Predict 452- Section 55: Nature & Environment Team – Final Report

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Problem Statement

The growth of the electric vehicle (EV) market, has been fueled by the economic feasibility of Lithium-ion battery production and technology improvements, as well as customer demand for affordable, high-performance vehicles with lower greenhouse gas emissions (Becker et al, 2009; Zhang et al, 2017). Chevrolet, producer of the EV Bolt has concerns about US sales to date. While not selling as well as expected in 2017, sales seem to be rebounding in early 2018. Management wants to track changes in consumer perception, search strategies, and market strength, relative to several competitors (*Nissan Leaf, Tesla Model S*). This will allow Chevrolet to engage in more targeted consumer marketing strategies, and better position the brand for continued sales growth.

Introduction

Since 2001, CarMax has sold close to 100,000 used hybrids and electric cars across the country (Carmax, 2017). The Chevy Bolt was selected as one of the top five hybrids/EVs in their 2017 survey, along with the Nissan Leaf and Tesla Model S. Review of historical new car sales data for Nissan Leaf, Chevy Bolt and Tesla Model 3 are shown in Appendix 1 and reveal that sales of Nissan Leaf started late 2010, peaked in 2014 and are now at an all-time low. In contrast, Chevy Bolt new car sales have been increasing since late 2016, outstripping the Leaf and are on par now with those of the Tesla Model 3, released in July 2017. Currently, in this three-way comparison, the Tesla Model 3 appears to be the major competitor to the Bolt, using cost and performance specification metrics shown in Appendix 2.

Data Gathering Methods

Historical EV Car Sales: The historical US new car sales for the three EV models (*e.g.* Bolt, Leaf, Model 3) were obtained by scraping HTML tables containing new car sales data from carsalesbase.com using the Python script, `HTMLTablescraper.py` (see Appendix 1 for tabulated and plotted results). Data for fuel economy, energy & environment, and vehicle specification for these models were obtained in a similar way from the

Department of Energy and the EPA (see Appendix 2).

Website Structure & Content: Using a web crawler and scraper, we created a text file with keywords for Chevy Bolt, Nissan Leaf and BMW i3 (since Tesla Model 3 website didn't support scraping) that was post-processed to remove stopwords from the python nltk.corpus library. We also identified a classification of "energy" words, that includes: energy, charging, battery, electric and Plug. In addition, an analysis of the sitemaps of the Chevy Bolt *versus* its competitors was performed. This involved utilizing an XML-version of the sitemap from each of the landing pages for the Bolt and its competitors, followed by: parsing the URLs from the XML sitemap file (using `XMLfileReader.py`); categorizing the URLs by apply an automated algorithm to peel back our sites layers and find the general structure (to a depth of 3 layers). The `categorize_urls.py` Python script allows us to understand the site layout and page distribution at a glance. The categorized sitemap can be visualized using the Graphviz package, using the Python script `visualize_urls.py`. This displays the URLs in each layer as a node, and edges defining relationship of the nodes in one layer to the previous layer or subsequent layers. The depth of URLs in the website structure that this algorithm explores is to three layers of connections, to limit complexity in order to display the results more coherently.

Search Rankings & Site Search Analysis: Using Google Trends search interest data over time, we have compared the search query for the main brand terms for each in the competitor set on exact match: *Chevy Bolt*, *Nissan Leaf*, *Tesla Model 3*, & *Electric Car* as a comparison point. This was limited to just the US for the scope of analysis. Although these are not actual numbers of impression share, this gives some great insight into the amount of traffic in relation to this set. Using the same search queries, we will be using scraping and robotic process automation to analyze the Search Engine Result Page. We will be conducting further analysis into specific landing pages, as well as the top organic results.

Social Media: Using the Twitter API a sentiment analysis is being performed to evaluate relative consumer sentiment between the Chevy Bolt and its competitor brands.

Results

Website Structure & Content: Chevy Bolt has the most text/language on their site, with 14k words! BMW has 6.5k words and leaf has 3.4k words. Looking at the top 20 most common words used, all competitors use their product name the most (Bold, Leaf and BMW). Looking at some of the common words on Chevy Bolt's website, EV, energy, charging, tax, battery and available are commonly used. The energy words is 3.3% of their overall content. Nissan Leaf uses fewer energy words (only electric) and the rest of they key words are related to features of the car, price and power. However, because there are also much fewer words on their site (3.4k), proportionally that one word is 10% of their overall content. BMW i3 uses 3 electric words (electric, hybrid and plug) that is also 3.6% of their overall content.

