Designing Mobile Applications for Official Statistics

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Abstract

In this paper we discuss the problems in the design of applications targeted at running on mobile devices, such as smartphones and tablets, and their usage in the context of official statistics. First we briefly survey the experience in this field at international level and discuss general design guidelines and techniques. Then we specifically focus on the experience of Istat, that by the early months of 2013 will have three different mobile applications released on the stores of the two major mobile platform.

Keywords: visualization, smartphones

1. Introduction

Mobile devices such as smartphones and tablets are an ubiquitous presence in our society nowadays. Among all the features of last generation mobile devices, the one that probably has mostly contributed to trigger a major change in users' habits is the possibility of downloading and installing on a device applications (or "apps") that provide a virtually limitless extension to its native characteristics. The offering in this field reached in 2012 the figure of one billion of applications available in the two most widespread platforms on the market (Apple iOS and Google Android) and the popularity of the usage of applications is such that a recent study highlighted how this way of using the device, after phone calls and text messages, is predominant within users, being also superior to common Internet navigation.

Mobile applications span almost every possible field of human activity and official statistics is no exception. In this paper we first survey the presently available applications that focus on the diffusion of official statistical data. Then, we introduce some general considerations on the design features of mobile applications targeted at the official statistics domain. Finally, we present two applications designed and developed at Istat whose release is planned before the end of 2012. We conclude by drawing some lessons learned from the development activity of Istat in this field.

2. Survey of Mobile Application for Official Statistics

In 2012 we carried out a preliminary study of the related work in the field, investigating what actors in the field of statistics (NISs, international institutions etc.) had realized specific products for mobile devices. The app stores of both iOS and Android were searched for keywords such as “statistics” or the names of specific NSIs and institutions
and a similar search was made on the institutions’ web sites. The results of this study are not intended to be comprehensive because new applications constantly appear and it is not possible to dig into the huge amount of applications available nowadays in the stores. Moreover, localized applications might be available only at local stores so they do not appear in searches made from a different country.

Using the above methodology, there were only two NSIs that, at the time of writing, had released an official mobile application. The first is CBS (Statistics Netherlands), with the StatLine application. Available only on iOS platform, it allows to browse the values of the main indicators by theme or region, providing at the same time quick access to featured statistics, with simple graph visualizations. Secondly, the United States Census Bureau has recently released an application named America’s Economy, available for both iOS and Android and focusing on economic indicators.

Several international institutions have already proposed their official mobile application. Eurostat and United Nations realized a "Country Profile" app, where the main indicators from different countries can be browsed and compared among each other. OCSE realized a smartphone version of the Factbook publication, where indicators can be browsed by theme and compared among different countries over time. Another interesting application is the PGI Data Explorer, which is a mobile version of the Principal Global Indicators web site, both released by the Inter-Agency Group on Economic and Financial Statistics (IAG). The application relies on official data fetched from the organizations that comprises IAG (Eurostat, International Monetary Fund, OECD, etc.) in SDMX format. Retrieved data can be shown in tabular form or plotted.

Another category of statistical applications is represented by non-official applications that exploit official data, often offering interesting interactive visualizations. Examples are Diversity Viewer, an iPad app that visualizes on a map data from the 2010 US Census, and StatFrance, that gathers various statistics from INSEE, again, represented on a map.

3. Design Considerations

Mobile applications present several peculiar aspects that should be considered in their design. In this section, we focus on the characteristics of interest in a mobile application targeted at the domain of official statistics.

3.1 Mobile Applications vs. Mobile Web Sites

A general issue to be addressed in the first place should be the very motivation that leads to the realization of a mobile application. NSIs and international institutions all have their web sites for diffusing statistics as well as other domain-specific products. Users expect a complete offering of data to be already available on web sites and publications and then might not be interested in other types of media unless some added value is provided. The application designer should then focus on the differentiation of the offering, that should fill a gap and integrate the products already available on publications and web sites by exploiting the particular features of the mobile media.
In particular, a strong attention should be devoted to clearly distinguishing mobile applications and (mobile-optimized or not) web sites, for which the following considerations apply:

- a mobile application once installed is directly available in the launch menu of the device, a significant access shortcut with respect to a web site, that is always filtered by the browser and requires knowing and typing a URL;
- whereas web sites must offer completeness, mobile applications should focus on rapid access to a restricted yet self-contained subset of functionality and/or data. Navigation must be quick and intuitive and should not overwhelm user with too many choices;
- user interfaces on web sites might not be mobile-optimized, often relying on non mobile-friendly technologies (e.g. Flash) or presenting interactions not feasible for touch interfaces (e.g. tooltips, rollovers, etc.) or simply appearing too small to be visible and/or navigated. In these cases, a mobile-specific alternative might be appropriate.

