"The Rise, Fall, and Resurrection of IBM Watson Health"

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1 Introduction

1.1 Background

IBM has transformed multiple times in its long life as an organization. Officially established in 1911, IBM is an organization focused on the manufacture of tabulating machines. Upon its establishment, IBM underwent 3 major structural transformations to cope with the changes in the business environment. The first time was a bet-the-business gamble on the legendary System/360 in the 1960s, which lay the foundation of the overwhelming 'Big Blue' in the mainframe era[1]. The second turnaround of IBM happened in the 1990s. Louis V. Gerstner diversified the business of IBM with a focus on global service[2]. Striding over the new millennium, IBM experienced a series of changes from the frontiers of a smarter planet to the CAMSS (Cloud, Analytics, Mobile, Social, and Security). The IBM Watson, *a cognitive computing technology*, has been created to support IBM's new strategy of being a leading cloud platform and a cognitive solutions company.

Deep Blue (a computer chess-playing system) is an earlier initiative of Watson. Dating back to 1997, Deep Blue beat the leading chess player in the world at that time, Garry Kasparov, bringing significant credibility for IBM in artificial intelligence. The potential and probabilities of Deep Blue inspired IBM to subsequently develop Watson from 2004 on to undertake 'Jeopardy', a famous quiz show[7]. Unlike chess game where rules and solutions are limited and well-structured[3], 'Jeopardy' requires the player to process unstructured data (such as natural languages) that neither has a pre-defined data model, nor is organized in a pre-defined manner[4]. In 2011, after defeating two human competitors in the famous quiz show 'Jeopardy', IBM Watson gained worldwide attention[5].

Watson's ability to incorporate facets of artificial intelligence (AI), such as machine learning, expert system, and natural language processing represented a substantial step forward from Deep Blue, and ushered in a new era of computing: The 'cognitive' era[6,7]. The definition of the term "cognitive computing", coined by IBM to describe the capability of Watson, is debated[8]. Nevertheless, here we define cognitive computing as *a subfield of AI, which focuses on making computers to understand, reason, learn and interact as a human*[9].

IBM did not stop there either. After Watson won *Jeopardy* in 2011, IBM has been engaged in multiple explorations of how to best apply Watson[10] (Figure 1 illustrates critical events of Watson and interest of the public towards Watson over the period 2010 to 2020). IBM soon turned to healthcare as the best place to plant its flag.

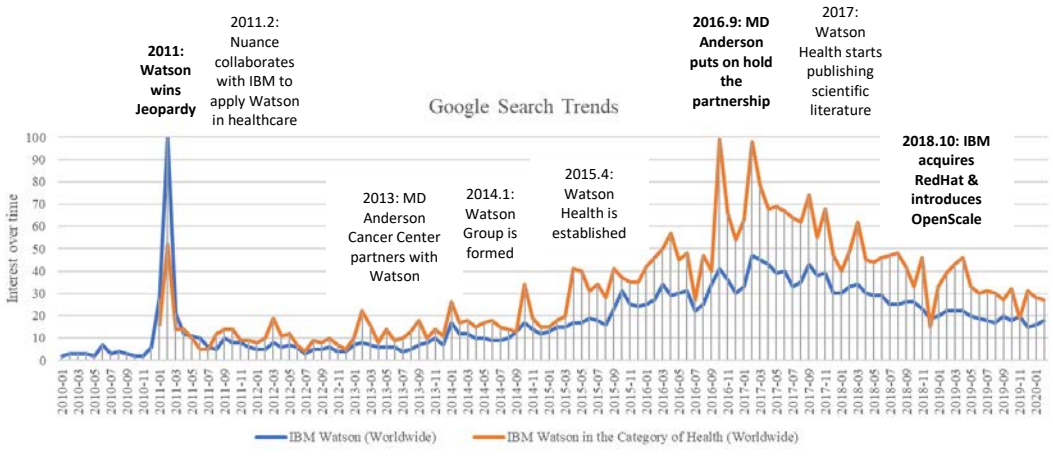

Figure 1. Critical events of Watson and public interest towards Watson over the period 2010 to 2020

So far, so good. IBM had a clear lead in the healthcare market, and invested significantly to build upon its edge, targeting this extremely large market where its technology could really make a difference.

However, applications of Watson in healthcare did not go off as expected. One particular moment denoting challenges was the decision of the University of Texas MD Anderson Cancer to withdraw from its partnership with IBM Watson in September 2016. An internal audit of the University of Texas found that the university had spent over 62 million dollars (not counting internal staff time) but did not meet its goals.

