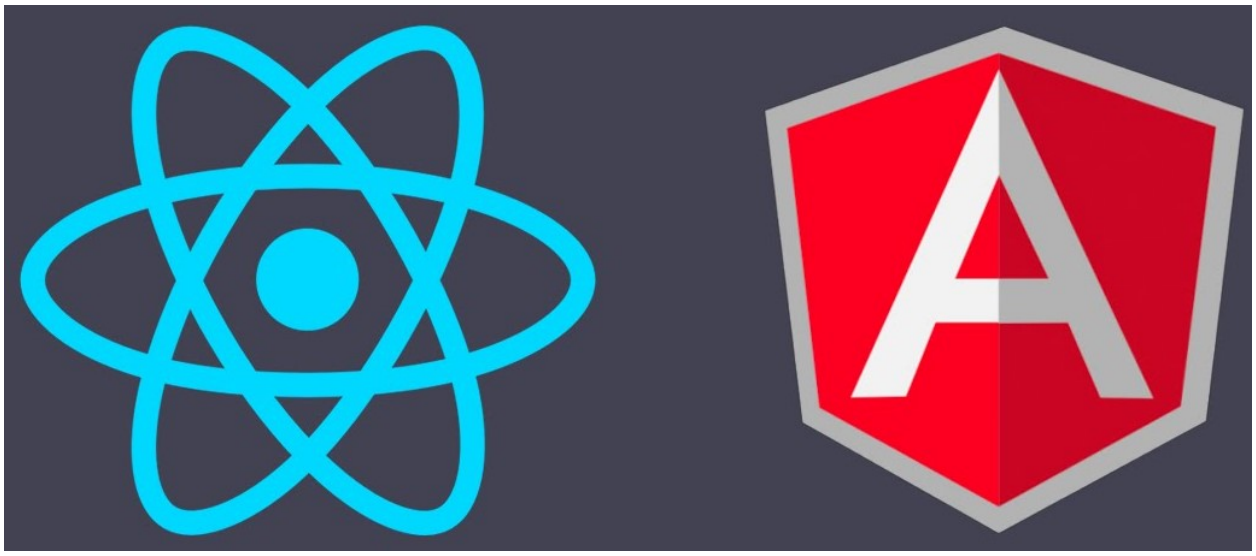

TERM PROJECT REPORT

TEAM 3, Fall 2016

REPORT ON

REACT vs. ANGULARJS

SSW - 533 Software Estimation and Measurement

TERM - FALL 2016

GUIDED BY

Prof. YE YANG

SUBMITTED BY

SONALI PATIL
EKKASIT PINYONUNTAPONG
YU ZHANG

Summary

In this project, we will provide comparison between two most popular JavaScript libraries, React and Angular. Both of them are very efficient and being used by many web developers, however it's hard for new web developers to make a choice between these two technologies. In our project , we use GQM analysis to define a set of metrics to help comparing the two libraries on different aspects. For the final conclusion, we will not only give a result of which library is better, but also provide a set of comparison results of the two libraries on different factors like license, performance, easy to use, etc. To help new developers to have a general understanding of the two libraries. Most of the comparisons available online have a give biased conclusions on one of them. Our result will give a fair and objective comparison for user's' reference. We will describe about the few limitations of this project and the areas where improvement can be done in future.

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1. Introduction

Web is the rapidly growing platform and we can find internet enabled devices everywhere. For connecting to the internet, web applications are required. Web application is basically a user friendly interface developed by web developers to interact with the web services stored on world wide web. Web developers use internet technologies like HTML, CSS, javascript, jQuery, XML etc. to create web pages.

JavaScript is an object-oriented computer programming language commonly used to create interactive effects within web browsers. It is used to make the web pages dynamic and more interactive. It is being used by multiple browsers like MS Internet Explorer, Google Chrome, Firefox etc. Almost 88% of all websites use javascript to design the web pages. Because of the large features set JavaScript has got huge popularity. There are multiple technologies and platforms coming up to help engineers to develop web applications.

React is the JavaScript library developed by facebook in 2013. Since then React has got many followers and people are getting shifted to react as their choice of development programming language. Angular is the well established javaScript framework used for single page web application development. Angular is developed by Google in 2010 and it is one of the most used JS technologies. There is a new version of angular, Angular 2.0 which was release in 2014. While searching about web services and web technologies we noticed that people are enthusiastic to know about the features and the differences of both of these technologies on the web. As both of them are equally popular many people face dilemma while choosing one of them for Single Page Application development.

To help people in solving this dilemma we have worked on this topic. In this report we are documenting our findings and observations. To start with the analysis we used GQM approach to reach to the conclusion. We defined few metrics based on the goal defined and established connection between the metrics and the datasets that we have documented.

Some people think that comparing React and angular is not illogical as Angular is a framework and React is a library. These both are different means to the same solutions. When it comes to work on the functionality which is supported by both of these technologies, people face confusions to chose one. Here we are presenting the factors using which people will be able to pick the most suitable approach according to their needs.

2. Proposed Metrics

To start with analysis we have used GQM, Goal-Questions-Metrics approach which a stepwise and efficient way of measurement. It involves 3 steps :

1. Define the Goals for measurement.
2. Define the Questions that will answer whether the goals are being satisfied.
3. Define and model the Metrics to answer the questions.