The results from analyzing the sitemaps as a proxy to investigate web structure of the Chevy Bolt *versus* the Nissan Leaf and Tesla Model 3 are shown in Appendix 4 and reveal the following: first, the Tesla Model 3 website shows the most detailed, complex and nuanced structure with 529 URL links indexed, followed by the Nissan Leaf (55 links) followed by the Chevy Bolt (7 links). Second, at the time the sitemap from the Chevy Bolt website was created (March 5, 2018), there were no links within 2018 Bolt model website and only 7 links indexed for the 2017 model. The rudimentary website structure may have been a likely consequence of the reorganization of the Chevy Bolt website. Either way there appeared to be little complexity in the 2017 Chevy Bolt site is observed, in contrast to those seen for the Nissan Leaf and Tesla Model 3 (see Appendix 4). The Model 3 displays the most voluminous (*i.e.* in the number of links) and informative site, since pure-play EVs are the primary business for Tesla, whereas Nissan and Chevy make numerous gasoline and hybrid vehicles. In addition, the Model 3 site displays links to international regional and language-specific sites for their models (*e.g.* N. and S. America, Europe, Far East), but also much more detailed information about vehicle specifications and locations of supercharging stations. Although some of this information is present in customer Q&A pages for the Nissan Leaf, they are entirely absent from the Chevy site.

Search Rankings & Site Search Analysis: After some large spikes before 2009, the search interest for electric cars had remained fairly constant over the years. As new makes and models enter the market, new trends in search

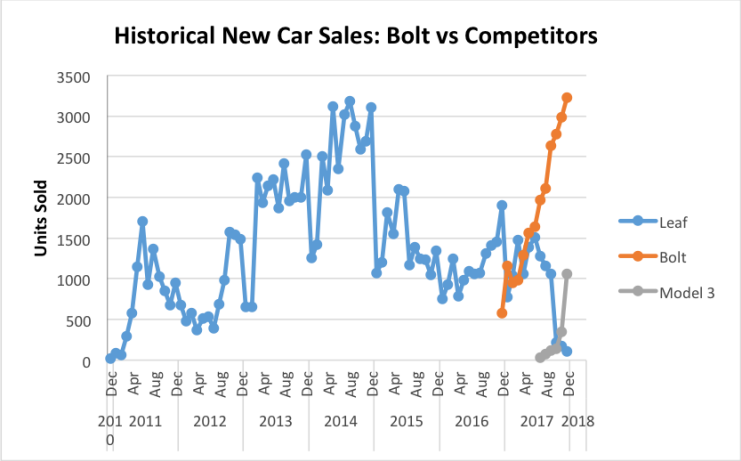
volume start to appear. Nissan Leaf had a lot of interest when it first entered the market in 2010, but has since seen a steady decline. Tesla Model 3 had very significant interest in 2016 when it was announced, and another large spike in 2017, and seeing some steady growth. Chevy Bolt has had some steady growth in interest over time, but not to the level of Tesla and is reaching volumes comparable to Nissan Leaf. Nissan Leaf is also, the only competitor in this set that has its own Paid Search presence, excluding location-based dealership ads.

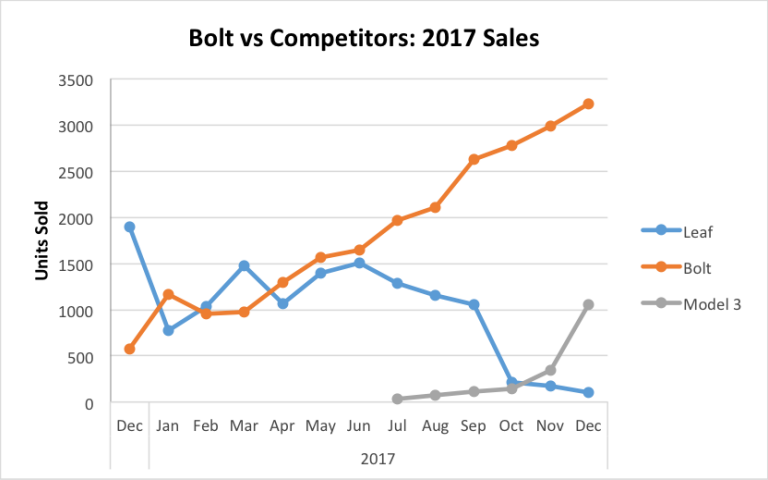
Conclusions

From the results from the website content, we would recommend including more details about the driving experience and aesthetics of the car, discussing more it's appeal and new trending technological features. In addition, the website structure needs to be developed further to add more nuance, and utilities to prospective EV buyers in different geographical regions, such as providing details of locations of charging stations and model specifications. In terms of site search, there might be some advantages to using paid search on more non-brand terms as there is not a lot of competition, but a steady amount of traffic.

