artificial intelligence is making **rapid strides**(высокие темпы). there's talk of a new evolution that could fundamentally change life on our planet. artificial intelligence has the potential to revolutionize every aspect of daily life- Work, mobility, medicine, the economy and communication. But will AI really make medicine better and dr.superfluous(лишний)? when will self-driving cars hit our roads? will intelligent robots usurp our jobs and are we heading for a dystopia with no privacy in total surveillance(мониторинг)(sɜːˈveɪləns)? what exactly is artificial intelligence and how much can it really do? what will change and what will remain pure fantasy? to answer these questions we embarked on an exciting journey to meet the scientists working on our future in the US, Britain, Germany and China.

Our first stop Silicon Valley in California. Apple Google and Facebook all have their headquarters here. it's the epicenter of the digital revolution. the tech industry has changed the face of the San Francisco Bay Area. new startup companies launch every day. rents have exploded and artificial intelligence is the buzzword(модное словечко). a new type of supermarket recently opened its doors here. amazon go. all you need here is a nap(вздремнуть). hold your mobile phone to the scanner and you're in.

as Leonardo shows me Amazon's new menu and explains that the language assistant Alexa can help with the preparation. at home I'm under constant surveillance. which shelf do I stop at? which products am i interested in? on the ceiling sensors(потолочные датчики) and cameras. intelligent image recognition captures my every move - what do I take off the shelf, what do I put back and what do I take with me? this branch is still in its test phase but Amazon plans to open 50 such grocery stores this year alone. the end of the sales assistant just walk out, no more standing in line, no cashiers. I feel a bit like a shoplifter(магазинный вор) as I leave. comfort at the cost of privacy. my receipt. one block away a robot café another test lab for the future. order by app and touchscreen. the increasingly **ubiquitous tools**(вездесущие инструменты) of trade. my first ever cup of coffee served by a robot. so, this is the taste of the future. AI will change our shopping experience but what will happen to employees?

Stanford University is at the forefront of global AI research with an annual budget of 6.5 billion dollars.

I want to know how will artificial intelligence change medicine? researchers here have developed an artificial intelligence algorithm that can screen x-rays for **certain diseases**(некоторые заболевания). computer scientists Pranav Raj Poorcar shows me how easy it is to use. take a picture of an x-ray with your mobile phone. upload the image in a few seconds later you get the diagnosis.

- **it's a mass(**это масса**)** and it's saying this thing over here is it possibly **cancerous lesion**(раковое поражение) and I can see that right over here.

- okay so it gives you if I may have a look at it. now probabilities for **pneumonia inaudible edema effusion(**неизлечимый отек пневмонии**)** and that goes bang.

-yeah

- now that's this work I mean how did you get to the point.

- we started with the large data set of chest x-rays which were released by the NIH and these contained x-rays and then also labels of different pathologies and whether they existed in those extra. so, it might say okay here's an image and, on this image, I have pathology one, two and three. and we had a hundred thousand of these images. so, we trained a model that can take in it as an input an x-ray and then output the probability of several different pathologies on this x-ray.

artificial intelligence is modeled on the human brain. a gigantic network of almost 100 billion interconnected neurons. put in very simple terms. this is how a brain cell works. incoming impulses are passed in a domino effect from one neuron to the next. the resulting circuit connects the neurons and it is this circuit. that artificial intelligence tries to simulate as a digital neural network. like our brains the network can learn how to identify **tuberculosis**(туберкулёз) for instance. first the network needs to be trained or taught. x-rays of tuberculosis patients are fed to the system. initially it struggles to correctly identify the condition. but every time an x-ray is fed in the network's structure is adapted and its diagnostic ability improves. it takes thousands and thousands of clinical data sets to train the machine. only after the network is optimized in this way can it correctly identify an unknown x-ray.

but how accurate is artificial intelligence compared to a doctor's expertise.

- we have actually done this test twice at this point once with a set of studies from the NIH data. set that we had a group of radiologists label and then we compared the accuracy of the model to the radiologists and we found that they were very similar in terms of accuracy on most pathologies on one of them the model was outperforming the

radiologists on three of them. the radiologists were outperforming the model and then we repeated the experiment this time using a data set from Stanford which we recently released which is two hundred thousand chest x-rays and then we had a similar setup where we had three subspecialty radiologists. these are very uncommon very trained radiologists to decide what the ground truth for a particular set of images was and then we compared general radiologists to the algorithm at the task and found that they had similar levels of performance. these are all Stanford radiologists.so, they're that they're trained should be good.

reading x-rays accurately is a complicated process, but artificial intelligence is making fast progress. when it comes to identifying or recognizing simple images computers **have surpassed**(превзошли) human accuracy.

