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A MODEL FOR COMPARATIVE ANALYSIS OF THE SIMILARITY BETWEEN ANDROID AND IOS OPERATING SYSTEMS

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Abstract: *Due to recent expansion of mobile devices, in this article we try to do an analysis of two of the most used mobile OSS. This analysis is made on the method of calculating Jaccard's similarity coefficient. To complete the analysis, we developed a hierarchy of factors in evaluating OSS. Analysis has shown that the two OSS are similar in terms of functionality, but there are a number of factors that weighted make a difference.*

Key words: *operating system, mobile, Android, iOS*

1. Introduction

Android (developed by Google) and iOS (developed by Apple) are the main operating systems for mobile devices such as smartphones, tablets or smart TVs.

From a technical standpoint, the Android operating system is based on Linux, while iOS is based on OSX and Unix.

The choice of a particular operating system depends both on the device on which that system will work, and on the subsequent applications to be installed, from Google Play or App Store for Android and Apple App Store for iOS. Android is the most popular operating system worldwide and can be used on several mobile devices created by different manufacturers, whereas IOS can only work on devices created by Apple.

2. The Jaccard similarity coefficient

The Jaccard index (or Jaccard similarity coefficient) is a statistics used for comparing the similarity and diversity of sample sets. The Jaccard coefficient measures the similarity between many sample sets.

The Jaccard similarity coefficient is defined as the size of the intersection divided by the size of the union of the sample sets:

$$J(A,B)=\frac{|A\cap B|}{|A\cup B|} \qquad (1)$$

where, $0\le J(A,B)\le 1$

The Jaccard distance, which measures the dissimilarity between sample sets, is complementary to the Jaccard coefficient. It is obtained by subtracting the Jaccard coefficient from 1. The same thing is obtained by dividing the difference of the sizes of the union and the intersection of two sets by the size of the union:

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$$d_J \le J(A,B) \le 1 \qquad (2)$$

The same thing is obtained by dividing the difference of the sizes of the union and the intersection of two sets by the size of the union:

$$d_J(A,B) = \frac{|A \cup B| - |A \cap B|}{|A \cup B|} \qquad (3)$$

Android and iOS features Table 1

	Android	**iOS**	**IDEAL**
Company/Developer	Google	Apple Inc.	
OS family	Linux	OS X, UNIX	
Customizability	1	0	1
Programmed in C, C++	1	1	1
Programmed in java	1	0	1
Programmed in Objective-C	0	1	1
Dependent on a PC or a Mac	1	1	1
Easy media transfer without desktop application	1	0	1
Source model	1	1	1
Open source Kernel	1	0	1
Widgets	1	0	1
Call features supported Auto-respond	1	1	1
Call features supported call-back reminder	0	1	1
Call features supported do not disturb mode	0	1	1
Multiple Internet browsing	1	1	1
Available on many phones and tablets	1	1	1
Interface Touch screen	1	1	1
Messaging	1	1	1
Voice commands	1	1	1
Maps	1	1	1
Video chat	1	1	1
App store	1	1	1
Market leader	1	0	1
Many available languages	1	1	1
Many device manufacturer	1	0	1
Jaccard similarity coefficient	**0.86957**	**0.69565**	**1**

3. Objective importance of the criteria

Depending on the values of the alternatives for each criterion, the *objective importance* of the criterion can be established. This importance is given by the information contained in the values of the alternatives.

The simple cardinal valuation method assumes that the decision maker establishes relative relationships between the criteria ordered by importance, which progressively increase the value of the associated weight.

The evaluation algorithm is:

Step 1. Criteria are sorted in ascending order based on the increase in importance. Let the order be *C1, C2, ..., Cn,* (*C1* is the least important criterion).

Step 2. The value x, $w_1 := x$ is attributed to the weight of criterion C1.

Step 3. The decision maker establishes the degree to which criterion C2 is more important than C1 by the subjective determination of the value of the ratio $\Delta w_2 = \frac{w_2}{w_1}$ ($\Delta w_2 \geq 1$ and the equality is valid if one considers that C1 and C2 are equally important). The procedure is applied for each criterion by comparing it to the previous one. Thus, Δw_j is determined for $j = 2,3,...,n$.

Step 4. The following equation results:

$$(1 + \Delta w_2 + \Delta w_2 \cdot \Delta w_3 + \Delta w_2 \cdot \Delta w_3 \cdot \cdot \Delta w_4 + ... + \Delta w_2 \cdot \Delta w_3 \cdot ... \cdot \Delta w_{n-1} \cdot \cdot \Delta w_n) \cdot x = 1 \quad (4)$$

The equation is solved and the value x is obtained.

