Using Raster Channelization Techniques to Build a Hyperspace Network for the Star Wars Galaxy

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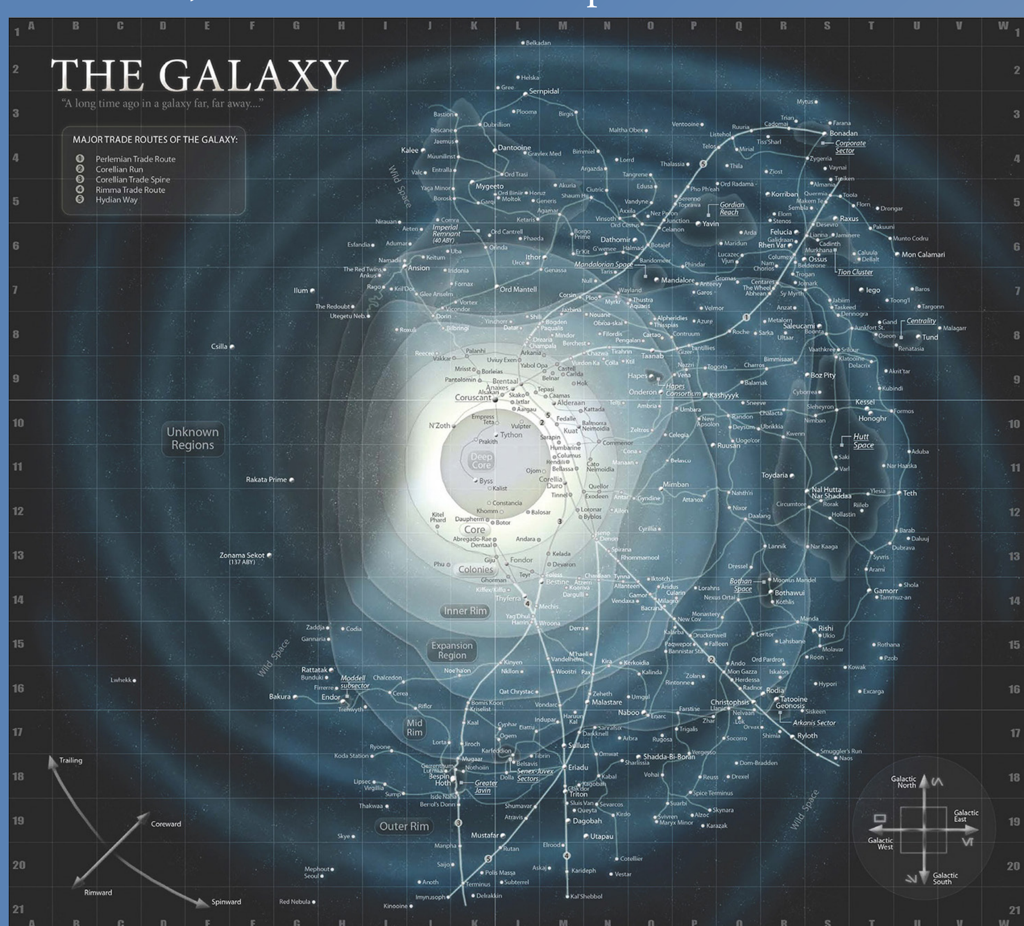
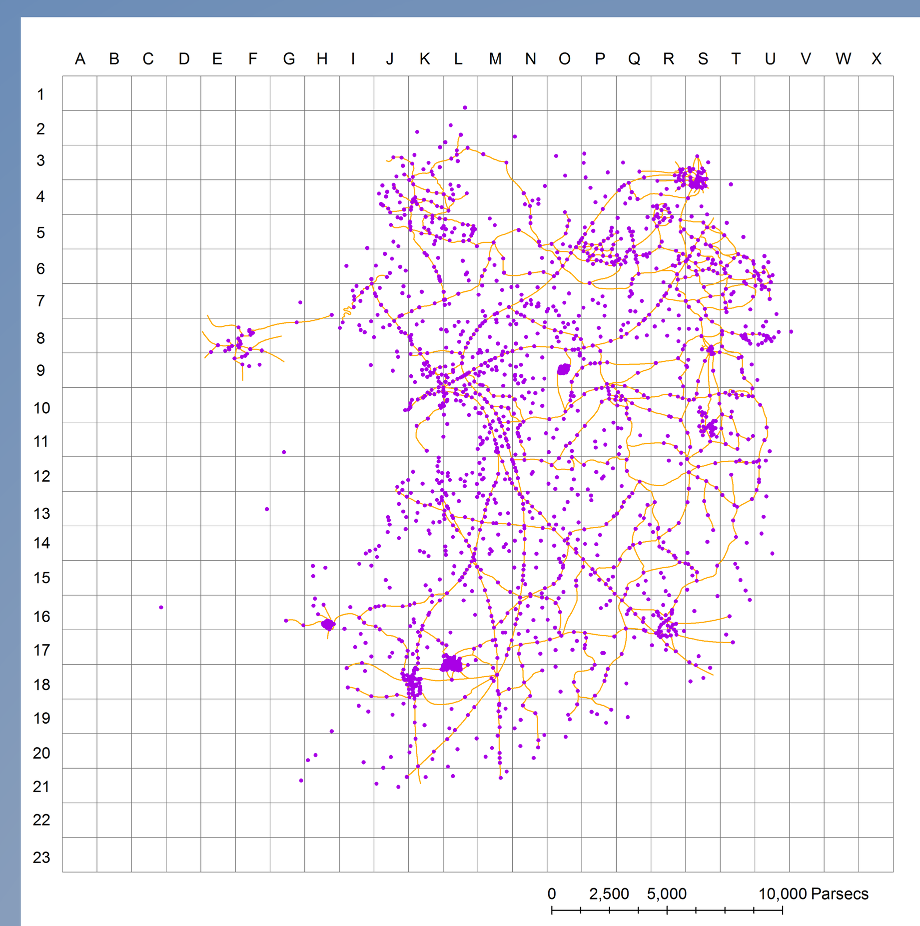
"Traveling through hyperspace ain't like dusting crops, boy! Without precise calculations we could fly right through a star or bounce too close to a supernova, and that'd end your trip real quick, wouldn't it?"
-Han Solo, Star Wars: A New Hope



