

# Sinkhole Detection App

Alan Andrews

# Overview

Problem statement

Data and Data preprocessing

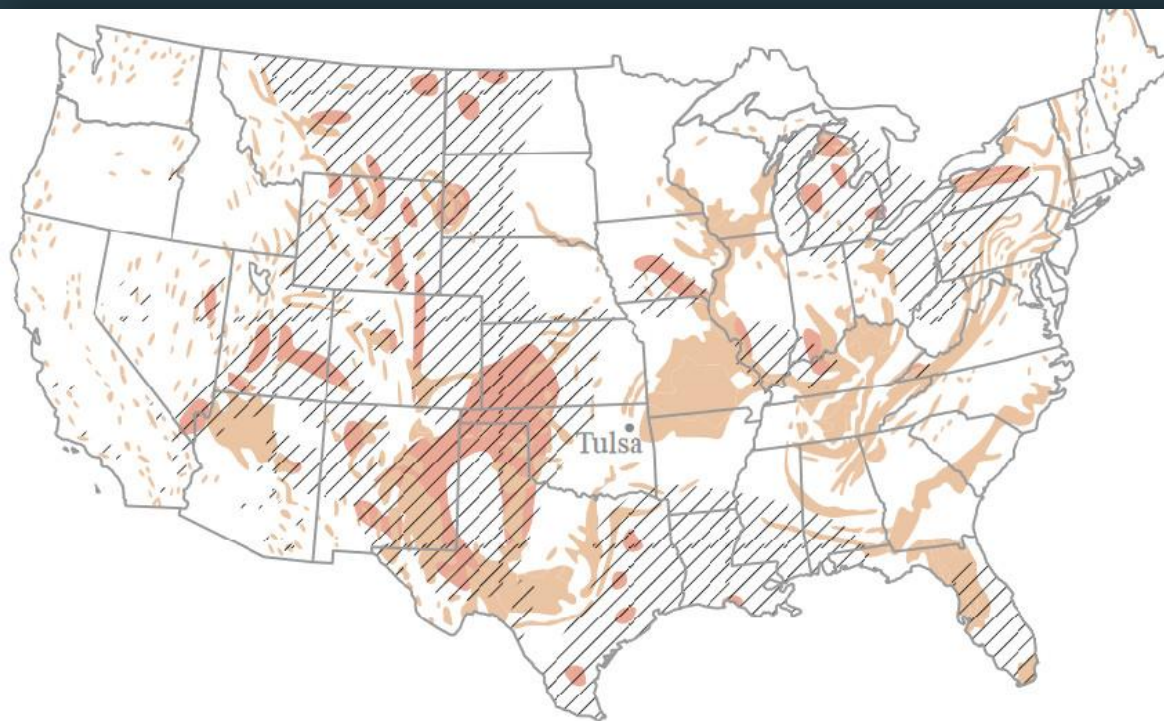
Modelling

Results

Next steps

# Problem statement

Can a segmentation model baked on machine learning be trained on LIDAR DEM imagery be used to detect the presence of sinkholes on the land surface?



**Figure 9.** Salt and gypsum underlie about 40 percent of the contiguous United States. Carbonate karst landscapes constitute about 40 percent of the United States east of Tulsa, Oklahoma (White and others, 1995).

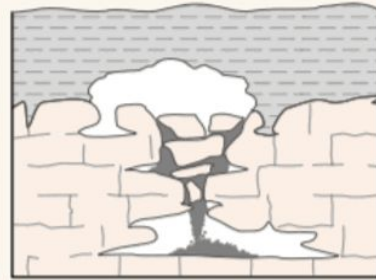
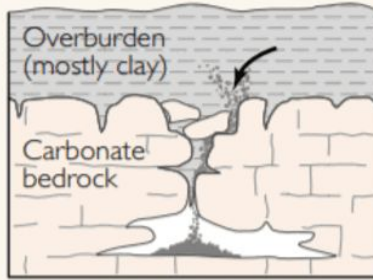


The sudden and sometimes catastrophic subsidence associated with localized collapse of subsurface cavities (sinkholes) is detailed in two case studies. This type of subsidence is commonly triggered by ground-water-level declines caused by pumping and by enhanced percolation of ground water. Collapse features tend to be associated with specific rock types, such as evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomite). These rocks are susceptible to dissolution in water and the formation of cavities. Salt and gypsum are much more soluble than limestone, the rock type most often associated with catastrophic sinkhole formation. Evaporite rocks underlie about 35 to 40 percent of the United States, though in many areas they are buried at great depths. Natural solution-related subsidence has occurred in each of the major salt basins in the United States. The high solubilities of salt and gypsum permit cavities to form in days to years, whereas cavity formation in carbonate bedrock is a very slow process that generally occurs over centuries to millennia. Human activities can expedite cavity formation in these susceptible materials and trigger their collapse, as well as the collapse of pre-existing subsurface cavities.