Even more widely, Watson's business performance was less than optimal. Watson Health just managed to break even in 2018, after massive layoffs. It must be said that IBM Watson has not delivered the results that IBM expected, thus raising the question "why did IBM Watson fail to generate significant profits?"

This report taps into this question from the point of view of the appropriability problem – the inability of an innovator to profit from its innovation[11,12]. Until now, the appropriability problem has been connected to other actors imitating the innovation (with strong patent protection considered as one solution to the problem), and/or to the lack of complementary assets that allow efficient commercialization[13,14].

However, IBM structured itself for success properly in this regard, with a strong brand, significant financial investment, deep technology, and strong IP protection. The question then is, why IBM fell short in appropriating value from its innovation – against expectations? What is it doing now to correct the problem, and what can the rest of us learn from this experience?

To address these questions, the first author (under the supervision of the second and third authors) conducted around 60 interviews with managers and experts who were involved directly or indirectly in IBM Watson's launch and operations in health care. All interviews were conducted under promises of strict confidentiality, so that respondents could feel free to express their opinions candidly. In this white paper, we report some of the main findings from this work. Appendix 2 contains a list of the people who were interviewed in the course of this work, by title or function and their current organization.

1.2 Framing of IBM's appropriability problem

We suggest, that generally speaking, *appropriability* can be defined as the *potential* to benefit from innovation founded on instruments (such as patents) that allow (but do not necessitate) protection and control over innovation for the innovator. Depending on whether these instruments provide adequate control, and – more importantly – on how they are used, this potential can be *realized*: actual *appropriation* depends on how well the instruments and their uses match the context and related contingencies.

Following the logic of limiting imitation and securing commercialization, innovation appropriability builds on *isolating appropriability mechanisms* and *complementary assets*. Intellectual property rights (IPRs) and contracts fall under the category of *formal* appropriability mechanisms that protect innovations through statutory means[15], while secrecy, lead time and complexity of design represent *informal* mechanisms that are strategic and usually non-statutory[16,17]. Appropriability regime, consisting of isolating appropriability mechanisms, is regarded as strong, when the innovation is protected successfully from imitation[18,19]. Beyond preserving the inimitability of the innovation, complementary assets such as marketing and sales capabilities, and control over distribution channels promote appropriability by supporting commercialization and benefits such as revenue streams accruing from innovation.

IBM Watson's appropriability regime and its complementary assets can be both regarded as strong. For example, IBM has received a large number of patents on its Watson technology (shown by Figure 2), and the brand can be considered more than adequate to promote diffusion in the markets. Therefore, current theories of appropriability would predict that IBM Watson was supposed to be a winner from the beginning. However, Watson performed against IBM's appropriability expectations. In IBM's case, despite the appropriability (potential) being high, appropriation (realization) was low. That is, the realization of the existing potential did not happen as expected. This inability of IBM to benefit from Watson seems to introduce a very specific type of appropriability problem. In order to be able to understand the nature of this problem, we conducted an empirical examination, and collected qualitative data on Watson. The method used to collect and analyze data can be found in Appendix 1.

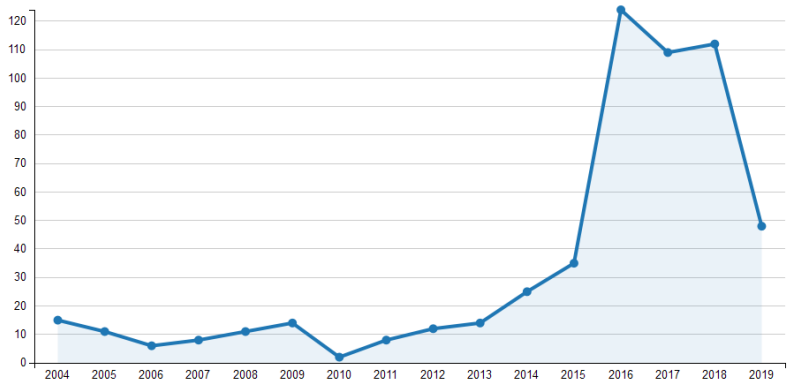

Fig. 2 Patents received by IBM on Watson (558 in total)

Notes:

1. Patent Inspiration, a (weekly updated) multi-national patent database was used for searching and analyzing patents.
2. Counting criteria: (1) one patent per family, (2) patents without empty title or abstract, (3) patents are granted, and (4) publication period: 1st January 2004 to 29th February 2020.

