



 University of St.Gallen

ETH zürich



Auto-ID Labs ETH/HSG
Year in Review
2015



Content

	Page
Director's Note	3
Lab Members	4
Project Reports	5
In-Store Personalization: Anonymous yet individualized	6
Proximity-based Services: Things at your service when you need them	8
Reality-Mining on Smartphones: Are apps mirroring our life?	10
Serious Games: Nutritional education becomes fun	12
HackZurich 2015: Retail Innovation Workshop	14

Cover photo credit: ETH Zurich / Silvia Schöning

Director's Note

Dear colleagues and friends,

On behalf of all our lab members, I'm delighted to share with you a few highlights of the research conducted at the Swiss Auto-ID Labs in the past year.

Our interdisciplinary team focuses on the consumer side of the Internet of Things. While most consumers are continuously connected to the Internet, the retail industry is still at the beginning of its digital transformation. Today, we are only seeing the tip of the iceberg with consumers scanning barcodes in stores and thereby unknowingly get in touch with a GS1 system originally created to make businesses more efficient.



To be at the forefront of what will shape and influence the next five to ten years of GS1 standards, we conduct research in close collaboration with leading industry players and tech start-ups. We love to build things and evaluate new technologies in the wild. As you will see on the next few pages, our work includes a wide range of topics from eCommerce-like personalization in physical stores, to machine learning of user preferences, to proximity-based services, and to scalable paths towards healthy nutritional habits.

We believe that when ideas are shared, they become bigger. Therefore, we publish our results in leading academic conferences & journals, maintain close relations to the other Auto-ID Labs, attend GS1 events, support the labs' annual Internet of Things conference and engage in Europe's largest hackathon.

It is exciting to see the GS1 community's open spirit of innovation. Thank you for letting us be a part of this journey!

Alexander Ilic

Director Auto-ID Labs ETH/HSG

Lab Members



**Assistant Prof. Dr.
Alexander Ilic**
Director
Auto-ID Labs ETH/HSG



Prof. Dr. Elgar Fleisch
Co-Chair
Auto-ID Labs



Runhua Xu
Ph.D. candidate and
doctoral researcher



Remo Frey
Ph.D. candidate and
doctoral researcher



Klaus Fuchs
Ph.D. candidate and
doctoral researcher



Denis Vučkovic
Ph.D. candidate and
doctoral researcher



Johannes Huebner
Ph.D. candidate and
doctoral researcher



Project Reports

In-Store Personalization

Anonymous yet individualized



Denis Vuckovac
Ph.D. candidate and
doctoral researcher

An increasing number of eCommerce vendors provide their customers attractive, personalized services, using individual product recommendations with consumer-specific discounts. Yet, even though the share of items bought online has been increasing steadily over the past years, brick-and-mortar retailers still account for the majority of revenues in retail. We aim to help these retailers to replicate successful strategies from online retailing by deploying personalized information systems (IS) in physical stores and offer new personalized services to the previously both unknown and disconnected consumer.

One approach to track behavior and interact with consumers is based on the usage of loyalty programs (LP). A LP essentially enables the information flow from consumers to retailers, fundamentally acting as a physical cookie and building an individual history of transactions. What until now has been missing was a scalable and convenient way of using such information to market to consumers individually. By combining a such a LP with digital in-store kiosks, our research partner has been able to provide personalized promotions and product recommendations to consumers in physical retail stores – without relying on any personal data.

LP retention and the cold-start problem [1]

Conventional LPs require consumers to fill out forms, sign-up in a long and time consuming process, wait for their card before they can start benefiting and disclose potentially sensitive data – which is not even required for most of the services LPs aim to offer. Yet, in a fast paced society of apps and freemium business models, consumers are used to try out things before giving any commitment.