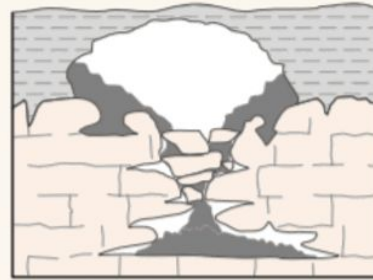




Sediments spall into a cavity. As spalling continues, the cohesive covering sediments form a structural arch.



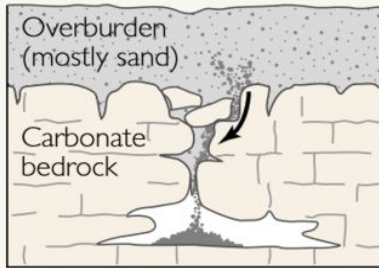
The cavity migrates upward by progressive roof collapse.



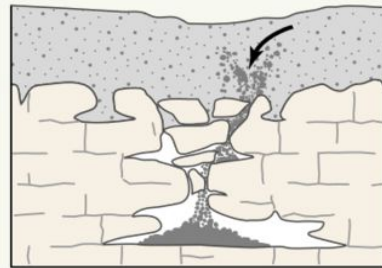
The cavity eventually breaches the ground surface, creating sudden and dramatic sinkholes.



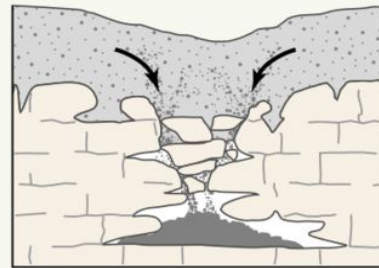
Granular sediments spall into secondary openings in the underlying carbonate rocks.



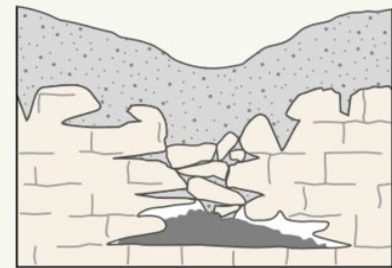
A column of overlying sediments settles into the vacated spaces (a process termed "piping").



Dissolution and infilling continue, forming a noticeable depression in the land surface.