- now if I look at your picture it's always probabilities. so there are cases where the machine is not really sure what would be sort of a clear decision to say okay this is I don't know pneumónia or something else.

- I think I mean I think it's good to talk in terms of probabilities, because probabilities also give a sense of the algorithm the models uncertainty on that **particular problem**(конкретная проблема). I think one difficulty with probabilities is that it does make it hard for humans to interpret like what is the probability of 88 percent versus. 92 percent mean in terms of the decision I should make in the clinic and so I think in that sense one of the things that we could experiment with doing in the futures rather than showing probabilities that are so **fine-grained**(мелкозернистый). maybe we can show things like unlikely or thus pathologies likely or this pathology is possible.

in healthcare artificial intelligence is powering a revolution. scientists are using artificial intelligence algorithms to sift through seemingly banal data such as the up-and-down motion of the steps we take every day. they're looking for **conspicuous patterns**(заметные признаки) that could serve as early warning signs of disease. scientists in the English city of Birmingham are working on a revolutionary diagnostic method. to date there are no specific tests to detect Parkinson's disease making diagnosis difficult. AI could change that. Max Little is a mathematician at Aston University.

Voice changes can be an early indicator of Parkinson's. Max and his team collected thousands of vocal recordings and fed them to an algorithm they developed which learned to detect differences in voice patterns between people with and without the condition. In a lab based study of the recordings the algorithm was able to correctly identify a Parkinson's diagnosis nearly 99% of the time. Max Littles work is an example of the **far-reaching changes**(масштабные изменения) AI is bringing to the field of medicine. it's no longer just doctors who are using artificial intelligence to develop new diagnostic methods but data scientists, programmers and mathematicians like Max.

one example when a person walks sensors in their smartphone register the up-and-down motion of their gait. but what information **can be gleaned**(можно выяснить) from such data?

- if we **measured a pattern**(измеренный шаблон) of someone's walking behavior, then someone who's healthy might have we might measure the accelerometer to look like that.

- okay, so it's just the sort of movement you would have. **their hips**(их бедра) going up and down regularly that kind of thing along with their pace. but if you looked at some of your Parkinson's disease they may have these small steps like this and they may be irregular or they may have patterns like that. well they may even freeze and stop like that. so, you can see that there's not a different there's a differenceю so you can also now train an algorithm for instance to pick out features like what is there the distance between the time distance, between these Peaks and it could also do the same with this and it would be able to do that very **precisely**(точно) and by doing so we may be able to measure for instance to here that there's a large variability in between these. so the advantage the algorithm really comes when the, for instance, you might have somebody who is say who measures a pattern which looks like this and it might just be one small change perhaps that **occurs**(происходят) very very maybe not like that, but sort of you know some variation, that's right, in the sequence of these in the timing of these events. even to a professional eye because they don't have the level of precision. they may not be able to detect that. this is outside of the normal range of a variation. but of course an algorithm connected to a high precision sensor. well you know we'll be able to **determine that difference** (определить эту разницу) and in this case this person here may in fact have a **precursor symptom**(симптом предвестника) of the disease.

-so, this would mean that this person with the help of an algorithm could be diagnosed as having Parkinson **whereas**(тогда как) the doctor himself would miss him out.

that could for the first time make it possible to detect precursor symptoms of Parkinson's and enable early **intervention**(вмешательство). but what else does the data on our smartphones **reveal**(появляющиеся)?

- right now you have already apps tracking your so-called activity. so, in fact the data

- the data potentially could be there that's right. but there are ethics about whether we collect that kind of data and use it for these sorts of purposes. now clearly we can't just collect this data and start diagnosing people which journalists we should not know absolutely look. we could but we really wouldn't want to there are very good reasons not to do it. and that there may be good reasons for doing it as well. but that's the kind of thing that needs to be worked through in a proper you know regulated setting

after our interview Max Little tells me he's **received several lucrative offers**(получили несколько выгодных предложений) to join tech giants who smell new business opportunities. he turned them down. artificial intelligence will undoubtedly improve doctors abilities to detect and diagnose disease. but amid(в рамках) all the opportunities AI offers there's an urgent need for regulation.