2 Insights into IBM's appropriability challenges

From our examination of the empirical materials, it can be seen that IBM Watson, in fact, had all the traditional means in place to have high levels of appropriability. However, the specific nature of the technology, combined with the environment in which it was placed, led to a somewhat unfavorable situation.

Our qualitative data indicates that AI (and Watson) is a General-Purpose Technology (GPT)[20]. General-Purpose Technology (GPT) is a term used by economists to designate technologies that have many possible uses across society. Even when protected with patents, and when supported with a strong brand, promising reputation, and good connectedness to different actors, features of a GPT caused hurdles to profit from innovation.

First, looking at Watson more closely, the notion of use cases recurred frequently. In essence, Watson was not particularly attractive as a ubiquitous creation, but it needed to be linked to specific uses – and this is where the challenges emerged. Finding these specific uses is time-consuming when done alone: IBM's decision to pursue various use cases for Watson entirely on its own was too restrictive (e.g., IBM released limited publications and no APIs or SDKs at the early stage of Watson's promotion[21]). This limited IBM's ability to be able to explore widely and identify the best use of Watson. In particular, the decision of selling Watson Health to hospitals and hospital administrators was top-down, which restricted Watson to be in the hands of a limited number of appointed physicians. As a result, the capability and limits of Watson, a GPT, was not fully understood at the beginning, and it only became gradually known with over-time reviews and developments taking place in many different areas. It greatly inhibited the discovery of the best ways to use this GPT.

A second limitation for Watson emerged from the need to connect it to the underlying complementary technologies that generated challenges: In our interviews, the needs to be open up data access, to learn from other actors, and to increase transparency came up frequently. For example, IBM Watson requires significant data to perform its technical tasks, so extensive data access is required. Also, IBM Watson's output must be validated against other data, requiring Watson's results to be shared and interpreted by others. Extensive iteration with both inbound and outbound data is required to calibrate Watson's algorithms and improved its predictive performance.

Third, and related to the general-purpose technology features and closed approach of Watson, timing proved to be quite important. Having a good example in winning Jeopardy, Watson was loaded with high expectations very early in its development. However, there is a long delay between the introduction of a GPT and the understanding of how to best utilize it. Different actors with different needs and perspectives need different timeframes to adjust their thinking and see the potential. Because of the limited number of areas IBM was able to explore for using Watson, we cannot tell whether there were other areas where Watson might have performed beautifully.

The following four tables show the concepts and themes that figured prominently in our analysis, along with illustrative quotations from the interviews. These show the details behind the main issues.

Table 1. AI is a General-Purpose Technology (GPT)

Themes	Concepts	Illustrative quotations
Evolving from prototype to use cases	AI is generic	"It's again, with Watson Health and Watson in generic terms. It's like AI, you know AI, it doesn't mean anything to you if you don't define specifically the use case."
	Watson can be applied to different industries and use cases	"Watson for communications, Watson for healthcare, Watson for retail industry. Then a lot of… lot of… lot of industries that they had."
	Watson is embedded in IBM's various products	"IBM was talking about the cognitive service, actually it is most the AI service, over-sharing service, using the natural language processing in machine learning models. We were asked to add the cognitive technologies or service into every product when I was in IBM."
	Watson has specific applications according to the need of customers	"Deep Blue, IBM Watson, etcetera, they're trying to create specific applications to customers."
Need for experiments to find the best way to use	Lots of use cases	"You can take IBM Watson to finance, it like audits, it can go into complex legal, you know all the text and text search and all of their etcetera complex legal cases. It can get into marketing like a lock's clicks in all of the analyzing who can be your next customer. It can look at overall social sense, looking at all the Facebook data, Twitter data, and all of that stuff. And it can even predict upsell, cross-sell, in a seller's situation. There are lots of use cases Watson can do it. It's a supercomputer."
	Proof of concept	"There, you have, you are conducting some proof of concept with Watson. The proof of concept is just trying something out."
	Need for intelligence to think of ways to use Watson	"When you discover things, you have to cast off all the preconceptions. You have to be a genius to think of ways to utilize Watson. We have big computers now that are pretty powerful and not as powerful as Watson, but they're pretty good. So it takes a genius to figure out how to use it, just like it took a genius to figure out how to use phrases, platelets, plastic bags, white cells, combination chemotherapy, all that stuff took geniuses."
	Watson is good at particular things	"Every platform always gets sometimes oversold to you and then you know, you think that you can solve every problem, but we are not naive exactly. We know that these systems have limitations and we work with them, but wasn't like, you know, it didn't do anything of what they said it would, 'Oh, I did.' Hum...they were good systems, but the... you know, as with any software, I mean today, years ago people saw was the big ERP program nowadays, and everyone's doing work day or something like that, so you have to see which one is good for whatever you want to do. So I would say it's a little bit unfair to say 'Oh, Watson was not a great platform.' I think it's a good platform for particular types of things."
	Watson cannot do everything	"I feel sometimes, they open market a little too much [soft laugh]. You know, they try to say you can do everything… And people have to understand that these pieces, these machine learning models especially are very very specific sometimes to particular...especially in healthcare to particular analysis situations. Can't we just...can't use it on everything."