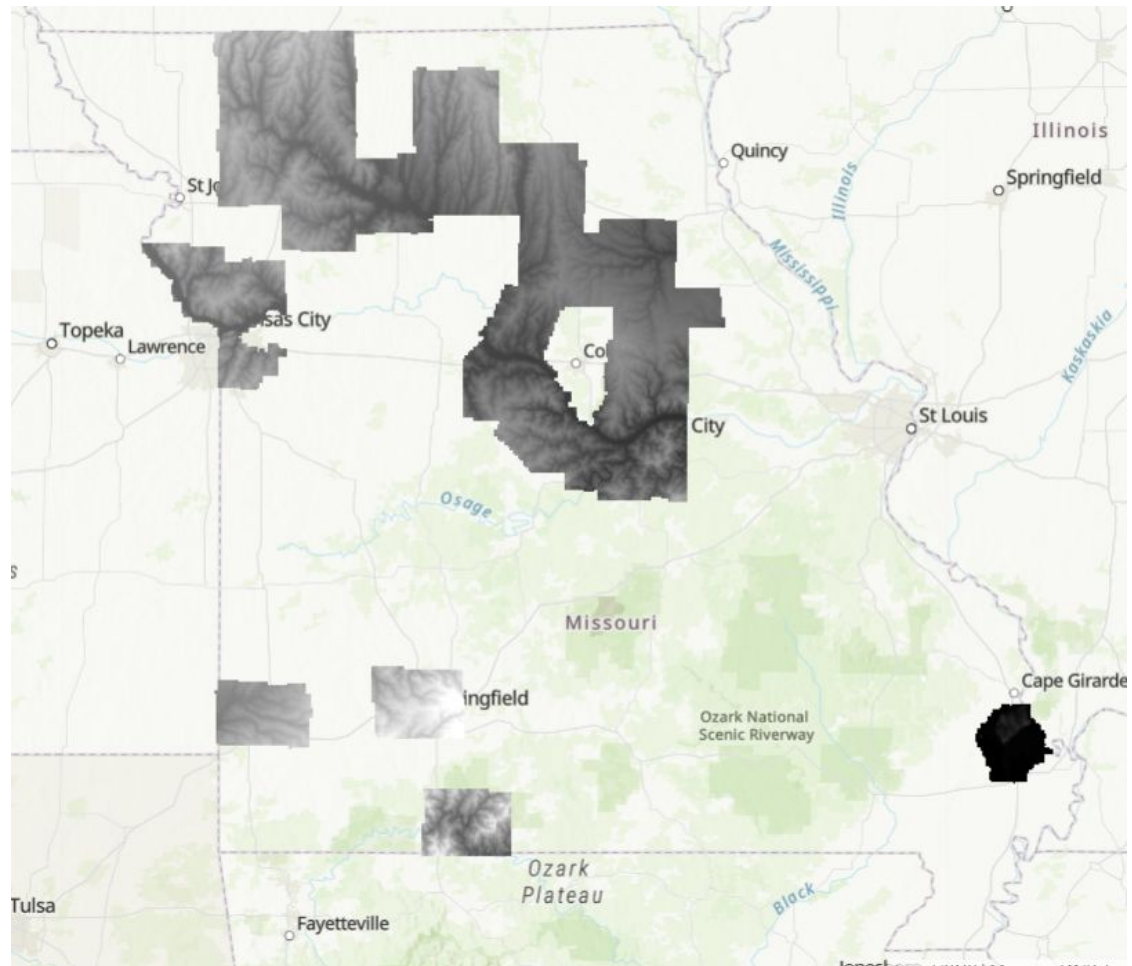
The slow downward erosion eventually forms small surface depressions 1 inch to several feet in depth and diameter.



# Why is it important to identify sinkholes

Identifying sinkholes on a property may help dictate where and what gets built or what activities can be carried out for safety and environmental reasons.

