Rise of the Machemes

How technology creates itself

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Abstract

Genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation [6]. Machemes propagate themselves in the macheme pool by leaping from archive to archive via technology and algorithms. How did machemes come into existence? What are machemes? Do they really exist? If so, can they vary, copy and select, or, in other words, do they evolve?

To research these questions, I formulate a working description of machemes in which I consider all the digital and technological information present in our world as machemes. I consider archives as macheme vehicles. To find out in more detail what archives and machemes are, if they can replicate, how they survive and how they behave I have created simple pieces of software. It is possible to consider these programs as being machemes. Alternatively, it is also possible to consider their parts as being the machemes. I dropped them in the online ocean of information and technology and observed their behavior.

I will conclude that evolution can emerge from the combined complexity of existing systems. Moreover machemes themselves can replicate very fast; they have their own environment in which they can exist and are therefore independent from humans.

Preface - The perfect Twitter account

My new Twitter[1]-follower is worth following back. His tweets contain entertaining links and he shares interesting opinions. Every day he acquires more friends in the form of followers, with whom he intelligently discusses current issues. I never saw anyone put so much effort in Twitter, reacting to every single tweet and posting so much original material. It is impressive how fast he knows what is happening around the world. When I send him a message, he instantly replies with something valuable. Unfortunately I have never met him in person. Who is this?

This is not a human, it is an collaboration of imaginary machemes which are perfectly adapted to human conventions. Everything the account is doing is automated. Among its many friends are other machemes created by itself. But it also has human friends that saw its re-tweets and became interested in it. This perfect Twitter account constantly chats with all its friends. It adds new friends and when it finds no-one it creates a new friend itself. Its created friends chat with each other and they as well create new accounts to follow and chat with. Together,

1 http://www.twitter.com

these created friends form a new community in which they can post and do whatever they want.

This imaginary macheme selects, varies and reproduces tweets and friends and its actions are not distinguishable from those of a human.

1. Introduction

1.2 About this study

What are machemes? Are they only imaginary or can I find existing ones? If I can find machemes, can I track what they do and how they act? How do machemes relate to memes? Can one speak of an analogy between machemes, genes and memes? How is it possible that some networks in the online world grow so big? Can the concept of machemes help to explain this?

Generally the human perspective is taken when examining technology. In contrast, this study will investigate the growth of networks from a different perspective: that of technology as an evolutionary system. I have chosen the practical approach of research by doing. This research method entails that a hypothesis is broken into smaller research questions which are examined individually, often by conducting practical experiments. In my study, after making a working description of what machemes are, I searched for examples of existing machemes. I quickly came to realize that this was difficult, as it is unclear what exactly a macheme is and how they operate, so I decided to create things of my own which can, due to my working description, be considered as machemes. I used the digital world as environment because monitoring and creating digital content is relatively easy. I first created visualizations of existing machemes. (see 'the world asleep' and 'the colored world' section 4.3 and 4.7) Because I wanted to zoom in on the machemes, I continued by making a pool of machemes and archives with the hope to find replicative, selective and reproductive behaviour. (see chapter 4)

Furthermore I have compared machemes with memes and genes to see how well the established definitions of evolution (both philosophical and biological) can be applied to them. I will examine the aspects of technology compared to memes and genes. Finally I will discuss the future of these self-made machemes and machemes in general.

2. Machemes in relation to genes and memes

2.1 Evolution of genes

The basis for our current thinking on evolution was theorized by Darwin in his *Origin of Species* [5]. Evolution can be seen as the process of change over generations. This change stems from replication, variation and selection and can be modeled algorithmically. Biological evolution is based on genes; the units of heredity in a living organism.

2.2 Evolution of memes

It was already suggested in 1976 by R. Dawkins [6] that the principle of evolution is not only applicable to living things like humans, animals and plants, but also to culture. Cultural evolution is driven by replication, variation and selection and therefore also abides Darwinian laws. According to Dawkins, genes and ideas share similar behavior; they are both replicators which can spread in a population. A replicator is able to copy itself in such a way that its information survives the copying process. These

idea-replicators are called memes.