1: Wallace, Daniel, and Jason Fry. *Star Wars:The Essential Atlas*. New York: Del Rey/Ballantine, 2009. P. 4-5.

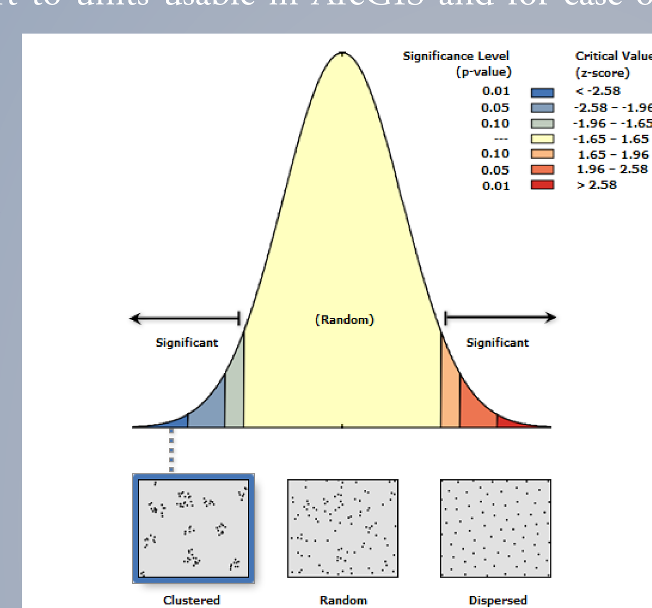


Vectorized planets and hypserspace lanes.

