The thesis of Widgerson’s essay is that the P vs NP question is central to our world.  An observation he makes that eventually supports this thesis is that efficient verifiability is a property possessed by challenging questions of human pursuit, broadly.  Explain why this observation is important for his thesis.  He gives very concrete examples of this in Math, Science, and Engineering.  Pick one of Economics and Politics or Humanities and the Arts and flush out (give more meat to) Widgerson's discussion by identifying two examples of important questions for which a solution could be easily verified.

P vs NP question holds the key to our ability to finding answers we raise, provides fundamental insight into our world

NP is the set of problems whose solutions can be verified by algorithms of polynomial complexity, while P is the set of problems that have solutions of polynomial complexity (rather than just a verification); in other words, NP is checking a solution, P is finding a solution. Widgerson’s observation that efficiency in verification is important for his thesis as it allows quick justification for solutions. Humans have designed algorithms for describing behaviors of atoms, thermodynamic systems, etc. which describe how said objects should behave under certain conditions. Without the P vs NP question, it would have taken an incredible amount of time and brute-force to find such algorithms and solutions. Efficient verifiability is what makes a “P vs NP problem” a “P vs NP problem”, as it makes up the NP side of the issue.

Such P vs NP problems can be applied to simple cases in the Humanities/Arts. Though one can very easily recognize an orchestral masterpiece and recall facts about it, it is extremely difficult to re-compose or simulate the piece—it is infinitely harder to find the solution (in this case, recreating) than to verify (recognizing) one.

If a piece of poetry exists that incorporates rhyming, one can immediately see whether the verse pairs rhyme or not. This is much easier than trying to write the poem, through which one may spend a significant amount of time on finding words that fit the rhymes and trying to make the poem sound coherent.

ALGORITHMS:

Correct

Fast

Compact

By releasing Swift, Apple hopes to replace the 30-year old Objective-C as the primary language for iOS development. Do you believe Swift will achieve the same longevity (or less or greater)?  Use at least two features from Mashey's article to defend your position:  Define those features in your own words. Describe why these two features are good features for justifying your prediction.  Explain why you believe these features are likely to lead to more longevity for either Objective-C or Swift.

Although Swift will take some time in its process of taking over Objective-C, I believe that Swift will achieve at least the same longevity as Objective-C.

Mashey in his article presents several goals that languages must achieve to be widely accepted. One of the most important is that the language should greatly ease programming tasks and raise the level of abstraction. This simply refers to making processes more efficient and to lower complexity of the code, and raising the level of abstraction means that programmers should be able to hide everything but the most relevant data. McCracken’s article discusses Lyft’s semi-sudden adoption of Swift, with which coding became far more compact and efficient—it took just a month for one person to create a prototype. Swift, being more modern, unifies the language and reduces complexity through a smarter compiler as well as the amount of code required (e.g. string interpolation), while Objective-C is a lot more verbose.

The second goal involves data types—the language should handle new data types that are poorly addressed by existing languages, and should adapt more easily. This means that classifying various types of data should be clear and encompass the wide range of data types that exist. According to Mashey, C’s normal data types deal poorly with hardware efficient for certain storage sizes. On the other hand, Swift is safer; for example, it handles all types of data individually and it also includes optional data types. This creates short feedback loops and thus allows programmers to be more efficient by fixing code as it is written, instead of trying to search and fix some random crash that happens after writing the entire code.

I believe these two features are the most important features because, after all, we live in a very fast-paced world, so the less “baby-sitting” or constant repairs a language and its code needs, the better and more easily we can move forward. Therefore, Swift is more fitting than Objective-C is for today, and it will perhaps take another 30 years or more until Swift does not match the pace of our future world.

