# THE DIGITAL SOCIETY[1] (Version 0.5) –

## A better future or worse?

**by Dirk Helbing**

*Smartphones, tablets, and app stores with almost unlimited possibilities have become symbols of the digital revolution. However, while all this makes our lives more comfortable and interesting, these innovations pave the way for much more fundamental transformations. They concern the way we learn, decide, act and interact. Big Data, the Internet of Things, and Artificial Intelligence in the background will create smart homes, smart factories, and smart cities, but not only this: our entire economy and society are likely to change dramatically. What are the opportunities and risks related with this? Are we heading towards digital slavery or freedom? What forces are at work? And how can we use them to create a smarter society? This book is offering a guided tour to a new world, the digital society ahead of us. We can already see the signs of change and entirely new trends...*

While we were busy with our smartphones, the world has secretly changed behind our backs. In fact, our world is changing ever more quickly, and much of that change is being driven by developments in Information and Communications Technologies (ICT). These technologies – such as laptop

[1] Dear Reader,

thank you for your interest in this chapter, which is thought to stimulate debate.

What you are seeing here is work in progress, a chapter of a book on the emerging Digital Society I am currently writing. My plan was to elaborate and polish this further, before I share this with anybody else. However, I often feel that it is more important to share my thoughts with the public now than trying to perfect the book first while keeping my analysis and insights for myself in times requiring new ideas.

So, please apologize if this does not look 100% ready. Updates will follow. Your critical thoughts and constructive feedback are very welcome. You can reach me via dhelbing@ethz.ch or @dirkhelbing at twitter.

I hope these materials can serve as a stepping stone towards mastering the challenges ahead of us and towards developing an open and participatory information infrastructure for the Digital Society of the 21st century that would enable everyone to take better informed decisions and more effective actions.

I believe that our society is heading towards a tipping point, and that this creates the opportunity for a better future. But it will take many of us to work it out. Let's do this together!

Thank you very much, I wish you an enjoyable reading,

Dirk Helbing

PS: Special thanks go to the FuturICT community and to Philip Ball.

computers, mobile phones, tablets, and smart watches – seemed to be about convenience. They came along as tools enabling us to calculate, communicate, and archive with greater speed and efficiency than ever before. But there was little recognition though that, one day, they would facilitate not only our cultural discourse and institutions, but potentially reshape our entire world. Large-scale mass surveillance, the global spreading of Uber taxis, and the Bitcoin crypto-currency are just a few of the irritating symptoms of the digital era to come.

Since many decades, the progress of Information and Communication Technologies is characterized by Moore's law: an explosive increase in processing power. Today, an average mobile phone is much more powerful than the computers used to send the Apollo rocket to the moon. And there is an even faster increase in the data volumes produced. Thanks to powerful "machine learning" methods, information systems are also becoming ever more intelligent.

Why should we care? Isn't it just great that computers do calculations for us more quickly than we can do them ourselves? Isn't it fantastic that our smartphones help us to manage our agendas, and that *Google Maps* tells us the way to go? Why not ask *Apple's Siri* to recommend a restaurant? I certainly don't object any of these functionalities, but this is just the beginning of what's going to come.

Exposed to an abundance of data, we will face new scarcities – time and attention, for example. While in the past, we often didn't have enough information to take good decisions, we now tend to be overloaded by information. To cope with this situation, we will need information filters, "digital sun glasses," but this makes us vulnerable to a manipulation by the creators of these filters. Furthermore, secrecy and privacy might get lost, and with this, we may lose security, mercy and forgiveness, too.

The digital revolution is changing the way we learn, behave, take decisions, and live. It also alters the way we produce and consume, and even property

and ownership. Information is, in fact, an interesting resource: it can be shared as often as we like. One doesn't have to divide it and, therefore, we wouldn't have to fight for it. This will, of course, depend on how the future economy is organized, in particularly, how we reward people and companies for the production of data, information, knowledge, and creative digital products. The currently negotiated free trade and service agreements (such as TTIP, CETA, TPP and TISA) may try to perpetuate the principles of the 20th century, or open the door for a smarter 21st century society. As the negotiations are secret, we can only guess, what will happen, but if we don't pay attention, we might miss an opportunity that emerges only every 100 years. In this book, I will try to describe the options we have, and how we can take our chance.

