Flights of the Future

Presented by Hoyalytics

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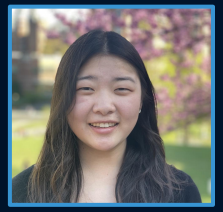

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HOYALYTICS

AGENDA

- Project Overview
- Data Analysis
- Related Factors
- Predictive Model
- Dynamic Temporal Visualization

Project Overview

- Project Deliverables
- Data Sourcing
- Delta Overview

Project Deliverables

Goal: Analyze Delta's past flight schedules and predict how Delta's flight routes will change over the next 5 years

Predictive Model

- Predict the change in flights from major hub airports and regions
- Use knowledge about Delta, historical data, and influential factors to predict shifts in flight schedules
- Identify trends and use a time series model to create predictions

Dynamic Map

- Mapping out past flight schedules
- Adjustable to show changes year over year
- Data analytics that compare a base year and end year
- Integration with predictive model

Data Sources

Flight Data

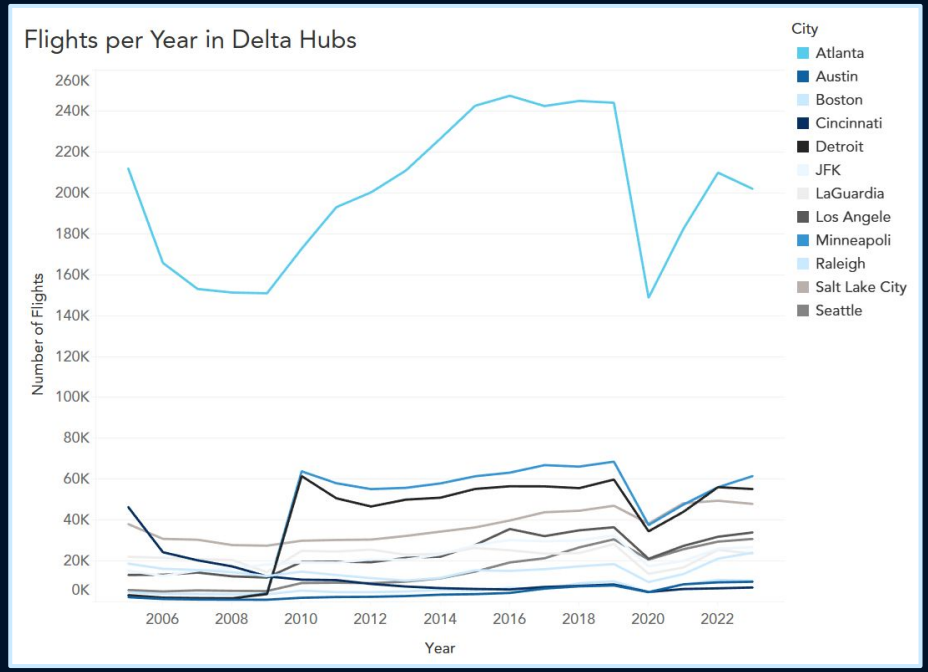
- Using official flight data from the Bureau of Transportation Statistics
- Limited to domestic flight data
- Scraped arrival and departure data for Delta Airlines going back as far as 2004
- Around 14M data points

Other Data

- Includes city and state GDP, population, and event data
- Data from official sources such as the Census Bureau
- Data preprocessing to clean and reduce the dimensions

Delta Airlines

- 10 hubs
  - Main hub: Atlanta
- 2016-2018: Focused on building and expanding hubs (e.g., Cincinnati, Salt Lake City, Raleigh), building out their national presence
- 2018-2019: Shifted their focus to expanding transatlantic flights
- 2021-2023: Getting back into the normal pace of pre-COVID flights
- December 2023: Announced the expansion of hubs in Miami, Charlotte, and Austin
  - A more aggressive approach as all of these are big American Airlines hubs



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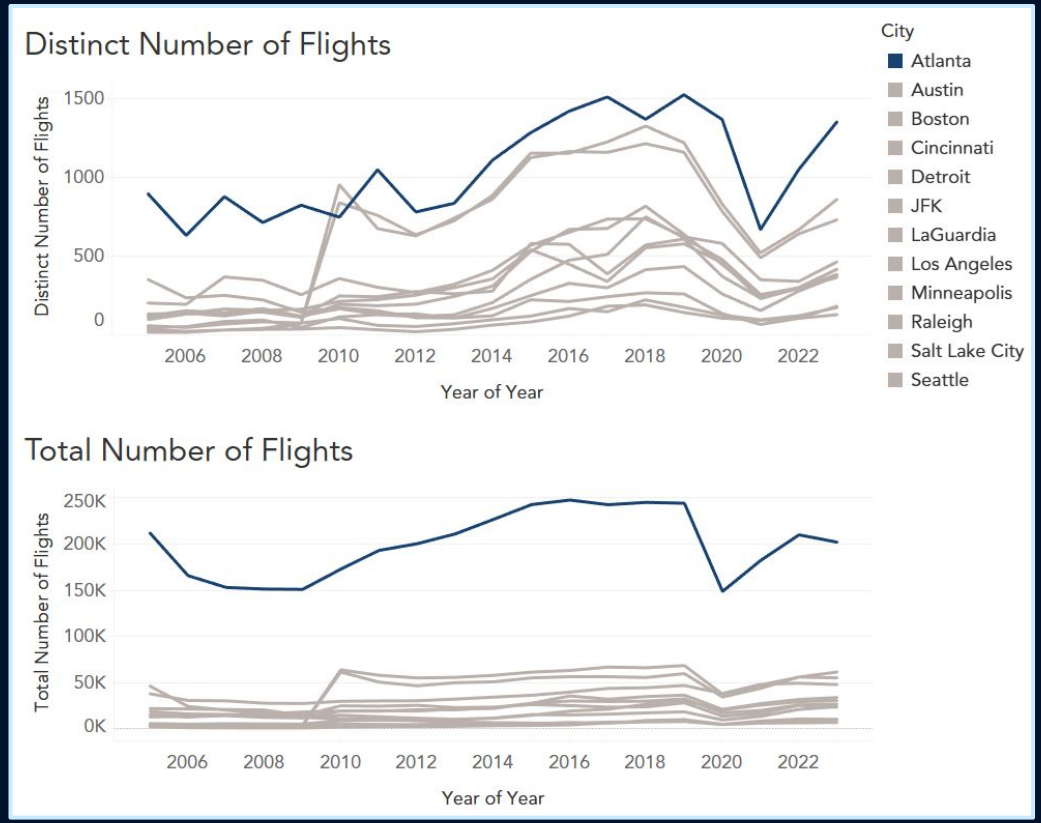
Data Analysis

- Hub Growth
- Total and Distinct Flights
- Flight Patterns

Atlanta and Hub Growth

Distinct Flight = unique flights (different times and/or destinations)

- Even though Atlanta has significantly more flights per year, it's distinct number of flights is not much higher than other hubs



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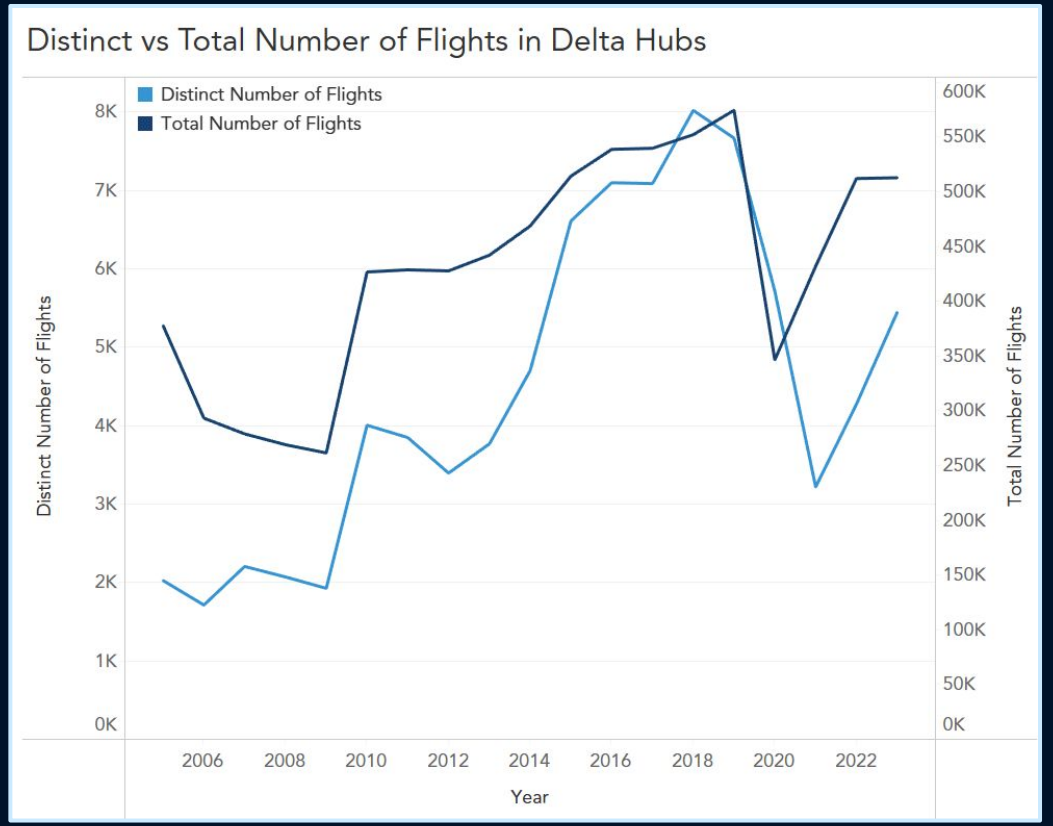
Total vs Distinct Flights