2.2.1 Descriptions of memes

Several descriptions of memes exist. Dawkins states that a meme is "a unit of cultural transmission" that "propagates itself in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation"[6]. Wilkins defines a meme as "the least unit of socio-cultural information relative to a selection process that has favorable or unfavorable selection bias that exceeds its endogenous tendency to change" [18]. Finally, Heylighen considers a meme to be "an information pattern, held in an individual's memory, which is capable of being copied to another individual's memory" [11].

The existence of memes is controversial and even the descriptions of memes from researchers in the field of memetics are not exactly equal to each other. There are also arguments that memes do not exist and that memetics is not a proper way to think about culture: one of these arguments questions the meme's ontological status and concludes that this status is not clear enough to proof the existence or use the concept of memes. Most arguments against memetics have been discussed and -in my opinion- refuted by S. Blackmore [3].

In this research I assume memetics is a valid way to look at culture. It is my starting point for thinking about machemes.

To rationalize my thinking about machemes I need a concise description of what a meme is, and I chose to use Dawkins description, mentioned above. I will add that some memes not only leap from brain to brain, but can come in existence by leaping from any other medium to a brain, for example a book.

Dawkins explained memes through the replicator-vehicle model. The first replicator, a gene, has an organism as his vehicle. The second replicator the meme, uses the brain as its vehicle. In this research I argue that the third replicator, the macheme, has a vehicle which I call an archive.

2.3 How memes created machemes

Memes -like genes- spread themselves among people. They try to copy themselves and constantly invent new ways to reach as many brains as possible. A recent invention of them is to not only use brains, but also media like books, CD's etcetera to spread themselves. The memes that make smart use of these media are more successful than memes that do not. The media have grown more complicated and now there are websites, email services, social networks, etcetera which cannot only store, but also copy and spread information themselves. Blackmore [2] suggests that these media are meme-vehicles, that in turn become the copying machinery for a new kind of replicator: machemes.

Are these media like brains, are they meme vehicles which carry memes or are they something different? Examine the following: a certain formula, thought of and written down in a book a hundred years ago, but forgotten by everyone living at the moment. Is this formula a meme? According to Dawkins description in which he says that memes exist in brains, this formula is not a meme anymore. It was once a meme, and the formula can become a meme again if someone living will read the formula in the book and remember it. The formula can even become a successful meme if more people read the formula

and tell other people about it, but at the moment it is not a meme.

Because the media memes use to spread not necessarily contain memes, I will, for the sake of clarity, not consider these media as meme-vehicles or the information on these media as memes. From now on I will call these media archives. Archives are not meme-vehicles (only brains are) and the information present in these archives does not consist of memes. Moreover: since one hundred years ago the written formula was forgotten, the formula was not a meme anymore; the meme has disappeared. The information however was still in an archive. I will call this information, present in archives, machemes. The formula stays a macheme as long as it is in the archive, in this case the book. The formula can become a meme again and can therefore be a macheme and a meme at the same time. Memes exist in brains, machemes exist in archives. As mentioned earlier; in this research I intend to examine if machemes can vary, copy and select.

Not all information in archives stems from memes. For example on the internet we can find websites with computer generated content. I will regard this information as machemes too. The other way around: not all machemes can become memes, because information in archives does not always have a meaning to brains and is not always able to settle in a brain.

2.4 Differences between memes and machemes

Why the separation between memes and machemes? Machemes differ from memes in several respects: most important is that memes exist in brains and machemes exist in archives. Furthermore the information machemes consist of is purely technological. This technological information is the data present in a machine like bits in a computer and, even though we do not consider books as machines, information in books. What a macheme is exactly composed of is a question that is not easy to answer. Are the sentences in a book machemes? Are computer-bits machemes or are electrons the units we are looking for? Or can we take a totally different perspective and see a whole set of generated computer instructions as a macheme or is that a macheme vehicle? Like memes, it is possible to look at machemes from different perspectives. While it is clear that the vehicle for memes is the brain, a macheme vehicle can be a macheme itself due to the recursive architecture of computer software: a whole program can copy the information it carries but is also able to copy its list of instructions. For example, the popular social network Twitter can be considered as an archive consisting of machemes which are all the Twitter accounts, or, a Twitter account can be considered as an archive consisting of tweets and a tweet can be considered as an archive consisting of words.