**China**

we're on our way to China a country that has experienced breathtaking change in recent years. its capital Beijing is **buzzing**(жужжание). the whole country is hungry for progress and is on a fast track to the future. time seems to move faster here. by the year 2030 China aims to be the global leader in the field of artificial intelligence. and there's a lot to indicate it will meet that goal because the government has Bank world subsidy programs worth billions of **euros**(ˈjʊərəʊz). These robots aren't **assembling cars**(сборочные автомобили). there the big attraction in Beijing's latest smart restaurant. AI in the kitchen and automated waiters. I have a meeting here with the design researcher Geisha Yust. A former Internet ambassador for the German government. she's currently spending a research semester at Tong jean University in Shanghai. I asked her about her impressions of China. there's this real hunger in the city and it's super fun to talk to young people because they want to be the motors of change. they work day and night. they have a new work-life balance model. it's called nine nine six. I thought what do you mean nine nine six and they said - we work from 9:00 a.m. to 9:00 p.m. six days a week. that's the better model now because they used to just work non-stop. but no one's stopping them no one's hitting the brakes(нажатие на тормоз). they work like crazy because they want to bring about change. this restaurant cost 20 million dollars. Just one restaurant. they've invested this huge sum to digitize the entire operation. they aren't just robots serving the food the whole kitchen is digitized. refrigeration has monitored supply chains are monitored there are **dashboards**(приборные панели) for everything. everything is connected here where they're testing what works and which aspects can be implemented in other restaurants of this chain. that's the idea here to just try things and to think big. thank you.

so, I'll just help myself. if I may. but what about privacy. they seem to be a trade-off between security and privacy. you often hear how AI has increased Public Safety for instance that the ability of surveillance cameras have dramatically increased the crime solving rate. it's **hard for us to relate to(**нам трудно понять**)** because privacy and personal rights are so important for Germans. but here there's a different tradition and take on the issue.

I'm **fascinated**(очарованный) by China but it also **puzzles me**(озадачивает меня). how can they be **reconciled**(примирившийся) the high civilization of ancient China and the modern industrial state with surveillance cameras everywhere?

the long-gone district in Shenzhen in the heart of China's booming economic region, north of Hong Kong. we visit the smart city control center. a giant monitor displays the data of the entire district in real-time. numbers of new residents by neighborhood to plan schools. water supply levels, power outages(перебои в работе)- all this information is collected compiled and evaluated using artificial intelligence. the showcase project was developed with Chinese tech giant Huawei. chief engineer Chen Bang Tai tells me- the city now operates more efficiently. so what you're doing here is urban planning? yes, the systems are a big help. these are hospital beds. right now there are 15,000 doctors and nurses and 7600 beds. so, a Shenzhen currently healthier(or) sick.

a smart surveillance system scans the entire city. illegal structures like this one on a roof are quickly identified and demolished. to me some of this feels like the backdrop to a science fiction movie. employees with livestreaming body cams inspect side streets. this is total surveillance.

chan shows me how cameras installed in restaurant kitchens even keep tabs on cleanliness. but doesn't the chef mind being monitored all the time? the system logs all the people who view the images. anyone who looks at them without permission is punished. total transparency for the purpose of progress. Chen says residents of Leung Gong District approve. jaywalking is not allowed and offenders are immediately identified. look here you jaywalk once and right away your social credit score drops. this degree of surveillance is unthinkable in the West. but here in China they take a different view and say it's driven a drop in crime. what does it say here? male youth without glasses! you yes suddenly you're a youth. I love Chinese facial recognition.

a transparent society in the interest of efficiency. some of this appears useful. but do we really want to measure control and analyse everything just because it's technically possible? won't that inevitably lead us down a road to data dictatorship? maybe trust is better than smart control.

Silicon Valley a synonym for innovation and unlimited freedom. the biggest players in the field of AI are based here. but their headquarters are hidden behind inconspicuous low-rise buildings. Facebook we use their services entrust them with our data but the company is impervious to the public. a selfie at the entrance gate is just about tolerated.

next door at Apple the visitor centers 3d model of the campus is as close as non-employees can get to the new building. what's going on inside?

it's all confidential.

we want to visit Google here in California and requested an interview weeks before our arrival. but all we get are stalling tactics. like these visitors Google leaves us out in the cold. apart from a small store this is the only visitor highlight accessible to the public. these Android lawn statues are even a designated location on Google Maps. welcome to Google.