Consider the software challenges of the CERN particle accelerator on the Franco-Swiss border near Geneva.  Software systems (a) control the accelerator, (b) collect and filter data (Recall the discussion in Widgerson’s article from the week on Algorithms and Tractability), and (c) allow scientists to remotely monitor and run experiments.  The concerns addressed in each of the three articles (Coverty, HTML5 vs Native, and Loop Perforation) are relevant to these three tasks.  Explain which is relevant to which and how?  You discussion should incorporate at least one main idea idea from each article.

Connections regarding properly functioning technology can be drawn between the controlling of the CERN particle accelerator and Coverity’s technology. In his article, Cohan discusses how static analysis can be used to automatically run through code to find errors through various techniques instead of sending them over to QA testers, therefore saving customers time and money. In fact, Coverity can be used with the CERN accelerator; the software controlling the CERN accelerator is so complex and thus must operate correctly in order to deliver correct and reliable data. Finding errors in the code that runs the accelerator is complex but crucial.

Loop perforation, referring to the loss in a bit of accuracy through skipping steps in return for higher performance and efficiency, is relevant to collecting and filtering data from the accelerator. The CERN particle accelerator collects an immense amount of data and crunches out numerous calculations at once, but for the entire process to be more efficient, it needs to know what data is significant and what to ignore. Such a filtering process similar to loop perforation can increase performance. Moreover, loop perforation also comes with verification, making tasks much simpler; verification tools incorporated into the data collection process with the accelerator can reduce the complexity of its different tasks.

The issue of scientists remotely monitoring and running experiments (as opposed to in person) can be related to apps running on the web versus native apps. Mahemoff presents a debate between HTML5 and native apps and how each one can be justified to be superior to the other in terms of speed, ability, performance, etc. Such criteria can also be used to determine whether monitoring experiments remotely is more efficient than doing so in the lab; therefore, both involve the issue of tackling the same task/device from different perspectives.

Briefly explain what the network neutralitydebate is about.  Leiner et al. (which describes the history of the Internet) highlights both (a) the **technical principles** and (b) the **properties of the culture of network researchers** that lead to the success of the research networks that we now call the Internet.  Describe at least two of (a) or (b) and their **relevance on the network** neutrality debate.  In particular, discuss whether a decision one way or the other on network neutrality would violate the technical principle or cultural property.  Such a decision would then be concerning because it might make the future Internet less successful.

Each distinct network had to stand on its own, and no internal changes could be required of any such network before being connected to the Internet. • Communications would be on a best-effort basis. If a packet didn’t make it to the final destination, it would quickly be retransmitted from the source. • Black boxes (later called gateways and routers) would be used to connect the networks. No information would be retained by the gateways about individual flows of packets passing through them, keeping them simple and avoiding complicated adaptation and recovery from various failure modes. • There would be no global control at the operations level

The net neutrality debate revolves around telecommunications practice and having an open and free internet. Supporters claim that ISPs should provide us with open networks and shouldn’t be in control of what one can have access to, while net neutrality opponents see it as hindering competition and privacy.

Leiner’s article describes several technical principles that helped the internet flourish, including free and open access to basic documents (e.g. internet protocols). The beginnings of the internet heavily promoted open publication ideas, permitting the sharing of information about the net’s design and operations. This parallels net neutrality and the spread of information in general—if net neutrality remains and the internet is open, different ideas and knowledge can be shared, and everyone can tap into the benefits of wide-spread information. For instance, as Leiner states, this open infrastructure can support the general academic/research community. Opposition to net neutrality would mean closing off these important documents and information from anyone who could benefit from it, thus hindering the dependable accessibility of the internet.

Another technical principle leading to the internet’s success is widespread development of local area networks, which increased the size of the network as a whole. However, on a LAN, a system admin is able to employ bandwidth throttling (the slowing of an internet service) to limit congestion and server crashes; this relates to the net neutrality debate in that it is similar to ISPs using bandwidth throttling to reduce a user’s access to a certain destination. If one who is able to control the traffic of a LAN is against net neutrality, it would take away from the LAN’s original concept of increasing connections to cables, routers, and internal servers.