- Total Flights are back to their pre-pandemic levels but not distinct flights
- Since distinct flights were decreasing pre covid as well, We don’t expect it to ever go back to pre-pandemic levels



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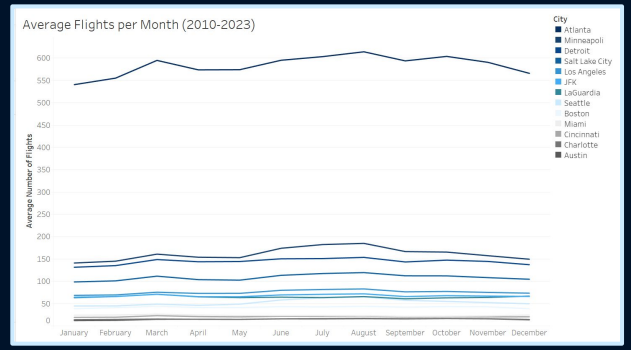
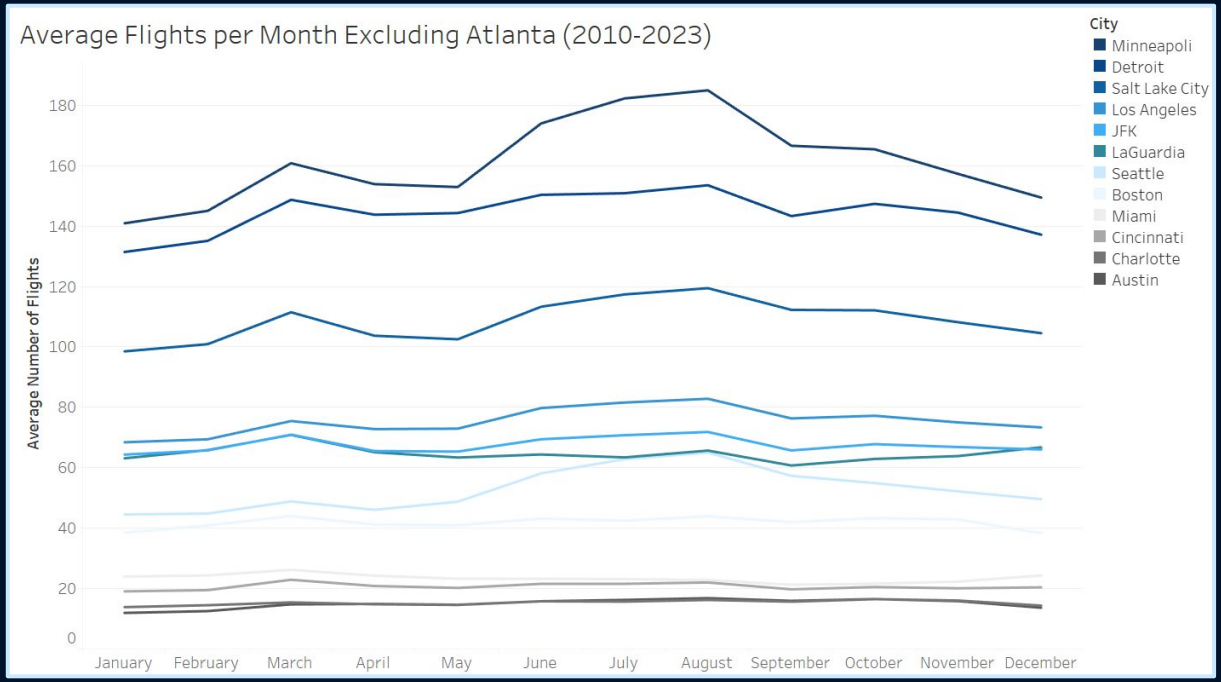
Flight Patterns

- Similar patterns across airports
  - Increase in March
  - Slight decrease until June
  - Increase until August
  - Decrease for the rest of the year





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Related Factors

- GDP
- Large Scale Events
- Population
- Findings

City Growth

- Based on UN city data (created in 2018):
- Expected Top Growing Cities (2025-2035) compared to their growth (2015-2025)
  - The past top growing cities is consistent with the future top growing cities
  - But growth rate is expected to decrease by 2-3x for most cities

-> Therefore we can use past growth to estimate future growth

1	Urban Agglomeration	Growth Rate (2015-2025)	Growth Rate (2025-2035)
2	The Woodlands	47.86%	13.00%
3	Concord	37.66%	11.92%
4	Temecula-Murrieta	38.96%	11.87%
5	Visalia	36.63%	11.79%
6	Myrtle Beach	34.47%	11.56%
7	Kissimmee	32.52%	11.27%
8	Fayetteville-Springdale	33.39%	11.24%
9	Charlotte	31.43%	11.15%
10	Raleigh	31.07%	11.08%

Flight Glowth Multiplier

- Combination of past GDP growth and UN predicted growth to create a multiplier for growth

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**City Name**	**State**	**2015 population**	**2025 expected polulation**	**2030 expected population**	**UN Data expected growth rate 2015-2025**	**UN Data expected growth rate 2025-2030**	**2015 gdp - city**	**2022 gdp - city**	**gdp growth - city**	**2015 gdp - state**	**2023 (Q3 adjusted annual) gdp - state**	**gdp growth - state**	**Total Multiplier for flight growth**
2	**weight**					**20%**	**20%**			**35%**			**25%**	
3	Cincinnati	Ohio	1692.54	1801.137	1880.763	6.03%	4.23%	127057	186141	31.74%	616406	880871	30.02%	**21%**
4	Detroit	Michigan	3648.167	3542.947	3678.965	-2.97%	3.70%	245607	305412	19.58%	474698	664452	28.56%	**15%**
5	Atlanta	Georgia	5161.71	6271.683	6602.213	17.70%	5.01%	339203	525888	35.50%	505199	880871	42.65%	**19%**
6	New York city - J	New York	18647.626	19154.024	19957.605	2.64%	4.03%	1412183	2163209	34.72%	1466458	2168133	32.36%	**27%**
7	New York city - L	New York	18647.626	19154.024	19957.605	2.64%	4.03%	1412183	2163209	34.72%	1466458	2168133	32.36%	**23%**
8	Boston	Massachusets	4261.184	4395.505	4581.1	3.06%	4.05%	355904	571666	37.74%	481630	741343	35.03%	**25%**
9	Los Angeles	California	12345.219	12677.559	13209.244	2.62%	4.03%	838101	1227469	31.72%	2496710	3898158	35.95%	**25%**
10	Minneapolis	Minnesota	2799.945	3039.163	3177.362	7.87%	4.35%	223718	277602	19.41%	336207	475590	29.31%	**17%**
11	Salt Lake City	Utah	1099.252	1225.789	1283.643	10.32%	4.51%	70176	135409	48.17%	149643	275048	45.59%	**24%**
12	Seattle	Washington	3259.129	3580.936	3746.558	8.99%	4.42%	283602	517803	45.23%	450575	808344	44.26%	**43%**
13	Autin	Texas	1691.867	2313.437	2452.998	26.87%	5.69%	110693	222054	50.15%	1580641	2596144	39.12%	**43%**
14	Raleigh	North Carolina	1145.156	1660.81	1767.344	31.05%	6.03%	68087	119675	43.11%	508241	773365	34.28%	**44%**
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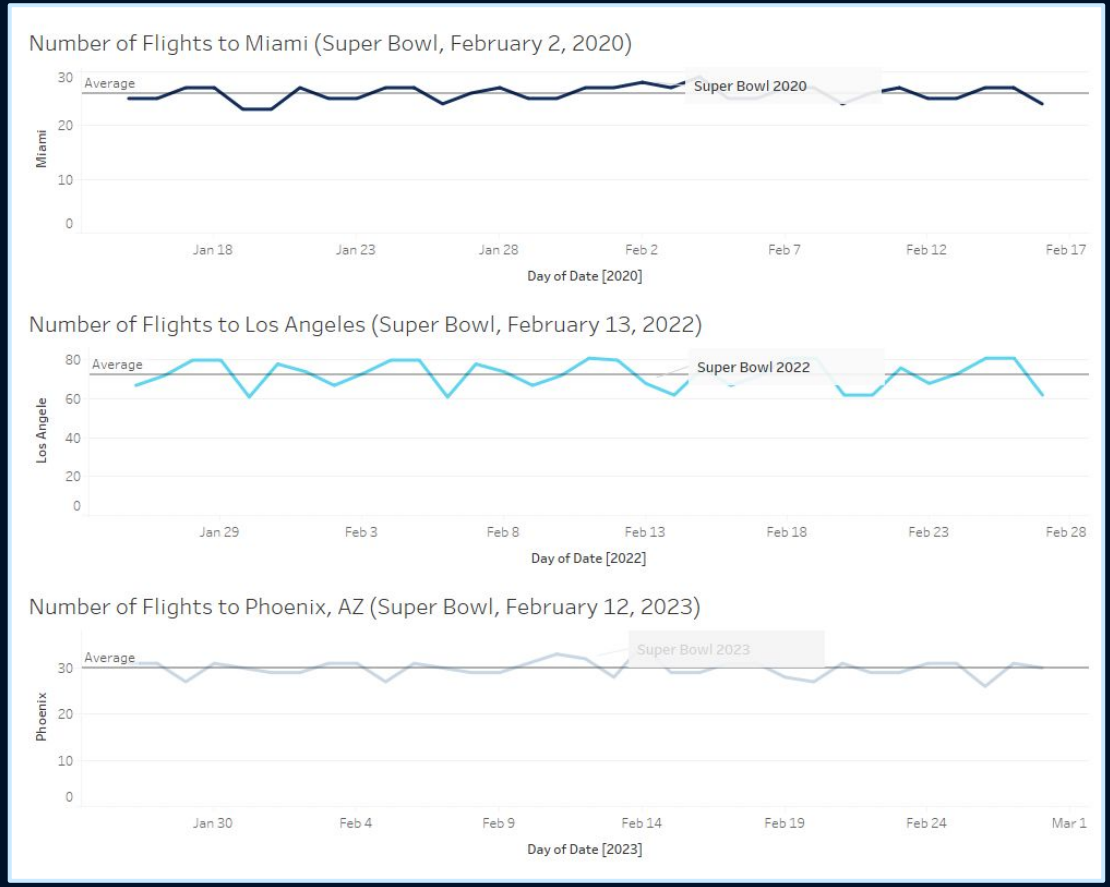
State GDP and Number of Flights