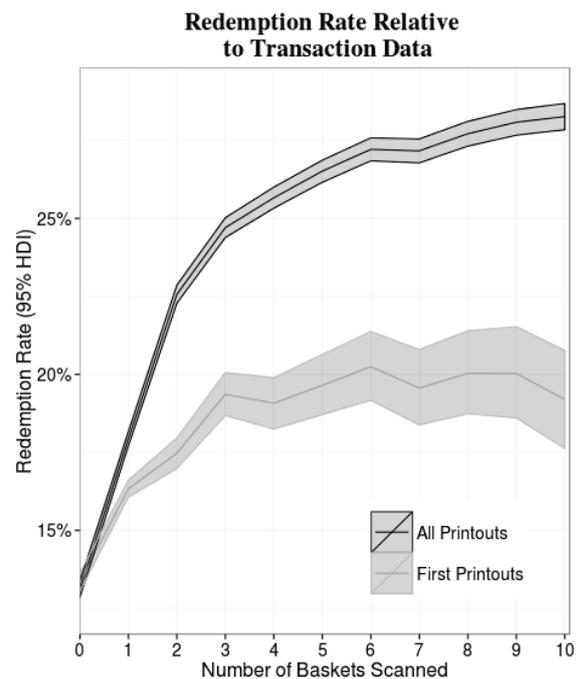


Figure 1: Redemption rate of recommendation batch (8 campaigns) increases with more available user transaction data

Thus, we analyze a case of a novel, smart LP with no entry barriers and more than 100,000 active users in a single city. The LP benefits are highly personal and provide users access to individual, exclusive price promotions and allow them to redeem loyalty points for free products.

The presented LP is smart and learns with each usage more about the customer. Figure 1 illustrates how the system learns with increasing transaction data. As the personalization gets better, the redemption rate increases. And this holds for both recurring as well as new consumers. Yet, as any personalized IS the system suffers from the so-called “cold-start problem” since new users’ preferences remain unknown, especially in such an anonymous LP setting. Thus, retaining new customers is an important and challenging topic. Our research provides valuable insights in particular regarding the design of a more holistic LP that can increase loyalty and user satisfaction thereby driving customer lifetime value and profitability. Our results show how access to exclusive, targeted promotions can be used as a driver for customer retention.

Getting the timing right [2]

In our second research stream we focus on how to improve the underlying algorithm deriving optimal recommendations for individual users.

Purchase incidence, or in other terms timing, is one of the key pillars of every customer decision. Yet, so far it has only received marginal attention in the context of recommender systems. However, as commercial recommendations ultimately aim at influencing customer choices, a timing variable needs to be incorporated when a recommendation is made. For this reason, we have analyzed customer data from the same LP and in-store recommendation system. Our findings support the view that recommender systems should not only focus on the product or service to recommend but also on the timing of the recommendation. We find that in many fast moving categories, there exists an optimal point in time for a recommendation which maximizes its acceptance among customers. We show that considering this optimal, category-specific point, has a positive effect on the success of recommendations. Figure 2 shows how this relationship differs for different

product categories. For most products there is a distinct penalty for recommendations that have been made too early. Yet, for hedonic products such as Cola, the earlier the better!

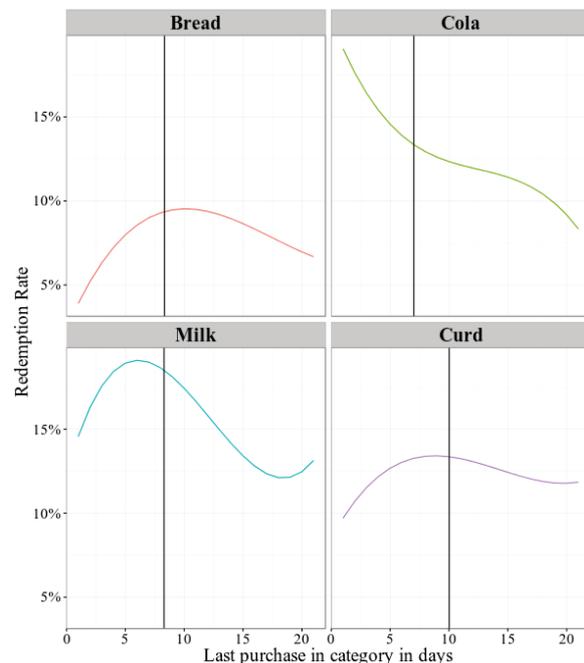


Figure 2: Redemption rates of recommendations for selected categories relative to the time of last purchase in the respective category and the average inter-purchase time (vertical line) of each category

The path to mobile [3]

We see this setup as a transitory setup towards mobile solutions purely based on now ubiquitous smartphones. Findings from this setup help us design new loyalty solutions, such as a purely mobile self-checkout App that is currently being developed.

