Journeying the Internet's Concept in an Animated Short

Senior Thesis Proposal
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MOTIVATION

Though I have many friends who admit to wanting to know more about the way that the Internet works, almost no-one I know who is not a computer scientist or software developer knows anything about it. Many of my non-CS friends have expressed to me that they feel incapable of taking a bearing on technical concepts, because they are not 'coder types.' It seems to me that there is an over-dramatized notion of computer science as a qualitatively ***different*** sort of knowledge from other disciplines. Though there are inevitably ruptures in the fabric of what is possible-to-know at any given level—if you want to know about concepts in computer science, you to some extent have to learn computer science— computer scientific thinking is prematurely presented as something that is only available to a certain kind of mind, a certain kind of person who takes to coding.

While computer science requires a combination of determination, analytical finesse and creative flair that is not everyone's cup of tea, it seems to me that the binary cross-section of stalwarts (who code) and dilettantes (who don't) in our contemporary cultural imaginary preemptively turns people away from learning technical concepts that are often fully within their intellectual grasp. The assumption that "you either get it or you don't" is especially prevalent in undergraduate discourse regarding Princeton's introductory course in computer science, the infamous COS 126. Capable minds turn away because they do not consider themselves of the fictionally elevated and technocratic class, those who 'know how to code'.

That there is such an misty, hyper-disciplinary gap to computer science is a serious problem in our current endeavor to educate the public at large about the digital. Pedagogical initiatives such MIT's ***Scratch***, as well as many general knowledge courses on platforms such as ***Khan Academy*** and ***Coursera***, recognize the importance of a general pedagogy of digital concepts that does not require code fluency, nor even assume proficiency. It is increasingly evident that we need to find ways to educate a general (non-scientific) audience about computer science and software, especially as software and hardware architecture grow more and more influential in governance, the economy, and everyday life at large.

The Internet is by far the most ubiquitous technology in today's digital landscape. It is the paradigmatic example of an understated failure on the part of software pedagogues to educate a general public about the technical concepts that now subsist everyday activity. Our culture is powered by the Interent, yet even the simplest moments in its mechanics are fundamentally opaque to the vast majority of users. There are several available explanations of the Internet available in various different modes, from YouTube video to the more classical whitepaper; yet Internet literacy is frighteningly low. We need resources that bridge the hyper-disciplinary gap to computer literacy.

CONCEPT

My thesis will be a 3-5 minute 3-D animated short that tells the story of a data packet's journey from a laptop, through the Internet, to Google's servers. This short is an attempt to educate a general public about the basic infrastructure of the Internet in a format more palatable to the contemporary attention span than a hefty textbook. Though

information regarding the way that the Internet works is available (indeed, on the Internet!), the fact that so few people understand even the gist of Internet infrastructure demonstrates that somewhere in the information pipeline, the data is being lost. My thesis is premised on the idea that, generally, people would like to know about the Internet, but that many who are not computer scientists feel threatened by its technical lexicon to such an extent that they are not willing to pick up a book and read about it. Though the technics of the Internet are too complex to compact losslessly into 3-5 minutes, my intent is that the clip will incite viewers to learn more about the Internet by 'showing' them how fascinating it is.

The representation of computer science concepts in 3-D narrative is, to the best of my knowledge, a new kind of project. There are many video explanations of the Internet (some with animation), but they are all from the 'classroom' perspective—the video explains how the Internet works as if a teacher telling a student.[1] The narrative method which I am proposing, however, is something closer to historical drama than documentary. The viewer learns about the subject not by being presented it as a collection of facts that ought to be learned, but rather by constructing a compelling imaginary world that is faithful to its real-world reference and presenting it narratively. Of course, the Internet is not derived from a particular historical time-period, and here my thesis branches from 'historical drama' and becomes something more like 'unhistorical drama'. The point is that historical and unhistorical drama are learning resources by means of the same pedagogical inflection; they teach by filmically inhabiting a world, rather than indicatively presenting it.

A quiet truth about the computing world is that it deals in untruths. Every technical understanding is a little fiction spun about the operations being performed at the hardware level. An operating system is one big abstraction that is composed of many smaller abstractions to make possible higher level concepts such as 'data and 'functions' at the level of software applications. A software program such as Microsoft Word is a grand falsification of what is actually going on under the hood so as to make meaningful operations possible—writing a book, for example. Thus, even though a short animation will necessarily 'falsify' and oversimplify certain aspects of Internet architecture, this is actually a feature rather than a bug. The project's intention is to compellingly present Internet architecture at a high level via narrative's abstraction; not to comprehensively detail its complexities. A fetishized take on the Internet is a useful building block of a more holistic understanding.