Identification of a sinkhole on property being purchased may necessitate geotechnical inspection.







## Sinkhole Boundaries



Tom Dyer

City of Springfield, Missouri

[View Map](#)

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### Summary

Sinkhole boundaries for Greene County, Missouri

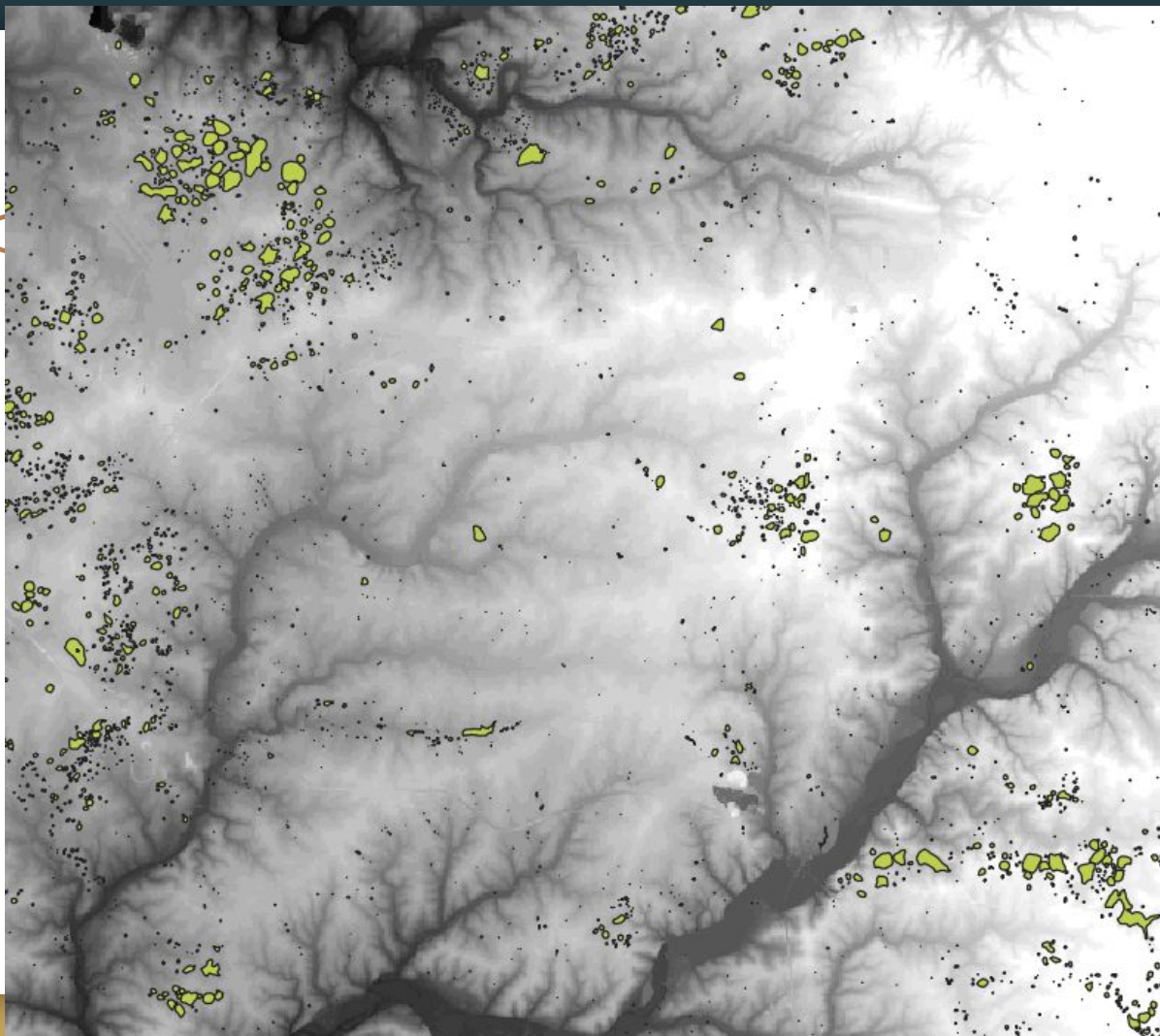
Polygon feature representing sinkholes in Greene County, Missouri. Attributes include length and width.