Table 2. Premises of appropriability

Themes	Concepts	Illustrative quotations
Formal appropriability mechanisms	Strong IPR	"So most of the technology is patented at the IBM, like 7000 patents in here with some stories. There's licensing avenue. They can come back."
	Contractual control (e.g. agreement, license)	"…at least, two years ago, one and a half years ago, IBM was more in the licensing part that… we have the IP on Watson and we allow partners into it, but we don't give, or the IBM doesn't give the IP out for free."
Informal appropriability mechanisms	Complexity of Watson	"So now what we're seeing is the team has kind of realized this. And when I say the team, you'll realize what is not a single team. Watson is maybe 200-300 clusters of teams focused on different items."
	IBM is early in the market	"I think IBM is very early in coming out with its patent. They invest a lot in research, and technology. There is the...so IBM traditionally comes out very very early with good patents and good products."
Complementary assets	Access to customers	"IBM, obviously, they've got access to big large enterprises, outsourcing and all of that stuff etcetera. I think they are making it as part of it."
	Relationship with customers	"[Our organization] has a very deep and long-standing relationship with IBM."
	Marketing campaigns of IBM	"So the thing, you need to know about Watson is that it is an incredible marketing campaign. It was[pause], you know, the challenge 10 years ago, is that people really didn't understand what AI was. This they don't today, but they understand it more. You know, people heard AI and like, oh, it's a computer that you talk to and it just does everything for you, right? Or it's a robot that is going to take over the world, right? To take it terminate. IBM really changed the game by focusing on and changed it with the word Watson. And Watson was just kind of reintroducing the concept of artificial intelligence. So, it was thinking, taking the... hum, you know, as I said like Deep Blue. I guess I kind of understand that it was like, you know, kind of a gaming approach like I don't know if they used it to like play go or something. "
	Strong brand[22]	"So IBM has obviously branded themselves very well, compared to a lot of others."
	Inside R&D of IBM	"So one of the things IBM excels is, in doing fundamental research and putting these projects in… so basically filing patents and then there's a commercialization division which looks at how we make money out of those patents."

Table 3. Openness

Themes	Concepts	Illustrative quotations
Watson Health is closed	Watson Health is not accessible by developers	"The Watson for health is still closed. I don't think, there is anything open there for developers to go and access it."
	Watson Health is not open for small-size companies to engage with	"They haven't opened their product platform, for innovative companies, their platform and their service model or their sales strategy is focused on very very large established companies."
	Limited opportunities for doctors who are interested in it to try it out	"Very limited knowledge about it. Yeah, of course, that's not an indication of my interests… high-interest, little interaction operation. And I think that's mainly due to just limited opportunity."
	Public impression of IBM as a closed company	"I assume they are closed because just in my impression [laugh] company. I don't know it's open or closed, but I assume this is closed system."
IBM's complexity and segments	IBM's complexity makes it tough to collaborate and be engaged	"I would say it's just their cost model, its multitude of products, very complex sales cycle, complex, complex pricing structure, makes it tough and to collaborate, and at the same token, we are working on a joint collaboration on couple of opportunities with IBM and so on."
	Segmented departments	"It's a complex to IBM, it's not one singular, you know, the guy who does Cloud doesn't really care about virtualization. The guy who works over the virtualization doesn't care about the Cloud."
Selective visibility	IBM does not publish as much as e.g. Google or Facebook	"They don't publish as much as Google or Facebook publish."
	Restrictions on publishing	"I know that they published some open models, but they don't do everything sometimes also, because they can't, because some of that is called IP, like something that they've developed with another University or institution."
	Understanding limited by publications	"But where would their understanding come from, about Watson? So where would they get that understanding?"
Need for transparency	Lack of transparency brings doubts about Watson	"If you protect something very well, and then it's not succeeding, people aren't going to assume you're protecting it because it's a valuable trade secret. They're going to assume you're protecting it because it's embarrassing, right?"
	Transparency influences human's trust and acceptance in Watson	"It gets to the situation where the customer sees that the black box and they don't understand what's going on inside the Box. And then, it's kind of like it lows the trust."
	Transparency is related to the chance of buying it	"In healthcare, we are dealing with people's lives and we can't just… you know, even a physician will not just say 'All the machine told me to do it.' You know, they will want to know how the machine arrived at that decision. So for company says, 'oh we can't tell you how it's doing that.' , the chances that anyone will buy that software pretty low."
Need for data	Need of professionals to provide and feed in data	"And I think one of the big issues we found that was that to provide that much information, you know, it really required very trained medical professionals who had umm dedicated time to be able to umm analyze and bring these references and then feed that specific information to Watson"
	Need for a lot of work to feed in updated data	"But the problem will be how are you going to be constantly updating somebody who knows medicine should keep updating this, and feed this information into the system, so it can be up to date reliable, so