Step 5. The weights of the n criteria are calculated:

$$w_j = w_{j-1} \cdot \Delta w_j, \quad \text{with} \quad j = 2,3,...,n \quad \text{and} \quad w_1 = x \quad (5)$$

Criteria sorted by importance Table 2

	Criteria sorted by importance	Importance factor	Weight of criteria
1	Many device manufacturer	2	0.3005
2	Market leader	1.1	0.1502
3	Customizability	1.5	0.1366
4	App store	1.5	0.0910
5	Available on many phones and tablets	1.5	0.0607
6	Interface touch screen	1	0.0405
7	Easy media transfer without desktop application	1	0.0405
8	Dependent on a PC or a Mac	1.5	0.0405
9	Source model	1.5	0.0270
10	Widgets	1.2	0.0180
11	Messaging	1.1	0.0150
12	Voice commands	1.1	0.0136
13	Maps	1.1	0.0124
14	Video chat	1.1	0.0113
15	Many available languages	1.5	0.0102
16	Multiple Internet browsing	1.5	0.0068
17	Call features supported Auto-respond	1	0.0045
18	Call features supported call-back reminder	1	0.0045
19	Call features supported do not disturb mode	1.1	0.0045
20	Open source Kernel	1.1	0.0041
21	Programmed in C, C++	1	0.0038
22	Programmed in java	1	0.0038
23	Programmed in Objective-C	x	0.0038

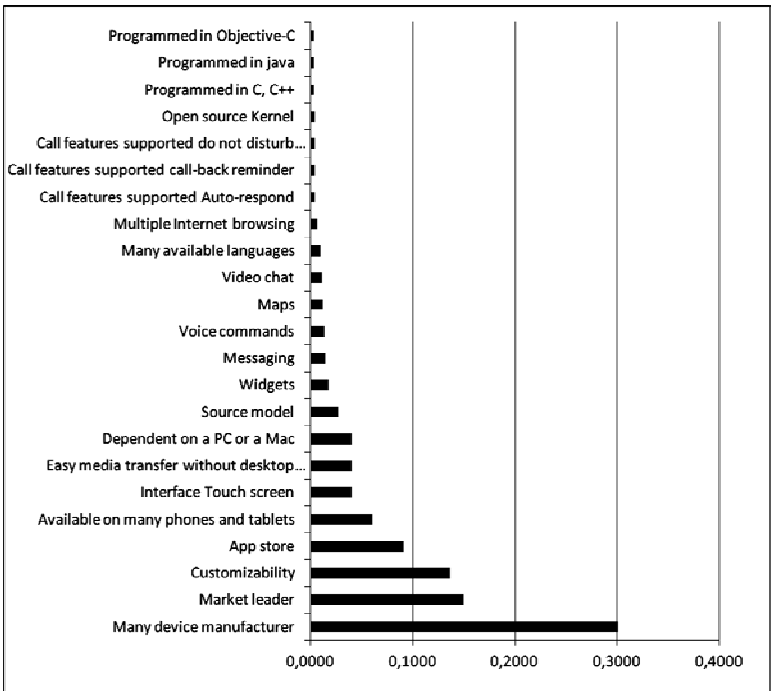

Fig. 1. *Criteria sorted by importance*

Android and iOS features - weight of critera Table 3

	Android	**iOS**
Many device manufacturer	0.3005	0.0000
Market leader	0.1502	0.0000
Customizability	0.1366	0.0000
App store	0.0910	0.0910
Available on many phones and tablets	0.0607	0.0607
Interface Touch screen	0.0405	0.0405
Easy media transfer without desktop application	0.0405	0.0000
Dependent on a PC or a Mac	0.0405	0.0405
Source model	0.0270	0.0270
Widgets	0.0180	0.0000
Messaging	0.0150	0.0150
Voice commands	0.0136	0.0136
Maps	0.0124	0.0124
Video chat	0.0113	0.0113
Many available languages	0.0102	0.0102
Multiple Internet browsing	0.0068	0.0068
Call features supported Auto-respond	0.0045	0.0045
Call features supported call-back reminder	0.0000	0.0045
Call features supported do not disturb mode	0.0000	0.0045
Open source Kernel	0.0041	0.0000
Programmed in C, C++	0.0038	0.0038
Programmed in java	0.0038	0.0000
Programmed in Objective-C	0.0000	0.0038
Evaluation with the objective criteria coefficient	**0.9909**	**0.3501**

4. Detailed analysis

Interface – From the point of view of the interface, both Android and iOS use touch interfaces, which are very similar, swiping, tapping and pinch-and-zoom. Both have a Home screen, similar to the screen of a PC desktop.

A major difference is given by the fact that iOS uses only several lines where the icons of applications are placed, while Android can also use widgets, which allow self-updating from the Internet with information such as weather forecasts or emails corresponding to an email address.