References

- [1] Vuckovac, D., Gabel, S., Guhl, D., and Ilic, A. Evaluating rewards in loyalty programmes – A novel approach to increase user retention. European Marketing Academy, (2016).
- [2] Vuckovac, D., Wamsler, J., Ilic, A., and Natter, M. Getting the Timing Right: Leveraging Category Inter-purchase Times to Improve Recommender Systems, under review
- [3] Vuckovac, D., Fuchs, K., Ilic, A., Mobile Self-Checkout – Connecting retailers with consumers through a novel mobile App, planned

Proximity-based Services

Things at your service when you need them



Runhua Xu
Ph.D. candidate and
doctoral researcher

The trend of providing services in addition to selling products starts in the manufacturing industry, where the room for product differentiation is limited but services provide another revenue stream for companies to stay competitive. With the increasing ubiquity and connectivity of smartphones, it becomes for the first time technologically and economically feasible for companies to offer services directly to end-consumers in B2C settings. In my research, I aim to leverage mobile technologies and auto-IDs to connect manufacturers with consumers by enabling physical products as service end-points.

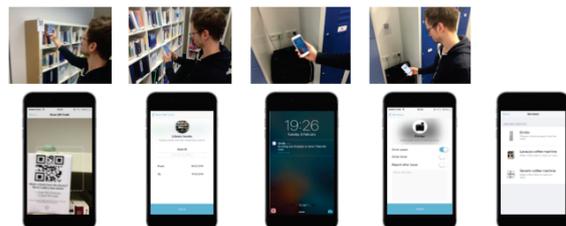
Enabling physical products as service end-points [1]

With the paradigm of the Internet of Things, the Internet extends to the physical world. Products can be enhanced with digital service offerings. A first generation of solutions already exists around QR codes and iBeacons to identify products and to provide consumers with services through their own mobile phones. As an alternative to fully connected "smart products", manufactures and service providers can use tags

to enhance their existing products with service offerings. Amazon has received wild success with their Dash product and Google's Physical Web shows how proximity interactions can work. However, these solutions are not scalable, focus on a single service, and require high effort. In addition, current Bluetooth based solutions overwhelm users with their push notifications – thus making it impossible for a deployment with multiple products and multiple users.



a) The CIRCLE Bluetooth Button



b) Screen snaps of the Mobile App

Figure 1. The prototype button and screen snaps of the mobile app.

We thus developed a new Bluetooth button, which can be set-up within seconds and turns any physical product into an easy to use service end-point. Unlike iBeacons or similar push based solutions, our smart algorithms overcome the spamming problem & information overload problem by letting the user initiate the dialogue.

The algorithm uses proximity measures to present the relevant services in a non-intrusive way already on the lock screen of a user's device. A field experiment was conducted in a closed environment with a prototype version of the solution. The feedback from 30 users was enthusiastic and they prefer to use the button to access product services compared to barcode and iBeacon.

Understanding personal differences in mobile service adoption [2]

Smartphones are the most personal devices people own and carry around with them all day. The number of available mobile apps in major app stores now easily exceeds one million – providing an app for almost any situation of our life. Consequently, the kind of apps people install and use could be closely linked to their interest, demographics, and personality. Due to the fact that 98% of the Fortune 500 companies have already started to offer services through mobile apps, we are thus motivated to understand how personality traits influence an individual's decision on adopting different mobile services.

We developed a mobile gaming app called personality test (as shown in Figure 2) to collect data about each smartphone user's personality traits as well as her app installation and update logs. The app is listed on Google Play Store and more than 2000 smartphone users used the app. In total, we analyzed 63,688 mobile apps and found that personality traits have a significant impact on the adoption of mobile services and such an impact is strongly dependent on the type of the service. Based on the type of a new mobile app, managers will know who are more likely to become adopters of the app thereby improving their marketing effectiveness.