Widespread development of local area networks (LANs) allowed the internet to flourish as well.

strategy of incorporating Internet protocols into a supported operating system for the research community was a key element in the Internet’s successful widespread adoption

Consider the mobile quake detection system described by Faulkner et al. and potential problems with the system with respect to the privacy of individual phone users (cf. Shilton).  Describe the quake detection system **and identify potential issues with privacy**.  Give one concrete example of something that could go wrong if privacy is not properly respected.  Discuss at least two concrete steps the designers of the mobile quake detection system could take to enabling participation in privacy (see Shilton).  Explicitly relate these steps to the suggestions of Shilton.

The quake detection system described by Faulkner et al. varies from the classic approach where data is collected centrally and the occurrence of the event is declared, taking up immense amounts of data space for collection and distribution. Instead, this decentralized community-sensor driven system depends on modelling and training data from those models to extrapolate approximations.

Because so much data is involved in a quake detection system, privacy issues can arise. As situational awareness is essential for first responders to deploy resources and take action immediately, keeping track of real-time time-location traces is necessary in order for community sensors to serve their purpose. Massive amounts of time-location information is thus the heart of the issue—it can reveal people’s private lives, including habits, routines, and personal associations.

If privacy is not respected, personal data can be very easily accessed, meaning that one’s identity can be leaked out. This leads to potential identity theft—an unlawful use of an individual’s information. Identity thieves steal personal information including social security number, credit card accounts, and use the information to make purchases and establish credit.

The designers of the mobile quake detection system could create an interface on the existing CrowdShake app where data is processed to let participants know and make sense of what the data they collect is exactly used for through data visualization. This means engaging the participant with **longitudinal engagement and data legibility.** The participants can therefore view a breakdown of how the system makes the necessary calculations and trace how their data is being used and shared; the interface would provide transparency and accountability.

**Participant primacy** is another step suggested by Shilton that the designers could take. This means giving participants control over what data they are willing to share. Though management tools and access-control options that can be personalized on each individual sensor phone application, participants are able to choose what they can see and share, thus appropriately protecting privacy.

Consider the arguments for and against encryption as a right, as described by O'Neill, and apply the same considerations to secure distributed electronic currency like Bitcoin.  For each of your points, give both the abstract philosophy and a specific example that illustrates your point.  Include at least one point for electronic currency as a right and at least one point against electronic currency as a right.  Conclude with your opinion -- either pro or con, but backed up by your previous discussion -- on whether access to electronic currency should be a right.

The argument for encryption as a right is that encryption can be guaranteed to protect confidential personal data; people should be able to store data without allowing others to access it. The argument against it is that encryption could inevitably enable and immunize criminals on a huge scale to the point of endangering national security, meaning criminals could be using encryption for certain purposes but no one would be able to find out what they could be doing.

Similar goes for the Bitcoin issue. The bitcoin should be a right for people because as an alternative to real currency (which can be a hassle because of small expenses such as fees), it has few limitations and offers a great amount of utility, making it very attractive, not to mention its security. One example is Etsy, where one can pay with bitcoins and not have to pay the transaction fee that usually goes along with an online purchase; this is due to authorities (government, banks) not being allowed to force fees on the bitcoin. There is no middle man, no having to trust others.

However, some may not feel that the bitcoin should be a right because if something goes wrong and investigation is necessary, it would be extremely hard to track. Just like in encryption, it is very difficult to know what data is being encrypted, bitcoin transaction and use is almost untraceable. For instance, it would be hard to track one’s record if he/she makes illegal purchases with bitcoins, and consequently, ending the illegal action would be a difficult task.

I believe that the bitcoin will gradually take over more of the markets and that it will be more beneficial for society as a whole; after all, technology is constantly on the rise. Despite risks, the system is still able to operate efficiently and the possibility of situations going awry over such a secure system is low. Transactions can be made with fewer restrictions and it would be unnecessary to store information regarding these transactions (like our central banks where we can look back at records).