Appendices (Supplementary tables and graphs)

Appendix 1: Historical New Car Sales





Chevy Bolt vs Competitors: New Car Sales Dec 2016 to Dec 2017

Model	2016	2017											
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	1899	772	1,037	1,478	1,063	1,392	1,506	1,283	1,154	1,055	213	175	102
Bolt	579	1,162	952	978	1,292	1,566	1,642	1,971	2,107	2,632	2,781	2,987	3,227
Model 3								30	75	115	145	345	1,060

Historical Nissan Leaf Sales: Dec 2010 to Dec 2017

Model	2010	2011											
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	19	87	67	298	573	1142	1708	931	1362	1031	849	672	954

Model	2012											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	676	478	579	370	510	535	395	685	984	1579	1539	1489

Model	2013											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	650	653	2236	1937	2138	2225	1864	2420	1953	2002	2003	2529

Model	2014											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	1252	1425	2507	2088	3117	2347	3019	3186	2881	2589	2687	3102

Model	2015											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	1070	1198	1817	1553	2104	2074	1174	1393	1247	1238	1054	1347

Model	2016											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	755	930	1246	787	979	1096	1063	1066	1316	1412	1457	1899

Model	2017

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf	772	1,037	1,478	1,063	1,392	1,506	1,283	1,154	1,055	213	175	102

Appendix 2: Fuel Economy, Energy & Environment, and Vehicle Specification Data*

Model	MSRP ($)	Annual Fuel Cost ($)	Cost to Drive 25 miles ($)	Savings per 5 yrs ($)	Range (miles)	CO_2 emissions
Chevy Bolt	**37,495**	550	0.92	4,250	238	0
Nissan Leaf	**31,545**	600	0.98	4,000	151	0
Tesla M3	**35,000**	500	0.84	4,500	310	0

*US Departments of Energy and Environmental Protection Agency:
https://www.fueleconomy.gov/feg/Find.do?action=sbs&id=39836&id=39786&id=39860&id=39322&#tab2

Appendix 3. Text analysis of website content

	BOLT	LEAF	BMW i3
Total words	**14052**	**3412**	**6451**
Branding	**1.52%**	**2.08%**	**3.60%**
Energy words	**3.29%**	**9.94%**	**3.60%**
	EV(229)	**LEAF(80)**	**BMW(232)**
	Bolt(214)	**Nissan(71)**	**electric(120)**
	u00a0(188)	2018(48)	driving(78)
	vehicle(187)	u00ae(46)	u2019s(78)
	energy(153)	Starting(36)	**AVAILABLE(72)**
	u2019s(145)	**MSRP(36)**	**MSRP(72)**
	charging(122)	Horsepower(33)	IN(72)
	tax(116)	Doors(33)	title(68)
	battery(110)	Seats(33)	3(64)
	This(104)	**electric(30)**	handling(64)
	available(98)	Pedal(28)	**hybrid(56)**
	information(96)	e(28)	excludes(56)
	Chevrolet(92)	features(27)	**Plug(56)**
	based(91)	today(24)	variants(56)
	You(91)	u2122(23)	iconic(56)
	driving(90)	**available(21)**	license(56)
	The(89)	getting(21)	registration(56)
	may(87)	**acceleration(21)**	Turbo(56)
	get(82)		
	electric(77)])		

Energy words
energy
charging
battery
electric

Plug
hybrid

Appendix 4: Website Structure for Chevy Bolt, Nissan Leaf and Tesla Model3 using Sitemap XML files

Using xmlsitemaps.com an XML-formatted sitemaps for the three models were created, given the map landing pages for the three models. This generated 3 sets of XML sitemap files that were used for subsequent processing (that produced their respective .txt and .dat files):

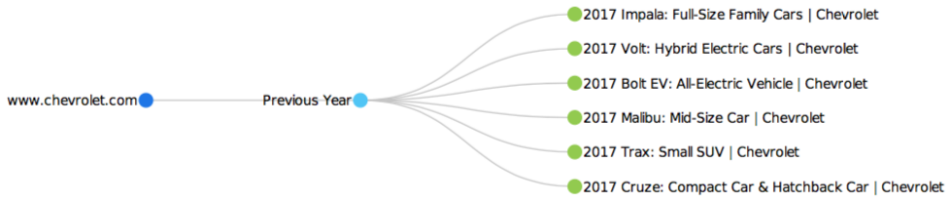
- 2017boltsitemap.xml output files: boltlinks.txt (boltlinks.dat input for categorize_urls.py)
- leafsitemap.xml output files: leaflinks.txt (leaflinks.dat input for categorize_urls.py)
- model3sitemap.xml output files: model3links.txt (model3links.dat input for categorize_urls.py)