		a lot of work."
	Need for a lot of work to evaluate publications and information	"And all interesting stuff being published, and the data published are either become standard of care or it just it's meaningless data. So I think uh it's really really challenging for the AI system or Watson, whatever might be to keep updated with that, because although the abstracts are published, but there's a lot of garbage. So it's going to be quite a bit of work to analyze what is relevant, what is irrelevant."
	Hard to access healthcare data	"Data is not centralized. It's hard to access. You know, we have it in silos. It's not very well integrated which makes it harder to run and develop kind of models against to do deep learning projects and things like that."
Need for collaboration	Need to collaborate for data	"I think we may also work with business partners. That's one more aspect. But if it's all clinical side, you don't do anything without having the clinical professionals involved, so that's absolutely mandatory. But at the same time, health care service provider has the data somewhere. So it needs to be in collaboration with the ICT part of the health care of all their ICT provider to get to the data."
	Competition together with collaboration	"It's a world where you have to compete, as well as you have to cooperate with your adversities in the industry."
	Open platform allowing multi-cloud access	"I think Watson wants to be an open platform as just as AWS, because they are just announced yet. Watson service will be available across the different cloud vendors, or cloud services. Then we were not the... um, or we are offering IBM cloud that you can be used on the Microsoft, too, or you can be used on the AWS as well."
Embracing and contributing to open source	IBM has been working with open source	"IBM started to move towards using open source long ago. We've been probably the first large windows to really embrace the open source. We had the first Linux Versions running in the mainframes like almost 20 years ago already. And it's been a long journey with open source, and that's probably one another thing that, you know, the public doesn't know that how long IBM has actually been working with open source."
	Watson embraces open source stuff	So IBM Watson is underneath its machine learning platform. It used lots of open source technology like Kafka, and the other open-source stuff. And then on top of that, IBM developed its own application, for example, Watson Health is one of the examples that use...that's kind of solution-based solution based using machine learning platform. And also recently, they are available big Cloud providers like AWS, Google as well and also Google Cloud."
	Watson competes with technologies which are open-sourced and moving faster	"They're bringing in the IBM Watson it with that platform. But there is another war, another world that is bringing up, you like the open source technologies and all of that. That's where the two battles are coming, you know. Both are winning at this point at the time but open source like a moving, like a lot faster in my opinion."
Investment	Acquisitions for developing business	"I remember it was his idea to develop this new business in health care industry, then ask it, again make a few acquisitions, real positions, Explorys, Truven Analytics, and also the other one in Texas, so this is the beginning of the Watson Health."
	Need to invest by both IBM and customers	"So IBM is also investing, significantly, and at certain places, customers are also investing significantly, but when they don't see the result immediately then they drop them, and all of them etcetera."