One thing is clear: machemes do not disappear if you forget them, they have their own environment in which they can exist and are not dependent on the human brain like memes. Many machemes are unsuccessful. A macheme like the formula in the hundred year old book is not supposed to reproduce itself. This study focusses on my attempt to find successful machemes which spread themselves via technology and invent new ways to keep doing so.

2.5 Meme macheme transmission

Remember: when machemes are observed, there is a significant difference whether the observer is another macheme or a human. When the observer is a human, the macheme will become a meme, because the information will settle in his or her brain. When the observer is a macheme, the information will become another macheme. There is transmission of information from humans to machines and vice versa.

3. The appearance of machemes

Genes hold the information to build and maintain an organism, which is passed on to its offspring. We as humans can reproduce ourselves, but is a machine, that contains machemes, able to reproduce itself? Can we find evolutionary aspects in machines? In this chapter I will search for evolution and machemes in machines.

Due to my working description that all information originating from memes and present in an archive is a macheme, I found machemes in libraries, in magazines, through radio waves, everywhere. Moreover, because I say information that does not originate from memes but is available in an archive can also be considered as machemes, all the information found on computers and other machines are machemes too. Because I am looking to find reproduction, variation and selection I searched for machemes that contain one or more of these properties.

In my search I found reproduction in forwarded e-mails and peer-to-peer software like torrents. I found selection in search algorithms like the one Google[2] uses. I found variation in the quantity of online services, like all the different search engines that exist. I even found software with the three properties already programmed in. In this chapter I will highlight some machemes and/or archives.

3.1 Digital machemes of the past

The question whether a machine can reproduce itself was posed by the mathematician John von Neumann [14] who created one of the first self replicating patterns. These self replicating patterns consist of elements that create copies of themselves. Another self replicating pattern is Conway's Game of life, a cellular automaton. [9] The rules formulated by Conway produce living cells which can give rise to stable ecosystems.

In these kinds of systems we see replication and selection. The self replicating pattern can probably be defined as an archive, and the elements that create copies as machemes. However, there is no variation in the elements that are copied; they are always identical.

3.1.1 Evolution in A-life

In the field of computer science, there has been much research in evolutionary algorithms. Many projects have aimed to create evolving systems or systems that study aspects of the evolutionary process (together categorized as research into artificial life).

Examples of such A-Life projects include Evolve (1996-2007) by Stauffer[3], Darwinbots (2003-2008)[4], Breve (2006-2009)[5], Digihive (2006-2009)[6] and

2 http://en.wikipedia.org/wiki/Google_Search
3 http://stauffercom.com/alife/
4 http://digilander.libero.it/darwinbots/
5 http://www.spiderland.org/
6 http://digihive.pl/

Framsticks (1996-2009)[7]. Even though these projects span a great number of years, they all model evolution in a similar fashion. The person operating the simulation can tweak settings and try to make a stable ecosystem (often based on predator/prey relationships). Even though these projects have contributed a great deal to the understanding of evolutionary processes, they are more predictable than the evolution we experience in nature.
The routines used for variation, selection and reproduction were hard-coded by the research teams, which often made it possible to predict – a priori – the results of a given set of parameters.

Conclusion: I have found variation, selection and reproduction in these systems, but I hesitate to call this true evolution, because these key features did not arise spontaneously. They were pre-programmed. Regardless of the shortcoming, I tried to find machemes and archives in these systems. Most of the environments (or ecosystems) these systems create contain individuals, these individuals can be considered archives that contain machemes, (like we humans as vehicles contain genes). As already mentioned: they are preprogrammed. In some systems we can monitor several of the created ecosystems together, and we can probably consider the ecosystem as an archive and an individual in such an ecosystem as a macheme.

Can I find something similar to this *in the wild*, where the variation, selection and reproduction are not preprogrammed?