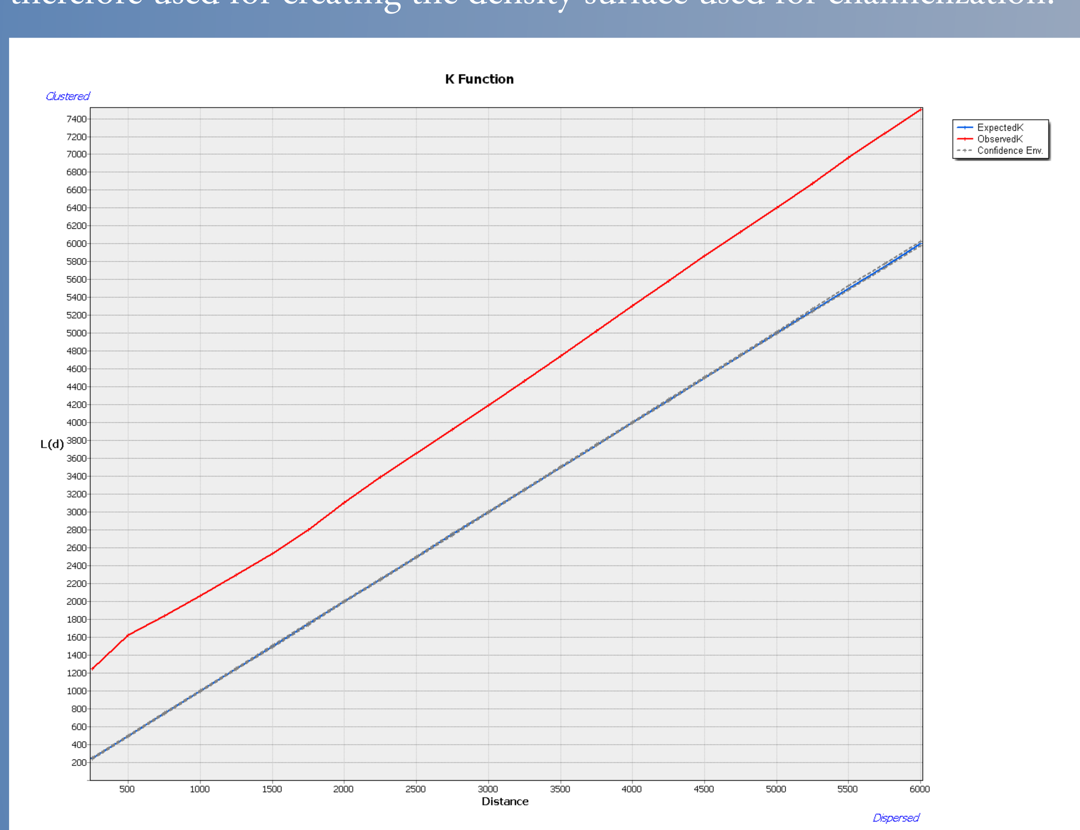
This project utilizes flow accumulation and channelization techniques to calculate an "optimal" network that links disconnected points to an existing polyline dataset using the Star Wars galaxy as a case study. An optimal network is described as the shortest path that connects all points to an existing hyperspace lane but also connects points to their neighbors in their local network. This methodology aims to minimize the distance in open space traveled between planets.

Data for this project was digitized from *Star Wars: The Essential Atlas*[1] and vectorized using a combination of ESRI ArcGIS, AutoDesk AutoCAD, and Adobe Illustrator. All data was scaled at 1 parsec = 1 meter to convert to units usable in ArcGIS and for ease of processing.

The source data consists of 2045 planets as point data and 1561 segments of existing hyperspace lanes as polylines. 712 of the planets do not fall on existing hyperspace lanes. Planets are significantly clustered, with an average nearest neighbor distance of 232 parsecs and a standard deviation of 224 parsecs. A K-Function analysis shows that the planets are most clustered at an approximate 500 parsec search radius, which was therefore used for creating the density surface used for channelization.