It is really important to realize that the digital revolution is not just about more powerful computers, smaller smartphones, and fancier gadgets. The digital revolution will not only change our personal lives; it will transform our economy and society, too. In fact, in the coming 2 or 3 decades we will see dramatic changes. A lot of production and services will be automated, and this will fundamentally change the way work looks like in the future. Two decades or so from now, i.e. pretty soon, less than 50 percent of people will have jobs in the classical economic sectors, for which we have been trained (i.e. agriculture, industry, and services).

In terms of hardware, computers may surpass the human brain already very soon. Our brain, with its approximately 100 billion neurons, a firing rate of 200 per second, and a signal speed of 120 meters per second currently has to compete with supercomputers having 100 times less transistors, but operated 20 million times faster, while the signal speed is 2 million times faster. Computers already beat the best players in games like Checkers, Chess, Backgammon, or Scrabble. They can even beat the best players in quiz shows such as Jeopardy! And they can do real-time translations between dozens of languages. Experts predict that computers will be able to perform each single task better than humans in 5 to 10 years, and reach brain-like

functionality within 10 to 25 years. You may watch this TEDx video to get an idea of what learning computers can presently do: https://www.youtube.com/watch?v=xx310zM3tLs

Many great digital services, such as real-time language translation, have become possible only by the use of Big Data. Without any doubt, there is currently a great hype about this. Therefore, Dan Ariely compared Big Data with teenage sex: "everyone talks about it, nobody really knows how to do it, everyone thinks everyone else is doing it, so everyone claims they are doing it..." But some are actually doing it, because the use of Big Data has already given birth to many interesting applications. Thus, what is "Big Data"? The term is used for massive amounts of data collected about techno-socio-economic-environmental activities. Every single minute, there are 700,000 *google* queries and 500,000 *facebook* posts. Add all the location data of people using smartphones, all the shopping data, and whatever leaves data traces on the WWW, then you have an approximate idea of "Big Data."

As I will discuss later, Big Data opens up entirely new optimization and business potentials. It's, therefore, no surprise that everyone suggests Big Data to be the "Oil of the 21st century," a new way of making money – big money. The consultancy company McKinsey estimates that Open Data alone can create an additional value of 3000 to 5000 billion dollars annually worldwide.[2] On average, this would be more than 700 dollars extra for every citizen of the world. Therefore, the potential of Open Data would probably exceed the value of the free trade and service agreements currently under negotiation, such as TTIP, CETA, TPP, and TISA (see Wikipedia for information). Given these numbers, are we setting the right political and economic priorities? This is something we should pay attention to, because it will determine our future.

Coming back to what one can do with Big Data, *Google Now* is a particularly interesting application. It's a digital assistant that makes use of your personal data, if you register for this service. For example, if there is a traffic jam on the

[2] http://www.mckinsey.com/insights/business_technology/open_data_unlocking_innovation_and_performance_with_liquid_information

way to your next appointment: no problem, you will be told to start, say, 15 minutes earlier. But where will such digital assistance lead? Will we end up in a golden digital cage, a "filter bubble" as Eli Pariser calls it? Will we just end up doing what smart devices tell us to do? Modern learning software already corrects us when we are making mistakes. Smart wristbands and eye trackers can discover when we are tired or stressed, and computers can figure out, when our performance is going down. It's quite possible that we will soon be patronized by digital personal assistants and lose our position as self-determined decision-makers and most intelligent species on Earth.

Given all the data one can now accumulate, could governments or big companies build "God-like," almost "omniscient" information systems and decide like a "wise king," taking optimal decisions for everyone? Could such a "benevolent dictator" overcome coordination failures as well as irrational and partial decisions? Would it become possible to create a "perfect world"? By collecting all the data in the world, could one build a digital "Crystal Ball" to predict the future, as some people have suggested? And if this were possible, given that "knowledge is power" as the saying goes, could one build a "Magic Wand," i.e. an information system enabling a government or company to keep the plan of a "benevolent dictator" on course? What would this take? It would certainly require an information system that, based on massive personal data, knows us so well that it can manipulate our decisions and actions with personalized information presented to us.