Below is the GQM model for this project:

Goal : Choose a Javascript framework that is best match for web application development
Questions :

1. Which is the most popular and multipurpose JavaScript framework?
   Metrics: number of people using respective technology
   Related Datasets: number of github repository, number of websites using them, tags on stackOverflow

2. Which one has better performance?
   Metrics: time required to develop the code and build the application, time to generate output
   Related Datasets: Nature and Structure, Performance, Flexibility

3. Which one is cost effective with respect to efforts required to use and implement ?
   Metrics: time required to learn and use
   Related Datasets: Easy to Use, Learning Curve, People Ask Question, Nature and Structure

Following section will describe the data points using which we have modeled the proposed metrics. At the end of the next section we will provide the same.

3. Results and Discussion

From each metrics, we did research and collect data from background information, expert opinion, and performance testing of both Angular and React. Also we collected data from number of people who access the website and number of developers that use each library. Then we rate each metrics based on the collected data statistics.

3.1. License

Both of them are open source but they are different license in term of use. **AngularJS** is under MIT license (https://en.wikipedia.org/wiki/MIT_License). Therefore, anyone can use with their own purpose, can modify code, or develop new code based on AngularJS . Moreover, they can use AngularJS for commercial in any business market. There is small difference from BSD license (https://en.wikipedia.org/wiki/BSD_licenses) which **ReactJS** use. Developers can also get access to all class in React, develop plugin or use with their own commercial software. But there is one rule that they can use this library as anything they want if it is not the competitive product of Facebook (the library's owner)

AngularJS : 5 **ReactJS : 4**

3.2. Nature and Structure

AngularJS represents itself as a framework for develop under Model-View-Controller (MVC) structure so developer has to develop need to follow strict rules. **ReactJS** is only library that developer can import as "new Class()" and use it anywhere. Moreover, AngularJS is developed as a whole bunch of code, all the class is developed by Google. On the other hand, ReactJS , Facebook developed the core structure and lets the community drives the third party library. In case of releasing the new version, AngularJS will update and test the whole framework but React, third party libraries have to be update their libraries to support new version of ReactJS core library.

In this data points AngularJS is more developed structure and compatible API.

AngularJS : 5 **ReactJS : 3**

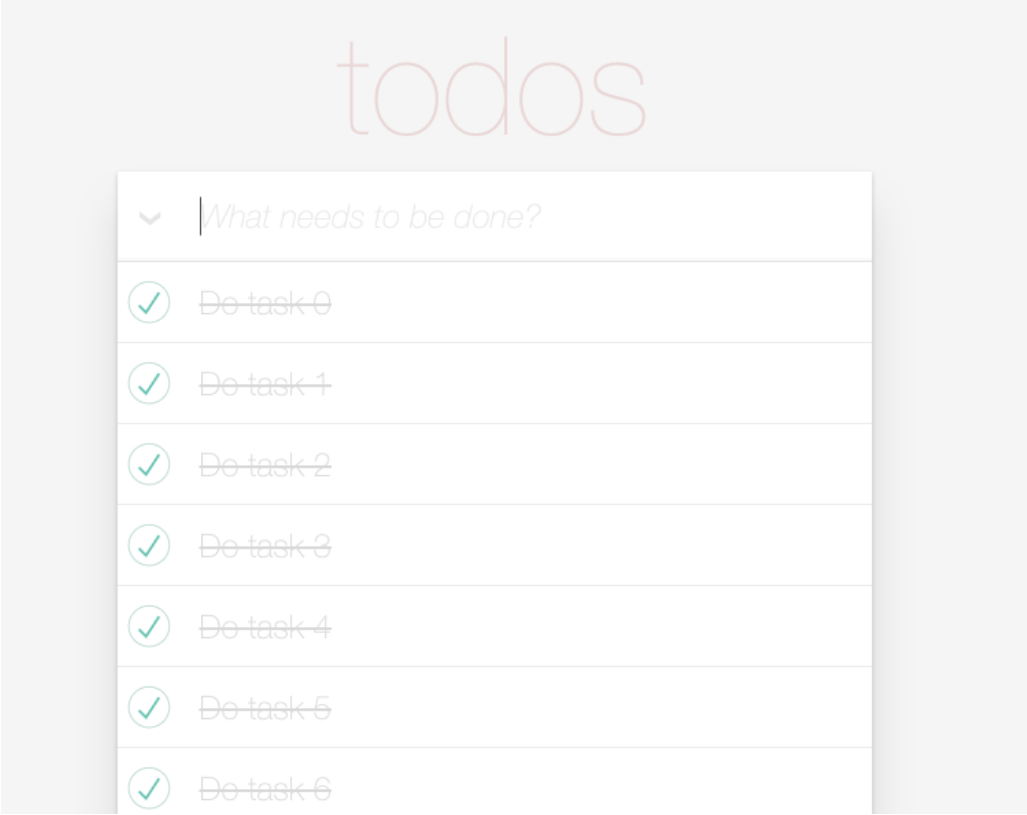
3.3. Flexibility

From the last part, nature and structure, **AngularJS** is the full framework has to be implemented by using Model-View-Controller (MVC) structure which is strict structure, difficult. Developer has to follow the rule. **ReactJS** is only library, developer create own structure so it is very flexible. However, **AngularJS** support both Typescript and Flowtype script but **ReactJS** support only Flowtype script.

AngularJS : 4 **ReactJS : 5**

3.4. Performance

To determine which library has better performance, we run the benchmark program to find the speed of rendering of To-do-list web application. The application will render to a thousand to-do-list elements and kill all the lists. The benchmark use the same CSS style, only the Javascript framework that is different. The image below is the application that we use for benchmark.