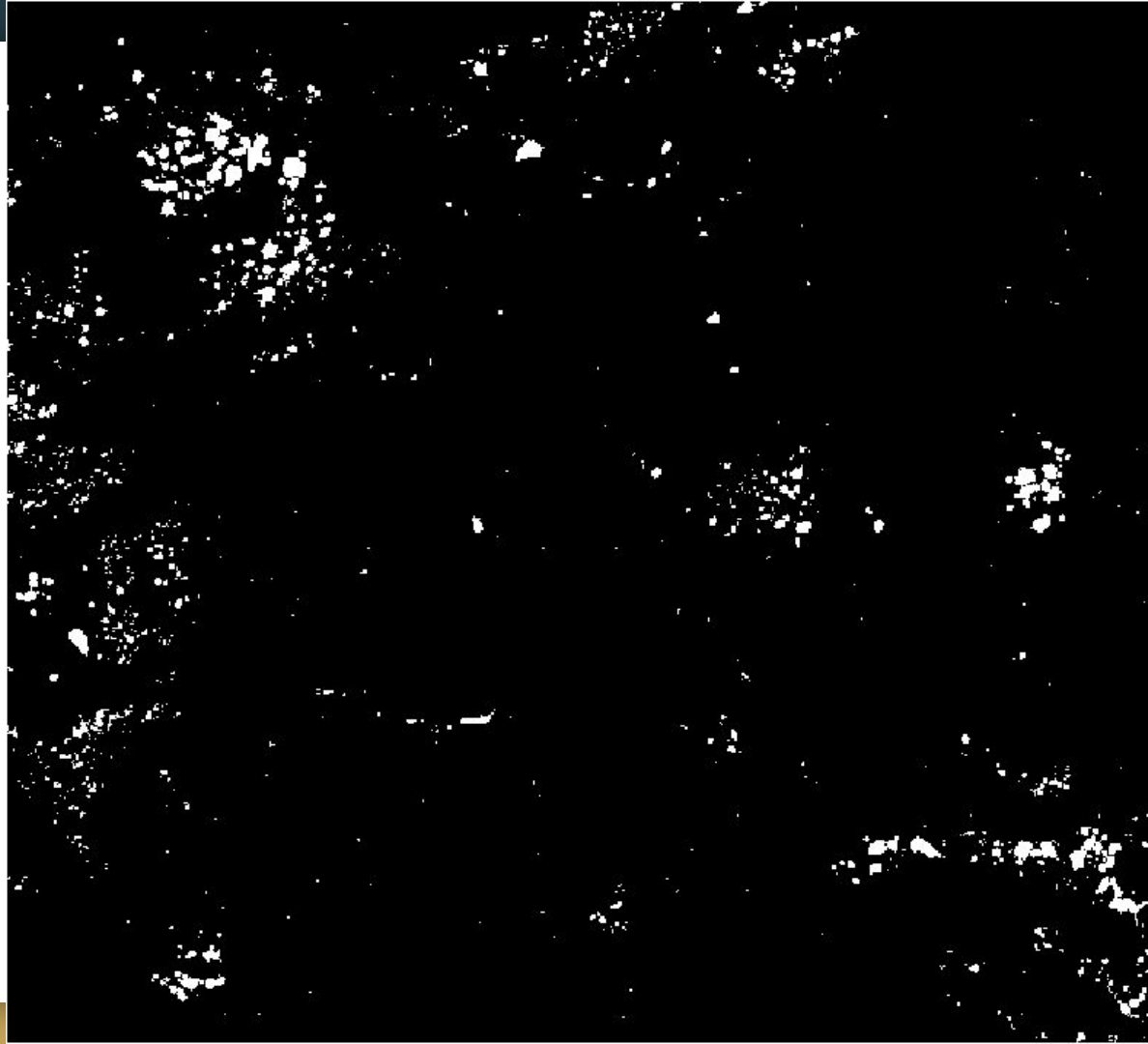


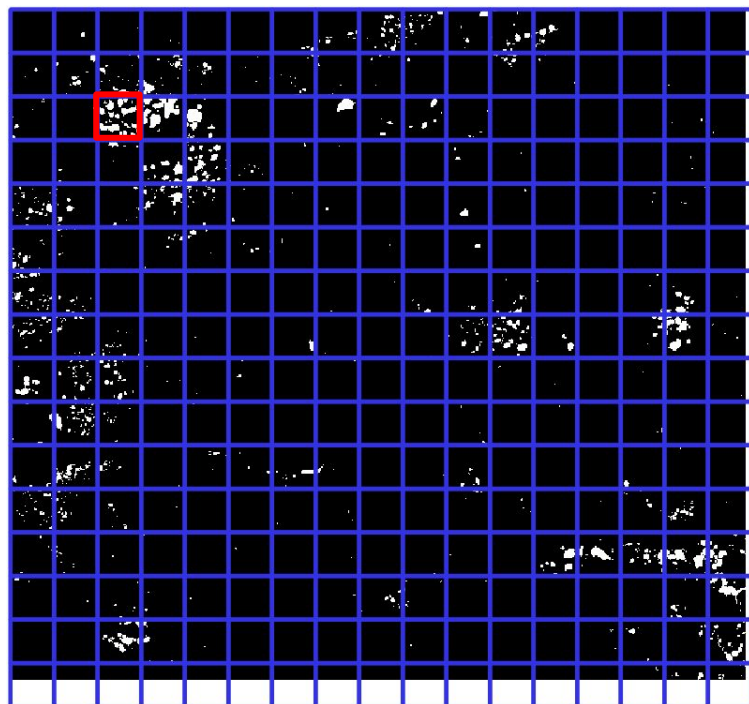
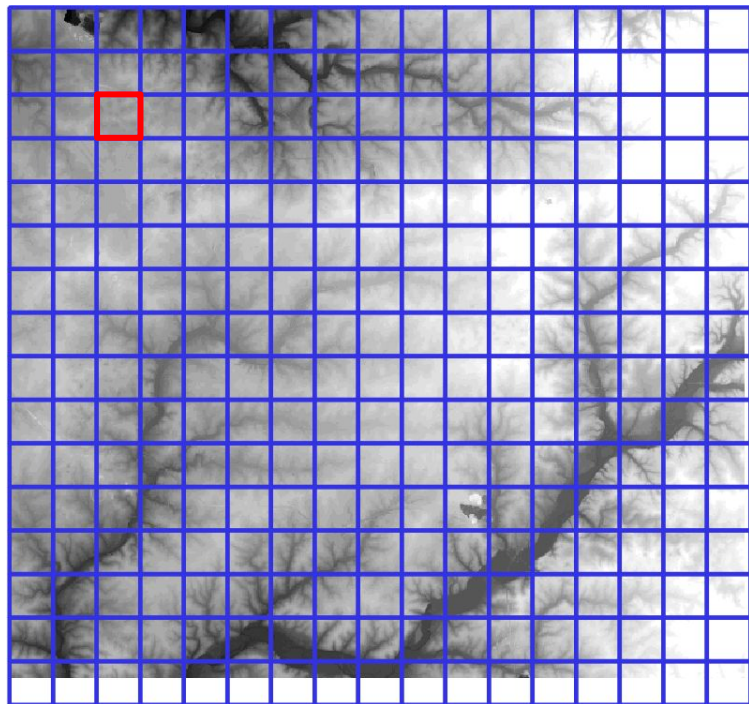
Open source GIS software to visualize, manage, edit, analyse data, and compose printable maps.