Average Nearest Neighbor



K-Function Analysis

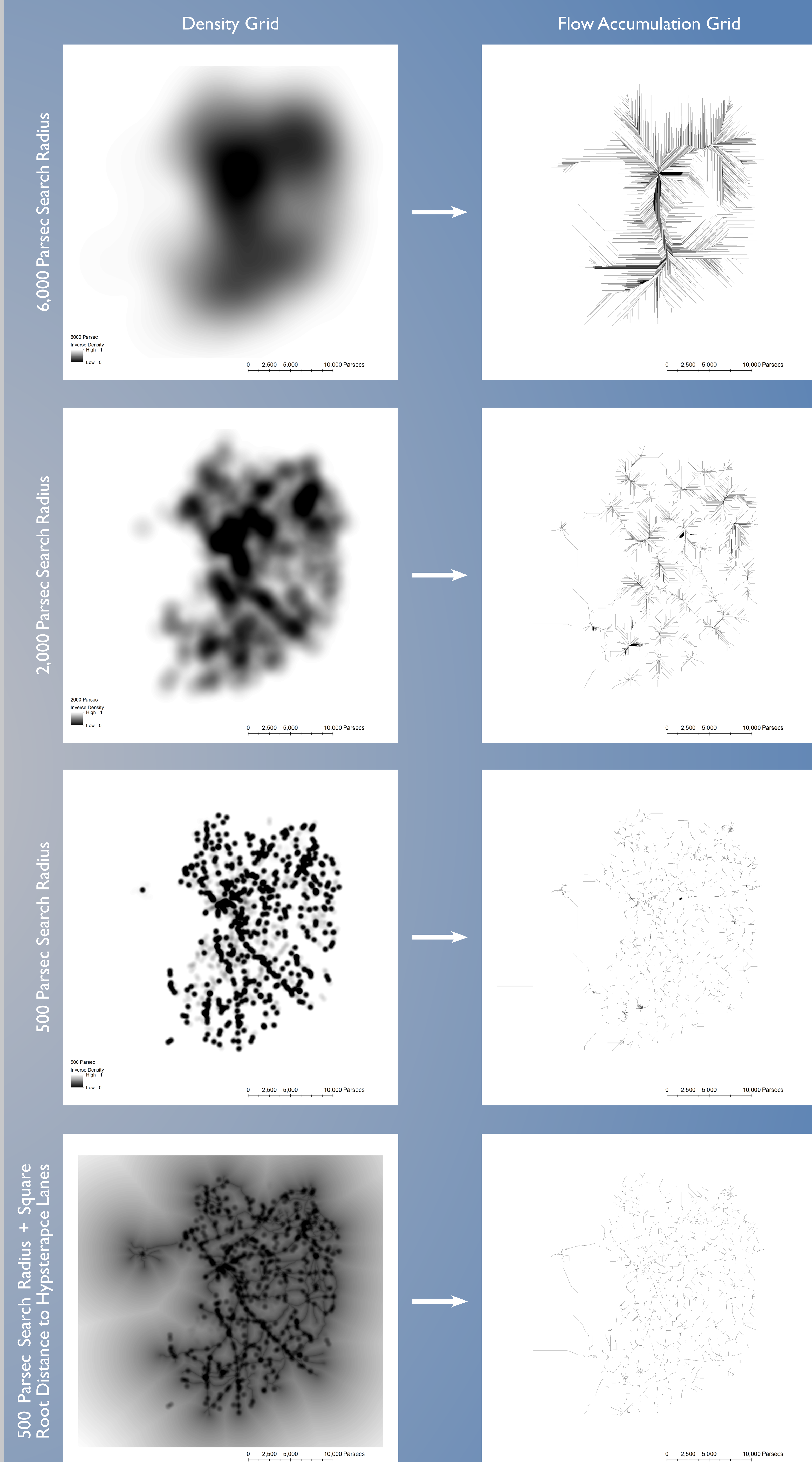
Near Distance	
Minimum	1.5 Parsecs
Maximum	5442 Parsecs
Mean	232 Parsecs
Standard Deviation	224 Parsecs
Median	196 Parsecs

