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How Smart Are Smartphones?

Bridging the marketing and information technology gap.

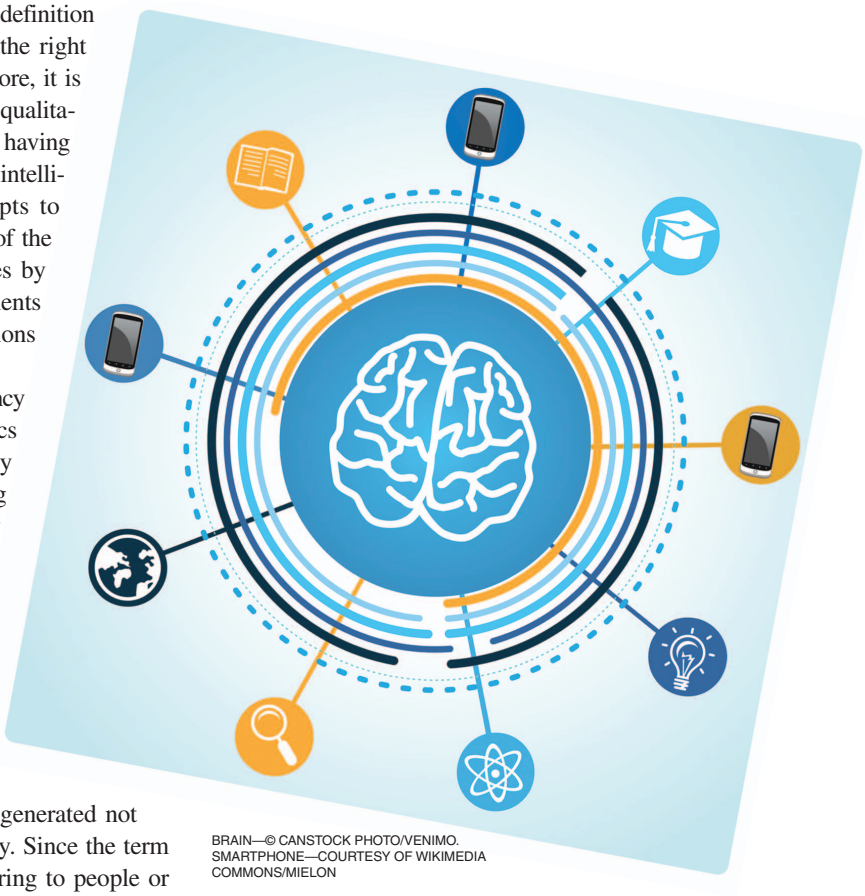
By Angelos Amanatiadis and Savvas A. Chatzichristofis

The term "smart" has become widespread in consumer electronics in recent years, reflecting the consumers' need for devices that assist them in their daily activities. The term has a long history of usage in marketing science as one of the most appealing ways of promoting or advertising a product, brand, or service. However, even today, there is much controversy in the definition of this term and even more ambiguities for the right use in consumer electronic devices. Furthermore, it is not possible to carry out any quantitative or qualitative analysis of how smart a device is without having some adequate conception of what a smart or intelligent application means. This article attempts to explore the smart and intelligent capabilities of the current and next-generation consumer devices by investigating certain propositions and arguments along with the current trends and future directions in information technology (IT).

The scenario of establishing a smart-efficiency classification system for consumer electronics equal to the widely known energy-efficiency classification systems would be very interesting for both consumers and industries. This new ranking system would lead to new challenges and competitions among consumer device vendors, which would favor the final consumer. However, this promising scenario is still in the future, and many would argue that is not even realistic, posing the question of how markets can massively adopt such a term without being able to measure or rank it.

This fundamental consequence is mostly generated not from the IT itself but from human psychology. Since the term is quite clear and understandable when referring to people or even animals, the transition from smart humans to smart devices seemed a great marketing tool. This easy adoption, however, has not been realized in IT or cognitive science. There is a great discussion on whether a machine can be intelligent with one of the main opponents being the philosopher John Searle in the famous Chinese room argument [1].

The Chinese room thought experiment can be summarized as follows: Imagine a native English speaker who knows no Chinese locked in a room full of boxes of Chinese symbols together only with a big book of instructions in English for manipulating the symbols. Imagine also that individuals who speak Chinese pass through a slot under the door strings of symbols that, unknown to the person in the room, are questions in Chinese. By following the instructions in the book, the man in the room is able to pass out Chinese symbols that are correct answers to the questions.