- Correlation between population growth and increase in flights
  - Darker red = stronger negative
  - Darker green = stronger positive
  - White = no correlation
- Low to no correlation between the two variables
- Most of the positive correlation can be attributed to the normal increase in both flights and GDP over time
  - Both variables trend in the same direction over time, but that doesn't mean they are actually correlated

	Quarterly correlation	Annual Correlation
United States	0.4140	0.0613
Alabama	0.0671	-0.2313
Alaska	0.1474	-0.0353
Arizona	0.5992	0.7987
Arkansas	0.1696	-0.0944
California	0.2300	0.0040
Colorado	0.2133	0.0856
Connecticut	0.7471	0.7042
District of Columbia	0.2401	-0.2799
Florida	0.4194	0.2663
Georgia	0.2375	-0.2593
Hawaii	0.8288	0.9163
Idaho	0.7896	0.8722
Illinois	0.6353	0.5724
Indiana	-0.0030	-0.3739
Iowa	0.1122	0.0300
Kansas	0.3092	0.0016
Kentucky	0.3893	0.1121
Louisiana	0.7654	0.8054
Maine	0.2906	0.1749
Maryland	0.3300	-0.0120
Massachusetts	0.6454	0.5729
Michigan	0.5723	0.2647
Minnesota	0.5165	0.0422
Mississippi	0.1490	0.0113
Missouri	0.4037	0.1747
Montana	0.1536	-0.0522
Nebraska	0.0057	-0.4112
Nevada	0.7482	0.5009
New Hampshire	-0.6213	-0.8047
New Jersey	0.4966	0.2117
New Mexico	0.5096	0.0668
New York	0.7264	0.6454
North Carolina	-0.0911	-0.4000
North Dakota	0.6653	0.6655
Ohio	0.2795	-0.1687
Oklahoma	0.5339	0.3531
Oregon	0.1231	-0.2126
Pennsylvania	0.5808	0.2180
Rhode Island	0.4539	0.1974
South Carolina	0.2121	-0.0173
South Dakota	-0.1775	-0.4519
Tennessee	0.3896	0.2164
Texas	0.7902	0.8476
Utah	0.5452	0.5573
Vermont	0.4038	0.3964
Virginia	-0.1196	-0.5382
Washington	0.4960	0.6498
West Virginia	0.1944	-0.0436
Wisconsin	0.3978	-0.0941
Wyoming	0.2761	0.1294
Average Correlation	0.3567	0.1499

Large-scale events had a minimal effect on the number of flights to a city

- Large-scale events (e.g., festivals, sporting events, conventions) had a smaller impact on flights than expected
- The image on the right displays the number of flights to Super Bowl host cities
  - On average, the Super Bowl only caused a 2% increase in inbound flights



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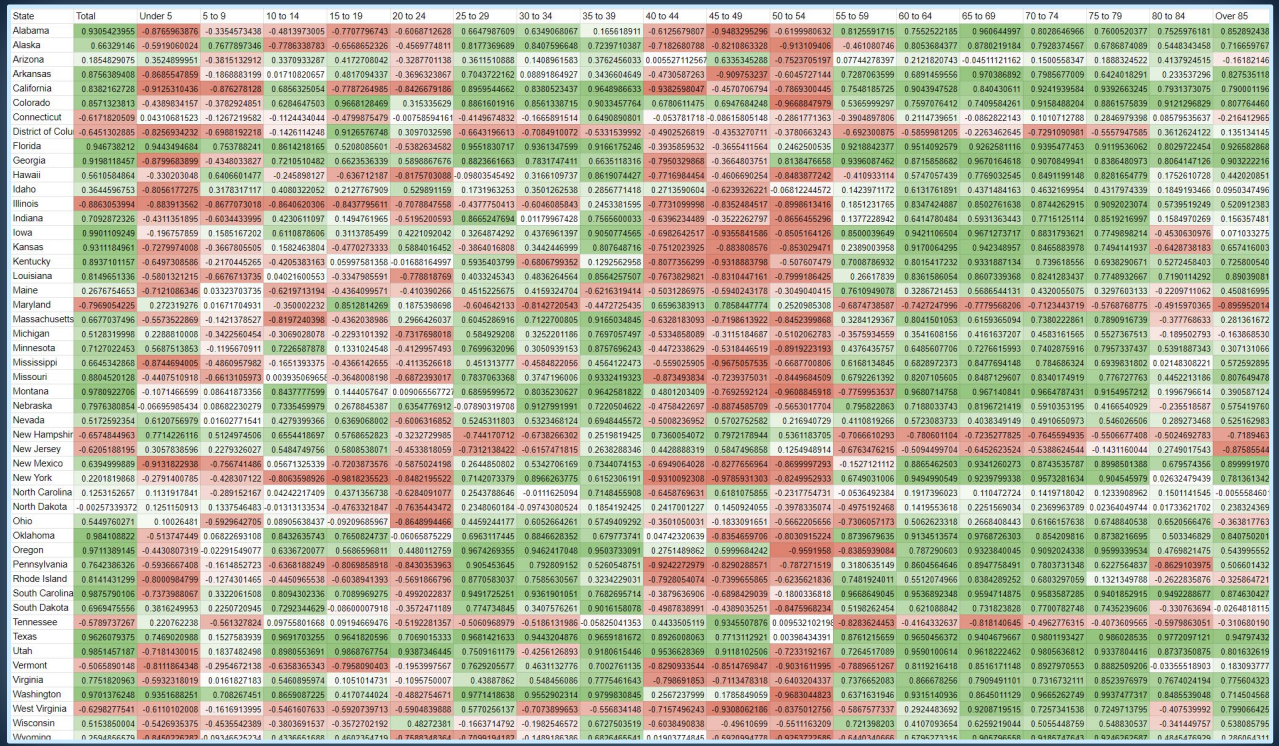