Describe the three key properties of clean elections of Farivar and Bismark.  Explain why each is important for democracy.  Explain why it is challenging to have one system that has all three of these properties.  Relate resolution of these challenges to the concept of zero knowledge as described by Quisquarter et al.

The first key property of clean elections is that each individual ballot must be **accurately recorded and properly tabulated**. This is crucial for democracy because the elections are by the people, for the people, and people want their votes to be represented correctly in the final results; that is why people vote in the first place. Ideally, the process should be so transparent that anyone, including news media and analysts, can download all the election data to check the votes themselves and report on the data.

The second property is that clean elections should be **verifiable**. This means that voters should be able to check that their votes are counted correctly without breaking through confidentiality. With verifiability, votes will not go missing and you can ensure that your vote has been casted. Furthermore, you know that no hacker can break in and change your vote; even if it does happen, you will know since the vote won’t match the receipt.

The third is that clean elections must **preserve privacy**—no one knows who you voted for; your selections are confidential and shielded from authorities. With guaranteed privacy, you know that no hacker can break in and change your vote; even in the rare case that it does happen, you will know since the vote won’t match the receipt.

Having one comprehensive system that covers all three of these properties at once is difficult; satisfying one property may make another property much more difficult to accomplish. For example, E2E, which uses cryptography to accurately count votes while preserving privacy, addresses the problem of whether each single ballot was recorded correctly but does not ensure that all the votes were tallied accurately (the third key property is not satisfied). The ThreeBallot system allows voters to easily verify that his or her vote was counted by searching for a unique identifier, but it has problems with privacy and security as it does not use actual cryptography.

Clean elections and their processes relate to the concept of zero knowledge protocol through the encryption factor— the ability to know how everyone as a whole voted (proper tabulation), but not specifically who voted for who (privacy). Quisquater’s essay discusses the zero-knowledge protocol through a story about Ali Baba solving a cave mystery and his descendent being able to convince a media reporter that he knew the secret without having to reveal the secret. Thus, the conclusion is that one party can prove to another party that a given statement is true without giving away any other information.

Describe Turing's Imitation Game (know known as a Turing Test) and how it can be seen as a test of machine intelligence.  Compare (a) the achievement of Watson in winning Jeopardy to (b) Alan Turing's question of whether machines can think.  Does (a) imply (b), (b) imply (a), or does neither necessarily imply the other?  Justify your answer.  What are the key similarities and key differences of the required computational tasks?

Turing’s Imitation Game, or the Turing Test, revolves around the question, “Can machines think?” In the original game, an interrogator puts question to a man and woman (A and B) in a separate room who reply with typewritten notes; the aim is to determine who is the man and who is the woman. Turing’s test then replaces the man with a computer running a program designed to deceive the questioner about its true identity. This can thus be seen as a test of machine intelligence because it evaluates and determines if a machine is capable of thinking in the place of a human. If the questioner could not tell the difference between human and machine, then the computer would be considered to be thinking—rather, considered to be intelligent.

According to Markoff’s article, Watson is a “question answering machine” that can understand questions posed and answer them. The Jeopardy questions, however, require complex thinking—the ability to untangle convoluted and opaque sentences as well as encyclopedic recall. Though Watson won Jeopardy with a landslide, beating two other ace human players, it cannot truly think like a human. Rather, it “thinks” superficially through manipulating symbols and digging through many sources of information. Watson’s success, however, still implies to some extent Turing’s question of “Can machines think?”, as Watson was IBM’s attempt to suggest the possibility of creating a supercomputer that could handle tricky human language and conversation. In general, key similarities between human and machine thinking reside on the surface level—they can both “hear” and take in information. However, the processes that happen inside are different; machines cannot generate as cohesive answers as humans can, and humans also have the ability to incorporate emotions, opinions, and ethics.