To-do-list Benchmark

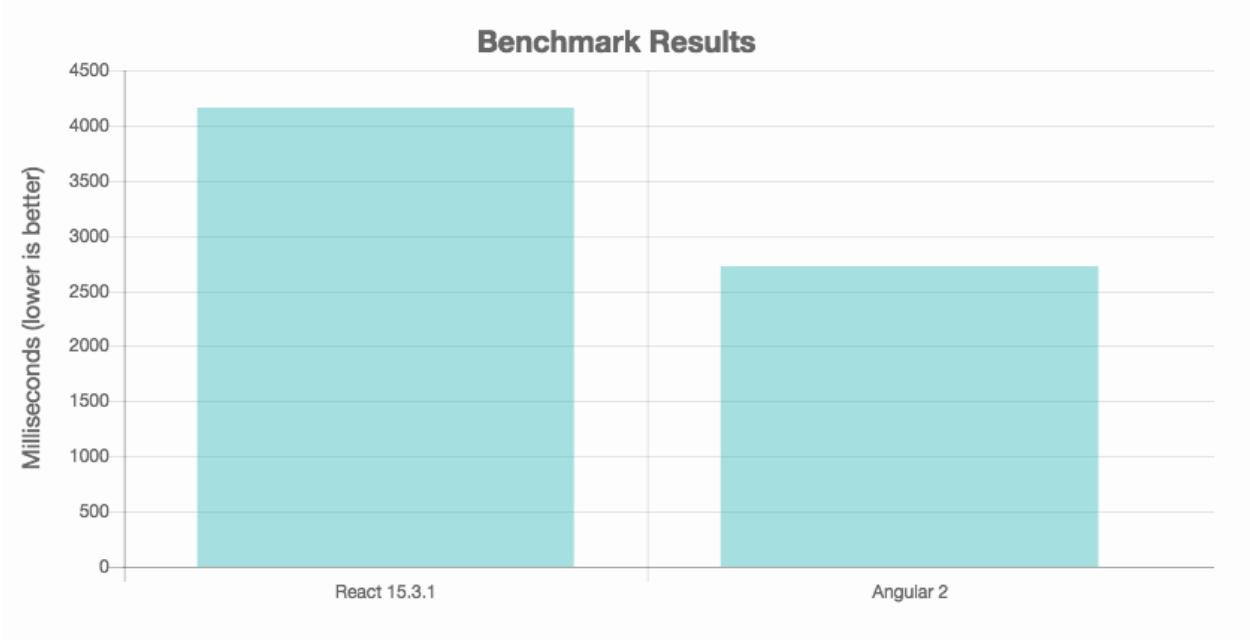
These applications run on MacBook Pro (15-inch, Mid 2012),

Hardware	Specification
Operating System	macOS Sierra Version 10.12.1
Processor	2.3 GHz Intel Core i7
Memory	10 GB 1600 MHz DDR3
Graphic Card	NVIDIA GeForce GT 650M 512 MB Intel HD Graphics 4000 1536 MB

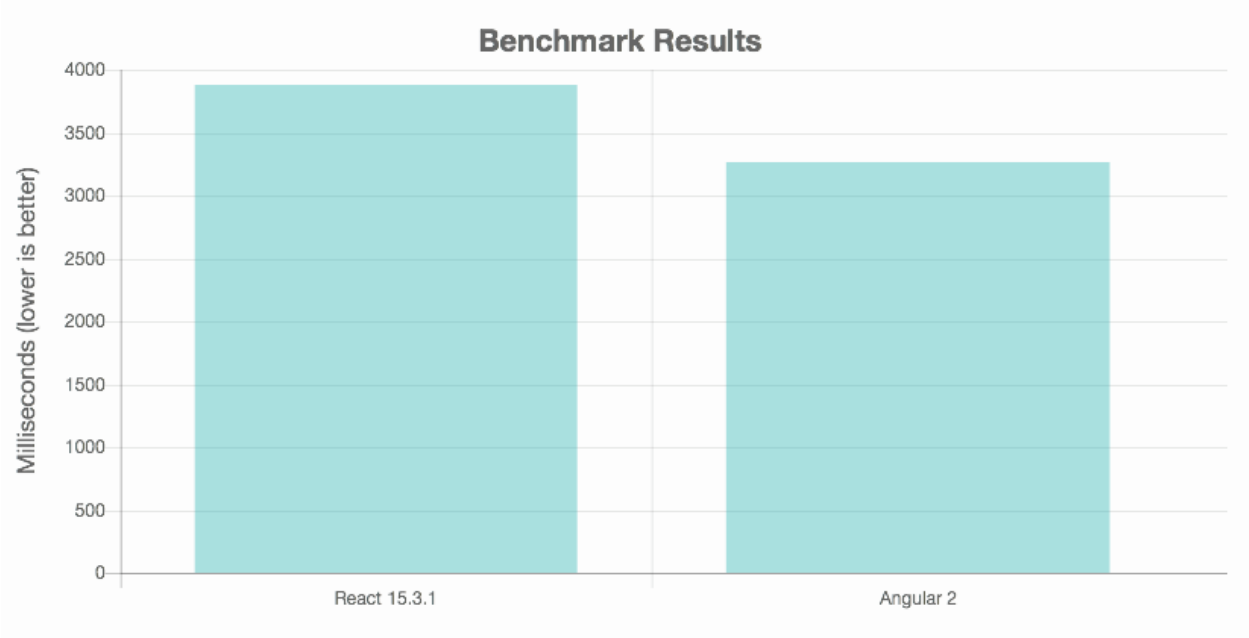
We run test on three different browsers. Here is the result.

