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AS Core 2018
a visualization of the Internet core

Introduction

The CAIDA AS Core visualization depicts the Internet's Autonomous Systems' (ASes) geographic locations, number of customers, and interconnections. Each AS approximately corresponds to an Internet Service Provider (ISP). The geographic location of the individual AS is inferred from the weighted centroid of its address space according to NetAcuity, a commercial geolocation service. The number of direct or indirect customers of an ASA is inferred using its customer cone (described below).

The goal of my project was to draw the visualizations of the AS core using data from CAIDA's API and focus on the topology for a specific AS.

Results

To achieve this goal, several options to highlight a specific AS and its customers were considered. The original plan to focus on a specific AS was to apply the fisheye effect to that AS, as seen in the picture below. Various mapping functions were tested to achieve this effect.
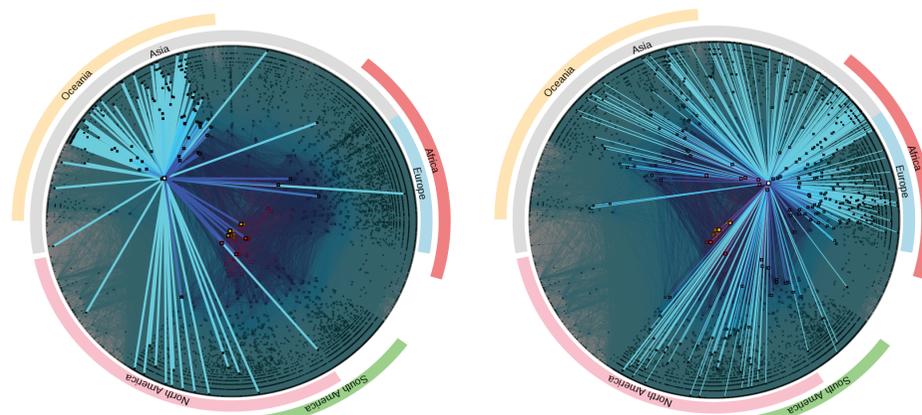

Example of an image with the fisheye effect applied. In the image, objects close to the focus point are expanded while objects far away from the focus point are compacted.

However, as seen below, the fisheye method did not produce the right image. To achieve the desired effect, the code would have to perform significantly more checks, and would become much more inefficient. As a result, a new method was required to focus on a specific AS.
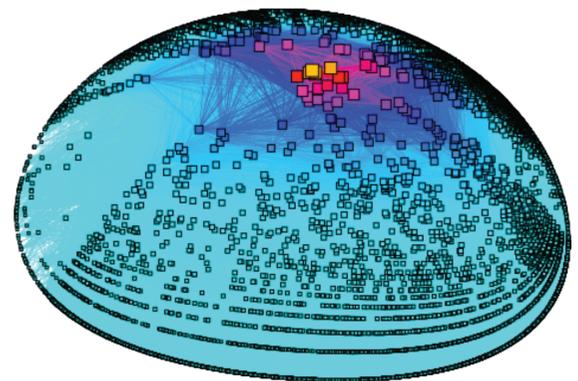
Example of an AS Core drawn using the fisheye mapping functions:
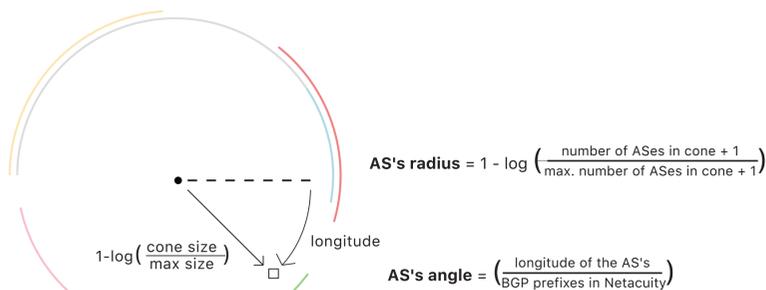With the standard mapping functions it was difficult to see which AS was being focused on.

With the method of focusing on a single AS, only the selected AS and its links are displayed, and the selected AS is colored white. The image is overlaid onto a color filtered version of the entire topology, as seen below. Not only is this method more efficient by only parsing the AS and links being focused on, but the selected AS is also more noticeable than the fisheye mapping option.

Methods

This project involved the use of CAIDA's RESTful API to query AS data. Scripts were written in Python and utilized the Cairo graphics library to draw the visualizations.

$$\text{AS's radius} = 1 - \log\left(\frac{\text{number of ASes in cone} + 1}{\text{max. number of ASes in cone} + 1}\right)$$

$$1 - \log\left(\frac{\text{cone size}}{\text{max size}}\right)$$

$$\text{AS's angle} = \left(\frac{\text{longitude of the AS's}}{\text{BGP prefixes in Netacuity}}\right)$$

Coordinates of ASes in AS Core: Each AS node is plotted in polar coordinates using the equations defined above

The distance of each AS node from the center of the circle (the radial coordinate) is the inverse of each AS's customer cone size, which is (roughly) the number of the AS's direct or indirect customers. ASes at the outer edge of the circle have no customers and ASes at the center have the largest number of customers.

AS	Size
A	6
B	3
D	1
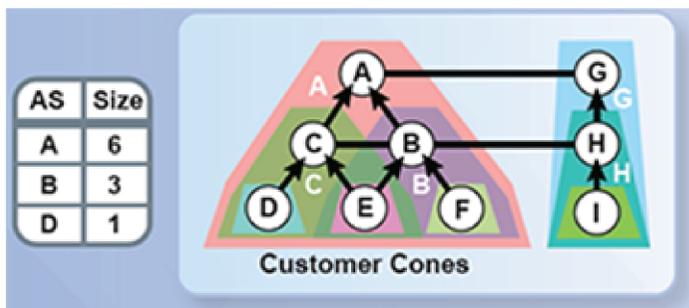
Customer Cones

Example Customer Cones: above, A has the largest cone with 6 ASes; H has two.

Summary

The purpose of this project was to not only convert a Perl program to create visualizations using PyCairo, but also to explore options to highlight a specific AS's topology. Although fisheye mapping was a good option in theory, focusing on a single AS and its neighbors and using a colored filter was more effective and practical. The resulting visualization allows us to view and analyze the geographical location and topological data of the focus AS and its customers.

Examples of As Cores: AS 7545, shown on the left, is centered in Oceania and serves mostly other ISPs in Oceania. AS 8359, shown on the right, is centered in Europe, but has customers from Europe to Asia to Oceania. Although these ASes have different customer bases, they both are high-ranking ASes with links to ISPs in North America.