Both systems have a status bar that provides information about the system, such as: time, Wifi signal, battery status, phone signal or data transmission enabled. In addition, Android allows displaying the number of new emails received or reminder messages.

Applications available - Android Apps are installed from Google Play, which contains over 600,000 applications available that can run on phones and tablets. Some devices running on Android (like Kindle Fire) have their own application store, containing a number of exclusive applications.

Currently there are over 700,000 Apple applications of which over 250,000 are available for iPad. Many application developers prefer to create games for iOS not for Android.

In terms of the comparison between the two operating systems, it should be specified that both systems contain most of the popular applications. As regards tablets, one can say that there are more applications for iPad.

Stability of applications - The Crittercism Mobile Experience Report published in March 2014 ranked Android KitKat as more stable than iOS 7.1.

The report includes[2]:

Android 2.3 Gingerbread has the highest total crash rate, at 1.7%. Other versions of Android — Ice Cream Sandwich, Jelly Bean, and KitKat — have a crash rate of 0.7%.

iOs 7.1 has a crash rate of 1.6%., and the rates for iOS 7.0 and iOS 5 are 2.1% and 2.5% respectively.

Phone versions of both Android and iOS are more stable than their tablet versions.

Crash rates for applications vary by category — games are most likely to crash (4.4% crash rate) and e-commerce applications have the lowest crash rate of 0.4%.

Software upgrades - Android is frequency-updated, but some users do not receive the new updates on the devices or they even buy new devices from stores with un-updated software. Usually device manufacturers are the ones who decide when they use certain updates. There are situations when some updates are available only a few months after they are released.

From this perspective, one can say that iOS has a great advantage. IOS upgrades are available on all iOS devices. There have been situations when iOS updates have not worked on devices older than three years. (It is the case of the Siri application, which was available for iPhone 4S, but which could not be installed on older versions of the iPhone).

Devices - In terms of the use of certain OS devices, it should be remarked that Android runs on many devices of different sizes and hardware capabilities. Conversely, iOS is only available for Apple devices (iPhone as a phone, iPad as tablet or iPod as Mp3 Player).

Maps - Both Android and iOS have available maps. Google Maps, Waze or Bing are available for both OSs.

Web Browsing - Android uses Google Chrome as a web browser, while iOS uses Safari. In terms of quality, both browsers are similar. Google Chrome can be installed also on iOS, but Safari cannot be installed on Android.

Facebook integration - Facebook is integrated into Android and iOS, allowing the change of status, the upload of images or adding contacts of friends.

[2] http://www.diffen.com/difference/Android_vs_iOS

Payments from mobile devices - For payments, Android uses Google Wallet, some Android devices being equipped with NFC chip (Near Field Communication), which is used for wireless payments simply by tapping the phone at the checkout counter.

iOS has Passbook application, which keeps track of tickets, reward cards and credit / debit cards. There are no mobile payment features in iOS.

Security - Android applications are isolated from the rest of the system resources. Nevertheless, by granting rights to the user, the access can be done. This makes the system more vulnerable to errors. Because it is the most popular operating system for mobile devices, it is more prone to attacks.

For iOS, there are fewer attack attempts because applications are checked more carefully as regards the identity of the creator before publication. However, jailbroken iOS versions allow applications outside the Apple store to be installed, so these versions are much more exposed to attacks and malware.

Creating Applications - Android Applications are created in C, C or Java ++. It is an open platform that can be changed for free. Anyone can create and distribute free applications. To publish applications in Google Play there is an initial fee to be paid by each application developer. The iOS SDK is only available for the Mac platform.

iOS applications are made in Objective-C. Developers must pay a fee of $ 99 per year for access to the iOS SDK and can publish applications in Apple's App Store. The iOS SDK is only available for the Mac platform.

5. Conclusions

5.1. Conclusions: Android strengths / weaknesses:

- Big number of devices on which it can operate, both in terms of manufacturer, size and capabilities

- High customizing possibility – the home screen can be customized according to each user's wishes by creating icons or widgets.

- Fewer restrictions of Google as regards publishing applications in Play Store. Android applications can also be installed from other sources than Play Store.

5.2. Conclusions: iOS strengths / weaknesses:

- Many applications available for both phones and tablets
- Deep integration with Facebook and Twitter
- The interface is blocked, limiting the user's customization
- Users can only install applications from the App Store
- Upgrades are available to all devices that have sufficient hardware capabilities.

The Jaccard similarity coefficient analysis shows that both OS are quite close, yielding values of 0.69 for iOS and 0.86 for Android, the latter having a small advantage.

If the objective importance of the criteria is considered, the situation changes, as the difference between the two OSs increases. Analyzing the factors that influenced the final score of 0.99 for Android and 0.35 for iOS, the following key factors not encountered in iOS should be underlined:

- many device manufacturer
- market leader
- customizability
- widgets

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