The URLs from the XML files were extracted, categorized and visualized using Python scripts:

- XMLfileReader.py
- categorize_urls.py
- visualize_urls.py

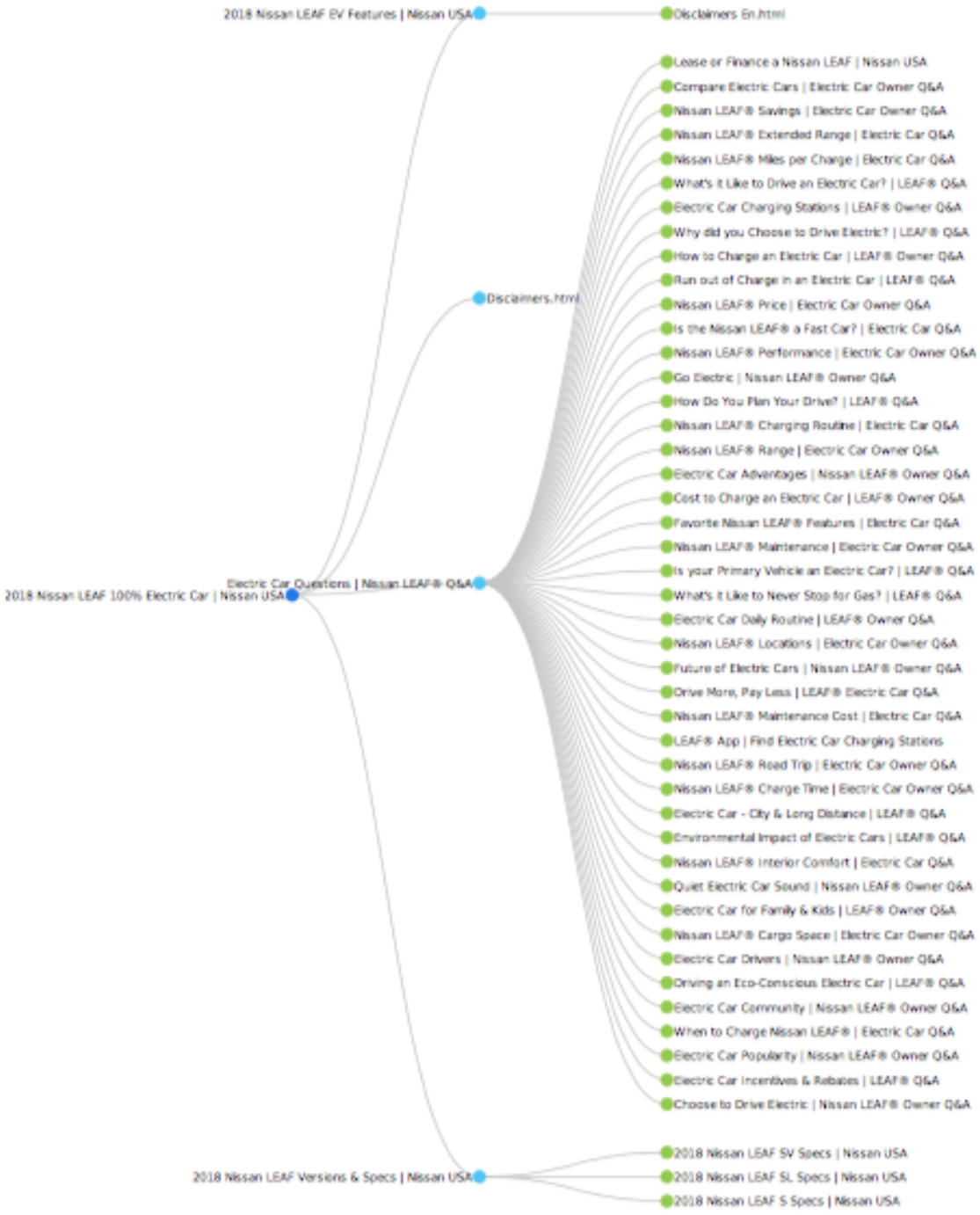
Three levels of URL categorization depth in connectivity are displayed for visualization simplicity, otherwise the graphs would become too complex and difficult to display. A similar but simpler and nicer looking output was obtained using a network drawing application called Dynomapper, as shown below.