The short will be structured in scenes. The current script runs as follows. Scene 1 will take place at the data packet's birthplace, 'inside' the browser. The data packet will be advised by a superintendent-like character, the WiFi protocol, who will give the packet a cryptographic cloak (assuming a WPA2 network), and will then transfigure the packet into a radio wave to be sent across the air to the router. In Scene 2, the packet is sent on its way by the industrial management of the router, traveling via fibre optic cables through several IP addresses, at each one directed towards its destination. Scene 3, the packet arrives at the gates of Google, and submits its contents as a request. Another packet is sent by Google's servers in response, addressed to the original packet's source. Curtains close.

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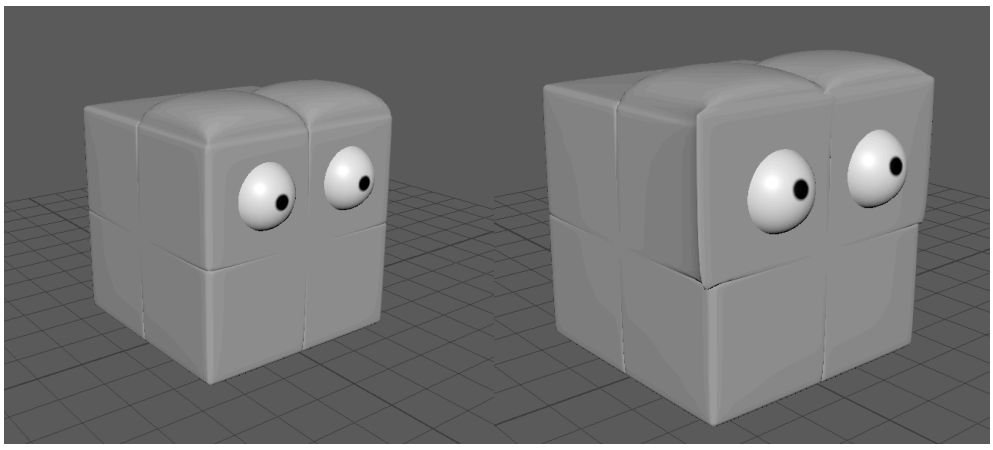
[1] For an example, see ***Internet Infrastructure as Fast as Possible*** by the popular channel, ***Techquickie***.

TECHNOLOGY

The short will be created using Autodesk's ***Maya***, a sophisticated software suite for modeling, rigging and animating 3-D models. ***Maya*** is a complete solution for the creative animation pipeline, and is one of the industry standards used in studios such as Pixar and Disney[2]. In addition to ***Maya***, I will use Pixar's ***Renderman***, the rendering software responsible for a large portion of the high-quality animated material in cinemas (and elsewhere) today, which is freely available for educational use. I also plan to use Pixologic's ***Zbrush***, an indispensable suite for 3-D painting and texture-map creation. (If my funding for ***Zbrush*** does not go through, Allegorithmic's ***Substance*** suite is a more affordable alternative for this part of the pipeline.)

Working in a 3-D suite such as Maya is, to my mind, essentially programming in a visual environment. The process of refining a model requires an intricate logical reasoning through the available primitives and operations in order to achieve the desired outcome. In a simple example, one might start with a primitive such as a cube, bevel its edges, construct and attach sligh protrusions on its top, and then model eyes with using spheres with a material that is a radial ramp from white to black. Insetting these into the front face of the cube creates the model of a basic anthropomorphized data packet.

To animate this model, one must first structure its possible deformations in a cohesive way, a process of the animation pipeline called 'rigging'. This often involves actual code, as one way of rigging is explicitly setting parametric relationships between different faces, vertices and/or sections of the model. For example, the packet's eyes might roll up and its blinkers flare up when it is apprehensive for some part of the journey, as shown in the second figure below. This gesture would need to encode a relationship between the extrusion of the edges on the left and right sides of face, and the upwards rotation of the eyes, so that this deformation can be conceived as a unitary expression at the animation stage, rather than as a collection of granular operations. In this sense, rigging a character is very similar to architecting a software application. The rigger must provide elegant abstractions (intuitive expressions) to the animator (the client program) to make for a smooth and natural product.



Animating is the final stage of the pipeline, the sexy 'frontend' sheen for the data-intensive operations of modeling and rigging. The animator needs to both script the

[2] I decided to use ***Maya*** after speaking on the phone with Andrew Gordon, ***Pixar***'s head animator, and learning that the software is used for all of ***Pixar***'s feature films.

deformations of the characters through the rigs, and also program virtual cameras that travel through the landscape of models. Though this is in some senses the most creative step, synchronizing camera perspectives with character movements is a technically-powered maneuver; not to mention the difficulties of making movements look convincing for anthropomorphic figures by appropriately simulating the physics of natural movement.