State	Total	Under 5	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 to 84	Over 85
Alabama	0.9305423955	-0.8765963676	-0.3354573438	-0.4813973005	-0.7707796743	-0.6068712628	0.6647987609	0.6349068067	0.165618911	-0.6125679807	-0.9483295296	-0.6199980632	0.8125591715	0.7552522185	0.960644997	0.8026646966	0.7600520377	0.7525976181	0.852892438
Alaska	0.66329146	-0.5919060024	0.7677897346	-0.7786338783	-0.6568652326	-0.4569774811	0.8177369689	0.8407596648	0.7239710387	-0.7182680788	-0.8210863328	-0.913109406	-0.461080746	0.8053684377	0.8780219184	0.7928374567	0.6786874089	0.5448343458	0.716659767
Arizona	0.1854829075	0.3524899951	-0.3815132912	0.3370933287	0.4172708042	-0.3287701138	0.3611510888	0.1408961583	0.3762456033	0.005527112567	0.6335345288	-0.7523705197	0.07744278397	0.2121820743	-0.04511112162	0.1500558347	0.1888324522	0.4137924515	-0.16182146
Arkansas	0.8756389408	-0.8685547859	-0.1868883199	0.01710820657	0.4817094337	-0.3696323867	0.7043722162	0.08891864927	0.3436604649	-0.4730587263	-0.909753237	-0.6045727144	0.7287063599	0.6891459556	0.970386892	0.7985677009	0.6424018291	0.233537296	0.827535118
California	0.8382162728	-0.9125310436	-0.876278128	0.6856325054	-0.7787264985	-0.8426679186	0.8995544662	0.8380523437	0.9648986633	-0.9382598047	-0.4570706794	-0.7869300445	0.7548185725	0.9043947528	0.840430611	0.9241939584	0.9392663245	0.7931373075	0.790001196
Colorado	0.8571323813	-0.4389834157	-0.3782924851	0.6284647503	0.9668128469	0.315335629	0.8861601916	0.8561338715	0.9033457764	0.6780611475	0.6947684248	-0.9688847979	0.5365999297	0.7597076412	0.7409584261	0.9158488204	0.8861575839	0.9121296829	0.807764460
Connecticut	0.643106815	0.04310681523	-0.1267219582	-0.1124434044	-0.4799875479	-0.00758594161	-0.4149674832	-0.1665891514	0.6490890801	-0.053781718	-0.08615805148	-0.2861771363	-0.3904897806	0.2114739651	-0.0862822143	0.1010712788	0.2846979398	0.08579553637	-0.216412965
District of Colu	-0.6451302885	-0.8256934232	-0.6988192218	-0.1426114248	0.9126576748	0.3097032596	-0.6643196613	-0.7084910072	-0.5331539992	-0.4902526819	-0.4353270711	-0.3780663243	-0.692300875	-0.5859981205	-0.2263462645	-0.7291090981	-0.5557947585	0.3612624122	0.135134145
Florida	0.946738212	0.9443494684	0.753788241	0.8614218165	0.5208085601	-0.5382634582	0.9551830717	0.9361347599	0.9166175246	-0.3935859532	-0.3655411564	0.2462500535	0.9218842377	0.9514092579	0.9262581116	0.9395477453	0.9119536062	0.8029722454	0.926582868
Georgia	0.9198118457	-0.8799683899	-0.4348033827	0.7210510482	0.6623536339	0.5856867676	0.8823661663	0.7831747411	0.6635118316	-0.7950329868	-0.3664803751	0.8134876658	0.9396087462	0.8715856862	0.9670164618	0.9070849941	0.8386480973	0.8064147126	0.903222216
Hawaii	0.5610584864	-0.330203048	0.6406601477	-0.245898127	-0.636712187	-0.8175703088	-0.09803545492	0.3166109737	0.8619074427	-0.7716984454	-0.4606690254	-0.8483877242	-0.410933114	0.5747057439	0.7769032545	0.8491199148	0.8281654779	0.1752610728	0.442020851
Idaho	0.3644596753	-0.8056177275	0.3178317117	0.4080322052	0.2127767909	0.529891159	0.1731963253	0.3501262538	0.2856771418	0.2713590604	-0.6239326221	-0.06812244572	0.1423971172	0.6131761891	0.4371484163	0.4632169954	0.4317974339	0.1849193466	0.095034749
Illinois	-0.8863053994	-0.883913562	-0.8677073018	-0.8640620306	-0.8437795611	-0.7078847558	-0.4377750413	-0.6046085843	0.2453381595	-0.7731099998	-0.8352484517	-0.8998613416	0.1851231765	0.8347424887	0.8502761638	0.8744262915	0.9092023074	0.5739519249	0.520912383
Indiana	0.7092872326	-0.4311351895	-0.6034433995	0.4230611097	0.1494761965	-0.5195200593	0.8665247694	0.01179967428	0.7565600033	-0.6396234489	-0.3522262797	-0.8656455296	0.1377228942	0.6414780484	0.5931363443	0.7715125114	0.8519216997	0.1584970269	0.156357481
Iowa	0.9901109249	-0.196757859	0.1585167202	0.6110878606	0.3113785499	0.4221092042	0.3264874292	0.4376961397	0.9050774565	-0.6982642517	-0.9355841586	-0.8500136429	0.8500039649	0.9421106504	0.9671273717	0.8831793621	0.7749698214	-0.4530630976	0.071033275
Kansas	0.9311184961	-0.7279974008	-0.3667805505	0.1582463804	-0.4770273333	0.5884016452	-0.3864016808	0.3442446999	0.807648716	0.7512023925	-0.883808576	-0.853029471	0.2389039558	0.9170064295	0.942348957	0.8465883978	0.7494141937	-0.6428738183	0.657416003
Kentucky	0.8937101157	-0.6497308586	-0.2170445265	-0.4205383163	0.05997581358	-0.01688164997	0.5935403799	-0.6806799352	0.1292562958	-0.8077356299	-0.9318883798	-0.507607479	0.7008786932	0.8015417232	0.9331887134	0.739618556	0.6938290671	0.5272458403	0.725800540
Louisiana	0.8149651336	-0.5801321215	-0.6676713735	0.04021600553	-0.3347985591	-0.778818769	0.4033245343	0.4836264564	0.8564257507	-0.7673829821	-0.8310447161	-0.7999186425	0.26617839	0.8361586054	0.8607339368	0.8241283437	0.7748932667	0.7190114292	0.89039081
Maine	0.2676754653	-0.7121086346	0.03323703735	-0.6219713194	-0.4364099571	-0.410390266	0.4515225675	0.4159324704	-0.6216319414	-0.5031286975	-0.5940243178	-0.3049404415	0.7610949078	0.3286721453	0.5686544131	0.4320055075	0.3297603133	-0.2209711062	0.450816995
Maryland	-0.7969054225	0.272319276	0.01671704931	-0.350002232	0.8512814269	0.1875398698	-0.6046421335	-0.8142720543	-0.4472725435	0.6596383913	0.7858447774	0.2520985308	-0.6874738587	-0.7427247996	-0.7779568206	-0.7123443719	-0.5768768775	-0.4915970365	-0.895952014
Massachusetts	0.6677037496	-0.5573522869	-0.1421378527	-0.8197240398	-0.4362038986	0.2966426037	0.6045286916	0.7122700805	0.9165034845	-0.6328183093	-0.7198613922	-0.8452399868	0.3284129367	0.8041501053	0.6159365094	0.7380222861	0.7890916739	-0.377768633	0.281361672
Michigan	0.5128319998	0.2288810008	-0.3422560454	-0.3069028078	-0.2293101392	-0.7317698018	0.584929208	0.3252201186	0.7697057497	0.5334858089	-0.3115184687	-0.5102062783	-0.3575934559	0.3541608156	0.4161637207	0.4583161665	0.5527367513	-0.189502793	-0.163868530
Minnesota	0.7172022453	0.5687513853	-0.1195670911	0.7226587878	0.1331024548	-0.4129957493	0.7699632096	0.3050939153	0.8757696243	-0.4472338629	-0.5318446519	-0.8919223193	0.4376435757	0.6485607706	0.7276615993	0.7402875916	0.7957337437	0.5391887343	0.307131066
Mississippi	0.6645342868	-0.8744694005	-0.4860957982	-0.1651393375	-0.4366142655	-0.4113526618	0.451313777	-0.4584822056	0.4564122473	-0.559025905	-0.9675057535	-0.6687700806	0.6168134845	0.6828972373	0.8477694148	0.784686324	0.6939831802	0.02148308221	0.572592895
Missouri	0.8804520128	-0.4407510918	-0.6613105973	0.003935069656	-0.3648008198	-0.6872393017	0.7837063368	0.3747196006	0.9332419323	-0.873493834	-0.7239375031	-0.8449684509	0.6792261392	0.8207105695	0.8487129607	0.8340174919	0.776727763	0.4452231186	0.807649478
Montana	0.9788922706	-0.1071466599	0.08641873356	0.8437777599	0.1444057647	0.009065567727	0.6859599572	0.8035230627	0.9642581822	0.4801203409	-0.7692592124	-0.9608845918	-0.7759953637	0.9680714758	0.967140841	0.9664787431	0.9154957212	0.1996796614	0.390587124
Nebraska	0.7976380854	-0.06695985434	0.08682230279	0.2678845387	0.6354776912	-0.07890319708	0.9127991991	0.7220504622	-0.4756422697	-0.8874585709	-0.5653017704	0.795822863	0.7188033743	0.8196721419	0.5910353195	0.4166540929	-0.235518587	0.575419760
Nevada	0.5172592364	0.6120756979	0.01602771541	0.4279399366	0.6369068002	-0.6006316852	0.5245311803	0.5323468124	0.6948445572	-0.5008236952	0.5702752582	0.216940729	0.4110819266	0.5723083733	0.4038349149	0.4910650973	0.546026506	0.289273468	0.525162983
New Hampshir	-0.6574844963	0.7714226116	0.5124974506	0.6554418697	0.5768652823	-0.3232729985	-0.744170712	-0.6732606302	0.2519819425	0.736005407	0.7972178944	0.6361183706	-0.7066610293	-0.780601104	-0.7235277825	-0.7645594935	-0.5506677408	-0.5024692783	-0.71894631
New Jersey	-0.6205188195	0.3057838596	0.2279326027	0.5484749756	0.5808538071	-0.4533818059	-0.7312138422	-0.6157471815	0.2638288346	0.4428888319	0.5847496858	0.1254948514	-0.6763476215	-0.5094495704	-0.6452823524	-0.5388624544	-0.1431160044	0.2749017543	-0.87585544
New Mexico	0.6394999889	-0.9131822938	-0.756741486	0.05671325339	-0.7203873576	-0.5875024198	0.2644650802	0.5342706169	0.7344074153	-0.6949064028	-0.8277656964	-0.8699997293	-0.1527121112	0.8865462583	0.9341260273	0.8743535787	0.8998581388	0.679574356	0.899991970
New York	0.2201819868	-0.2791400785	-0.428307122	-0.8063598926	-0.9818235523	-0.8482195522	0.7142073379	0.8966263775	0.6152306191	-0.9310092308	-0.9785931303	-0.8249952933	0.6749031006	0.9494990549	0.9239799338	0.9573281634	0.904545979	0.9263247939	0.781361342
North Carolina	0.1253152657	0.1131917841	-0.289152167	0.04242217409	0.4371356738	0.6284091077	0.2543788646	-0.0111625094	0.7148455908	-0.6458769631	0.6181075855	-0.2317754731	-0.0536492384	0.1917396023	0.110472724	0.1419718042	0.1233908962	0.1501141545	-0.005558460
North Dakota	-0.002573397	0.1251150913	0.1337546483	-0.01131133534	-0.4763321847	-0.7635443472	0.2348060184	-0.09743080524	0.1854192425	0.2417001227	0.1450924055	-0.3978335074	-0.4975192468	0.1419553618	0.2251569034	0.2369963789	0.02364049744	0.01733621702	0.238324369
Ohio	0.5449760271	0.10026481	-0.5929642705	0.08905638437	-0.09209685967	-0.8648994466	0.4495244177	0.6052664261	0.5749409292	-0.3501050031	-0.1833091651	-0.5662205656	-0.7306057173	0.5062623318	0.2668408443	0.6166157638	0.6748840538	0.6520566476	-0.363817763
Oklahoma	0.984108822	-0.513747449	0.06822693108	0.8432635743	0.7650824737	0.06065875229	0.6963117445	0.8846628352	0.679773741	0.04742320639	-0.8354665976	-0.8030915224	0.8739679635	0.9134513574	0.9768726303	0.854209816	0.8738216695	0.503346829	0.840750201
Oregon	0.9711389145	-0.4430807319	-0.02291549077	0.6336720077	0.5686596811	0.4480112759	0.9674269365	0.9462417048	0.9503733091	0.2751489862	0.5999684242	-0.9591958	-0.8385939084	0.787290603	0.9323840445	0.9092024338	0.9599339534	0.4769821475	0.543995552
Pennsylvania	0.7642386326	-0.5936667408	-0.1614852723	-0.6368188249	-0.8069858918	-0.8430353963	0.905453645	0.792809152	0.5260548751	-0.9242272979	-0.8290288571	-0.787271519	0.3180635149	0.8604564646	0.8947758491	0.7803731348	0.6227564837	-0.8629103975	0.506601432
Rhode Island	0.8141431299	-0.8000984799	-0.1274301465	-0.4450965538	-0.6038941393	0.5691866796	0.8770583037	0.7585630567	0.3234229031	-0.7920054074	-0.7396655865	-0.6235621836	0.7481924011	0.5512074966	0.8384289252	0.6803297059	0.1321349788	-0.2622835876	-0.325864721
South Carolina	0.9875790106	-0.7373988067	0.3322061508	0.8094302336	0.7089969275	-0.4992022837	0.9491725251	0.9361901051	0.7682695714	-0.3879636906	-0.6898429039	-0.1800336818	0.9668649045	0.9536892348	0.9594714875	0.9583587285	0.9401852915	0.9492288677	0.874630427
South Dakota	0.6969475556	0.3816249953	0.2250720945	0.7292344629	-0.08600007918	-0.3572471189	0.774734845	0.3407576261	0.9016158078	-0.4987838991	-0.4389035251	-0.8475968234	0.5198262454	0.621088842	0.731823828	0.7700782748	0.7435239606	-0.330763694	-0.026481815
Tennessee	-0.5789737267	0.220762238	-0.561327824	0.09755801668	0.0914966476	-0.5192281357	-0.5060968979	-0.5186131986	-0.05825041353	0.4433505119	0.9345507876	0.009532102198	-0.8283624453	-0.4164332637	-0.818140645	-0.4962776315	-0.4073609565	-0.5979863051	-0.310680190
Texas	0.9626079375	0.7469020988	0.1527583939	0.9691703255	0.9641820596	0.7069015333	0.9681421633	0.9443204876	0.9659181672	0.8926080663	0.7713112921	0.00398434391	0.8761215659	0.9650456372	0.9404679667	0.9801193427	0.986028535	0.9772097121	0.94797432
Utah	0.9851457187	-0.7181430015	0.183748249	0.8980553691	0.9868767754	0.9387346445	0.7509161179	-0.4256126893	0.9180615446	0.9536628369	0.9118102506	-0.7233192167	0.7264517089	0.9590100614	0.9618222462	0.9805636812	0.9337804416	0.8737350875	0.801632619
Vermont	-0.5065890148	-0.8111864348	-0.2954672138	-0.6358365343	-0.7958090403	-0.1953997567	0.7629205577	0.4631132776	0.7002761135	-0.8290933544	-0.8514769847	-0.9031611995	-0.7889651267	0.8119216418	0.8516171148	0.8927970553	0.8882509206	-0.03355518903	0.183093777
Virginia	0.7751820963	-0.5932318019	0.0161827183	0.5460895974	0.1051014731	-0.1095750007	0.43887862	0.548456086	0.7775461643	-0.796691853	-0.7113478318	-0.6403204337	0.7376652083	0.866678256	0.7909491101	0.7316732111	0.8523976979	0.7674024194	0.775604323
Washington	0.9701376248	0.9351688251	0.708267451	0.8659087225	0.4170744024	-0.4882754671	0.9771418638	0.9552902314	0.9799830845	0.2567237999	0.1785849059	-0.9683044823	0.6371631946	0.9315140936	0.8645011229	0.9665262749	0.9937477317	0.8485539048	0.714504568
West Virginia	-0.6298277541	-0.6110102008	-0.1616913995	-0.5461607633	-0.5920739713	-0.5904839888	0.5770256137	-0.7073899653	-0.556834148	-0.7157496243	-0.9308062186	-0.8375012756	-0.5867577337	0.2924483692	0.9208719515	0.7257341538	0.7249713795	-0.407539992	0.799066425
Wisconsin	0.5153850004	-0.5426935375	-0.4535542389	-0.3803691537	-0.3572702192	0.48272381	-0.1663714792	-0.1982546572	0.6727503519	-0.6038490838	-0.49610699	-0.5511163209	0.7213982033	0.4107093654	0.6259219044	0.5055448759	0.548830537	-0.341449757	0.538085795
Wyoming	0.2594855679	0.8460226287	0.0934653234	0.4336651688	0.4602354719	-0.7688348364	0.7098194182	-0.1489186386	0.6826465541	0.0190377484	0.5929994778	-0.9263723686	0.6440340666	0.6796773316	0.90679668	0.9186747643	0.9246362687	0.4864756929	0.286064311