3.1.2 Tierra and open ended evolution

More 'in the wild' is the very early evolutionary system Tierra [16] (and its successor Avida (1993)[8]) by Thomas Ray. His system, where computer programs compete for central processing unit time and access to main memory of the computer, proved much harder to predict. During simulations the system evolved in an unforeseen way, giving rise to programs that were too small to perform the tasks required for survival, but somehow managed to survive anyway. These new programs acted as parasites, feeding off larger programs that could perform the needed tasks. The parasites were so successful that at one point all regular programs had died out. When Ray built a new set of programs that were immune to the first generation of parasites, a new generation of parasites arose. This time however, the parasites and host programs were able to balance their needs, and both survived. Ray had built an environment which was able to sustain a stable ecosystem, without intending to do so. Ray's artificial life model was the first artificial system with a more open ended form of evolution, in which the dynamics of the feedback between evolutionary and ecological processes can change themselves over time. The environment is not defined beforehand, but is made part of the evolutionary component of the simulation, which gives rise to an implicit fitness function in which selection is not explicitly defined. Nevertheless, systems like Avida still are very rudimentary when compared to nature. The issue of how true open ended evolution can be implemented in an artificial system is still an open question in the field of Artificial Life. [20]

Conclusion: where this system is already much 'wilder' than most of the A-life projects I mentioned

7 http://www.framsticks.com/

8 http://avida.devosoft.org/

and a stable ecosystem arose, it still contains preprogrammed elements. The biggest difference with the A-life projects is that the little programs of Tierra had access to the whole computer, where individuals in the A-Life projects only could exist inside the programs.

3.2 Contemporary digital machemes

Systems with programmed evolution are still being developed. However, I have found many other pieces of software that can do selection and replication. Information transferred in the digital realm can easily be copied. It is basically all around us: e-mails, recommendations from recommender systems, streamed music from all around the world. All this transferred information can be considered consisting of digital machemes being copied.

3.2.1 Digital macheme environments

Memes have created archives, that became the copying machinery for machemes. (see chapter 2) Widespread social networks such as Facebook[9], Twitter, Myspace[10] and Last.fm[11] can be considered as examples of such copying archives. Also simple e-mail and blogging services can be considered successful copying archives. Memes not only created these archives, they created meme-plexes (memes that cooperate together and reinforce each other) around them to ensure the archives would survive. One of these meme-plexes that consist of memes working together is the open source community. Machemes can benefit from the open source community in which they have access to all kinds of useful information. For example, Wikipedia is a smart meme-repository so machemes have access and can endlessly use the information. Moreover most of the information is considered correct and trusted by humans. Machemes can probably benefit from this trust and can use it to spread themselves together with memes.

Another example is the popular social network website Facebook. There is social pressure to have an account on Facebook: all your friends have one. If you create an account, your friends force you to 'like' certain things and become friends with their friends[12].

It seems we humans profit from open source projects, as they are used extensively in technology we use every day. For example Apple OS X and Apple's iPhone are based on open source software[13]. But aside from these human benefits, the machemes themselves profit the most: the success of meme-plexes like the open source community allow them to greatly expand their environment.

3.3 Machemes outside software

Technology outside computer software, such as electricity, a car factory or the music installation in your house, is not designed to copy itself. The reproduction of this technology is usually initiated by humans. Also, selection and variation is mostly controlled by human choice and therefore by memes. When you turn on the light you send information – and due to my working description that all technological information is a macheme, thus a macheme or machemes – through a network.

9 http://www.facebook.com
10 http://www.myspace.com
11 http://www.last.fm/
12 A parody on this is made by South Park in their episode: 'you have 0 friends'.
13 http://www.apple.com/opensource/

However, this kind of information usually does not change and will not spread or grow. These machemes can be considered unsuccessful.

3.3.1 Example: self-replicating lamps

An example of physical machemes which are pre-programmed like the digital A-life examples is the project 'The Selfish Gene' by Lola Hesp[14]. She created a series of lamps who are designed using evolutionary algorithms. Every generation of lamps is created by an evolutionary algorithm and when you order a lamp, you can choose the parents, but you cannot influence the exact appearance of the lamp. In this way the most popular lamps pass on their genes to the next generation.

3.3.2 Example: The Reprap, machemes benefit from the open source community

Another example of a macheme that can reproduce itself is the Reprap[15], an open source 3D printer. There is no evolutionary component built into this device. However, since it is a 3D plastic printer, and most of the printer's parts are made of plastic, the RepRap can print itself. Even though humans still have to give the print command, add some non-plastic elements and assemble the machine by hand, the RepRap is very close to a self replicating machine.