Automatic user profiling [3]

Although personality traits are proved to be important in enhancing consumers' adoption of mobile services, an individual's personality

remains unknown until being measured by lengthy survey, which is costly and not scalable. As a result, we propose a scalable machine-learning approach to predict personality traits with information like app installation and update events that are openly accessible to all app developers. The precision of our model is 65% higher than a random guess. Additionally, the model can be deployed in a non-intrusive, low privacy-concern, and highly scalable manner as part of any mobile app. In addition to service

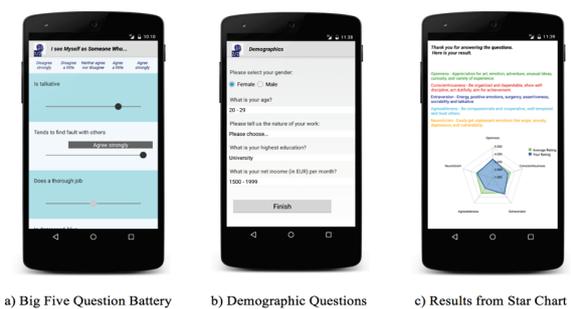


Figure 2. Screenshots of the Personality Test app.

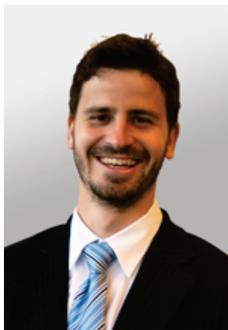
adoption, research in other fields shows that personality traits influence people's decision on product choice, purchasing behavior, store selection, brand loyalty, reaction to marketing campaigns, etc. By combining such findings with our models, firms can conduct better market segmentation and targeting, to improve customer relationship management, to enhance customer brand loyalty, as well as to cross-sell other products and services to potential adopters in their mobile apps.

References

- [1] Xu, R., Stroisch, P., Ilic, A., How to Enable Products as Service End-Points? Insight from a Field Experiment. *Journal of Service Research*, planned.
- [2] Xu, R., Frey, R.M., Fleisch, E. Ilic, A., Understanding the Impact of Personality Traits on Mobile App Adoption – Insights from a Large-scale Field Study. *Computers in Human Behavior*, 62:244–256, 2016.
- [3] Xu, R., Frey, R.M., Ilic, A., Individual Differences and Mobile Service Adoption: An Empirical Analysis. *IEEE BigDataService2016, Oxford, UK*, 2016.

Reality-Mining on Smartphones

Are apps mirroring our life?



Remo Frey
Ph.D. candidate and
doctoral researcher

Smartphones have become our daily companions and support us in almost any situation of our daily life. The way we use smartphones is correlated with individuals' needs, interests, habits, and personality. Thus, tracking devices over a certain period of time to gather user data enables new marketing and business opportunities. Custom-tailored content like recommendations, advertisement, personalized prices and search results can be presented to consumers, based on observed activities on their devices. In this project, we focus on the list of installed apps on mobile devices.



Figure 1. Schematic view of the investigated process.

We constantly install, update, or delete apps on our devices to match our personal needs – thus making this data stream valuable for reality-mining. Figure 1 shows a schematic view of the process to generate personalized content (e.g.

recommendations, advertising, news and offers). First, an app (marked by the star icon) sends data about all the other apps on a user's mobile device via Internet to a service or content provider. Then, based on these data, the provider sends personalized services or content back to the user.

Prediction of Life Events and Life Stages [1]

Life events and life stages are often described as major forces that are going to shape tomorrow's consumer need, behavior and mood. Thus, the prediction of life events is highly relevant in marketing and sociology. It is important to detect events like getting married or starting a new job in order to improve customer services or conduct more effective personalized promotion. Today, firms proactively approach their customers through surveys, emails, phone calls, advertising, or face-to-face interviews to inquire about recent or upcoming life events – which is time-consuming and not scalable. Due to the nature of the events, they are very rare and thus it is nearly impossible to detect them in a timely manner with the present methods. We propose to use the list of installed apps to predict individual life events in real-time.