Population Growth and Flight Growth

- Positive correlation between flights and:
  - Total population
  - Population of people ages 25 to 40
  - Population of people 60 and older
- Few outlier states
- While there is a correlation, population has a very small impact on the flights
  - Interesting that it has an impact but most likely cannot be used to predict a change in flights

HOYALYTICS

Findings

Plans for Expansion

- Growth in Raleigh, Miami, Charlotte, and Austin
- Number of flights may not return to pre-pandemic levels because Delta is using larger planes

Cyclical

- Flight routes are seasonal with a peak over vacation seasons
- Some flight routes repeat daily

Large-Scale Events, Pop., and State GDP

- No correlation with state GDP, population, or large-scale events
- Possibly because Airports have local influence and schedules are pre-planned

City GDP

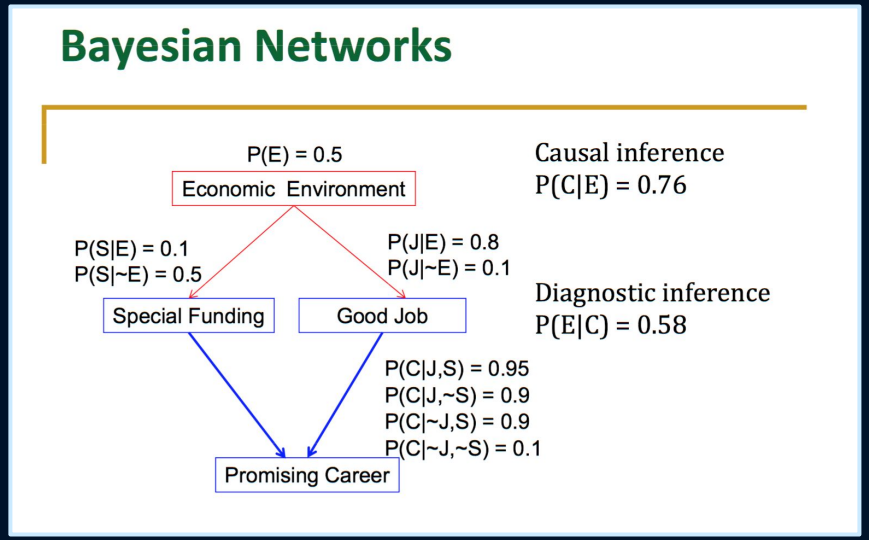
- Correlation between city-level GDP and flights
- Can use future predictions of city GDP and populations to estimate future flight changes

Predictive Model

- Bayesian Model
- Neural Network Approach
- SARIMA Model

Bayesian Networks

- Bayesian networks represent probabilistic relationships in a system
- We wanted to see how changes in factors such as population and GDP growth, special events, and Delta airline planning may affect the network
- Bayesian networks are not the most natural method for time series analysis however