<https://www.qgis.org/en/site/>

Prep

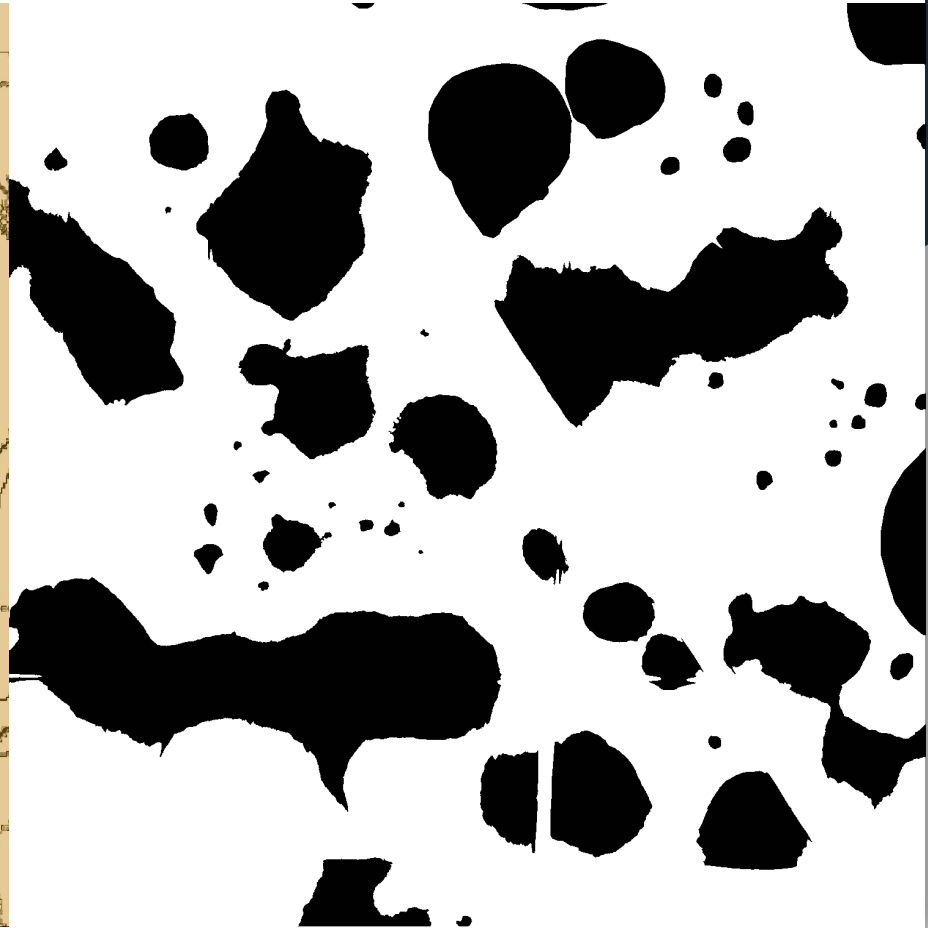
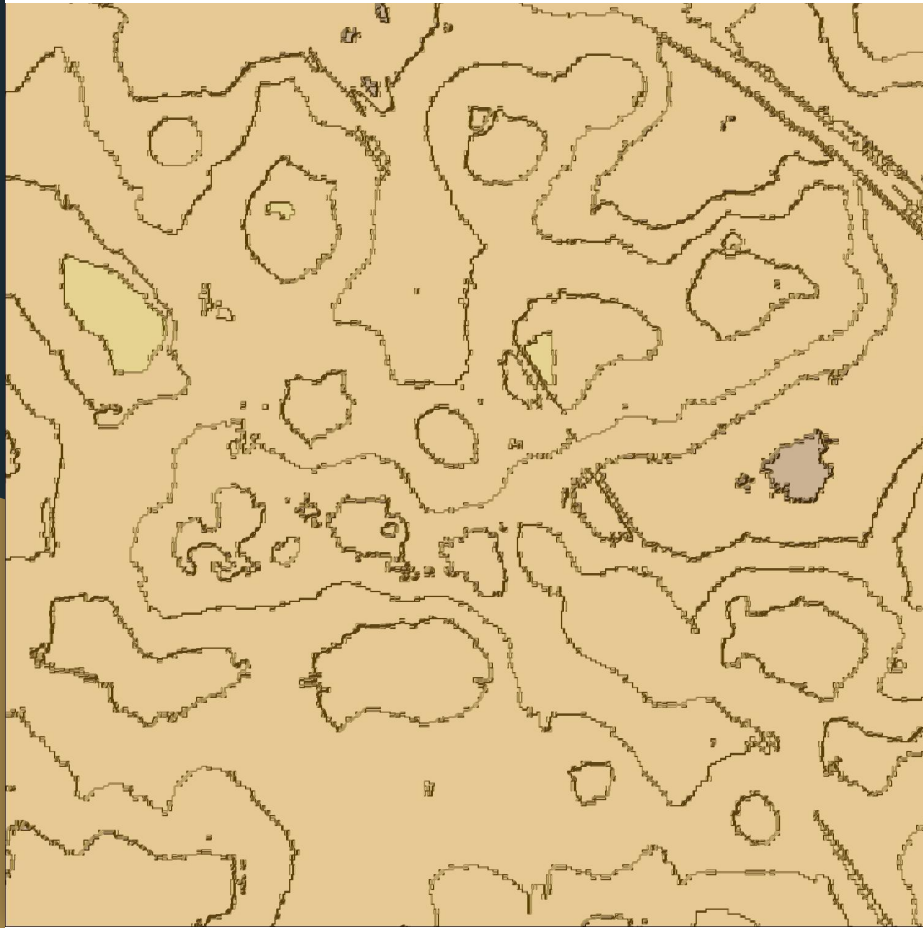