Table 4. Maturity

Themes	Concepts	Illustrative quotations
AI's opportunity time	AI needs experiments and investments	"I mean unless you see commercial benefits coming out or return on investment, all other intangible benefits, I would say it's not a common commercial success yet. But you know, I'm curious still now. … The whole AI system out there in the market which is turning profits. Lots of these are experiments, people are doing lot of industries are putting money in, so instead of putting money into generic ID projects, now CIO and CEOs, all want to have AI system and that's what where they're investing in."
	AI now built into many products	"Common person like you and me who can then use AI in their daily life, you know, think about it, your phone, it can listen to you and it can suggest to you without you even… excuse me asking it to do, so, it's all because AI is now built into so many products, so many apps that you don't even know."
	AI's important role in future healthcare	"I think there is an opportunity for, you know, AI to play a very important role in the future of healthcare. I would say more AI. It could be IBM Watson. Huh. It could be Google TensorFlow, and Microsoft AI etcetera. I think these have a potential to play huge whale role on healthcare and particularly on top of this one, it's the Apple watches and smartwatches which are feeding the data, the pay and even for type 1 diabetes, etc. where you insert a… you know, watching your insulin and all of that stuff."
	Need of technological improvements to boost AI's development	"So, you know, timing, I think it really just has to do with, you know, machine learning and you know, the historical timing of that, right? However, in the 1960s, machine learning was incredibly exciting. It was super excited about it. But then we realized that computers couldn't handle the computational load required to run a neural network. So, kind of fell off. But once video games picked up and, you know, the first decade of 2000, you know, 2000 to 2010. We saw a computer game company is developing these incredible, graphical processing units should be used that, you know, we're capable of running these neural networks. So machine learning really had a resurgence around 2011, and until today. So I think the timing is just as most, the most things are driven by technological improvements that allow us to run these neural networks."
AI market is not mature	Gap between R&D and commercialization	I feel like probably, somebody just bought everything that was said or maybe hyped it up even more. And they didn't really truly evaluate whether this thing was going to be able to do what they thought it was going to be able to do.
	Abused use of the term AI leads to decreasing market trust	"But all these items had Watson and Watson really utilizing... some of them weren't even utilizing that much AI or very simple AI models. And so, I think that's where we lost a lot of the market's trust, right?"
	Overpromise	"There are some gaps between the business team and the research and development team. I think this is not a problem in IBM, it is a problem in many other companies as well. Maybe the business team promises too much that they didn't realize there are some limitations, and in reality, when the product comes out, it may not meet this promise. So, I think this is a reason they decided not to continue the services, but I'm not very familiar with Anderson's use case."
	Hyping of AI	"Personally what I think happened was that sellers got a hold of this idea of Watson and started talking about it beyond the actual capabilities. And they reintroduce that idea of, you know, General AI. You have this problem Watson can solve it. Oh, you want to categorize a bunch of, hum, autecology data that Watson can do it and

		that was kind of the conversation. And they didn't really think about it in... Okay, you know, AI is not one application. AI is a series of statistical models that are designed to do one specific thing and need to be kept up and need to be monitored for bias, need to be[pause]… You know, constantly tended to like an unruly plant that continues to grow and get crazy."
	Understanding level of individuals is different	"There's a lot of perceptions from the management, from the doctors, and they probably see the new technologies as a threat or a... not for themselves, but the threat for the quality of the healthcare overall. They don't understand it enough yet."
	Digital expertise from customer side is needed	"That's the thing that people used to think that 'Okay, we just fit AI bit by bit inside our company. We get one application there, and then we got the other one here.' And it gets too fragmented if digital transformation strategy is not built from the ground up. And that's where companies and organizations are now struggling. So they don't have enough expertise or in-house expertise to think about the strategy well enough."
	Information management consumes a lot of time	"I am going to use artificial intelligence, to get some insights. It's from this data. Yeah? And you spend 70% of your time, actually making the data useful enough, or converting it to a form. That is, that, your AI tool can use. So you're actually spending very little time actually using the tool itself, the AI tool. You're spending more time, most of places, people spend more time trying to get the data in the form that is compatible for using the tools. "

3 Summary

To conclude, we found that the GPT character of Watson, combined with IBM's overly closed commercialization of the technology, likely accounted for why IBM failed to profit from it. To its credit, IBM seems to understand this, and is now taking actions to correct the problem. IBM's recent movements towards openness (e.g., the introduction of OpenScale[23] to allow Watson to be used across clouds) helps mitigate this appropriability problem, representing an opportunity to resurrect Watson. Even today, however, Watson Health is kept still very closed (no APIs are available for the technology in the Cloud as of this writing), which awaits efforts to make it more open.

