first applying a set of basic morphological operations to a grayscale image to extract cracks, then running Otsu’s thresholding method, described by El-Youssef, to convert to a binary image.

After implementing a reliable algorithm to extract crack-patterns into binary images, I will implement the second algorithm, which generates a “crack network” of nodes and edges representing the cracks on a painting. At this point, I will run my algorithm on a large volume of high-resolution paintings in order to draw correlations and conclusions between paintings of different geographic origin, material, conservation techniques, and crack-patterns. To obtain such high-resolution images, I will work with conservators at the Yale Institute for Preservation of Cultural Heritage, as well as consult online sources such as the Metropolitan Museum of Art’s extensive catalog of high-resolution images.

Finally, and time-permitting, I will build a web framework to host the image processing software described above and design an interface that allows a user to upload a high-resolution image of their choosing, convert it to a binary image, and present analysis of its craquelure.

**Process**

I will be using MATLAB to process the images. As previously discussed, the algorithms will be based primarily off of those described in the El-Youssef paper. After collecting data on the relationship between geographic origin, material, conservation technique vs. craquelure, I will use various JavaScript libraries to build visualizations and diagrams of the findings. I will build the web framework with Ruby on Rails, hosted with Heroku.
Deliverables and Timeline

- **Definite deliverables**
  - Develop and test algorithm (1) to reliably extract binary image of craquelure from high-resolution images of paintings (to be completed before October recess).
  - Develop and test algorithm (2) to reliably convert binary image to crack networks (to be completed before October recess).
  - Process large volume of high-resolution images on algorithms, extract data based on correlations between geographic origin, material, conservation history and craquelure style and shape (to be completed before Thanksgiving break).
  - Construct visualizations based on findings from data (to be completed before Thanksgiving break).

- **Time permitting deliverables**
  - Build a web framework that harnesses the above algorithms and enables users to upload and analyze the craquelure of any image (by the end of the semester).