PLAN

1	Tutorials for ***Maya***, ***Modeling, Rigging,*** and ***Animation*** complete.	8th Nov
2	Basic script for short written.	15th Nov
3	Solo 'data packet' character (DP) modeled and rigged.	22nd Nov
4		29th Nov
5	A 20 second film animating solely DP complete.	5th Nov
6		12th Nov
7	Research regarding similar projects and related pedagogy complete.	19th Nov
8		26th Nov
9	Scenery for each individual scene ~80% modeled.	3rd Dec
10		10th Dec

December 10th-15th, Oral Progress Presentation

11	Script finalized.	17th Dec
12	Other characters that require rigging conceived and modeled.	24th Dec
13		31st Dec
14	Timing map complete (path through scenes).	7th Jan
15		14th Jan
16		21st Jan
17	Technical prelim of short complete (scenery, rigged characters, timing).	28th Jan
18		4th Feb
19		11th Feb
20		18th Feb
21	Draft 1 complete (concept animation, unfinished product).	25th Feb

March 2nd, Draft Paper

22	Draft writeup (motivation, etc).	4th Mar
23		11th Mar
24	Draft 2 complete (some scenes approximately finalized)	18st Mar
25		25th Mar
26	Texture refining, etc, other touches.	1st Apr
27		8th Apr
28	Draft 3 complete (all but finalized).	15th Apr
29	Render??? (need to look into how long this will take, where I can render)	22nd Apr

April 23rd, Oral Presentation

30	Revise write-up (more theory if I have time)	29th Apr
31		6th May

May 7th, Written Final Report

EVALUATION

The basic criteria for a successful thesis are as follows:

1. **The narrative representation of Internet architecture is faithful to technical architecture of the physical Internet**. As discussed in the CONCEPT section above, the project will necessarily contain oversimplified projections of many aspects of the Internet. Every element in the animated world, however, even if it is somewhat 'falsified,' should be grounded in a faithful representation of the underlying concept.
2. **The short is accessible and interesting to an American/British, English-speaking audience in their teens or older**. One of the pedagogical premises of 'unhistorical drama' is that it is more engaging than traditional textbook, and thus it ought to be fun to watch.
3. **After watching several times attentively, viewers have a high-level understanding of the basic protocols that make up the modern Internet, such as WiFi, routing, packets, and encryption/decryption**. I appreciate that it is unlikely I will be able to encapsulate every available protocol of the Internet. I will focus on four or five concepts which will be specified early on in the project's timeline.

The basic modes of evaluating these criteria are as follows:

1. An assessment by a computer scientist regarding whether the world presented is representative of actual Internet architecture. Towards this assessment, I will provide a booklet that details the aesthetic logic of the world.
2. Asking viewers to complete a questionnaire where they may signal how interesting they found the short. Were they engaged for the whole film, or just a part of it? How inspired to learn more about the Internet are they after watching the short? If another film about cryptography were made in the same fashion, would you watch it?
3. Asking viewers to complete a short quiz on the Internet's basic concepts. A control group of students will be given an Internet whitepaper and asked to read it before completing the quiz. (Lower scores do not necessarily indicate a failed project. It is possible that the film will not teach as distinctly as a textbook, but that its concepts are more memorable a week later than what was gleaned from a whitepaper. I will devise the quiz and testing conditions according to these hypotheses.)

These basic criteria and evaluative methodologies are subject to improvement and modification as the project devleops.

EXPERIENCE AND FUTURE DIRECTIONS

Over the summer, I took four online courses on *Lynda.com*: ***Maya 2018 Essential Training, Modeling a Cartoon Character in Maya, Rigging a Cartoon Character in Maya, Animating Cartoon Characters in Maya***. I now have a general understanding of the modeling, rigging, and animating workflow in Maya, and am currently working through various tutorials that refine different parts of the workflow. I have worked with 3-D models before as a hobbyist in Unity and other game development softwares, so the space is not completely unfamiliar.

Though the animated short will be the main product of my thesis work, I also intend to open source the 3-D models of the elements used to create 'data space' in the animated

short. I will also provide an instruction booklet that demonstrates how the models were animated to create the short, and how they can be re-used and developed by animator-pedagogues to present other explanations of technical concepts in computer science. Models essentially function as high-level primitives for animators, as in theory anyone can take those files (which are cross-compatible with various animating software suites), and create a new animated short in the same world using the set of models as a 'framework'.

If this project is successful, and does indeed present an engaging way to introduce a general audience to technical concepts such as the Internet architecture, as I hope, it would be interesting to apply the pedagogy to other concepts in computer science. Operating system architecture would be the next area in which I would personally be interested in visualizing and teaching through animation, as the seemingly complex relationship between virtual memory and physical memory might be much simpler to grasp if there existed a 3-D representation of it as a learning resource. With widespread Virtual Reality and Augmented Reality potentially on the horizon, a 3-D model framework could also be applied in VR/AR applications, which could be revolutionary pedagogy.[3]

[3] See http://elevr.com/ for a range of suggestions regarding the transformative role VR/AR might play in pedagogy. In particular, ***Real Virtual Physics*** and ***ontologyVR***.