Can drought conditions be used to predict the likelihood of utility-caused wildfires?

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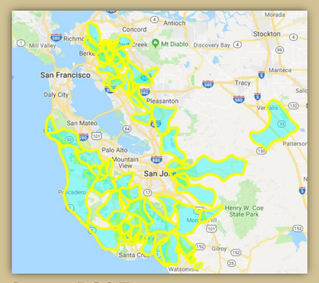
Problem Statement



Source: PG&E

2019 preventative PG&E outages

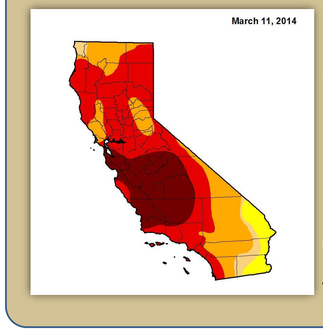
- More than 800,000 customers affected [1]
- $2 billion cost [2]

The three main investor-owned utilities have caused over 2000 wildfires between 2014 and 2017 in California [3]

Source: bkeepers

- **Can drought conditions be used to predict the fires?**

Data

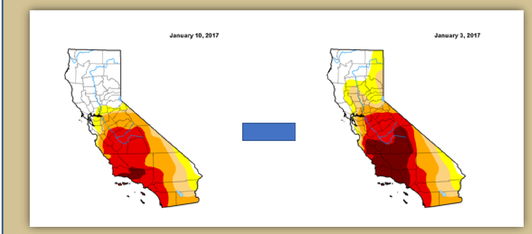


209 weekly drought maps produced by US Drought Monitor [4] 912x912, RGB

CPUC database of utility-caused fires (GPS, start date)

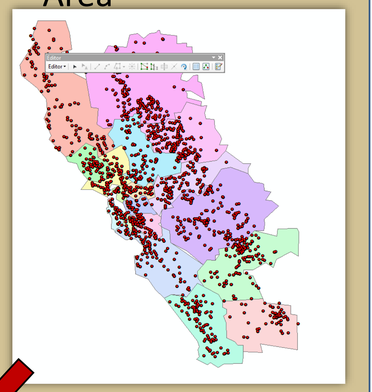
Experiments/Model

Difference



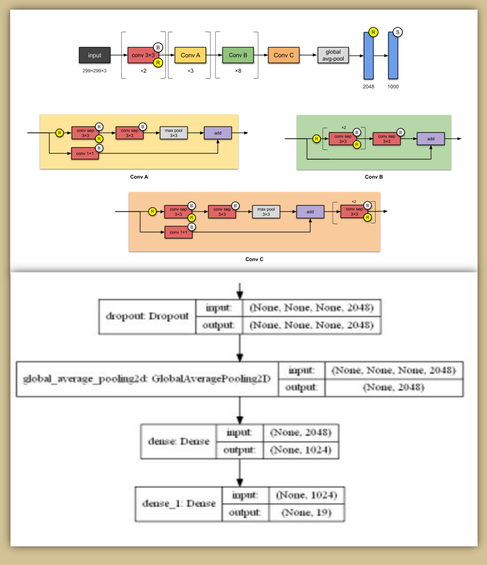
difference between two weekly drought images in January 2017

Area



1. Fires 2014-2018 by PG&E 19 economic areas, ArcGIS

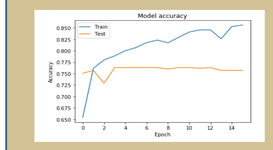
CNN Classifier

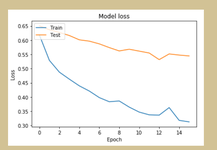


Xception

Source: Raimi Karim [5]