We developed an Android app which is described as a personality test game, where user can find out more about their personality and their life. Figure 2 shows two screenshots of the app. If the user accepts the privacy policy, a background process is initiated, which reads app installation logs from the device and sends it to a backend webserver. The user can choose between several personality tests. Each test is shortly explained and contains a questionnaire (Figure 2a). The result is illustrated by a spider

graph (Figure 2b). It is the main incentive to the user. 2092 people installed the app between March 27 and April 1.

On average, our prediction model perform 64.5%, 183.1%, and 88.0% better than random guess in terms of model accuracy, precision and specificity, respectively. The life event 'First Child' reaches the highest values for accuracy (93.5%), precision (50.0%), recall (22.4%) and specificity (98.4%). It is understandable because of the fact that there are many useful apps especially for that life event, like apps that support pregnancy, track child growth.

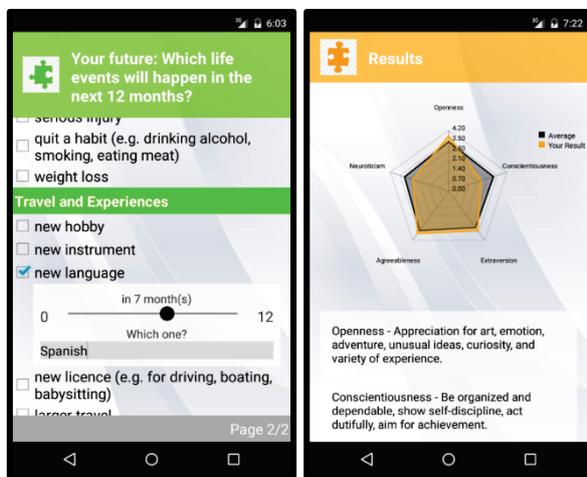


Figure 2. Screenshots: (a) questionnaire, (b) results.

Estimation of Digital Inventories [2]

Today, there are a number of young companies that help people to build their own digital inventory of personal items. Customers can overlook their products, manage the guarantee certificates, contact the manufacturer in case of a malfunction, use post-purchase services, etc. Unfortunately, they suffer from a big problem: Customers have to add all of their items manually into the inventory, which is cumbersome and user-unfriendly thereby preventing adoption. We propose to automatically build a digital inventory based on the list of installed apps. In the Internet of Things (IoT), selling smart physical objects together with a compatible mobile app becomes an upcoming trend. For instance, smartphones provide

dashboards to manage our smart home appliance (like heating system, light-bulb, key, TV) as well as retrieving and presenting data from our smart gadgets (like pedometers, body sensors). Using our previously described app, we analyzed the list of installed from 2410 participants. As a first result, we manually identified a selection of corresponding physical objects: 377 cars, 70 sports tracker devices, 4 smart watches, 11 dogs, 2 smart washers/dryers, 2 smart toothbrushes, and 67 printer devices.

User Tracking [3]

Since 2013, Google and Apple no longer allow app providers to use the persistent device identifiers for user tracking on mobile devices. Other tracking options provoke either severe privacy concerns, need additional hardware or are only practicable by a limited number of companies. We propose a lightweight method which overcomes these weaknesses by using the set of installed apps on a device to create a unique fingerprint. We evaluated the method in a field study with 2410 users. Furthermore, we reduced the granularity from apps to app categories in order to reduce users' privacy concerns related to the set of apps. Since the information of installed apps and app categories on each device is freely available for anyone who places an app on that device, the method is a valuable instrument for app providers.

References

- [1] Remo Manuel Frey, Runhua Xu, and Alexander Ilic. 2015. Reality-Mining with Smartphones: Detecting and Predicting Life Events based on App Installation Behavior. *International Conference on Information Systems, ICIS 2015*.
- [2] Remo Manuel Frey, Runhua Xu, and Alexander Ilic. 2015. A Novel Recommender System in IoT. *International Conference on the Internet of Things, IoT 2015*.
- [3] Remo Manuel Frey, Runhua Xu, and Alexander Ilic. 2016. A Lightweight User Tracking Method for App Providers. *ACM International Conference on Computing Frontiers, CF 2016*.