Figure 3 shows the model we built to visualize how to address the appropriability of a GPT by being more open. For a GPT, multiple experiments are needed to find the best application(s) for the GPT. These experiments yield two results: success or failure. Successful experiments tell innovators where to apply this GPT and what kind of actions are suitable, while failed ones tell where not to go. At the same time, there are future, unknown experiments whose results are unknown. Successes and failures can pave the road for the ongoing and future explorations in terms of, for example, settings and ways of working. Together, these experiments reveal what kind of appropriability mechanisms and complementary assets are useful, and how they should be used when interacting with different stakeholders, for example.

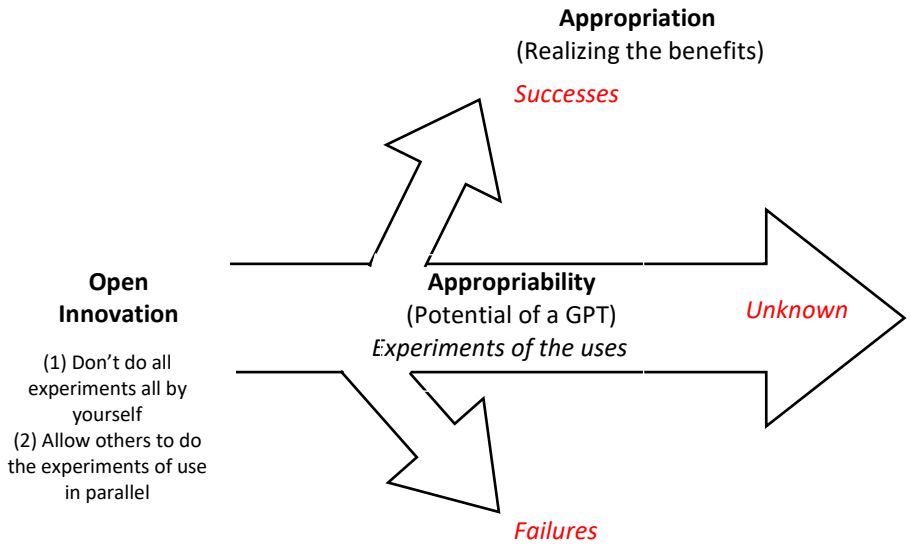

Figure 3. Addressing appropriability problem of a GPT by being more open

Overall, we can learn two important lessons of Open Innovation from Watson. First, for a GPT, an individual company is not advised to do all the market experiments (the "use cases") by itself. In addition, during the experiments, it is important not to overinvest in things that are overly specific. For example, during the collaboration between Watson Health and MD Anderson Cancer Center, both IBM and MD Anderson invested a lot, but their co-developed Watson Health went nowhere – it was unable to go outside MD Anderson (as was originally planned) due to regulations and privacy issues. Nor can it outperform physicians' own diagnoses within MD Anderson, due to the technology limitations of Watson. The decision to cancel the collaboration ended up damaging the reputation of both parties.

Second, allowing outside players to do experiments in parallel can speed up discovering the best applications of a GPT. In the practice of Open Innovation, if a firm has a GPT like Watson, it can consider building a platform underlying

it to provide access points to outsiders, so that others can apply the GPT to the places where they want to pursue and bring things in. IBM Watson OpenScale is an example of a platform allowing not only the direct partners of IBM, but also the whole AI community, to do experiments on Watson[24]. This may lead to a brighter future for Watson in health care.

There are lessons here for any company seeking to commercialize a broad, powerful technology like AI, especially in such contexts where it is highly difficult for any single actor to set the direction for the sector in question. In fields like healthcare, where Watson tried to enter, the versatility of motivations, need and demand, traditions, and norms make it extremely challenging to identify one valuable way to employ general-purpose technology. No single company can explore all possible ways to appropriate value from innovation on its own. Therefore, it is a good, if not necessary business practice, to carefully consider what can be done with the technology and the associated appropriability mechanisms, and to open up. In highly regulated industries such as healthcare, being more open via building platforms allows not only the supply side, but also the demand side, to co-develop a GPT and point towards areas where individual value capturing can thrive.

Appendix 1: Method of collecting and analyzing data

Data collection

The data for this research consists of semi-structured interviews. We started the interviews with healthcare/AI experts to understand the general context of healthcare and AI, and then gradually narrow the scope of interviewees to people who directly worked for/on IBM Watson Health. A total of 58 interviews were conducted over a six-month period, from August 2019 to February 2020.