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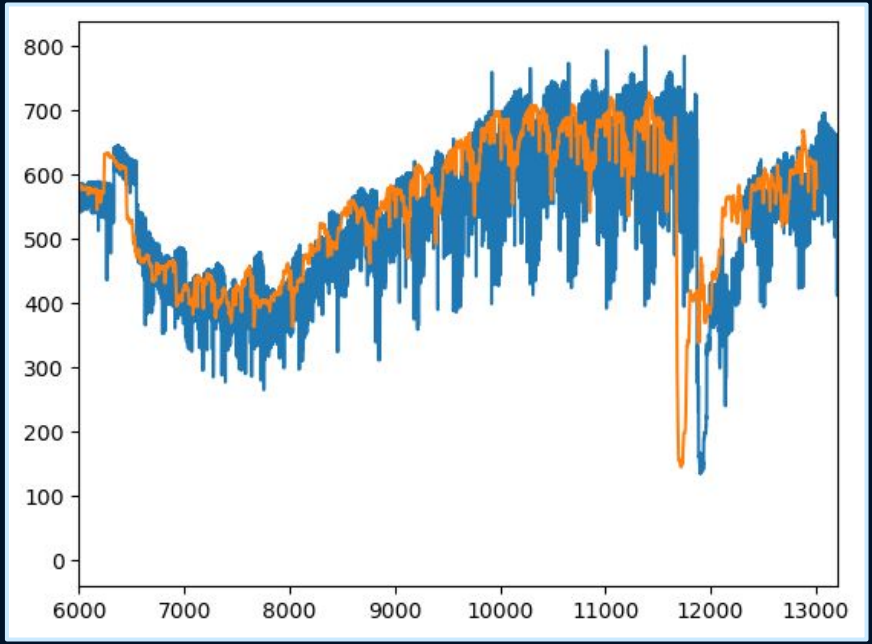
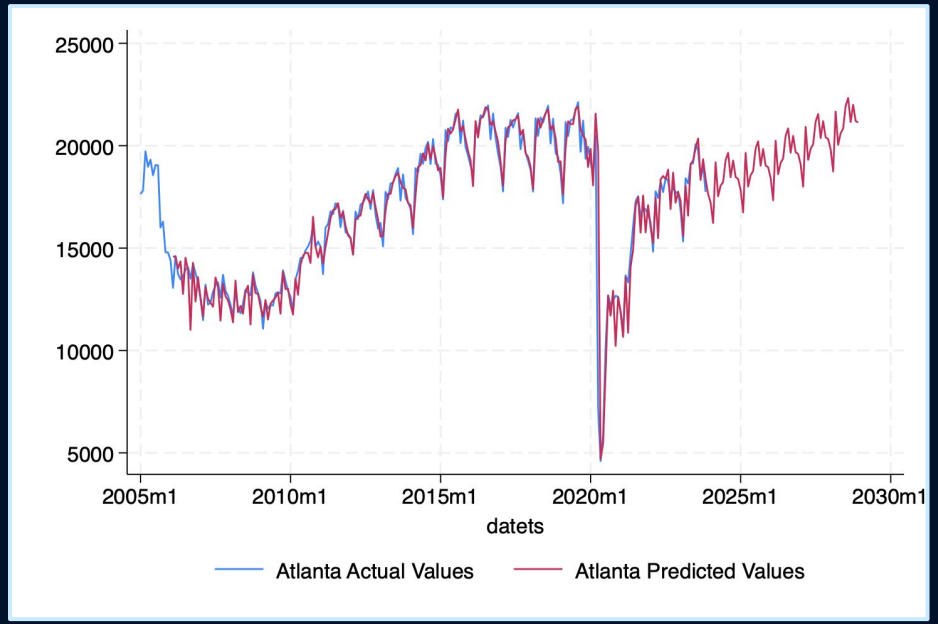
Neural Network Model

- Neural Networks are very kind towards time series data
- LSTM architectures are meant to capture long term dependencies needed for long term time series analysis
- Flight data is extremely seasonal however and other models may prove more strongly correlated



SARIMA Model

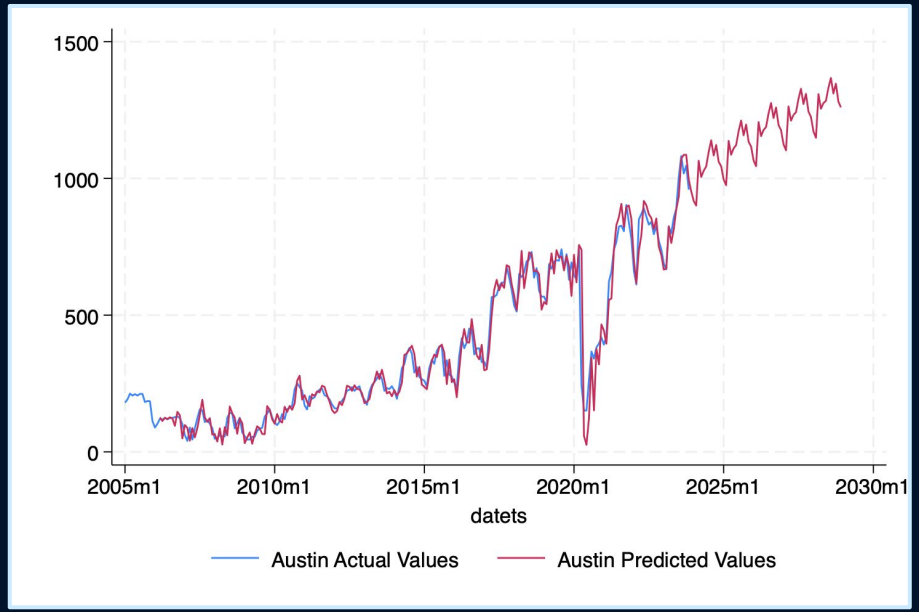
- Model predicting next five years of airline growth
- Utilizing data since 2005
- Currently assuming no other exogenous variables
- Can be modified to include predictions such as GDP growth, population growth, etc



HOYALYTICS

SARIMA Model

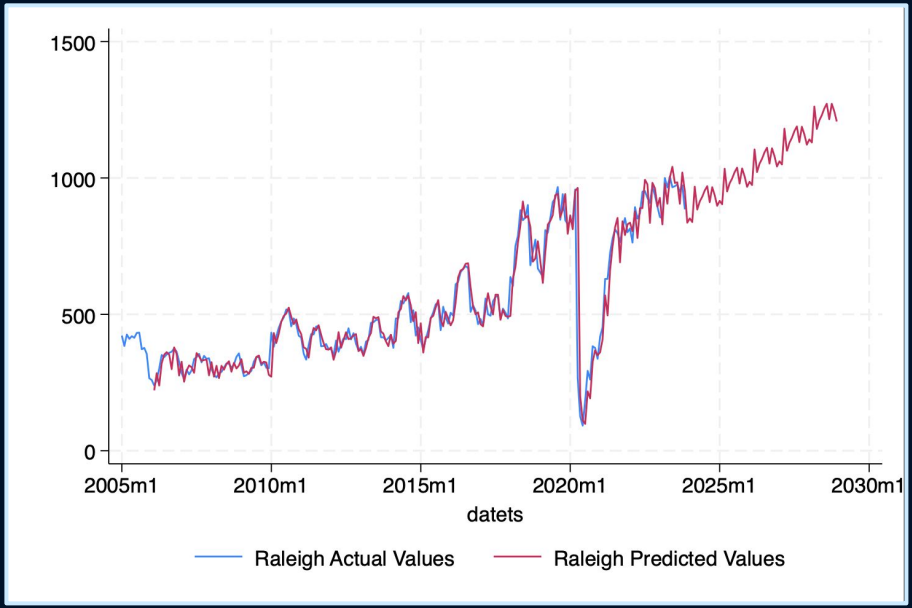
- A basic ARIMA model assumes that one of the best predictors of a future value is a weighted average of it's past values.
- A SARIMA model is the same, but accounts for seasonality by only utilizing past values from the same month
- Does a very good job of predicting the next two to three years
- After that, accuracy begins to fall off sharply



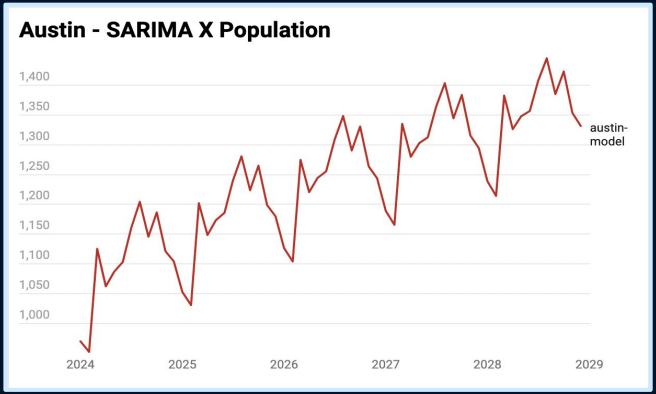
HOYALYTICS

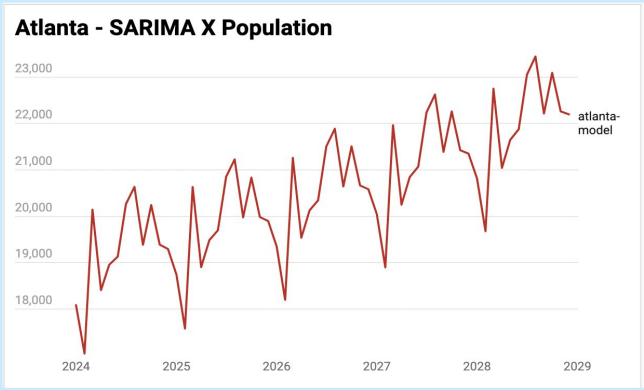
SARIMA Model Limitations

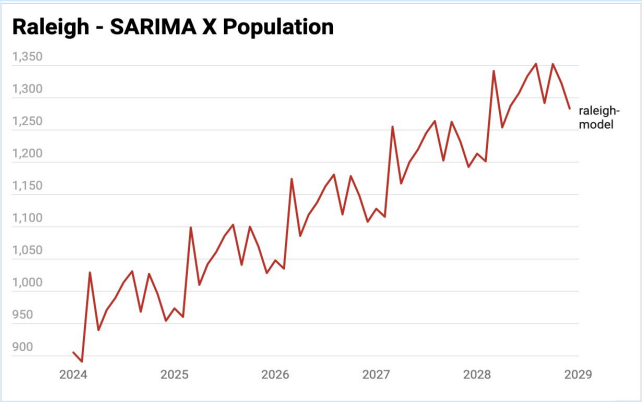
- It is very hard to mass-fit the model to every airport.
- The model has drastically increased error around large shocks, in this case the pandemic
- Would not work on smaller data samples
- Very easy to accidentally overfit the model