Facebook refused to answer questions. the European Union handing Google a 2.7 billion dollar antitrust fine. these companies command growing power over our daily lives and growing political influence. Google spends more than 6 million euros a year lobbying Brussels alone. the e-use transparency register lists more than 200 meetings with Google representatives since 2014. Google is the busiest lobbyist in Brussels. we finally get our interview not in California but in Munich Germany. with one of the longest-serving employees yen's made ma.

how important is AI for Google? AI is so important to us. that two years ago we rebranded our entire research to mission to Google AI. AI drives a significant part of our product development. AI above all drives a significant part of our efforts to improve the quality of our products. take machine translation. through the use of machine algorithms we've seen faster progress over the last two years than we did over the entire previous decade. Society will undoubtedly be propelled forward by the implementation of these services and the use of AI in the years to come. what's key is that it's done responsibly. under the principles of transparency. we need to explain how things work. why they are needed? where people's data goes? how they can control it? how they can delete it if they want to delete it? the user must have the control.

but what about technologies like Google home? the smart microphone sitting in people's living rooms. Google home isn't East dropping. there's a small chip on the device that listens out for the so called hot word. it's waiting for the command ok Google or hey Google and only then is the microphone switched on to send a voice command for search requests into the Internet. the Google server it and then presents the results. so as a science reporter I'm naturally curious about the future. there's this patent application from September 2016.

Google's application gives a detailed account of what can be deduced from household noises. how long we brush our teeth, whether we argue or whether a housemate is ill. it's much more about capturing atmosphere and habits than words and it's a Google patent application that anyone can look up.

– I don't know anything about this particular patent application. we have a whole series of patent applications every year. most of them are imaginary fictitious services which like in many other companies are never translated into real services. so I can't say anything about this particular patent at this point. patents for imaginary fictitious services Google's EU lobbying activities at least are unarguably real

how much does Google intervene in the EU? I think the more important question is the one that lies between the lines. namely how ethically does a company deal with product development? and we have set our own rules according to principles that guide our own actions research and product development. That also guides our business decisions. on its home turf in the United States Google is facing mounting political pressure. in Washington we meet Barry Lynn head of the think-tank open market Institute. he warns of the dangers posed by tech giant's influence. we need to know in our society that the people who bring information to the public sphere, who talked to the press, who talked to the representatives in Congress, that they represent their own selves that they're speaking in their own name and not for someone else. that they're not stooges, that they're not puppets and the fact is today our society this is true here in Washington is true in Europe our society is filled with puppets, with Stooges who represent the interests of Google and Facebook and Amazon. given Big Tex monopoly power calls for regulation are growing louder in Washington. when you have a monopoly, whether it's over retail, whether it's over search, then it means that the public doesn't actually have the ability to understand how that information is being used, how that power is being used, but not only Percy unless it is regulated closely by the public is a danger. Google means to take over the world. they mean to direct our thoughts between person and person our communications between person and person, our dealings and business between person and corporation. they mean to direct everything that they can. they want to know what's going on in our thermostats in our houses. they want to know what we're watching on TV. they are at a level of hubris that even the Stalinist could never have imagined pushing for. Google Facebook Amazon will the influence of tech giants continue to grow. what can be done to rein in their monopolies? one thing is clear artificial intelligence is consolidating their grip on power. there's an urgent need to rethink antitrust policy.

mobility is another area in which AI is powering the march of innovation. in the near future it could put self-driving cars on city roads. but how realistic is this vision? we've come to Boston to the prestigious Massachusetts Institute of Technology. sir touch Caramon is a leading expert in the field of self-driving cars. he and his team are working on prototype autonomous vehicles. I think that we've nailed a couple items with computers and machines. one is all of this mapping and localization all the technology works super well. computers can know where they are within centimeter maybe sometimes even millimeter precision very more than what is required to drive. computers are now able to look around and understand where everybody else's. but that's not that's not what's required for driving. what's really required is to understand what's going to happen next, in the next three seconds, five seconds, next minutes maybe you know sometimes next hour. and so that's the key missing piece and I think the problem there is that right now it's very hard for you to describe to me how you understand whether or not a person is gonna use the sidewalk or is gonna use the crosswalk and cross the street. sometimes you look at the face of a person and that facial impression gives them away and you will slow down. sometimes not. they may be looking at the same direction. they may be standing in the same location. it's just a little face impression. maybe just the way they stand. then unfortunately that kind of intuition gut feeling and so on is very hard for us to program into the computers. it works in a simple lab environment but in real-life settings the algorithms are still totally out of their depth. not that that bothers advertisers.