BRAIN—© CANSTOCK PHOTO/VENIMO.
SMARTPHONE—COURTESY OF WIKIMEDIA COMMONS/MIELON

The man inside does not understand the meaning of any Chinese character, but the room appears to behave as though it understands Chinese.

In this article, we will interpret the Chinese room in a different way, making broader implications of John Searle's argument, considering the room as a smartphone. We will make comparisons with the 1980s Chinese room and a future room enriched with some of the most emerging IT topics in ubiquitous computing. More precisely, the recent cloud computing, human–computer interaction, and the continuous enrichment of mobile phones with multiple sensory modalities will be discussed for exploring the underlying key elements of the smart

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and intelligent abstraction hierarchy in consumer electronics. In such a way, the boundaries between the sole marketing etiquette of smart devices may seem not too far-fetched from the intelligent capabilities that these emerging topics can offer to a next-generation device or service.

THE TRUTH BEHIND MARKETING SUCCESS STORIES

As discussed earlier, the terms "intelligent," "smart," "expert," and other fancy terms have provided great cover stories in previous decades. In the 1980s, artificial intelligence (AI) was shown in a form of a brain-in-a-box software called the "expert system." The media coverage was so huge that many companies rode that wave of enthusiasm to make their products public. A great industry grew up to support it, including software companies, such as Teknowledge and Intellicorp, and hardware companies, such as Symbolics and Lisp Machines, Inc. However, in 1987, this market for specialized AI hardware collapsed [2].

In the early 1990s, the first fuzzy-logic washing machine burst onto the consumer market, advertising explicitly the use of fuzzy-logic technology. Consumers easily accepted the term fuzzy as a novel intelligent technology. This impression of intelligence in an everyday appliance led to an extremely high record of sales and prompted major electronics companies to use and advertise fuzzy technology in many other consumer products. Marketing in conjunction with a previously nonexisting technology term was celebrating another success story. Today, however, the consumer must try hard to find the very limited versions of washing machines that use fuzzy-logic controllers. Furthermore, the biggest paradox is that the vendors of those limited washing machines do not at all highlight the term fuzzy logic in their promotion and marketing strategies.

Such examples are numerous throughout marketing history and even more are the explanations for their notorious endings, leading to the famous AI winters. While marketing raised the expectations, when the time came for the consumer industry to push such products into the mainstream, there were finally too many obstacles for such an adoption. The lack of support for mainstream hardware, the inability of smooth integration into existing systems, and the nonestablished design methodology were some of those obstacles [3]. The gap was very clear since the marketing effort could not then lower the barriers for making the adoption more sustainable.

In the early 2010s, smartphones arrived. Will they have the same ending leading to a new AI winter era, or can emerging technologies bypass the aforementioned obstacles, driving a new generation of companies and research efforts? Will smartphones finally be in favor of the AI critics [4], or will they take the place of robotics, which currently has the lead in AI applications [5], [6]? The future researchers will probably answer that, but, in the meantime, let us go back to the Chinese room.

INTELLIGENCE IN THE INTERSECTION OF CLOUD COMPUTING, INTERACTION, AND SENSORY DATA

The relation between the room and a computer or smartphone is straightforward. The book of instructions represents the program itself, the man inside the room represents the processor, the question in Chinese is the input, and the boxes of Chinese symbols represent the database. Finally, the answer to the question slipped under the door is the output of the Turing test [7].

Let us now imagine some different situations in the way or type of input that is passed through the room and try to guess the room behavior from the point of view of the people outside it. The first situation involves a young Chinese-speaking child instead of an adult. The young child is in his first steps of written language and understanding, and, thus, the questions that he passes to the man inside the room have some grammatical and syntactical errors. The man would probably still provide the correct answers, but, since the codebook had not foreseen these kinds of errors, the answers could include some syntax or spelling errors. In that case, the room would be characterized by a different level of smartness compared to the initial example.

In the second situation, one Chinese-speaking person spells out loud the sequence of strings constituting the input question instead of writing it. Surely, in such a case, the people outside would not receive a correct answer and would agree that the machine did not understand the question. Finally, if the string passed to the room is in Greek letters, the man inside, without having a book of instructions in English for manipulating Greek letters, would not again answer the questions.