Population Multiplier

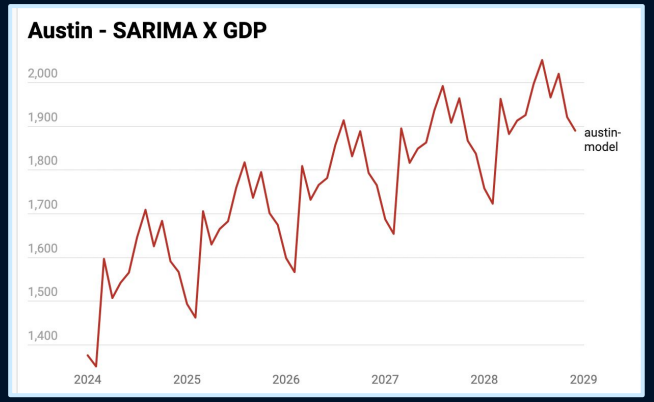


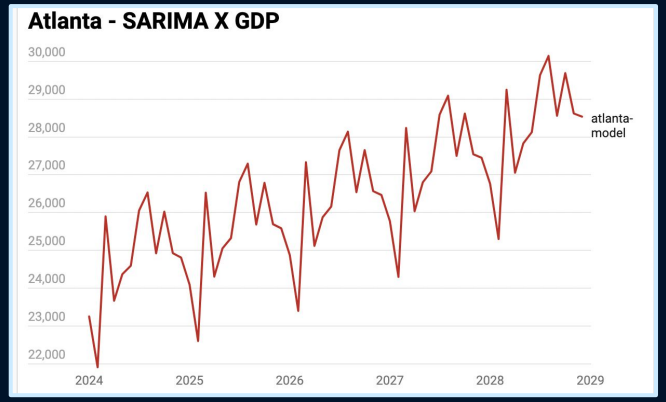


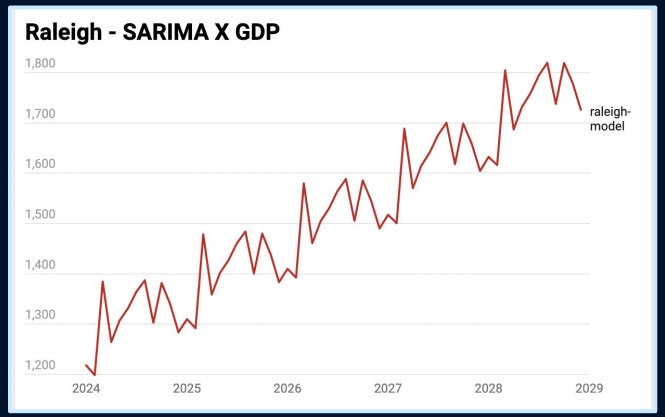


HOYALYTICS

GDP Multiplier

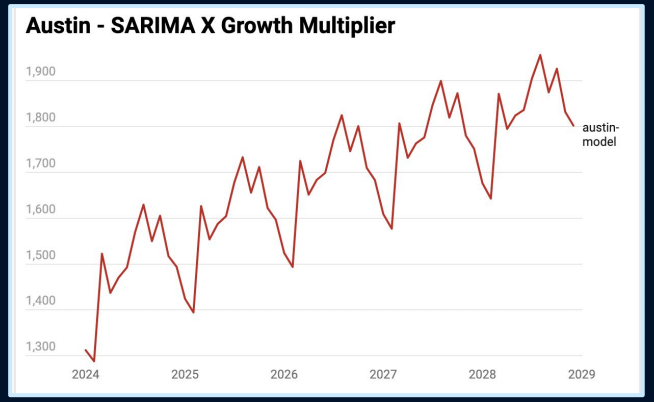


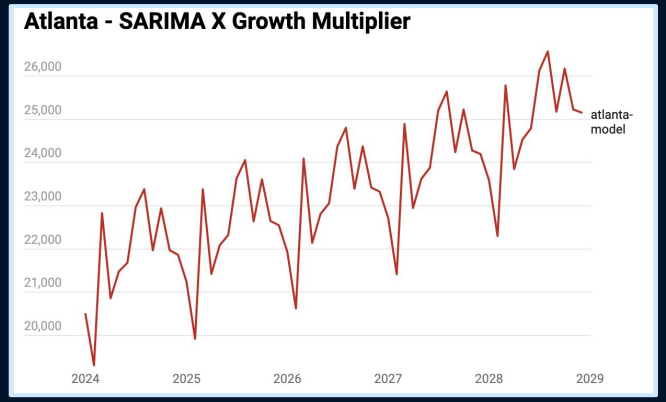


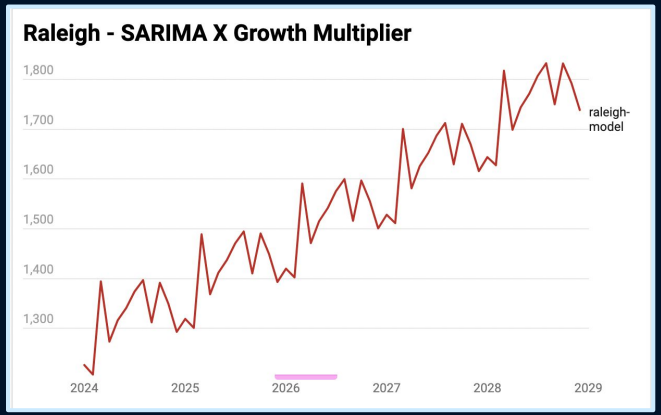


HOYALYTICS

Combined Growth Multiplier



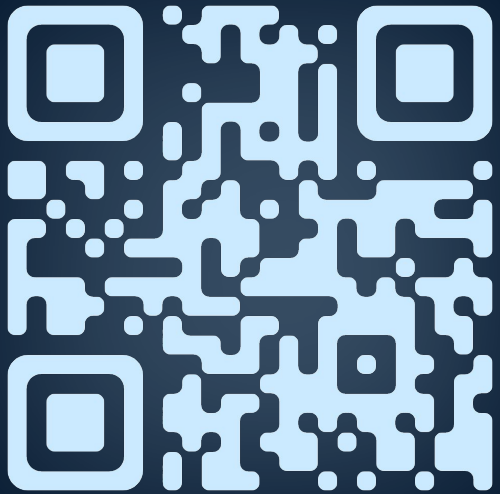




HOYALYTICS

Dynamic Map

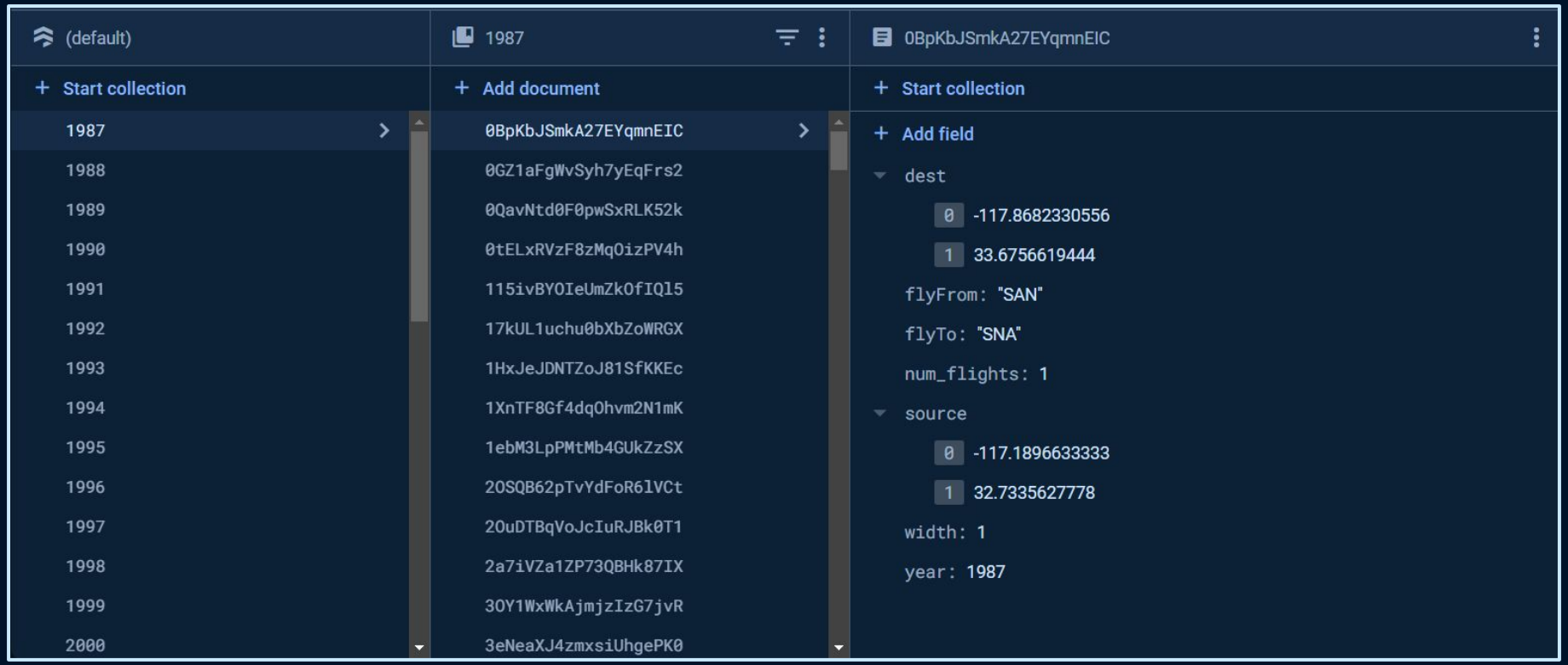
- Data Processing
- Interactive Map
- Airport Focus
- Integration with SARIMA Models