Discuss Facebook's algorithms for selecting news feed items (as discussed by Oremus) in the context of machine learning (as described by Abu-Mostafa).  Is Facebook doing supervised learning, reinforcement learning, unsupervised learning, or using a combination?  Justify your answer with specifics.  Compare the learning task of optimizing Facebook's news feed to that of Netflix's movie recommendation.  Describe one similarity and one difference.

Facebooks’ algorithms for selecting news feed items involve A/B tests (comparing two versions to see which performs better), surveys, and data on the time users spent on certain posts. The vast amounts of data Facebook collects is then designed to generate insights and predictions regarding selecting certain news feed items. This is essentially machine-learning, as the machines Facebook use are taking in past information and consequently learning and predicting from it; in other words, the machines learn from experience.

It seems that Facebook is using supervised learning. This means that Facebook uses some algorithm that is good at understanding how people use the news feed (which is the data they have available to them) to automatically personalize suggestions for you. For instance, when users click on a New York Times article and stay on it for a while, Facebook infers that these users find NY Times articles more relevant and interesting, and as a result, may populate their news feeds with more NY Times articles. Netflix’s movie recommendation is similar in that it also uses supervised learning; both Netflix and Facebook depend on mass amounts of true, real-time data with which they manipulate to create models.

One major problem, however, is that Facebook can be a lot more personal; what Facebook’s algorithms choose to show on one’s news feed can affect people’s emotions, which is, according to Booth, an emotional manipulation through Facebook’s data use, especially since Facebook cares most about engagement and advertising. The users of Facebook ultimately become Facebook’s subjects of market research studies. On the other hand, on Netflix, people simply provide ratings for different movies, and there is no significant consequence on an individual’s emotions. The product in question is a movie, not someone else’s life event.

In your own words describe two key properties of calm technology as discussed by Weiser and Brown.  Use Google Glass (discussed by Chi) as an example to illustrate these key properties.

Calm technology is a type of information technology that engages our attention in a very particular way. First, it must be designed to be able to **occur in the user’s periphery** rather than in the center of attention. In other words, calm technology is technology that should be so embedded and commonplace that we forget its immediate impact, and recedes into the background of our lives. Google Glass is an example of calm technology as it overlays digital things directly in your eyesight—it is unnecessary to go out of our way to use it. Google Glass is not a keyboard or a touchscreen. Rather, it has an extremely simple stroke interface and anticipates what one is going to do with it—a sort of context awareness that transforms experiences of interacting with the world. Therefore, Google Glass satisfies the concept of calm technology—it is a device that does not randomly intrude and remains with the individual, and, according Weiser and Brown, informs without overburdening.

A second key property is **comfort**. Calm technology should not take away comfort and leave us feeling uneasy at the cost of complexity and excitement. It should make us feel at home, or simply in a familiar place without surprises. Even at first glance, it is clear that Google Glass attends to this property of comfort. To compare, Tom Chi shows us various different headset systems that have been built, all of which seem bulky, cumbersome and uncomfortable to wear, proving how much lighter and convenient Google Glass is; in fact, it was easily and well prototyped through the concept of weight distribution on the nose and ears.

Describe the goals and appropriateness of Scratch Jr in the context of Victor’s need-tool-capability breakdown.  Identify and describe the need, the tool, and the capability.  Explicitly reference points from both Victor and Guernsey to reinforce your discussion.

Scratch Jr is an introductory programming language for young children to create interactive games and stories, acting as a gateway into computer programming. It has several important goals—to have young students reinforce what they learn (Guernsey brings up an example of kindergartners using Scratch to illustrate the biblical plague of locusts), express themselves through this “language of expression” (one can code scenes in which characters have “thought bubbles”), to build fundamentals of logic (“if, then” language of coding), and to boost the role computer science in public education in general.