Chevy Bolt Website Structure



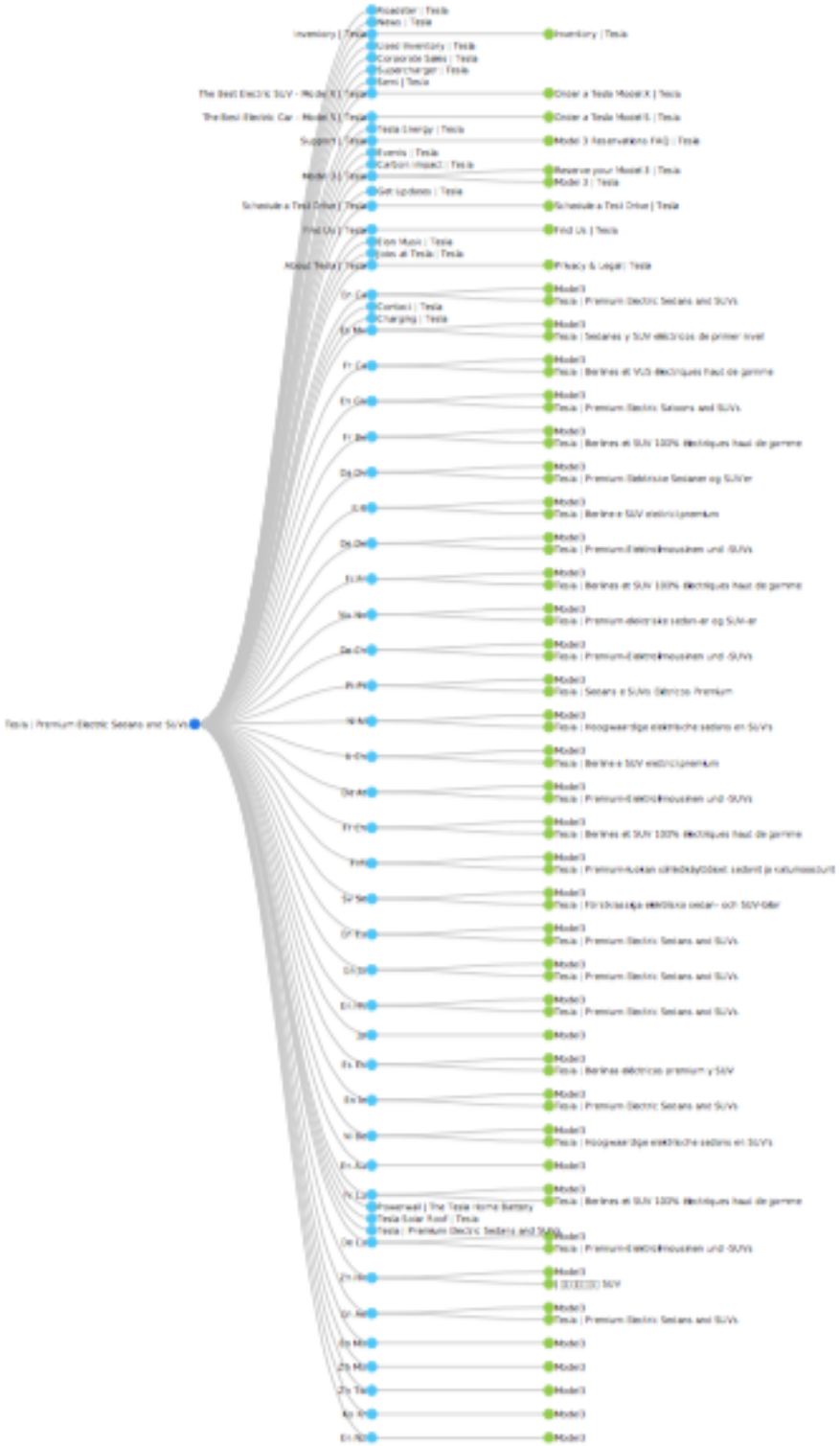
Summary: At the time the sitemap from the Chevy Bolt website was created (March 5, 2018), there were no links within 2018 Bolt model website and only 7 links indexed for the 2017 model. Consequently, the links indexed and represented in the rudimentary network diagram above, are likely a consequence of the reorganization of the Chevy Bolt website. Either way little complexity in the 2017 Chevy Bolt site is observed, in contrast to those seen for the Nissan Leaf and Tesla Model 3 (see below).

Nissan Leaf Website Structure



Summary: More links in the Nissan Leaf website (55 links indexed) compared to the Chevy Bolt. Most of the links (48) reside in customer Q&A related to the 2018 Leaf model, as well details regarding model specifications.

Tesla Model 3 Website Structure



Summary: Greater detail, complexity and nuance in the Tesla Model 3 website structure (569 links) *versus* Bolt and Leaf

sites.

Appendix 5. Search Interest Over Time