Characterization of planets dataset

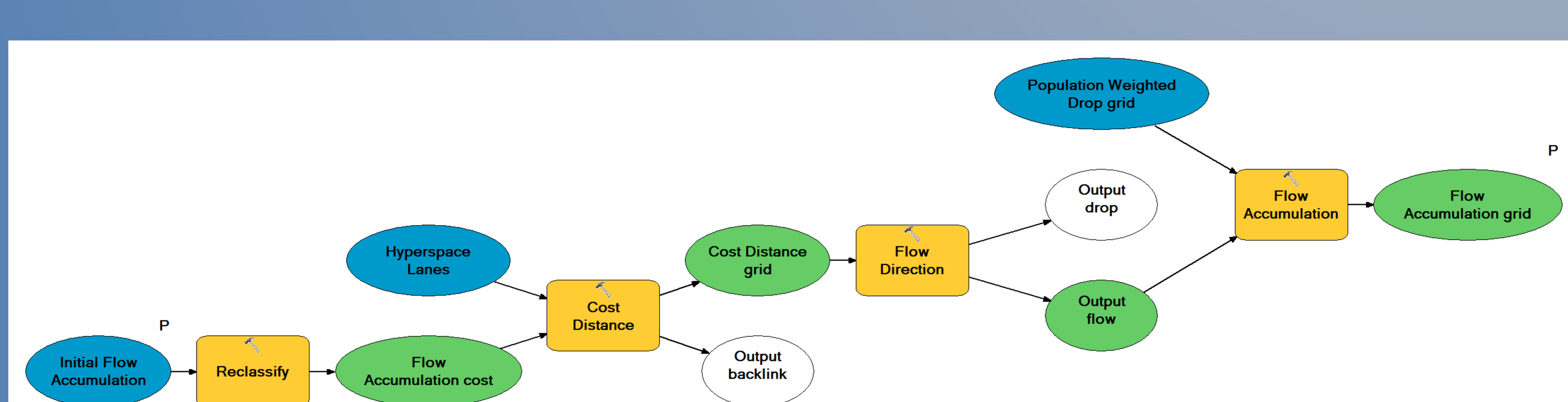
Surface Interpolation and Flow Accumulation

Surfaces were created at varying search radii using the Kernal Density tool to identify the local population density with the intent of channeling new hyperspace lanes through the areas of highest density and the Euclidean Distance tool too identify distance to the nearest existing hyperspace lane. The original density grids were normalized and inverted so that highest density equated to lowest elevation.

The Flow Direction and Flow Accumulation tools were applied to the surfaces created in the previous step to visualize the flow patterns and identify localized clusters for each search radius.