We aimed to elicit participants' views about IBM Watson, Watson's applications in healthcare, and Watson Health's collaborations with hospitals (especially with MD Anderson). When interviewees provided a new or unanticipated response, the interviewer probed into the response and encouraged the interviewees to expand their statements[25]. The average length of the interviews was 49 minutes. All interviews were recorded and transcribed. We also consulted intensively with cognitive scientists and AI experts, discussing findings with them, seeking clarification on particular terms, and deepening our understanding of Watson.

Data analysis

We conducted qualitative content analysis (with the help of Nvivo software) for knowledge exploration with reference to the Gioia method[26] and the techniques of open, axial and selective coding[27] as exemplified by Orlikowski[28] and Urquhart[29,30]. Our data analysis consisted of four main phases[31]. First, each interview's main topic was summarized narratively. Second, interview transcripts were analyzed to develop first-order concepts. Anything in the text of the interviews that could pertain to IBM and Watson was coded. Third, first-order concepts were incorporated into our theorizing as second-order themes, and the connections between these themes were identified to build aggregate theoretical dimensions. Finally, a model was developed to show how to address the appropriability problem by being more open.

Appendix 2: Acknowledgement of respondents

Name (in alphabetical order)	Position and Affiliation
Interviewees	
Amit Bansal	Founder of Diya Health Inc.
Carlos Selmonosky	Fellow of the American College of Surgery ACS; Fellow of the American College of Chest Physicians ACCP; Fellow of the American College of Cardiology FACC (1989–2000); and a Life Member of the American Academy of Family Physicians AAFP
Emily Weng	Senior Director, Theravance Biopharma
Linda Isaac	Faculty of Cognitive Science Department, UC Berkeley
Ling Shen	Director, Statistics at Vir Biotechnology
Musa Yilmaz	Assistant Professor, Department of Leukemia, MD Anderson Cancer Center
Prabhu Shankar	Clinical informatician, Faculty at UC Davis Health
Sebastian Carru	Watson Health Specialist EMEA, IBM
Sivaram Arabandi	Clinical Informatics Consultant, NameOntopro LLC
Solomon Darwin	Executive Director, Garwood Center Corporate Innovation (offering the class on how to apply Watson at UC Berkeley)
Stratos Davlos	CTO, SVP, and Managing Director of Innoplexus; Vice President, Watson, AI & Engineering of IBM (2018–2019)
Sven Semet*	Business Development Manager, Assima; Thought Leader IBM Watson, IBM
Tingyan (Tina) Wang*	Postdoctoral Fellow, University of Oxford
Vijay Nadkarni	Vice President and Head of Artificial Intelligence, NameTech Mahindra
Other respondents	
Bill Paseman*	President of Paseman & Associates
Junda Zhu*	Engineer of Ericsson
Prasad Mavuduri	Chairman, Global Institute for Professionals of Emerging Technologies

Note:

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Notes

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20. There are two different perspectives in terms of whether AI (and Watson) is a GPT or not: One argues that AI is a field and the technologies applied by IBM's various consulting groups are mostly unrelated, while the other one believes that AI (and Watson) is a GPT [see e.g. Erik Brynjolfsson and Andrew McAfee, "The Business of Artificial Intelligence." Harvard Business Review, (2017): 1–20].
21. APIs of Watson were there since 2015. There are APIs for Natural Language Processing, Speech to Text, Text to Speech, Language Translation, Image Recognition etc. However, Watson Health doesn't have APIs as of this writing.
22. Another perspective is that IBM's brand cuts both ways. Sometimes IBM is perceived as pointing to older technology, not newer one.
23. Watson® OpenScale™ is a technology platform, available via the IBM Cloud. It allows AI models to be used and connected across vendors, aiming to spur AI's adoption and transparency. With OpenScale, AI can be tracked across its lifecycle and adapted as well as governed by the users. For more information about Watson OpenScale, see:

https://www.ibm.com/cloud/watson-openscale; and https://newsroom.ibm.com/2018-10-15-IBM-Introduces-AI-OpenScale-to-Spur-Artificial-Intelligence-Adoption-and-Transparency

24. How to develop an early-stage platform can be learned by two posts of Henry Chesbrough, "Don't Play Games with Platforms - A Lesson for Google Stadia," March 3, 2020, https://www.forbes.com/sites/henrychesbrough/2020/03/03/dont-play-games-with-platformsa-lesson-for-google-stadia/#11318d97f243l; and "What Nokia Teaches Us about Tesla," February 6, 2020, https://www.forbes.com/sites/henrychesbrough/2020/02/06/what-nokia-teaches-us-about-tesla/#6a74cb784560
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