For all three different scenarios, the perception of the outside observers is conceptually and empirically correct, giving no or a lower level of smartness to the machine or room. Clearly, someone would argue that the aforementioned scenarios would need a different realization of the room, and this is the underlying concept. All three different cases highlight the current demands from the end-user side, seeking more advanced capabilities.

CLOUD COMPUTING

Let us start by discussing the last situation first. Answering the Greek questions correctly would at least require a codebook for manipulating Greek letters along with boxes of Greek letters. However, if there was another room connected with a closed door behind the primary room, maybe the man could pass the Greek question to the person in that room, hoping that he would receive the correct answer in Greek. The new room is exactly like the previous one, with a native English speaker, but with a different codebook and boxes. If the man in the second room cannot use his codebook, since it might be for different symbols other than Greek, he can just pass it to the next room. By following the same sequence using many different rooms, someone would finally reply correctly in Greek. Since all of the other rooms cannot understand it, they just pass the answer back to the first room, which finally gives the correct answer to the people outside.

The final perception of the outside observers would be that the room correctly answered the question but the response was not fast enough. Cloud computing hides the same

attributes [8]. More precisely, the room interconnection can be seen as the mobile phone cloud interconnection, offering many possibilities. The new services will include a vast variety of applications and services with one of the most promising ones being machine learning as a service, where vast amounts of training data would be available through the cloud. The observed latency is the only drawback of such a service, which will soon be resolved by next-generation mobile communications.

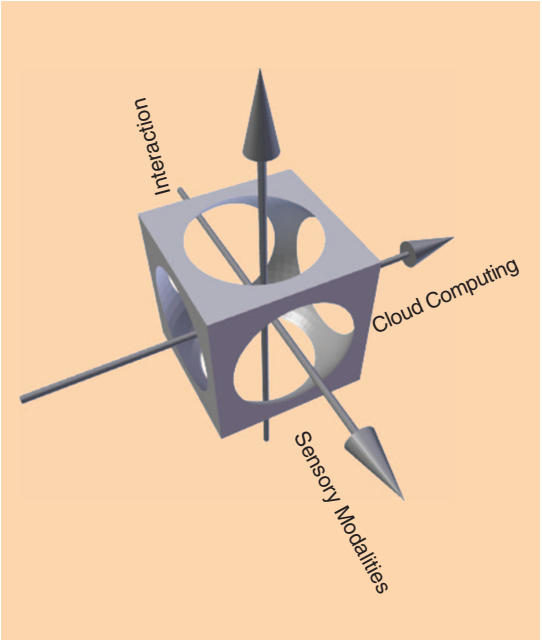

FIGURE 1. Smartness at the intersection of three different mobile emerging technologies.

HUMAN–COMPUTER INTERACTION

In the child scenario, an interesting link might be developed through the series of interactions between grammatically incorrect questions and the codebook-filtered answers. The man who does not understand Chinese not only provides answers that the child understands but also helps the child improve his or her grammar and meaning comprehension. The meanings that were communicated through this interaction lead to a paradox of a man who does not understand Chinese being able to make a child smarter in terms of grammatical structural rules.

SENSORY MODALITIES

Spelling out loud the sequence of strings constituting the input question in Chinese would be of no use to the man inside the room since he could not correlate the Chinese symbols of the boxes with the spoken symbols. In such a case, a tape recorder would be very handy along with a tape of the codebook and the spoken symbols. In this scenario, hearing the instructions for manipulating the spoken symbols again does not create any understanding, but it gives the opportunity to the man not only to answer on paper but also to speak it aloud.

Equipping the room with additional sensory modalities would mean additional syntactic inputs, but, again, they will do nothing to allow the man to associate meanings with the Chinese characters. This scenario meets Searle's argument against "robot reply," which supports that a digital computer equipped with sensors in a robot body, freed from the room, cannot attach meanings to symbols and actually cannot understand anything except the rules for symbol manipulation.

However, since the man or robot is inside the room, the only reasonable solution is to adopt the aforementioned cloud computing and interaction capabilities. The integration of these trending technologies in the room would finally give the man the ability to attach meanings to symbols and probably to understand the natural language. This intersection is likely the key element for bringing new dimensions to the room and, by extension, to our next-generation mobile phones as shown in Figure 1, with the communication between these modules being equally important.