Browser Version	React 15.3.1	Angular 2
Chrome Version 54.0.2840.98 (64-bit)	4160 ms	2718 ms
Safari Version 10.0.1 (12602.2.14.0.7)	3875 ms	3268 ms
Firefox Version 43.0.4	8329 ms	4017 ms

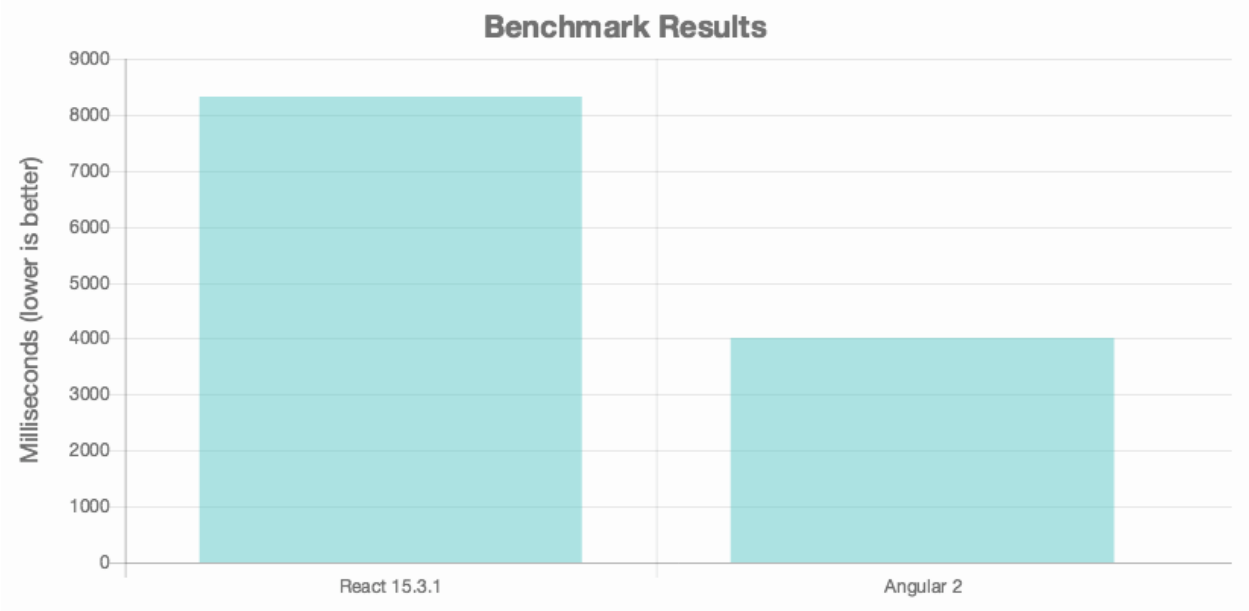
Result in graph :



Chrome Version 54.0.2840.98 (64-bit)



Safari Version 10.0.1 (12602.2.14.0.7)



Firefox Version 43.0.4

From the result, we see that Angular 2 is faster in all browser (on MacOS) and run faster more than twice times on Firefox. From three browser, the average render times, **React** is 5454.67 ms and **Angular 2** is 3334.34 ms. However, there are Javascript frameworks that can render faster than Angular 2 so we rate Angular 2 only 4

AngularJS : 4 **ReactJS : 3**

Moreover, we think that only one rendering test is not enough to justify precisely which one does better performance. If we have more time we will create benchmark in the other topic with other application too. However, this performance testing can represent overall performance of both of them.
Here is the source code that we use from github
(https://github.com/evancz/react-angular-ember-elm-performance-comparison)

3.5. Number of Repositories (on Github)

Number of data of repositories on Github can refer to number of developer. More developers mean that there are more developers, more tutorials, more 3rd component, more developers answer our questions. We consider three data on Github.

1. Watch is for developer how want to get notification from that repository when there is new information such as new version release.

2. Star When developer want to the repository on their own dashboard.

3. Fork For developer who want to implement code base on the existing repository.

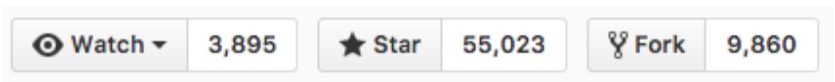
But only the number of each data in repositories is not enough because the age of each repositories is not equal. The repositories that came before tend to has more number of developer in each data. Also we will consider Angular 1 and 2 in this metric. Angular 1 came first, React send and Angular 2 is the third. So can see the trend of developer that using Angular 1 and 2 that have different age.