In his article, Victor identifies three elements in prototyping interfaces—needs, tools, and capability—that are appropriately and well encompassed in Scratch Jr. The needs part is self-explanatory, referring to what things we must address in order to advance in life. In the context of Scratch, the human need is to translate/transform computer programming knowledge into something that students even younger than the age of 8 can understand and interact with—which is the entire point of having Scratch. Therefore, through scratch, we satisfy the need to **educate young students** about programming. The tool is the technology we invent; in the case of Scratch, it is the **Scratch product itself**, acting as a vehicle between the designers of Scratch and the young students learning fundamentals of programming. The last factor, capability, is crucial (and the most neglected) according to Victor because, after all, the tool is designed to be used and manipulated by a person to satisfy the need. Just like with most technology, the capability in Scratch involves the **student’s actions** they use to create whatever they are making. Scratch is interactive—students use their hands to snap together graphical programming blocks and modify the appearances of characters they use, while their minds work to convey what story they are trying to tell. Students thus use their physical and mental capabilities to use to the tool, Scratch, and achieve their need.

Compare and contrast the perspectives of Eagleman and Durand who both view the human brain as a computer (similarly to our discussion of the human brain as a computer in Week 1).  Describe at least one similarity in perspective and at least one difference.  Describe and justify (a) at least one advantage of Eagleman’s approach via a stimulating vest over Durand’s two-dimensional depiction and (b) one advantage of Durand’s approach over Eagleman’s

Eagleman discusses how the human brain is a sort of computer – a special device that senses electrochemical signals that come in along data cables. It does not care where this data comes from, only about the data itself. This would justify the effectiveness of an “incarnation” – like a chip you can attach to a part of the body that will send signals to the brain. Similarly, Durand depicts the brain as a computer as well, claiming that the takes in information through the eyes. Whether an image is presented in 2D or 3D or in person may still be processed in our brains in the same way; how the image is originally oriented does not play a big role.

The main **difference** is that Eagleman is inventing a device that will help disabled people sense important things, or even help people feel things they do not normally feel such as one’s blood sugar level. On the other hand, Durand is optimizing 2D pictorial representation compatible with a 3D scene to increase the sense of sight.

The advantage of Eagleman’s approach over Durand’s is that his device could help deaf people hear and blind people see through some sort of signal (i.e. vibration for sound).

The advantage of Durand’s is that humans will not have to change themselves biologically in any way for the body to receive all the electrochemical signals – in other words, there must be a USB port for a USB to actually be used. Another interesting advantage is the potential for a huge advance in computer graphics—pictures can provide more information and be more realistic and more expressive.

We aren’t equipped with all the tools to pick up all the information around us

Brains sample a small bit of the world; in other words, brains

rain is not hearing or seeing any of this. Your brain is locked in a vault of silence and darkness inside your skull. All it ever sees are electrochemical signals that come in along different data cables, and this is all it has to work with, and nothing more. Now, amazingly, the brain is really good at taking in these signals and extracting patterns and assigning meaning, so that it takes this inner cosmos and puts together a story of this, your subjective world.

Durand: goal = extract the essential

Compare Li’s goal of designing algorithms to describe what is happening in an digital image to the problem solved by Google Translate (formerly: Word Lens) as described in Nat and Lo’s 20 Percent Project.  Explain (a) why one is easy and (b) why the other is hard.  How does the problem solved by LeafSnap compare?

In Google Translate, as described in Nat and Lo’s 20 Percent Project, the phone receives the image and goes through a refining process to isolate the text or whatever is necessary. Through a scoring process, it then classifies the letters/objects in question, and throws back the result that fits the best. Li’s case is much harder and more complicated than this (since the objects in question are real, 3D objects as opposed to flat text) but still uses the same fundamental concepts of big data. Li’s goal in designing algorithms is to teach a computer to see a picture and generate sentences, implying the need for a further step in the marriage between big data and machine learning algorithm. Like a brain’s neural network, the computer takes input from various nodes and sends output to others. This network, with billions and billions of connections, is used to train the object recognition model. Powered by the massive data, the computer can then tell us what a picture contains.