### 3.2 User Interface

The obvious consideration about user interface is that its design must take into account all the limitations that derive from the form factor of smartphones: small screens, that are controlled by touch actions and gestures. Tablets offer larger screen real estate and pixel resolution but this means that in most cases the user interface must be revised in order to take advantage of this. For example, displaying data on an interactive map on a small smartphone screen might not be practical for the user, then this is a feature that is generally available on tablet-specific applications.

The small dimensions of the screen also limits the possible domains in which the choice of an application can be effective. For example, it would be very difficult to implement a complex electronic questionnaire adapted to a small smartphone screen. On the other hand, a tablet version would only mimic a well-designed web site, making worthless the additional development effort for the mobile application.

Other important features of mobile devices that can be exploited within applications are:
- Georeference: devices mount GPS sensors that can detect the position of the user. This can be used to provide location-specific content;
- Touch-optimized user interface with gesture recognition: apart from single touches, gestures such as swipes and multitouch can be recognized for providing a rewarding and smooth user experience;
- Offline data storage: almost all the modern devices are equipped with a generous memory dotation that can be used for storing application-specific data. This feature can be exploited in application design for storing data that is also available offline so that a permanent Internet connection is not required. We give further details on this in Section 4.
3.2 Technology

The coding of a mobile application is based on “native” languages, APIs and tools that are specific for every platform. Typically the learning curve of such technologies is steep and the code written for one platform cannot be directly ported to others, doubling the efforts (and costs) for development. For example, iOS applications are written in the Objective C language, a superset of the C++ language, and exploit several native APIs for accessing to the functionality of the operating system. Android applications are implemented in Java, a programming language that is much more common than Objective C, but still require the knowledge of APIs and abstractions that are specific for mobile development, so that even for an experienced Java programmer an initial training phase is required.

Recently, in order to overtake the difficulties and costs of setting up the know-how for multi-platform mobile development, an alternative solution to the development of mobile applications is being considered in the developers community. The idea is to create an application comprising only a single user interface component that incorporates a so called “web view”. A web view is the equivalent of a browser window that can execute code written with common web technologies. That is, the whole application can be completely implemented using the mix of HTML, CSS3 and JavaScript commonly known as HTML5. Through HTML5 it is possible to create dynamic and smooth user interfaces that maintain the look and feel of a native mobile application.

In support to the web view approach, frameworks are available (such as Apache Cordova) that facilitate wrapping a HTML5 application within a native container, also providing JavaScript interfaces for accessing native functions of the device, e.g. access to the address book, use of the built-in camera, use of geolocalization etc. Besides this, more and more JavaScript frameworks have appeared targeted at building interfaces for mobile apps, making available user interface widgets that present the typical look and interaction of their native counterpart. Popular examples of JavaScript mobile frameworks are Dojo Mobile, JQuery Mobile and Sencha Touch.

The main advantage of HTML5 is in it being largely (though not completely) cross-platform. The same code base can be reused for multiple platforms thus reducing almost to a half the effort required to build an application running on two or more platforms. Moreover, web technologies are widely popular among developers and the learning curve is surely less hard to attack. On the other hand, it is not easy for an HTML5 application to reach the same level of perceived quality as that obtained with native technologies, since the actual performance strongly depends on the ability of both the device and the operating system to quickly execute the JavaScript code. HTML5 applications can easily manifest slow response times and stuttering user interface, a less-than-optimal behavior that is hardly tolerated by unforgiving contemporary users. A significant effort is then due to developers for writing optimized and efficient JavaScript code so that the reduction of the time due to development with respect to the native approach might in the end be lower than what expected.
4. Architectural Patterns

Mobile applications for statistics are based on data that is either produced within an NSI or, in general, publicly available. A general question is what are the possible solutions for the integration in a mobile application of data extracted from the information system of one or more organizations. In this section we present three architectural patterns that represent general solution that can be followed, limiting ourselves to the case when a single organization is involved, without loss of generality. We analyze each solution highlighting the contexts where it is more suitable.