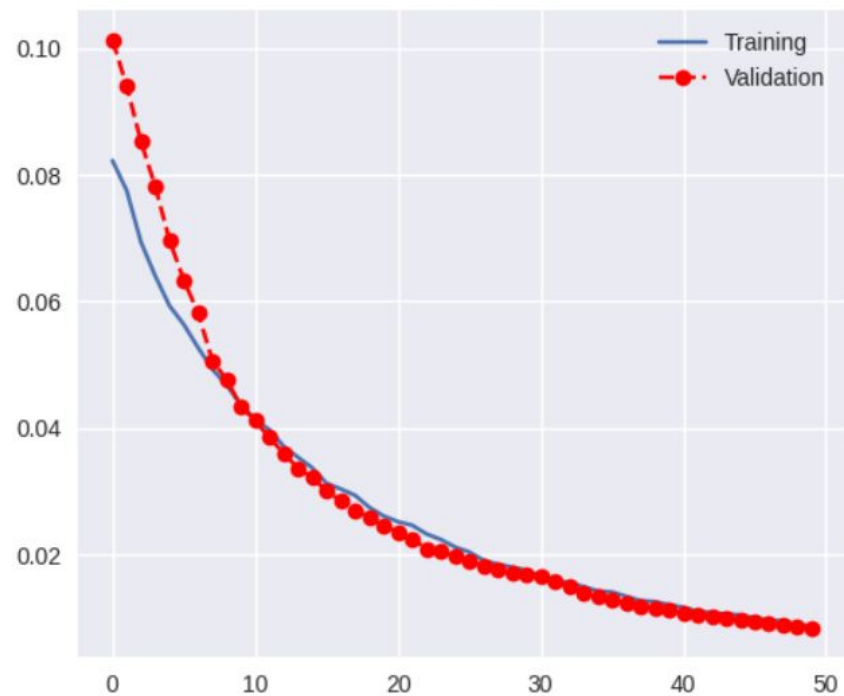


# Segmentation Models

Python library with Neural Networks for Image Segmentation based on [Keras](#) and [TensorFlow](#).

Allows for simplified implementation of several segmentation model frameworks including U-Net.