Leafsnap, an electronic field guide that identifies tree species based on the shape of their leaves, runs similarly on a sort of graphic machine learning—its computer program compares the leaf snapshot to a library of leaf images. However, the results leave us not with one distinct result but rather five or ten choices; it is less definitive. The final identification thus relies on one needing to look up more specifics about other characteristics, such as the description of the bark. Additionally, the database is constantly being updated, making it able to take into account new species of leaves.

Every volunteer crowdsourcing system must tackle the problem of motivating participants to participate.  Solutions to this problem vary across systems.  Describe and compare and contrast the distinct approaches to solve this problem.  Include at least one method discussed by von Ahn and one method discussed by Sillivan et al.  What are some features of the system that make one approach or the other approach more appropriate?

Unlike computer processors, humans usually want an incentive to become part of a collective process; this incentive can come in many forms—monetary rewards, friendship, or fun and entertainment—depending on the situation.

In solving this problem of incentives, von Ahn relies on social incentives and tries to make tasks fun. For instance, he uses online games to encourage people to participate by using brain power to solve problems. Such computer games must ensure that game play results in a correct solution while being entertaining. One game is Peekaboom, a web-based game that help computers locate objects in images. In the game, people guess words that are associated to a certain image. With entertainment value, it brings people together for leisure purposes. Its other incentive relies on competition—Peekaboom has a point system, and since people are inherently competitive, people are encouraged to play as their success in the game is reinforced (such as the milestone of getting four images correctly). Therefore, this approach is quite appropriate because it builds off of human tendencies to want to have fun as well as innate competition; after all, no materialistic incentive is involved.

On the other hand, Sullivan’s problem revolves around data collection for ecological patterns which often requires the study of natural systems at a large scale. One approach to such data gathering is eBird, which operates with a huge network of human observers to report bird observations to better understand bird distribution patterns (migration, species occurrence, etc). It is built around the concept that each time a bird-watcher raises binoculars, he/she can collect useful data. Therefore the immediate incentive is that one can become a better scientist by understanding what data-gathering techniques are used. Users are driven by the desire to find and identify birds through competition as well. eBird taps into self-motivation by providing exposure and recognition for people’s work through tools that provide user-reward (i.e. assigning geographic values to checklists), increasing participation. Therefore, this app takes on an even more appropriate approach (while catering to a much smaller audience) than the one used by Ahn by depending on the spread of knowledge and people’s genuine interest, which are more valuable than incentives such as points or money.

Miller et al. develop the idea of humans as subroutines that accomplish small tasks in a larger algorithm that is attempting to accomplish a larger task.  Discuss the important issues with using humans as subroutines.  In your discussion (a) describe an advantage of using humans as subroutines (over using digital computers) and (b) at least two of the unique challenges that come with using humans as subroutines.  Come up with a novel problem (like helping the bind recognize objects, or editing an essay, but that is not explicitly discussed in the reading) that algorithms with humans as subroutines can solve, but digital computers alone cannot.  Justify your reasoning (for why algorithms with humans as subroutines can solve the problem but digital computers alone cannot.

The issue of using humans as subroutines is essentially an element of crowd computing, which combines human intelligence (the crowd) with artificial intelligence. In collecting massive amounts of real data to accomplish a certain task, it makes sense that the more humans involved, the better, because more work can be achieved—a group of people has more abilities and knowledge than a single person. Many solutions to problems draw on the crowd through the “many eyes” principle, according to Miller, which has a strong trait—diversity: a crowd of people contains a wide range of opinions and skills. For instance, with Soylent, not only can crowds proofread and edit each paragraph of a document to find errors that one writer might miss, but they can also all suggest ways to fix errors. Therefore having humans as subroutines makes a processes such as verifying much more efficient yet meticulous and comprehensive. On the other hand, in the case of editing a paper, a digital computer may miss errors (like Word’s built-in grammar checker), and give very fixed (not personalized) comments on how to correct the errors that may not even apply to the situation due to its lack of common sense.