But isn't this already happening? An Internet search quickly reveals that there are several softwares, projects, or even companies (including *Recorded Future* and *Palantir*), which are committed to creating something like a Crystal Ball. There are also so-called Cybermagicians who try to manipulate the Web and Social Media, as *The Intercept* and *The Guardian* have reported, based on materials that Edwards Snowden has leaked. Is personalized advertisement just an exercise to develop this system to perfection? Don't *google* or *facebook* know already what we are interested in, placing ads that fit exactly our interests and tastes? Doesn't *amazon* suggest us what to buy?

Doesn't *trip advisor* suggest us what destinations to visit, and what hotels to book? Doesn't *twitter* recommend us whom to follow and *facebook*, who to be friends with? And aren't there *apps* suggesting us whom to date? Would we still find our way through our lives without *google* and all these smart personal assistants? And what if we didn't follow their advice? Would an insurance company punish us for eating unhealthy food? Would a bank offer us bad conditions for a loan, because we are living in the wrong neighborhood? Or would we get restricted offers or pay higher prices, because we are not fitting certain expectations? While this might sound like a dystopian science fiction phantasy, much of this is actually happening already.

Of course, some people might say: if this increases the efficiency of our lives, or at least of our economy or society, why shouldn't we do this? Isn't the main point of history books that society keeps changing? So, why should we care, if companies and governments take care of us? The question is: are they doing a good job caring of us? And can they do a good job at all in the way we are currently using Information and Communication Technologies today? Are we heading towards a state of society where everyone is taken care of well (some might call it "paradise")? Or are we running into deep trouble? How would a smarter, digital society have to look like? Could a government or a company, with all the data of the world, run our complex world in an optimal way? Or may we unintentionally slip into an evil regime, where we are "enslaved" by means of intelligent Information and Communication Technologies, based on surveillance systems that are combined with sophisticated punitive and reward schemes? These are the kinds of questions I will ask in this book.

In fact, we are at a crossroads. We must consider very carefully how to make the genie of digital technologies work for us, not against us. We have the choice between a future, in which everyone's decisions and actions are controlled from the top down by powerful information systems, and a future, characterized by bottom-up participation, creativity, and diversity.

This book offers a framework of concepts and ideas that could contribute to a smarter and more resilient Digital Society. Such a framework is needed,

because in many important respects, the world has become pretty unpredictable and unstable. Some of the reasons for this can be identified clearly. Much of it has to do with the increasing interdependencies in and between our systems, often driven by advances in Information and Communication Technologies. Now there is perhaps too much data, too much speed, too much connectivity, and too much complexity.

*The complexity dilemma*

Globalization and technological progress have enabled the global exchange of people, goods, money, and ideas. In addition, humans have created an amazing amount of networking and interdependency. In fact, we have networked most of our computers and a large fraction of all people in the world. Now, the "Internet of Things" – an extension of the Internet, in which computational devices communicate with humans and among each other – is connecting smartphones, TV sets, fridges, coffee machines, and other things. Will this improve the stability of our world or create new kinds of vulnerabilities and threats? It depends on how we organize and use these systems!

As we are networking our world, its complexity is surpassing our capacity to understand it well. Interaction strengths have increased, and the rate of change of our world is outpacing our ability to adapt. Every year, politicians pass more laws and regulations, but the established and straight-forward way of solving problems increasingly fails to manage the problems humanity is faced with: September 11, the wars on Afghanistan and Iraq, the world financial and economic crisis, the Arab Spring, the wars in Syria and Ukraine, or the wide spreading of Ebola witness that we are rather losing than gaining control of what happens in the world. One could add many more examples. On May 6, 2010, a flash crash caused a sudden drop of the financial markets with temporary losses of almost 1000 billion dollars. The Internet, on which we all depend, is also becoming less and less secure, it seems. Cybercrime is

exploding, and cyberwars are becoming a scary threat to the world – perhaps more dangerous than nuclear wars. Estonia, Syria, and North Korea, for example, have already suffered from large-scale Internet blackouts.

I fully recognize that many politicians and business leaders are working hard to do the right things. But are these efforts always effective? It often seems that the established models and approaches work increasingly less. This, in fact, is a result of the complexity of the systemic interdependencies we are faced with. But if we want to fix these problems, goodwill is not enough. In case of systemic instabilities, no matter how well skilled and informed the actors are, a loss of control will happen sooner or later, despite best intentions to avoid this. As a consequence, one may run into a vicious circle, where one has to spend a substantial fraction of time on fixing problems created before.