team-planes.vercel.app

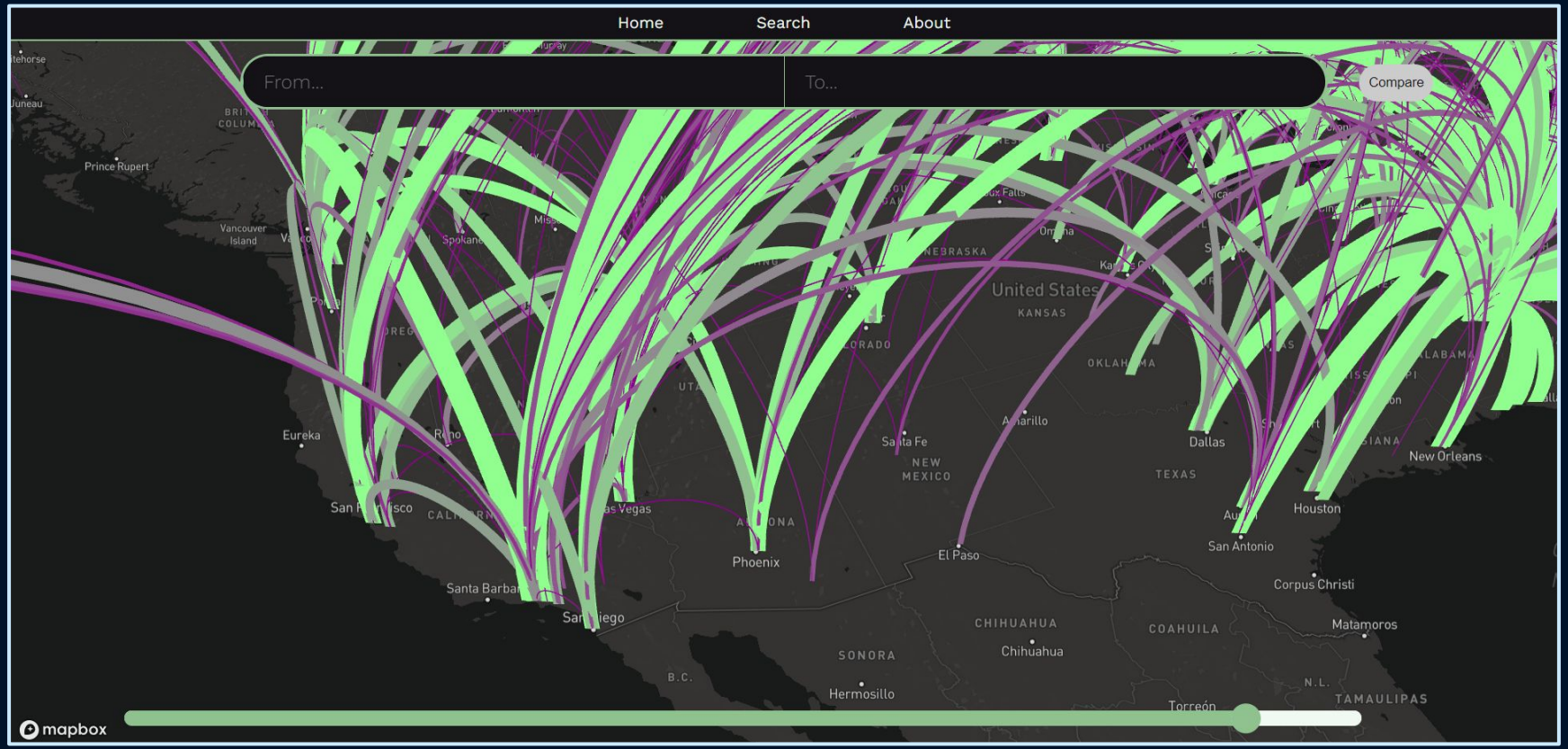
Data Processing

Data was converted to JSON format and loaded into Firestore for access.



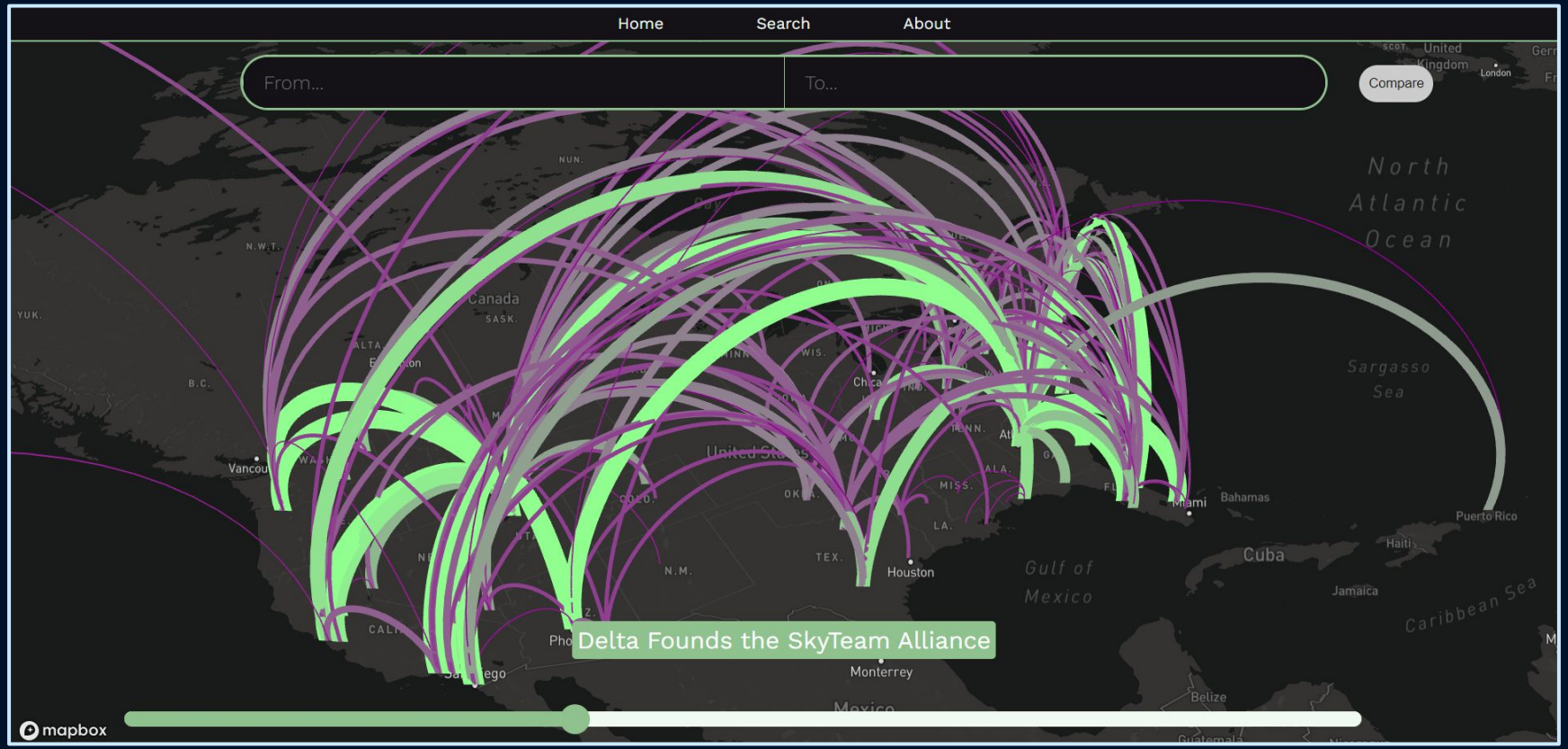
Interactive Map

The interactive map allows users to compare years and visualize geographic concentration



Relevant Events

The map displays relevant events to provide context for changes in route popularity



Comparison View

This view visualizes the percent change across a given time span, with drastic differences having wider lines

Airport Focus

Allows users to see an airport by airport breakdown and integrate our predictions

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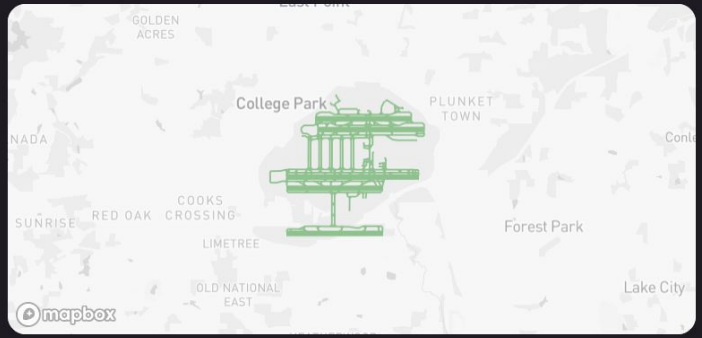
Hartsfield - Jackson Atlanta International Airport #1

Yearly Flights: 364088

Destinations: 127



Salt Lake City International Airport #2

Yearly Flights: 96503

Destinations: 56