However, using humans as subroutines comes with challenges. One is the accuracy of data that people enter—how will we know that the data that people put in is accurate and really what they got? Hopefully, there would be enough people who participate to identify those select few who put in random data that does not make sense. Another challenge is getting enough participation. This is where the idea of incentives comes in. Unlike digital processors, we usually want incentives in order to actively become involved in a collective process.

A problem that algorithms with humans as subroutines can solve is navigating a route. Through crowd-sourcing, drivers can know about where traffic jams are from other people’s data about where road closures, accidents, hazards, and heavy traffic jams are. In fact, Waze, the app that does just this, is powered like so by drivers. These drivers connect with one another and work together to improve each other’s driving experience. Digital computers alone cannot solve this problem because it is hard to computationally measure traffic jams (as opposed to someone reporting and describing a traffic jam circumstance), and to create a better routes just based on this basic information. It is also challenging for a digital device to immediately detect real-time accidents and hazards along a route.

Each of the three articles describe physical challenges for robots.  Discuss one physical challenge from each article, explain why it is challenging for robots, and give an assessment of how good robots are, currently, at solving it.  Use points from the articles in your discussion.

In Ackerman’s article, a major challenge for robots was stability. Sometimes, robots were too big to pass through doorways and while attempting to enter, robots fell over. Stability is challenging for robots because many of these robots are big and super complicated, and not intended to be protected against falls—they are not designed to fall, and in addition, it is dangerous. It is difficult to control where a robot will fall. Currently, groups are working to overcome this challenge and in fact, have been successful. One robot, HKU, faceplanted on its very first step, but was able to reset and walk successfully immediately afterward. Furthermore, people realize that walking probably is not the best method of mobility; rolling is much easier and more stable for doing tasks.

Dario in his article discusses the bulk and power requirements of motors used to drive and propel the robotic pills in a human. Motors and actuator mechanisms along with the most important parts such as the sensor end up making the capsule almost too big to swallow; it is hard to miniaturize. In addition, the capsule must exert a great force to distend tissue, putting a strain on its battery life and limits how long the devices can operate. The most recent proposal to solve this problem involves surgical robots that configure themselves inside the body, but this is still an advanced concept that has yet to be completed. In each of these capsules would be a component with magnets; once in the stomach, these capsules would assemble themselves. This then further leads to the idea of miniaturization of robots.

In the ICT Results article, one challenge for the robot made to learn about its environment is to learn concepts such as movability. This is challenging because it does not have a cognitive system like a human that would enable it to naturally explore the world around it; it must be “trained” through experimentation. Therefore, it is important that the robot has the ability to build its knowledge base, otherwise there would be no incremental learning. So far, through machine learning, robots have been quite successful—robots with the Xpero cognitive system have moved objects to learn about their environment and have even used objects as tools. The robot can thus learn the concept of movability, although it still does not understand movability in the human sense.

Describe two of the challenges Gates sees in taking robotics from where it is now to "a robot in every home"?  How does Microsoft's work in robotics, as described by Gates, address these challenges?

The first challenge Gates sees in taking robotics from where it is now to a robot in every home is that it has been difficult to enable computers and robots to sense their surrounding environment, and consequently react quickly and accurately. Essentially, it is difficult to give robots human capabilities, such as responding to its environment, nearby sounds, and understanding speech. One of Microsoft’s robotics groups has drawn from technology that will help solve this problem, particularly the challenge of concurrency. In tackling concurrency, the chance of robots running into walls, for instance, will dramatically reduce, because its software can coordinate a number of simultaneous activities, taking advantage of the power of multicore systems.

Another challenge to this development of robots is that the standardization of robotic processors and other hardware is limited, and very little of the programming code used in one machine can be applied to another. One way Microsoft tackles this challenge is through its BASIC programming language. BASIC provided the common foundation that enabled programs developed for one set of hardware to run on another. It also made programming much easier and learnable; it was a low-level foundation for integrating hardware and software into various robot designs.