4.1 Web Service integration

In this pattern the data is exported through a web services interface implemented within the organization’s information systems. Data is extracted upon application’s request through a pull-style service call and can be the result of a query. This pattern should be used whenever the data to be used by the application is part of a complex information system that, for its size and complexity, cannot be copied in the application as a whole. Moreover, this approach allows to keep data in the application always updated without releasing a new version, hence it is an obliged choice whenever the data is foreseen to be periodically changing. The main drawback of this pattern is that an Internet connection should be always available for the application to run. Moreover, if the size of transferred data is relevant, the download time might be long, resulting in the user “hanging” on a loading screen waiting for data to appear. A final consideration about the web service pattern is that it obviously requires a web service interface to data to be available on the server side, which might not always be the case. If not so, the effort required to design, implement and maintain an efficient web service infrastructure must be taken into account in the choice of the pattern.

4.1 Embedded data

In this pattern the data is extracted once from the organization during the development phase, and is embedded in the application package. Data extraction is performed using ad-hoc methods (i.e. with a specific ETL procedure) and the extracted data is maintained in the device internal storage. This approach is suited to situations where the size of application data make it possible to store all the data inside the application, without resulting in a final application package of unreasonable dimensions that would be hardly downloadable and consume too much storage in the users’ devices. Embedded data provides faster responses to queries, a primary feature for data that must drive immediate responses in the user interface (e.g. an autocomplete field). Moreover, an internet connection is not required for downloading data, so the application is always available even if the device is not connected to a cellular of wi-fi network. Obviously, embedded data is immutable once the application is being compiled and deployed to the store. Then, this approach is not applicable to situations where data can change since updating data is possible only by releasing a new version of the application.
4.2 Offline caching

A third pattern consists in a hybrid solution where data is downloaded through web services and written in the internal storage of the device. This solution presents the advantages of both abovementioned approaches because data is primarily accessed from the storage, which is available also offline, so maximum efficiency in data access is guaranteed, and web services are concerned only when data is recognized to be out-of-date and must then be uploaded again. Offline caching is also useful in query-oriented application as it allows to user to save and quickly retrieved the results of previously executed queries. The downside of this approach is an increased complexity on the development size, that must take into account the correct management of the cache.

5. Mobile Applications at Istat

In 2012 Istat has initiated a line of activity regarding the development of mobile applications. Three applications will be released and available on app stores, both for iOS and Android platforms by initial months of 2013. The technology used is HTML5 in all cases, exploiting the Dojo Toolkit framework for building the user interface and managing the data storage, and Apache Cordova for HTML5-to-native encapsulation. We discuss the consequences of this choice and the details of the development experience in Section 6. Initially, only the smartphone version of all applications will be available, to be expanded and adapted for tablets in the next planned releases. The following of this Section is devoted to the presentation of the applications.

5.1 Population Census

This application has been released in the context of the first (partial) release of official population data, as produced in the 2011 Population and Housing Census. It includes data on population, split on different dimensions such as sex, citizenship and age group, that are the only dimensions available at present.

Figure 1. Screenshots of Population Census mobile application
The idea of the application is straightforward: it is based on a single view with a search box; by typing the name of a city, province or region, users can access the corresponding data on population. Various visualizations on graphs are available as well as comparisons of distributions between a chosen city and Italy or among three different cities.

The application design strictly follows the “embedded data” pattern. Since the data does not change over time and its dimension is limited, a one-time extraction has been performed from the internal data warehouse used for storing and analyzing the Census statistics. The extracted files, in CSV format, were embedded inside the application and are directly queried.

At the time of writing, this application is the only one from Istat that has been already released in the platforms’ app stores, hence we can report about download statistics and user feedback. At the time of writing, 2000 downloads are reported in overall for both platforms, the 60% of which for Android and 40% for iOS. Reviews from users reveal on one hand appreciation for the idea but on the other also complaint about the provided data not being as extensive as expected, since it does not cover all the gathered data. Updated versions of the application will be released in correspondence with the definitive release of the complete set of Census data, which is scheduled to be released by the end of 2013. Some users also complained about poor performance on certain (older) devices. We discuss this issue in Section 6.