How to escape this vicious circle? We must go to the roots of the problem. For this, we need a much better understanding of complex dynamical systems. Based on this, we must change our current approach of designing and controlling systems. We must shift our attention from the components of a system to their interactions. When the interactions become strong, they often create counter-intuitive results and unstable systems.

How can we win the battle against this ever-increasing level of complexity? It's both a symptom and a potential saving grace that we have much more information about our world than ever before. The amount of data doubles every year – which is to say that every year we produce as much data as in the entire history of humankind. So, is the collection of massive data about our world the solution to our problems?

Mining Big Data can certainly support evidence-based decision-making. Without any doubt, it can open up entirely new potentials for business, politics, science, and citizens. But the accumulation of socio-economic data often implies privacy issues and a number of other problems, which raises fundamental ethical questions. For example, what undesirable side effects does Big Data have? Does Big Data undermine human rights? Do we need

new safety precautions, something like digital guardrails and digital airbags? How would these look like? Do we need to own the data collected about us? Should we be able to manage our personal data? Should citizens have more or less control? How to redistribute authority and responsibility without creating chaos? And how will this eventually change our economy and society?

Furthermore, how will the future Digital Society be organized: more top-down than today or more bottom-up? Do we need a powerful state to create a well-organized society, as Thomas Hobbes (1588-1679) suggested it, or will the principle of the "Invisible Hand," for which Adam Smith (1723-1790) is known, be the superior approach for the Digital Society to come? Will democracies turn into "democratorships," in which people will have nothing to say and no real participation? And would democratorships be justified by the socio-economic benefits derived from Big Data?

Or is there an alternative and perhaps better approach, based on distributed control? Many examples, ranging from traffic to production to crowds and beyond, demonstrate that it is indeed possible to manage complex systems in a bottom-up way, such that the outcomes are beneficial. What are the general principles behind such a "self-organization" approach? Is there a tool set allowing each of us to navigate our complex future, enabling us to create a stable and thriving Digital Society? Is collective intelligence the answer to the combinatorial complexity of our globalized world, and how would it work?

Rather than trying to control and fight the self-organized dynamics in complex systems such as our economy, financial system, global trade, transport and power networks, can we harness the underlying forces to our benefit? Can we modify the ways in which the basic components of these systems interact? Can we let desired outcomes emerge by self-organization, in a manner akin to the “Invisible Hand” that Adam Smith imagined to govern our economy and societies? Can bottom-up self-organization create well-ordered, effective,

efficient, and resilient systems?

While self-organization has been shown to work in complex technological systems such as traffic control or industrial production lines, can it work in socio-economic systems, too? After all, society isn't a giant clockwork. Things there are more subtle than in a technological system, because people won't necessarily follow the rules producing a desired behavior or outcome in a self-organized way. To enable successful self-organization, we also need suitable compliance mechanisms: incentives to "do the right thing." In fact, social norms build on social sanctioning systems, and our economy on financial reward systems. Now, there are also novel ways of bringing compliance about, such as digital reputation systems, as used by *eBay* and many others.

Can self-organization outperform conventional top-down control in managing complex dynamical systems? If yes, what would it take? How to find suitable institutional settings and interaction rules? How to get the real-time data enabling adaptive feedback mechanisms, such that the system is automatically driven to the desirable state? Would the emerging "Internet of Things" with its underlying sensor networks make socio-economic self-organization possible? Would these data allow us to detect emerging "social diseases" such as crime, war or financial crashes, before they break out, and help us to heal them? Could one enable everyone to take better-informed decisions? And how to build suitable information systems for this? These are some of the questions addressed by this book.

*On the way to a smarter digital society*

It seems that, from the personal level to the functioning of governments, markets and economies, information and communication technologies have produced an accelerating rate of change in our societies, and nobody is currently able to control the effects. We are experiencing nothing less than a

“third economic revolution,”[3] leading to the "Economy 4.0." Its effects will be at least as profound as those of the first (agrarian to industrial) and second (industrial to service) revolutions. The ubiquity of digital technologies such as the Internet and World Wide Web, social media, portable digital devices, artificial intelligence and robots – is driving the birth of a Digital Society.