Age of Each Repositories

Library Name	Date	Age
React	May 26, 2013 – Dec 1, 2016	1285 Days
Angular2	Sep 14, 2014 – Dec 1, 2016	809 days
Angular1	Jan 3, 2010 – Dec 1, 2016	2524 days

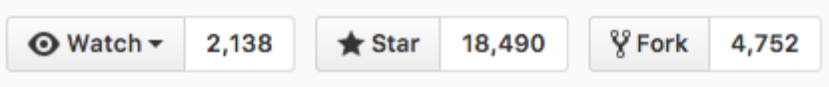
Data of Each Repositories

1. **React :**



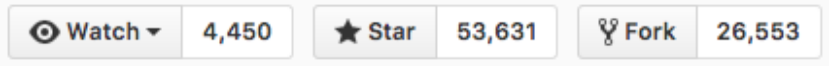
https://github.com/facebook/react/stargazers

2. **Angular 2 :**



https://github.com/angular/angular/stargazers

3. **Angular 1 :**



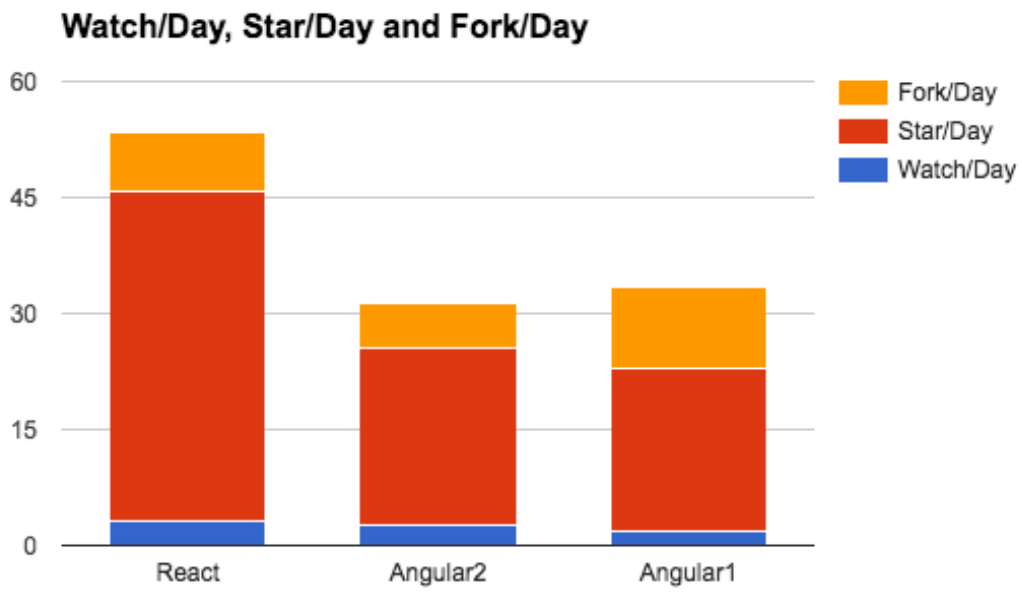
https://github.com/angular/angular.js/

Watch, Star, and Fork by Day

We consider each data by day because they are not the same age

Library Name	Watch/Day	Star/Day	Fork/Day	Total
React	3.03	42.82	7.67	53.52
Angular2	2.64	22.86	5.87	31.37
Angular1	1.76	21.25	10.52	33.53

From average data by day of each libraries, if they are considered only Angular 2, all data React is higher. From Angular 1, we see that Fork/Day is higher than React but Watch and Star is lower. So we consider the total number of average data per day.



The result shows that React has the most value in overall average data per day of each frameworks. Moreover, we can see that Angular 1 is a little bit more popular than Angular 2.

AngularJS : 3 **ReactJS : 5**

3.6. Number of Users Access to Website

We use data from Wappalyzer which is the plugin of firefox, chrome, and opera. It shows the libraries and architecture of website that user currently open and corrects all data in the server. So we can find overall number of user access to the website that use each libraries. We count the user from top 10 popular websites that use Angular 2 and React in last 7 days. We update the latest data on December 1, 2016

ANGULARJS

WEBSITES USING ANGULARJS

These are the top AngularJS websites based on the number of detections by Wappalyzer in the last 7 days.

#	WEBSITE	DETECTIONS
1	upwork.com	197,038
2	rpm.newrelic.com	93,892
3	freelancer.com	74,174
4	udemy.com	44,657
5	youtube.com	38,009
6	angular.io	28,853
7	web.telegram.org	25,204
8	ovh.com	22,124
9	docs.angularjs.org	19,980
10	istockphoto.com	18,663

Total Reach of Top 10 = 562,594
(https://wappalyzer.com/applications/angularjs)