CURRENT TRENDS AND APPLICATIONS

Smartphones have penetrated the market and will surely be the standard definition when referring to mobile phones, as shown clearly in the Google search trend shown in Figure 2. The major factor behind this trend is the enormous popularity of the mobile applications that are available to the users for download to their devices.

When comparing the trends of smartphones along with the explosion of mobile applications, the question that arises is whether the applications make the devices look smarter or vice versa. In comparison with the Chinese room, this question can be restated as: who defines the intelligence, the room itself or the answers that it gives?

Since mobile applications are on the rise, many of them have already adopted cloud services, interaction, and multiple sensor features. They support a diverse range of services and daily life activities from Web browsing to georeferenced situational awareness, trying to enter the market as smart or intelligent applications.

In Table 1, we list a collection of applications that have been introduced to the market as intelligent or smart applications. Apart from the brief description, we present the level of integration of the aforementioned emerging technologies. As it can be seen, all listed applications have fully or partially integrated these technologies into their software core. Taking advantage of interaction, cloud computing, and sensory modalities allows for the market promotion of such an application to describe its software functionalities in a smart and intelligent way using terms such as "learning," "predicting," and "training." One surely

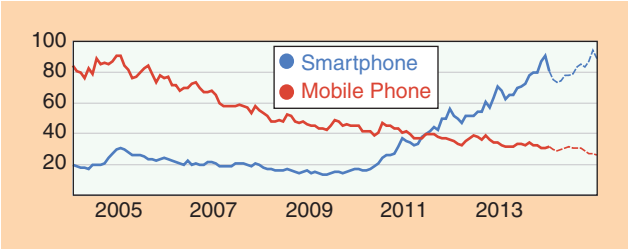

FIGURE 2. Google search trends since 2004 for the terms "smartphone" and "mobile phone."

Table 1. Smartphone applications that have integrated cloud computing, interaction, and sensory modalities.

Application Name	Brief Description	Cloud Computing	Interaction	Sensory Modalities
Siri/Google Now	An intelligent personal assistant that uses a natural language user interface to answer questions, make recommendations, and perform actions by delegating requests to a set of Web services.	●	●	◐
SwiftKey	It predicts next words and phrases before the user types them. Extended use improves its accuracy, as it is able to learn writing styles and favorite words.	◐	●	○
Foursquare	A location-based social networking application that uses a model training engine to automate learning from user data.	●	◐	◐
Random	A predictive discovery engine that learns from the user. The more it is used, the better it gets.	●	●	◐
MyCity EPFL	The application learns from the information that users provide and their behavior on the spot to notify them of the relevant points of interest in relation to their preferences and other external elements such as the weather or time of day.	●	●	◐
Tempo Smart Calendar	A mobile productivity app that imports events and applies AI and machine learning to provide more contextual information for tasks and events throughout the day.	◐	◐	◐

●: Fully integrated, ◐: Partially integrated, ○: Not integrated. Note: All listed applications are native applications and can be downloaded freely.

cannot make the judgment that the use of these capabilities automatically makes an application intelligent; however, the consensus is that smart applications make effective use of them.

By examining the level of integration between the applications and the emerging technologies, it is clear that there is a great potential to enable even "smarter" experiences to consumers by using mobile phone platforms with more embedded sensors, faster cloud services, and enhanced interactions [9]. More sensor modalities means more ways of human and environment interaction while faster cloud services can achieve better and richer data mining.

Revisiting the question of the whether the applications make the devices look smarter, or vice versa, we can answer in the following way: It is the mobile apps that make the smartphones look smarter, but the smartphones themselves provide the technologies and functionalities to support such apps. With this implication, finally the marketing and IT gap will be substantially reduced.

CONCLUSION

In all three different scenarios of the Chinese room, the main claim remains the same as the one in Searle's initial thought experiment. The man inside the room does not understand Chinese, but the room manages to give the right answers to the new challenging questions by adopting new concepts and models. The new generation of mobile phones will probably not be intelligent according to Searle's formalism; however, they will surely provide smarter services in a rather explicit way. Integrating these three emerging trends and concepts into mobile devices would allow the next-generation consumer electronics to be adapted to the current demands and needs of the users, allowing us to discuss the strong AI issue in the near future.

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