The signs of this change are everywhere, from automated market trading to the use of robotic systems in military combat, from the role of social media in revolutionary movements to the transformation of the world economy. We can no longer afford to just watch this societal transition. We must prepare for it and take decisions. But we should not see it simply as a threat to social and global stability. In fact, we are facing the biggest moment of opportunity in the past hundred years. Our networked, information and communication technologies enable entirely new solutions to the world's problems, and they could take our civilization to the next level: the Digital Society.

I guess nobody doubts that information and communication technologies will be changing our world. Everyone starts talking about "smart homes," "smart factories," "smart grids," and "smart cities." It's just logical that we will have a "smart economy" and a "smart society" as well. But how will the digital revolution reshape our socio-economic institutions? And who will finally be right: Thomas Hobbes or Adam Smith? What will be the smarter digital society? One that is organized in a top-down way or one organized in a bottom-up way? Can the organization of the smart (electricity) grid be a model for the organization of future information and communication systems? Will a centralized organization of the power grid be better or a participatory system of electricity generation, as it is currently built in Germany and other European countries? Talking about society, will a centralized system as in Russia or China win on the long run, or will a distributed, federal system be superior, as we have it in Germany or Switzerland?

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[3] see, for example, Jeremy Rifkin, The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World (Palgrave Macmillan, 2013).

While addressing such questions, I am trying to pursue an apolitical approach, which is neither oriented left nor right, but forwardly directed. I am analyzing socio-economic trends and the technological, social and evolutionary forces at play. The technological "forces" include Big Data, the Internet of Things, and Artificial Intelligence. I also attempt to judge the implications of these forces, particularly the opportunities and risks associated with them. I will further show that it would be little successful to oppose these forces. We can benefit the most, if we learn to use these forces for us, in the same way as we learned to let the forces of nature work for us.

This book will try to explain how we can use the digital revolution to make our society more innovative, successful, and resilient, by applying the new logic of the digital era to come. It will explain how to enable real-time adaptation, using just emerging information and communication technologies. It will describe tools to gain knowledge about our world, to increase awareness, and to take better-informed decisions. And it will sketch how to build an information and innovation ecosystem that could create new jobs and opportunities for everyone.

We are now ready to dive into the details of why our world is troubled and how we can fix it – by using advanced information and communication systems in new ways. The following chapters will focus on subjects such as prediction and control, complexity, self-organization, tools supporting awareness and coordination, protection and responsible decision-making, real-time measurement and feedback, mechanism design and system exploration, innovation, reward and exchange systems, co-creation and collective intelligence. I hope this journey through the opportunities and risks of the emerging Digital Society will be as exciting for you as it was for me!

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Finally, why did I write this book and how did it come about? My research activities, on which this book is based, had three essential triggers. While I studied statistical physics in Göttingen, Germany, I specialized on modeling complex systems and got increasingly interested in addressing real-life problems, such as the conflicts between neonazis and left-wing students that were looming in town at that time.

Later, when I was Managing Director of the Institute of Transport & Economics at Dresden University of Technology, the beautiful historical city of Dresden and a huge area around it were hit by a major flooding in 2002, which drew my attention to studying disasters and how to respond to them.

Finally, when I worked as a professor of sociology at ETH Zurich, during the financial crisis in 2008 one thing became obvious to me: we needed entirely new ways of thinking about socio-economic systems in order to master the subsequent economic crisis, political extremism, and increasing level of societal conflict that would result from it.

Therefore, I started to launch the FuturICT initiative back in 2010 (see http://www.futurict.eu). This was a response to a European call for two 1 billion EUR "flagship" projects aiming to strengthen Europe's innovation in the information and technology sector. So, we are talking about real big money here. The project aimed to create new science and technology to manage our future in an increasingly complex world. In particular, FuturICT wanted to develop a "Living Earth Simulator" that would allow one to explore and better understand the likely opportunities and risks implied by decisions one might take. This simulator intended to be an open and participatory platform committed to the protection of people's privacy and not a closed project aimed to predict everyone's future, as some people claimed.