5.2 Noi Italia

Noi Italia is the name of a annual release by Istat, collecting a set of indicators grouped into thematic factsheet for several areas of interests, ranging from economical to social, demographic and environmental. Being Noi Italia not only targeted at a technical audience but to a wider category of general users, each factsheet is enriched with extensive comments and explanations of the statistics as well as territorial comparisons.

In its previous issues Noi Italia has been released both as a paper publication and as web site, featuring several interactive data visualizations. In the 2013 edition it will be also available in e-pub format and as a mobile application.

![Figure 2. Screenshots of Noi Italia mobile application](image-url)
The user interface of Noi Italia resembles the organization of the web site, where statistics are organized into themes and indicators and can be easily browsed in a menu structure whose graphical layout has been completely redesigned in a mobile-friendly fashion. Facing a strict release deadline and given the impossibility of directly reusing the Flash-based visualization technology used in the web site, the interactive visualizations available on the web site have been replaced with static bar plots. Screenshots of the user interface are shown in Figure 2.

As for Population Census application, the architectural design of Noi Italia strictly follows the “embedded data” pattern. The main relevant aspect of the development process was the ability of the development team to complete the application in a relatively short time thanks to the know-how acquired during the development of the Population Census application, which has also been exploited as a base of reusable code.

5.3 Rivaluta Mobile

RivalutaMobile is the mobile version of Rivaluta, a web application that focuses on the diffusion of 5 different price indexes, offering to users the possibility of exporting documentation with legal value regarding prices revaluation. RivalutaMobile is based on data extracted from Rivaluta through a web service-based integration and provides quick access to the latest values of the indexes and to the calculator function, that allows to compute the variation, according to the consumer price index, of the value of a sum of money between two different time periods.

Data in Rivaluta is updated several times per month, whenever a new value of each index is issued. Moreover, the data required for computing all the possible variations is the monthly value of the consumer price index starting from 1947, both considerations make it not practical to adopt the embedded pattern. Rivaluta already provided access to all its datasets through REST web services, a feature that allows for a seamless integration with any external application. The calculator function hence calls the web services passing the parameters required for the computation, which is performed on the server side. The idea was to allow the usage of this function only when the device is online for the sake of efficiency and practicality.

However, RivalutaMobile also presents various plots of the time series of the different indexes. This data is sufficiently “stable” and does not depend on user input. In this case a offline caching approach was deemed suitable: at each application startup, the server is contacted and a query for the last data update is executed. If a new issue of an index is available, only this value is downloaded and added to the local storage. Time series are plotted directly from data in the storage so they can be accessed also in offline mode, the only requirement for correct data update being the possibility of the device to connect to a network when the application starts.
6. Lessons Learned

We conclude the paper by presenting some lessons learned from the design and the development of the three applications. The first challenge was the design of the user interface, because it was not an easy task simple to correctly place all the element without cluttering the screen, at the same time guaranteeing an easy access to all the application functions. Every aspect of the user interface, starting from the size and the placement of the buttons to the organization of the menus, must be carefully planned and tested on the device. It is very important to study and follow the user interface design guidelines that sets the standards and best practices for every platform, because they allow to obtain a design that is both meaningful for the user and consistent within the platform’s ecosystem.

However the most interesting aspect to be noted lies in the experience of developing mobile applications following the HTML5-based “web view” approach. As previously anticipated above, the main problem was to achieve satisfying performance and quality of the user interaction for all the platforms. There were several cases where user interface components behavior simply “did not look good”, being sloppy and non-smooth, and a low-level tweaking of the JavaScript code has been necessary in order to reach an acceptable quality level that would have been effortlessly guaranteed by native coding.

In overall, by adopting the HTML5 approach to mobile development we could efficiently start this new line of activity, releasing three different applications, each supporting two different platforms, within a relatively short time frame. However, in order to achieve this result, we had to face some compromises in the quality, with a generally unpredictable behavior and non-optimal performance on older devices. Hence, whenever we should plan to develop applications with more demanding requirements, we will seriously consider the adoption of native technologies, limiting the use of HTML5 to simpler cases.

In conclusion, we can say that the first feedbacks received revealed that user expectation for mobile applications for statistics is very high and there is definitely a sense for letting mobile platform gain their place as a new mean of statistical dissemination. Future work in this field by Istat will focus on applications optimized for tablets, where the use of interactive map visualization will be of primary importance. We are currently investigating technologies in this filed specifically for allowing the integration of mobile applications with the GIS platform of Istat.