Serious Games

Nutritional education becomes fun



Klaus Fuchs
Ph.D. candidate and
doctoral researcher

Limited Effectiveness of Nutritional Education

Overnutrition is becoming an alarming issue all over the world: In 2014 over 600 million adults and 42 million children were affected by obesity with growth rates of epidemic proportions [1]. Education programs provided by nutritional experts have been proposed to counter the trend of excessive energy intake, identified as the main driver of overweight. Still, due to lack of financial resources, only a small part of society can be included in these personnel-intensive programs. Software-based Health information systems (HIS) in nutritional education have the potential to overcome these limitations, but still suffer under low end-user acceptance and interaction rates. Further, their current focus lies in abstract, too generic behavioral recommendations, which the end user cannot directly translate into health-beneficial real-world choices.

Preliminary Study of “Swiss Foodquiz”

In order to address these issues, we built an automatic HIS prototype together with the Swiss Society for Nutrition and GS1 Switzerland – based on product master data from GS1 Source (GS1 trustbox). The application is realized in form of a mobile Android app by the name of “Swiss FoodQuiz” and is tailored to support the average consumer in gaining nutritional knowledge by applying paradigms from visual

learning and serious gaming, established approaches in related fields to improve users’ acceptance, motivation, intention and ultimately likelihood for health-beneficial behavior changes. Preliminary results of a study with 350 users show high acceptance rates even for previously uninvolved users and measurable gains in nutritional knowledge over the usage phase. With the approach, which has been published [2], it can be shown that the extension of serious game principles to nutritional education can overcome contemporary HIS shortcomings of low acceptance rates among average, uninvolved and unhealthy users.

Design of Swiss Foodquiz

“Swiss Foodquiz” was inspired by the world’s most played educational trivia game Quizup, adapted to asking users to conduct a visual examination task requiring nutritional knowledge. The user task simulates choosing products at the supermarket shelves, as the user has to choose the one out of two similar, visually presented food products with the higher content of a relevant given nutrient, e.g. identifying the product with significantly higher amounts of salt compared to its substitutable alternative. A single round in the game is composed of ten questions that are randomly generated by the question generation algorithm. Before each round, educational elements provided by the Swiss Society for Nutrition teach the user about general nutritional facts, such as nutritional impact and recommended nutritional consumption quantities based on the user’s data. As product data base GS1 Source (trustbox) was chosen, as it is the largest, curated product data base in Switzerland and includes images of products. Swiss FoodQuiz was realized as native

Android application developed for smartphones, while the server side is realized as a RESTful, PHP-based API, used to store user entries and performance, as well as to load the generated quiz rounds including nutritional and image data for each of the twenty products randomly selected for each round of ten questions by the question-building algorithm. "Swiss Foodquiz" has been released in the Swiss Google Android Play store and has recruited 475 downloads within a two-months preliminary testing period from Nov. 27th 2015 to Jan. 27th 2016. In total, 350 users (74%) completed the mandatory, introductory survey and were admitted for usage of the prototype. Up to April 2015, almost 1000 users have downloaded "Swiss FoodQuiz".

Success: Reaching Uninvolved & Learning Effect

The user distribution is composed of a majority of females (19.7% male, 80.3% female), predominately adolescents and adults between 15 and 44 years of age and a realistic representation of the Swiss population's BMI distribution. Especially worth mentioning is that the majority of user base can be considered uninvolved in (nutritional) health, as they are physically rather inactive in their leisure time (58%) and state that their self-evaluation towards nutritional knowledge is average or limited (56%). Participation was entirely motivated through intrinsic, voluntary motivation, as there was no incentivizing scheme or enforced enrolment obligation applied within the recruitment process. Usage duration reached an average of 167 answered questions (\approx 17 rounds) per user, which can be estimated to equal circa 50 minutes of nutritional education. By receiving nutritional information while engaging with the game, users eventually gain knowledge about products and nutrients. Learning curves show that player performance starts at below 61% and grows to above 72% throughout the game, thereby doubling their performance when compared to pure guessing strategies (i.e. 50%). As learning curves follow

logarithmic paths, a logarithmic regression was applied on the subset of users who played multiple times within the same product category out of the 19 available main categories. Since the regression yields significance ($R^2 \approx 0.76$), the hypothesis of a positive learning effect is supported. Additional analyses also proved that the positive learning effect holds true despite the dropouts of users, i.e. short- as well as long-term users of "Swiss Foodquiz" gained knowledge and increased performances.