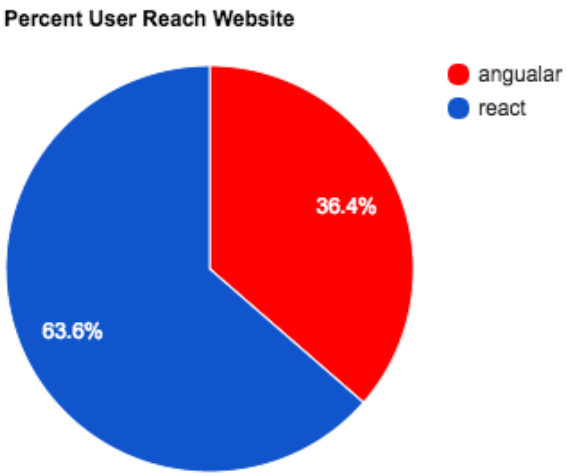
REACT

WEBSITES USING REACT

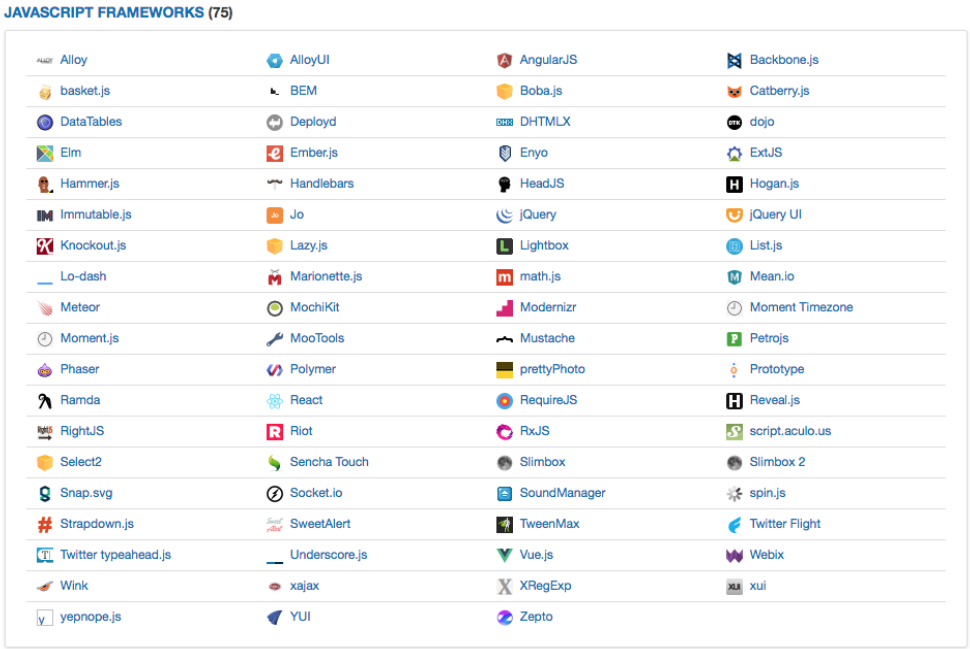
These are the top React websites based on the number of detections by Wappalyzer in the last 7 days.

#	WEBSITE	DETECTIONS
1	web.whatsapp.com	144,743
2	imgur.com	144,590
3	imdb.com	114,761
4	dropbox.com	114,044
5	instagram.com	105,252
6	netflix.com	86,932
7	fiverr.com	80,271
8	facebook.com	74,404
9	app.hubspot.com	68,753
10	vimeo.com	48,742

Total Reach of Top 10 = 982,492
(https://wappalyzer.com/applications/react)



The result shows that React has more user than Angular 2 around two time as much. Even though, Angular and React is the most popular Javascript libraries, there are a lot of libraries in the world and it market share is not much different.



https://wappalyzer.com/applications

AngularJS : 3 **ReactJS : 4**

3.7. Easy to Use + Easy to Learn (Learning Curve is low)

Because Angular is strict structure MVC framework and use Typescript that is the new language that developed for write javascript with type casting and compile to normal javascript that browser can read. So it is more difficult than React that is only view library and use regular Javascript syntax.

Moreover, when we try to correct data for population metric. We found that the number of tags in stackoverflow is **conflict** with number of data in repository on Github.

Number of Tags in Stackoverflow of React

Number of Tags in Stackoverflow of Angular 1 and 2 ("angularjs" is the tag of Angular 1)

So we consider the total number and the number of tags in this week to find growth rate of each libraries.

	Total	Week	Growth Rate
React	28016	597	2.10%
Angular 2	26713	870	3.30%
Angular 1	209728	1355	0.60%

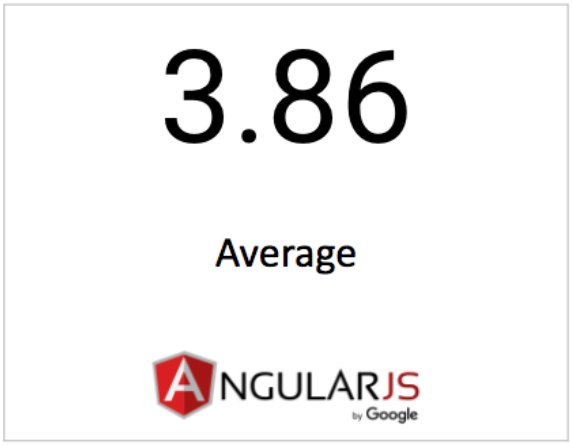
From the result, Angular 1 has a lot more total number of tags and Angular 2 is the most growth rate.

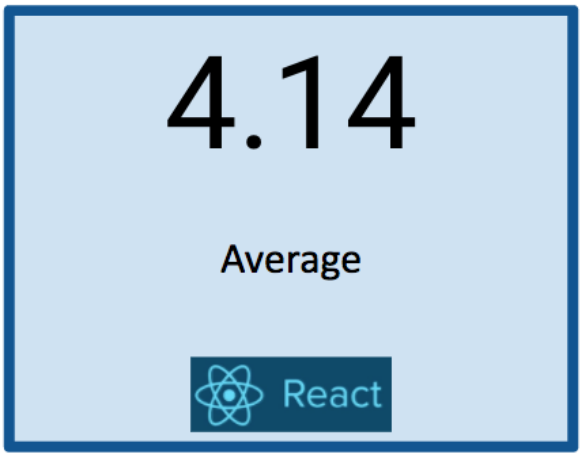
But why it is conflict to the Number of Repositories (on Github) that we mention in [7.5]. We found that even though React has a lot more developers but it is easier to understand. So there are a lot more question of Angular in Stackoverflow.