FuturICT was recognized as highly innovative project, bringing the best researchers in the social, natural, and engineering sciences together. Eventually, we had established interdisciplinary research communities in more than 25 European countries, in the USA, Japan, Australia and many other

countries. Far more than 100 academic institutions and a similar number of companies wanted to be partners of the project. About 90 millions of co-funding were promised for the first 2.5 years.

However, leading the FuturICT project also turned out to be an adventure. Big players all over the world got interested in the project. The USA quickly launched Big Data research programs amounting to 150 Million Dollars or more. China broadcasted a movie about the project on national TV, watched by hundreds of millions of people. Russia sent three big TV teams to feature the project. Moreover, in its Christmas edition 2011, the Scientific American presented FuturICT as no. 1 world-changing idea on its title page.

Months later, the FuturICT project got into the very final round, but contrary to everyone's expectations, it wasn't funded. At this point in time, I started to worry that governments might run into a digital arms race rather than building the global, participatory information and communication system that FuturICT had proposed. Therefore, I wrote the article "Google as God?" to make the public aware of the dangers of information and communication systems.

Afterwards, I made an Internet query for "Google as God?," and I was surprised to find results such as the "Church of Google." While these were perhaps not meant to be serious, they are still interesting food for though. At http://www.thechurchofgoogle.org/Scripture/Proof_Google_Is_God.html you can find 9 proofs that *google* is God, for example: "Google is the closest thing to an Omniscient (all-knowing) entity in existence" or "Google is everywhere at once (Omnipresent)" or "Google can 'do no evil' (Omnibenevolent)". Therefore, my book is exploring these ideas further and asks, how realistic they might be in the future.

When I talk about a "Crystal Ball" or "Magic Wand," a "wise king" or "benevolent dictator," I use them as abstract concepts. I don't have a particular company or institution such as *google*, the *NSA*, or a possible Artificial Intelligence in mind. Nevertheless, we must ask, whether we could run into a digital nightmare even if all Big Data companies and institutions had

the very best intentions? And, if yes, what could we do to minimize the risk of such a scenario? In other words, what institutions and technological solutions does the Digital Society need? How much decentralization and how much encryption are required to ensure sufficient Internet security? How much transparency and informational self-determination is needed to avoid "digital slavery" and ensure "digital freedom"?

For sure, if we want to succeed in the future, we must better understand the new world we are currently creating – a world that is characterized by more data, more processing power, and more connectivity. In my book, I intend to explain the functional principles of this new world, and how we can turn them into our advantage. However, when I wrote it, I found that we are at a crossroads, where we might take the wrong way by mistake – a way that would lead to more instability and potentially to global-scale disaster.[4]

In fact, our world might be at great risk. I will discuss the reasons for this in the chapter on the Complexity Time Bomb. When this concept came to my mind, I first could not believe it – it sounded just too fantastic. I had analyzed a variety of complex techno-socio-economic systems and discovered that many of these systems got out of control when the interaction strength between the system components got too high. So, the question was, how would the dynamics of an increasingly networked and interdependent world change?

I came to the conclusion that, even with the best technology ever, huge amounts of information, and the very best intentions, our world might turn uncontrollable. The best analogue is probably a bomb, which explodes as a result of chain reactions, when a "critical mass" is exceeded. It turns out that, in socio-economic systems, similar kinds of "explosions" exist, too. They are much slower, but similarly destructive – think, for example, of a political revolution. Therefore, I was wondering, whether our global system had unintentionally become a "global time bomb," and if yes, whether it was already ticking?

[4] And that's why I sometimes reflect critically about current trends. But my intention with this is to provide better orientation, in the same way as I expect from my team members to criticize me if they don't agree, because it helps me to develop a more differentiated view and take better decisions.

I certainly don't want to worry you, but from my personal family history, I know what the results of such explosive socio-economic processes can be. My grand parents had been exposed to different political regimes, economic crises, financial hyperinflations, and wars. This includes the Hitler regime, World War II, and the former German Democratic Republic. These times were unjust and cruel. It's, therefore, important to avoid running into similar scenarios, and for this, it is essential to better understand the causes of "societal diseases" such as crime, war, and financial crises. Therefore, in this book, I try to provide a new and integrated perspective of how society works, and how we can use this knowledge to master our future. In fact, I believe we shouldn't be pessimistic about our future. We should rather take it in our hands, because we can make our society more crisis-proof and change the world to the better!

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