Results





The validation model accuracy is failing to improve.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	0.329251	0.140269	0.216029	0.124332	0.425488	0.271288	0.38935	0.503202	0.26919	0.306461	0.421064	0.259534	0.389622	0.047984	0.28108	0.423238	0.300648	0.494861	0.502119
	0.328627	0.140941	0.219461	0.123617	0.42327	0.273017	0.387717	0.50382	0.271936	0.306158	0.419297	0.264656	0.392299	0.048584	0.279003	0.428567	0.301959	0.501455	0.501381
	0.324894	0.139327	0.21852	0.122068	0.42077	0.270729	0.387467	0.50652	0.271242	0.305634	0.419148	0.265087	0.391743	0.048351	0.277623	0.426997	0.303553	0.5015	0.500474
	0.328443	0.140851	0.219376	0.123549	0.423147	0.272847	0.387736	0.503956	0.271898	0.306059	0.419284	0.264692	0.392203	0.048575	0.278978	0.42847	0.301962	0.501351	0.501344
	0.32294	0.139054	0.214493	0.121978	0.420078	0.270606	0.387047	0.505665	0.270593	0.305077	0.418888	0.265125	0.390145	0.048475	0.277724	0.42634	0.303044	0.500475	0.499942
	0.319833	0.134764	0.210675	0.120292	0.42418	0.261374	0.38871	0.517933	0.272319	0.308309	0.416065	0.259806	0.390673	0.046778	0.275392	0.41697	0.304114	0.493855	0.501062
	0.328369	0.140878	0.219738	0.123469	0.423043	0.273023	0.387859	0.504143	0.272127	0.306237	0.419462	0.264651	0.392747	0.048592	0.278854	0.428508	0.30249	0.50177	0.501333
	0.329104	0.141722	0.216944	0.125996	0.428448	0.272646	0.390323	0.514244	0.27022	0.308021	0.421224	0.266045	0.392387	0.047902	0.28121	0.426271	0.303562	0.501692	0.509473
	0.329683	0.141808	0.223526	0.124091	0.419389	0.271089	0.391051	0.506132	0.269467	0.309787	0.418975	0.262313	0.393297	0.0479	0.27903	0.428348	0.308934	0.504598	0.505711
	0.328709	0.14096	0.219447	0.123658	0.423285	0.273039	0.387767	0.503821	0.271907	0.306165	0.419352	0.264673	0.392246	0.048585	0.279071	0.428601	0.301978	0.501418	0.501382
	0.32874	0.141069	0.219949	0.123548	0.42323	0.273343	0.387914	0.503748	0.272164	0.30628	0.419518	0.264578	0.392864	0.048621	0.278935	0.428673	0.302389	0.501912	0.501435
	0.32923	0.13954	0.218186	0.123666	0.425498	0.271298	0.388442	0.500386	0.268212	0.306128	0.417921	0.261037	0.388062	0.048121	0.281094	0.426396	0.298994	0.497069	0.501044
	0.329994	0.142966	0.227183	0.125109	0.425664	0.271565	0.387181	0.489346	0.263971	0.310423	0.406669	0.254361	0.384591	0.048099	0.280085	0.431652	0.300897	0.49392	0.511831
	0.328712	0.140512	0.219279	0.124488	0.421843	0.271078	0.389203	0.506088	0.271435	0.307446	0.420179	0.263447	0.391807	0.048481	0.279616	0.427189	0.304673	0.499595	0.501848
	0.327691	0.140159	0.220592	0.123223	0.422304	0.272656	0.387798	0.502988	0.271086	0.3078	0.418262	0.264046	0.391344	0.048489	0.279113	0.428753	0.303751	0.500694	0.500483
	0.325586	0.139877	0.218947	0.122695	0.421183	0.271375	0.3878	0.50667	0.271784	0.305528	0.415526	0.265711	0.39187	0.048602	0.278276	0.427618	0.303493	0.501689	0.500809
	0.328918	0.140722	0.219983	0.123753	0.423265	0.273282	0.389092	0.504348	0.271448	0.306955	0.419818	0.26406	0.39246	0.04851	0.27969	0.428004	0.302439	0.501501	0.502218
	0.324558	0.139211	0.218144	0.122127	0.420963	0.270524	0.387314	0.50633	0.271122	0.30521	0.418919	0.265062	0.391123	0.048333	0.279911	0.426575	0.302538	0.500717	0.500567
	0.323804	0.138709	0.217832	0.121861	0.420498	0.270071	0.387179	0.50631	0.270369	0.305121	0.418445	0.264983	0.389867	0.048214	0.277963	0.425859	0.302391	0.499879	0.500303
	0.328232	0.140881	0.21951	0.12247	0.423008	0.272918	0.387837	0.504309	0.272168	0.306029	0.41941	0.264855	0.392458	0.048632	0.278947	0.428417	0.302299	0.501647	0.501321
	0.330778	0.137422	0.215688	0.123065	0.430316	0.267616	0.392214	0.500113	0.269822	0.312486	0.418146	0.250429	0.385919	0.04654	0.282882	0.42007	0.302363	0.485229	0.503781
	0.328331	0.140803	0.219732	0.123763	0.422067	0.272548	0.387612	0.502762	0.271668	0.307176	0.418809	0.263761	0.39246	0.048587	0.278756	0.427358	0.302231	0.499755	0.500559

Output analysis in Excel, color scale from green to red represent higher fire probability. Each area probability output converged around the average probability of fire for the area

The main limitations and issues of our analysis

(1)PG&E does not cover all of California,
(2)some fires that were small or in urban areas may have needed to be excluded because they are unlikely to be drought-dependent.
(3)Lack of data
(4)One single factor.: drought
(5)Using classifier as an approximation for probabilities
(6)PG&E areas were based on economic factor rather than climate, vegetation and geological factors

References

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[4] What is the USDM | United States Drought Monitor." [Online]. Available: https://droughtmonitor.unl.edu/About/WhatistheUSDM.aspx
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Conclusion/Next steps

We initially were hoping to be able to predict an increase in wildfire caused by utilities from drought-maps in California. We used the weekly drought maps produced by US Drought Monitor and Convolutional Neural Networks to attempt to predict the likelihood of utility caused wildfires Because of the limited data, it is difficult to know if the lack of results meant that we needed additional data or that the drought was not a significant enough factor.
Next steps: (1)Our next steps would have been to explore LSTMs as a way to capture temporal variations of the drought and see if this helped the predictions (2) Treating the problem more as a segmentation than a classification, which was a flawed approach and would capture spatial data much better. (3)Adding additional data, like soil moisture or wind.