AngularJS : 3 **ReactJS : 4**

3.8. Total Score

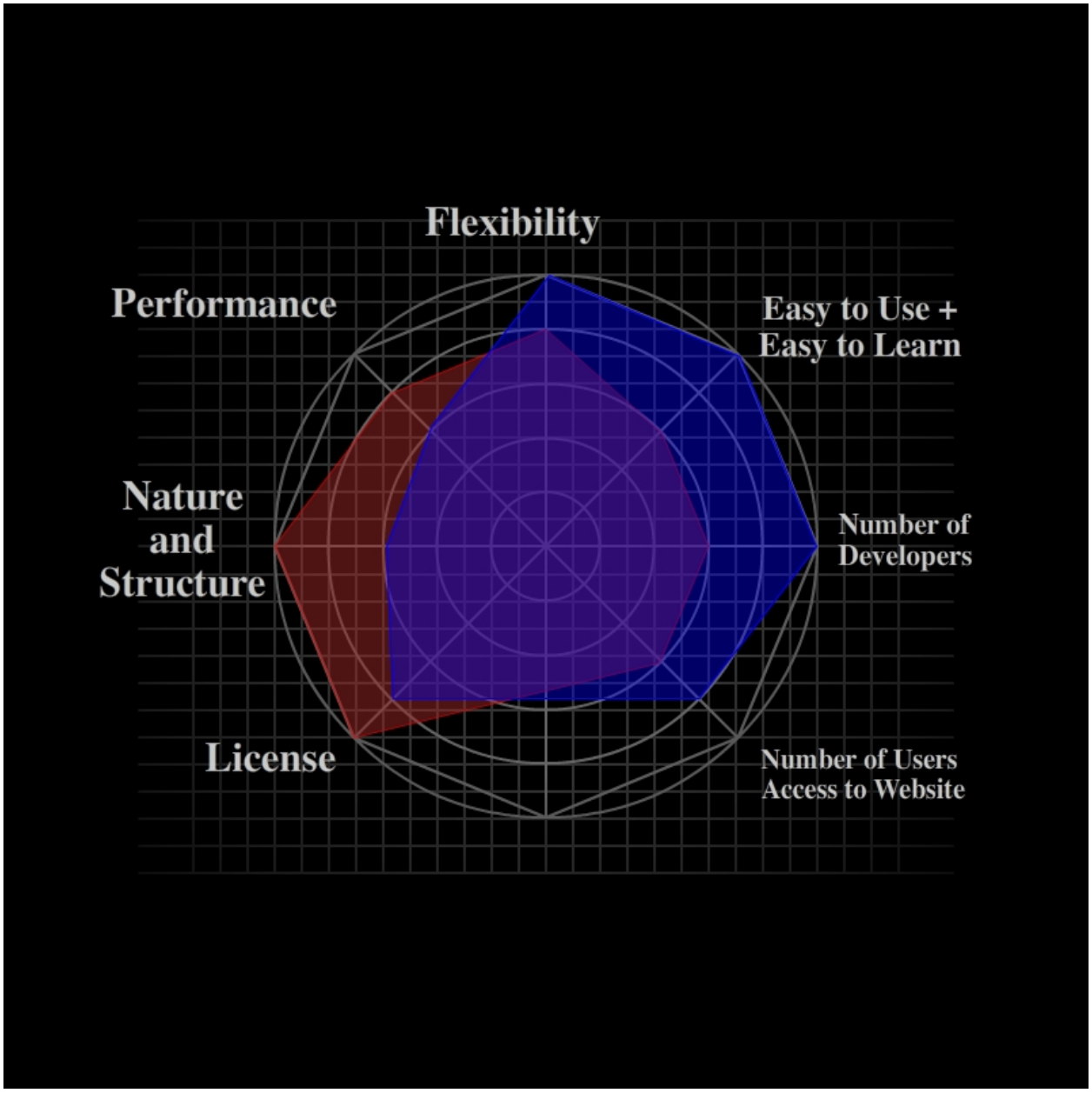
Angular 3.86 and React 4.14





4. Conclusions

From the total result React gets higher score than Angular but it is not a good decision to pick up the libraries on overall rates score. We have to choose library based on the project and our team skill. So we summarize in spider graph in order to see overall strong and weak points of each libraries.



Below table shows the answers to the questions in GQm based on the datasets presented in above sections. Sometimes findings of one dataset are related to more than one metric.

	Angular	**React**
Goal: Choose a Javascript framework that is best match for web application development		
Q1: Which is the most popular and multipurpose JavaScript framework? **Metric:** number of people using respective technology		
number of github repository	3	5
number of websites using them	3	4
tags on stackOverflow	3 (28016)	4 (209728)
Q2: Which one has better performance? **Metrics**: time required to develop the code and build the application, time to generate output		
Nature and Structure	5	3
Performance	4	3
Flexibility	4	5
Q3: Which one is cost effective with respect to efforts required to use and implement ? **Metrics:** time required to learn and use		
Easy to Use	3	4
Learning Curve	3	4
People Ask Question	3	4
Nature and Structure	5	3

Overall strong and weak points of each libraries

So if the project has no complex ui and the team has own structure, or the team has limit of time to learn new library. React is the better choice.

If the project is big and the team does not has own structure, there are many developers in the team, the User Interface is very complex so the project required more structure. In this case Angular is a better choice.

5. Limitations

There are still some limitations in our project and we will talk about these limitations in the following paragraph. For these aspect, we can do better next time.