Conclusion and Outlook

"Swiss FoodQuiz" exemplifies that automatic HIS can indeed address (un-)involved adolescent and adult users, thereby teaching quantifiable gains in nutritional education and achieving high acceptance and interaction rates. Especially since the majority of users are uninvolved in healthy nutrition or physically rather inactive, and therefore unlikely to be reached by other contemporary interventions, serious games offer promising potential of enrolling the previously uninvolved and uninterested users and to eventually change their attitude, involvement and behavior in regards to nutritional education and healthy dietary intake [3]. As democratizing nutritional knowledge is a key element of obesity prevention strategies, such scalable, serious gaming based HIS can become a vital part of effective healthy strategies.

References

- [1] M. H. Forouzanfar, L. Alexander, H. R. Anderson, et. al., "A systematic analysis for the Global Burden of Disease Study 2013," *Lancet*, vol. 386, no. 10010, pp. 2287–2323, 2015.
- [2] K. L. Fuchs, V. Huonder, D. Vuckovac, and A. Dr. Ilic, "Swiss FoodQuiz: Inducing Nutritional Knowledge via a Visual Learning based Serious Game," in *ECIS 2016 Proceedings* (accepted), 2016.
- [3] L. Hebden, A. Cook, H. P. Van Der Ploeg, and M. Allman-Farinelli, "Development of smartphone applications for nutrition and physical activity behavior change," *J. Med. Internet Res.*, vol. 14, 2012.

HackZurich 2015

Retail Innovation Workshop

Hackathons are one- to three-day non-stop programming competitions and are becoming a new, viral phenomenon all over the world. The increasing number of hackathons not only includes small, regional events, but also large-scale competitions, such as NASA's "Space Apps Challenge" which attracts >8'000 developers in multiple locations at the same time. So, we at Auto-ID Labs thought that it is time that GS1 joins the hackathon mania and starts working together with mobile developers to create new, innovative apps that might become "the next big thing" in the retail. Therefore, we partnered with Swiss retailers to host "Retail Innovation Workshop" at HackZurich, Europe's largest hackathon.

Hackathons as Ground for Innovation

What is a Hackathon? Hackathons are programming events that usually take place over a 24h-, 40h-, 48h- or even 72h-time window and gather tech enthusiasts, e.g. app developers, software engineers, data scientists, creative designers, etc. to come up with creative, new, innovative software and/or hardware based solutions to a challenge. Hackathons have proven to be a true incubator for many ideas that turned into world-famous internet companies, e.g. Twitter. Therefore, more and more companies and organizations are sponsoring hackathons to collaborate openly together with developers to create applications on top of their infrastructure which might become valuable projects in the future.

Success Story: 25 Retail Apps in GS1's Track

GS1 and Auto-ID Labs joined forces with Swiss retailers Migros and Valora to host the "Retail Innovation Workshop" at HackZurich. In total, 890 developers participated in 2014 and 2015 combined, developing a total of 224 applications (See Table). Within our workshops, a total of 25 retail applications were developed at HackZurich.

	2014	2015	2016
Programmers	340	550	t.b.d.
Retailer	Migros	Valora	Valora
Total Apps	101	123	t.b.d.
Retail Apps	15	10	t.b.d.

Notable apps were 1) mobile Self Checkout which allows shoppers to use their own device to scan items at the shelf, pay within the app and not having to queue in line at the POS any more (Valora is actively realizing the mobile SelfCheckout), and 2) Swiss Foodquiz, which is a viral educational serious game teaching Swiss app users about nutrition, based on GS1 Source (Trustbox), has been downloaded >1000 times now and received positive PR in the media.

Why should GS1 engage at more hackathons?

Hackathons are ideal opportunities for GS1 to collaborate with young developers. Furthermore, Hackathons are nowadays a vital part of the developer community, which often is not yet familiar with the world of GS1 standards. In order to become more relevant in the digital space and spread adoption of standards, GS1 and its members should definitely keep an eye on upcoming hackathons.

<http://www.autoidlabs.ch>