our test drives were nothing but a series of glitches. an inexplicable emergency stop. and another one on the second attempt. the sensors on this vehicle were overtaxed by a car parked on the curb. and here this smart car overlooked a car veering into our lane. well that didn't work. talking to the MIT engineers it becomes clear that to build a self-driving car developers need to meet a massive scale of technical requirements. what I think about fully autonomous cars is that I think I'll be very surprised if it happens in less than 10 years. also I will be very surprised I'm a big believer I'd be very surprised if it doesn't happen in 20 30 years. I think it will happen at some point. but I do think that people really underestimate. the kind of technology required to be built to make your car fully autonomous under every condition every circumstance every whatsoever. that's the very hard part.

driving is not as trivial a process as you might think and that's because you constantly have to watch what's going on around you. Cyclists, pedestrians, sometimes you have to second-guess. does this guy want to cross the road or not? it's hard to imagine all that being calculated automatically.

a self-driving vehicle would have to be able to deal with all of this too - here we have a truck doing a three-point turn I may have to back up now if he doesn't make it.

does she want to cross the road or not some people don't even wait?

the fully autonomous car is a distant dream. but driver assistance systems are already making our roads safer. an accident filmed from a car equipped with emergency brake assist. the sequence of events can be assessed in slow motion. the red vehicle ahead overlooks the upcoming traffic jam. no brake lights appear. but the distance sensor in this car registers the jam brakes and prevents a further collision. but which principles should guide decisions made by technology in an accident situation. in recent years MIT’s media lab has been addressing the ethical questions raised by artificial intelligence - what moral compass should future smart devices refer to? eeeh Travan is one of the world's leading experts on such issues. he and his team developed a survey called the moral machine to explore ethics for programming autonomous vehicles like in the event of an accident.

most of the time people don't remember anything and people have no time to react everything happens very quickly. so they just are surprised maybe they see something in front of them and they just swerve in some random direction or maybe they just freak out and press the brakes. so you cannot expect a human being to do the right thing in that in such a small time scale. unless you know they they made a decision beforehand like you know did they drink and drive or did they know that they were going to cross a red light. then you blame them but otherwise you can't really blame the human. but with a machine because of the speed of the electronics because the autonomous car is evaluating the environment. you know millions of times per second then time goes much slower for the machine and it's able to recalculate the situation and maybe recalculate the strategy. and this is where we can make a potentially better judgement and or whatever random choice the human used to make in this situation. now what is better though is a very interesting question and it's not obvious. let's see a case where we have people versus people. so now we have the vehicle has two people inside of it. and it's going to either swerve and hit the barrier so the people will die in

the car or the car will go straight and kill all the pedestrians. the pedestrians who are crossing illegally but there are also women and these the people in the car are males. so now it gets very complicated very quickly should you prioritize women over men or should everybody be the same should you prioritize pedestrian over passenger or not. should you take into account the fact that people are crossing illegally in this case and so as you can see once you have multiple dimensions. it becomes not obvious what the right thing to do. a or B who should die. the elderly lady crossing on red or the child in the self-driving car? what choice should the algorithm make d ads online survey presents respondents with various scenarios each with its own unique dilemma. respondents are then asked to choose how they would want an algorithm to decide. so as a result we have 40 million decisions and they're still counting. from people all over the world and it enables us to start analyzing what do people agree on, but also how do they differ..

so does our culture influence our moral judgments. people always agree on saving more lives, saving children, saving people who cross legally, over people who don't cross legally, and so on. the most interesting part is you could pick a country, mm-hmm like Germany, yes really and you could see how they compared to the global average, you could see okay so the status is not really important but what you can

see. much as many is preferring in X yeah so if you don't have to if you prefer to just go straight .yes which is the default. don't take a decision. exactly this means Germans don't like to take a decision. yes you say close your eyes and go and just go. so so this means in other words you can see a bit the acceptance of technology taking a decision and the more you say in action means, means that the car goes straight. here okay

fate

a comparison of Germany and France reveals cultural differences. the French tend to favor sparing women and there's a stronger focus on children. and contrary to Germans the French don't want to leave things to fate. they want the machine to make the decision. and the machine is kind of a mirror. for the first time something that you did subconsciously or maybe instinctively in the case of an accident you know you just act randomly. now you have to make a conscious choice and the machine is forcing you to make a choice right. you cannot hand waive it because in the end you have to program something.

driverless cars aren't yet ready for the road and ethical questions still abound. artificial intelligence harbors immense potential to benefit daily life medicine or mobility. but we also need to look beyond the technical possibilities. what aim does such progress serve? it's a question artificial intelligence algorithm can't answer. only humankind can do that.