For the metric number of Users Access to Website, in this metric it's difficult to find the precise enough data from every websites in the world. We try to find data from website that run bot to all over website in the world such as Builtwith but the website just provide a ambigus data for free, the precise data is need to be charged. Consider the time is limited, and it will take a lot of times on debugging and testing the data mining code written by ourselves. We finally chose the way of count the user from top 10 popular websites that use Angular 2 and React in last 7 days which is not typical and precious enough for the two webframe.

For performance of the two libraries, we using the benchmark program to do this job. But for the benchmark we test only one bench mark in three major browsers, consider the data we got on different browsers is in big difference, we may have same result for comparing the two webframe on different browsers but the data maybe different. And the test work also takes time, the result may be influenced by the testing ways. We also trying to write our own test code to do the job, but the two web frame are different and we can not handling the quality of the code we write as the example code being more and more complexity. we did not choose this idea.

Github only show current data in repositories. So we cannot find number of data in specific time in history. Which means we can only analysis which one is more popular from the current numbers without knowing the growth tendency and can not find a precise growth rate for Angular2 and React. This may cause misunderstanding on the comparing, the web frame with high numbers maybe was popular in the past but few people use it now.

And for our project it's also hard to ask people and trying to getting data from people online. We try to find answers on Quora, and the opinion in answers are very close, and Stackoverflow does not support to ask opinion question. From the following links you can found the opinions is quite similar:

http://stackoverflow.com/questions/34920550/angular-2-vs-react

http://stackoverflow.com/questions/28151067/angularjs-vs-reactjs?noredirect=1&lq=1

The problem is we don't know the background of the people answer this question, if the people familiar with one web frame more than another, they may bring their own bias to the answers. And the poll we found online is also not precious, we finally didn't use these data.

6. Reflection

From our dataset, Easy to use metric can be used in Environmental Factor to find the total effort of the project. So we put 5 for “Difficult Programming Language” factor for Angular and put 4 for React. Because Angular and React is only front end libraries so we have to consider backend language too. We assume that both project use the same backend language.

Environmental Factor		Multiplier	Relative Magnitude (Enter 0-5)
8	Difficult Programming Language	-1	5
Calculated EF			1.22

8	Difficult Programming Language	-1	4
Calculated EF			1.19

Then we get total Hours of Effort for Angular is 2,061 and React is 2,010. So it shows that React can decrease total effort around 2.47%

7. References

- Basic information
  - https://AngularJS .org/
  - https://facebook.github.io/react/
  - http://tutorials.pluralsight.com/front-end-javascript/angular-vs-react-a-side-by-side-comparison
  - https://www.codementor.io/ReactJS /tutorial/react-vs-AngularJS [react win]
  - https://medium.freecodecamp.com/angular-2-versus-react-there-will-be-blood-66595faafd51#.6sw6bt9bp [react win]
  - https://www.airpair.com/AngularJS /posts/angular-vs-react-the-tie-breaker#1-2-learning-curve [Angular win]
  - http://mlsdev.com/en/blog/68-AngularJS -vs-ReactJS -comparison-what-to-choose [Tie]
- Code comparison
  - Source code for benchmark test : https://github.com/evancz/react-angular-ember-elm-performance-comparison
  - Code performance comparison angular1 : http://blog.500tech.com/is-reactjs-fast/
  - Angular 2 : http://merrickchristensen.com/articles/react-vs-angular-2.html
  - Angular 2 : https://www.codementor.io/codementorteam/tutorials/react-vs-angular-2-comparison-beginners-guide-lvz5710ha
  - Testing https://medium.com/front-end-hacking/automated-performance-benchmark-test-for-web-apps-c87cf561c2b4#.yxcy3ijo1
- population
  - Github
    - https://github.com/facebook/react/stargazers
    - https://github.com/angular/angular/stargazers
    - https://github.com/angular/angular.js/
  - stack overflow http://stackoverflow.com/tags
  - Webanalyzer
    - https://wappalyzer.com/applications/angularjs
    - https://wappalyzer.com/applications/react
    - https://wappalyzer.com/applications
  - [w3techs]
    - overall https://w3techs.com/technologies/overview/javascript_library/all
    - Comparison https://w3techs.com/technologies/comparison/js-angularjs,js-react

- Builtwith
    - https://trendspro.builtwith.com/report/7814d1d9-bc36-4e3d-886f-893854c9ba35
    - https://trends.builtwith.com/javascript/Angular-JS/Market-Share

8. Appendices

Except Angular and React, there are also other libraries widely used in JavaScript web development,such like VueJs and Ember, we will compare Angular and react with them in the future study.

VueJS is a progressive framework. Unlike other monolithic frameworks, Vue is designed from the ground up to be incrementally adoptable. The core library is focused on the view layer only, and is very easy to pick up and integrate with other libraries or existing projects. On the other hand, Vue is also perfectly capable of powering sophisticated Single-Page Applications when used in combination with modern tooling and supporting libraries. One of the Chinese biggest meal ordering platform eleme (www.ele.me) is using VueJs.

Ember.js is a frame based on the Model–view–viewmodel pattern. It allows developers to create scalable single-page web applications by incorporating common idioms and best practices into the framework. Ember is used on many popular websites, including Discourse, Groupon, Vine, Live Nation, Nordstrom, Twitch.tv and Chipotle. Although primarily considered a framework for the web, it is also possible to build desktop and mobile applications in Ember. The most notable example of an Ember desktop application is Apple Music, a feature of the iTunes desktop application.

In the future work, we will compare more webframe and provide fair and objective reference of web technologies to developers.