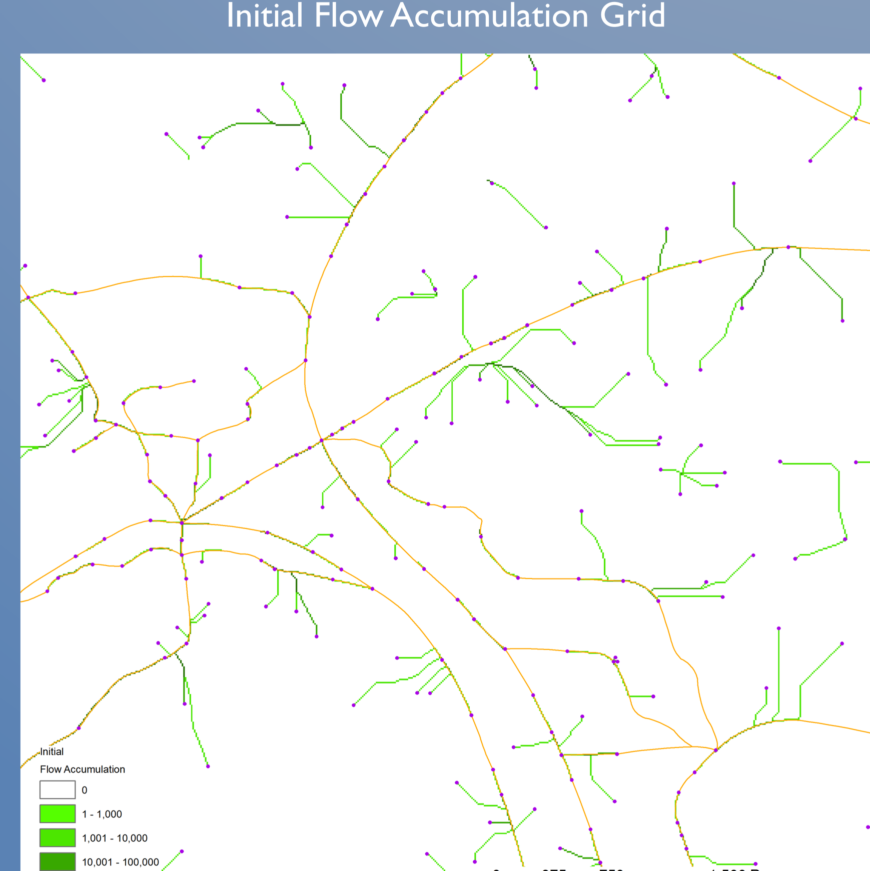
Channelization



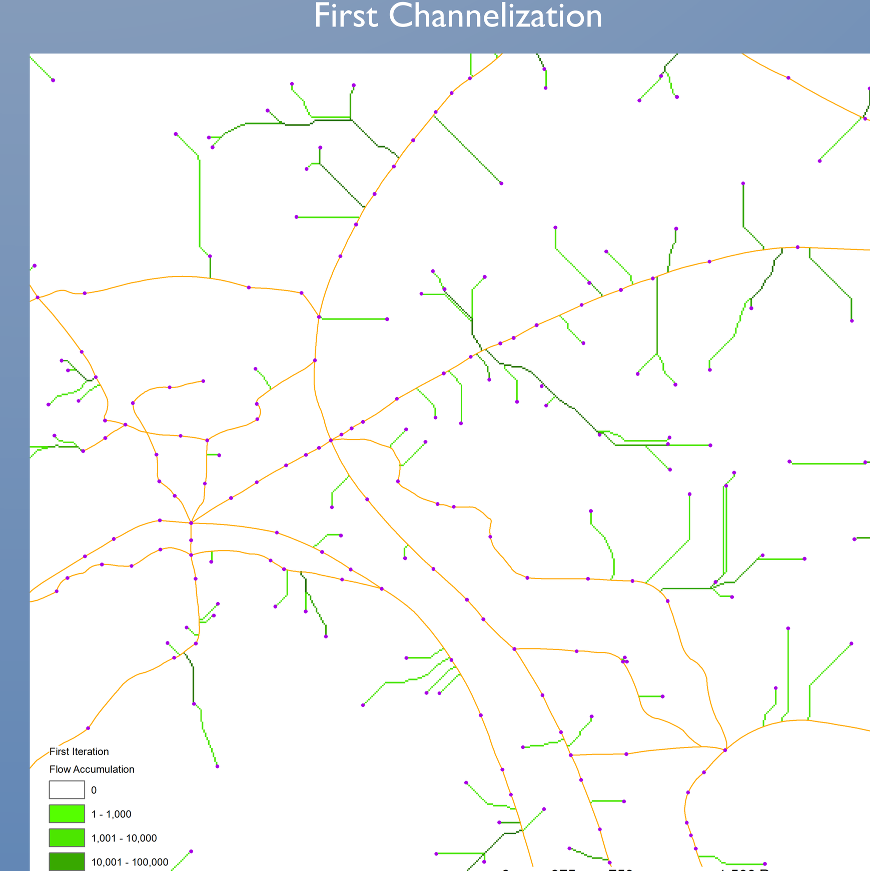
The 500 parsec kernal density grid and the square root of distance to hyperspace lanes grids were combined to create an initial surface for flow calculations. The output flow accumulation grid was run through a process of channelization, where it was reclassified so that the highest levels of flow were assigned the lowest cost, lower levels of flow were assigned medium cost, and no flow was assigned the highest cost. This was used as a cost surface for the Cost Distance tool to calculate drainage to existing hyperspace lanes. Flow Direction and Flow Accumulation was then calculated using the cost distance grid as the input.

This process was repeated, using each resultant flow accumulation grid as the input for the next iteration, until there was no change between the input and results. The final flow accumulation grid represented the most optimal hyperspace network for the given input criteria.

Initial Flow Accumulation Grid



First Channelization



Fourth (final) Channelization