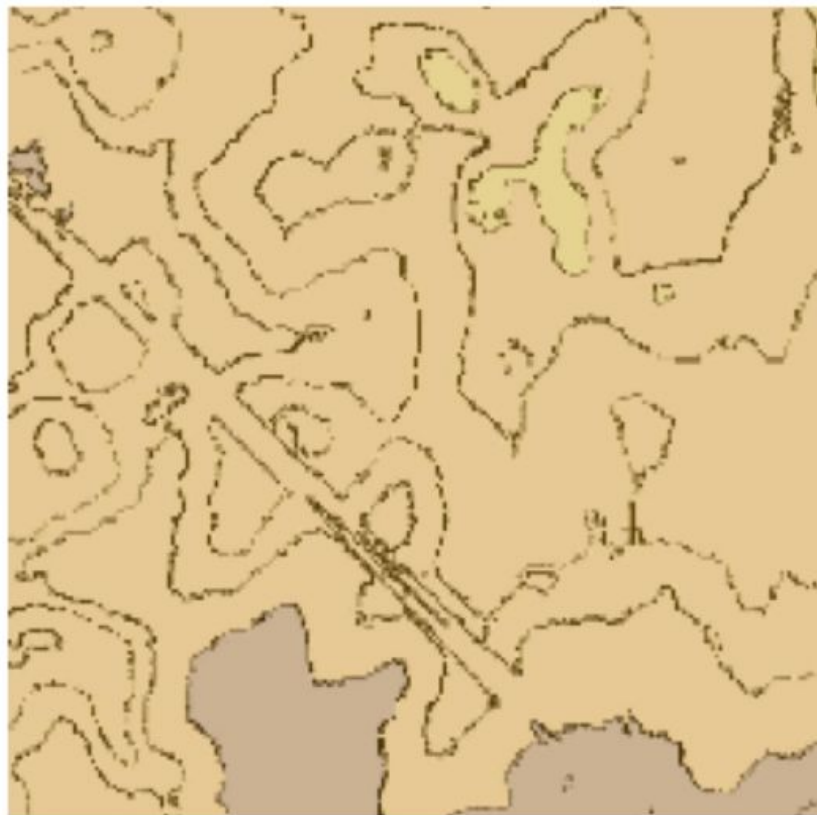
Loss



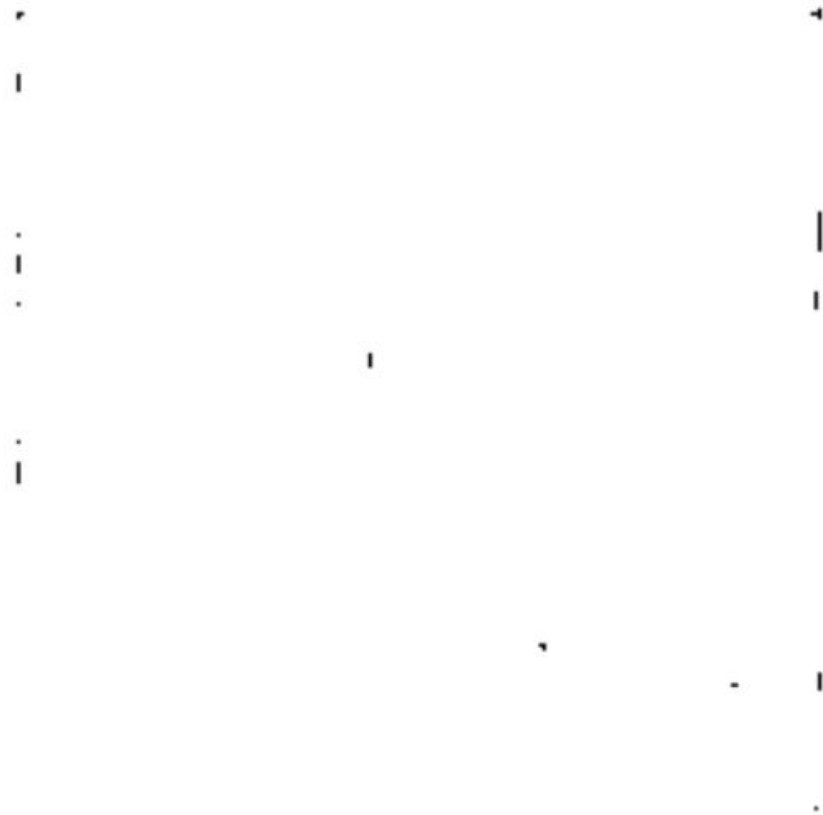
IoU Score



Image



Predicted Mask





# Next Steps

IMPROVE PREDICTION!

Dataset is imbalanced is very imbalanced.

Only 2.19% of the pixels in the training dataset correspond with a sinkhole.

Filter out image/mask pairs so that there is a higher proportion of sinkhole pixels.

Experiment with tensorflow class weights.