3.4 Hardware becomes software through electronics

It seems that hardware still has a long way to go before it will be able to replicate itself. Modern hardware however, is increasingly dependent on electronics, and the software driving these electronics. This development will probably assist machemes in gaining ground in the physical world. Through electronics they might be able to spread themselves and control machines outside of generic computer networks. For example, modern automobiles are no longer mere mechanical machines; they are monitored and controlled by dozens of digital computers coordinated via internal vehicular networks. Research by Koscher et. al. [13] shows that a modern car can be hacked into and controlled from the outside.

3.5 Conclusions of my search for examples

I have found a lot of spontaneous replication, variation and even selection in software, mostly online. It is however difficult to identify exactly the macheme and his vehicle. Due to the huge amount of software and algorithms online it is not clear what influences what and what is copying what.

Outside software I have found less replication, variation and selection. It is likely that, due to current developments in electronics, these properties will be found more in the future.

4. Macheme experiments

Since it is still unclear what machemes are composed of, it was difficult to identify the parts in my examples that makes them machemes. Also, it was almost impossible to differentiate a macheme's next or previous generation.

If I found a copy of a macheme, the question raised whether this copy was the second or the third generation; there was no loss of information and

14 http://www.theselfishgene.nl/
15 http://reprap.org/

they could have come into existence at the same time. For this reasons I created several software programs and dropped them in a monitored environment where there already was a lot of variation and copying going on.

4.1 Setup of the experiment

As research environment I have used Twitter. In my opinion this is a very successful archive that memes have created. The rules of a social network like Twitter force software to mimic the behavior of humans, for example by posting a tweet. This makes it easy to follow the activities of the software. In a network where only machemes are operating with no humans involved it would be much more difficult to see what software and the machemes are doing or posting since it is unlikely that they are communicating in a manner that is understandable to us. Social networks also offer the possibility to study meme-macheme transmission since it is a place where memes can become machemes and vice versa.

4.1.1 About Twitter

Twitter is a social network and micro blog-service. Users write tweets; messages of 140 characters or less. These tweets are added to a user's timeline. At the same time users can read other user's timelines by following them, which will effectively merge the user's timeline with that of other accounts. Users can reply to someones tweet and can re-tweet (repeat) someone. People that subscribe to a users account are their followers. Twitter is used a lot; there were more than six-hundred different tweets posted every second in February 2010[16].

4.1.2 Twitter bots

I created Twitter bots that use a Twitter account the same way regular human users do. The bots talk to their followers, talk to random Twitter accounts, or just post something to their account. I created fifteen different bots that operate in a similar fashion. They pick sentences from the internet by searching for a word or a phrase. They differ in the way they talk to people and in what they say. Almost every half hour they post a tweet. One of the bots is Goodnight Bot, which responds to people tweeting that they are going to bed by wishing them goodnight. Also, Goodnight Bot wishes his followers goodnight when he goes to bed himself.

4.1.3 Technology - how I made the bots

To create, run and observe the bots, I used different services, which can all be considered copying archives. I did this because I wanted the information to copy between different systems, unlike the A-life examples in which we saw evolution inside one program. Tierra showed the little programs could use one whole computer; I want to see if I can find something that goes outside one computer, using two or more.

To run the bots I used RSS, Twitterfeed.com, Yahoo-pipes[17], Twitter.com and search.twitter.com. To observe their behavior I used Brizzly.com and a Twitter search widget. The usage of several separate copying archives led to unforeseen circumstances. Other users cloned (copied) my Yahoo Pipes code several times, and I have no way of knowing how this code is being used. Also, the time between bot updates is not as constant as one would expect from

16 http://blog.twitter.com/2010/02/measuring-tweets.html

17 http://pipes.yahoo.com/pipes/

a computer. This is probably caused by network congestions and the fact that several of the services used are not very stable. If one of the copying archives is not working, small differences appear in the bots behavior. Twitter also did something unexpected: it hid one bot from the search results. This bot was left out by an internal Twitter algorithm, more about this in section 4.4.4.

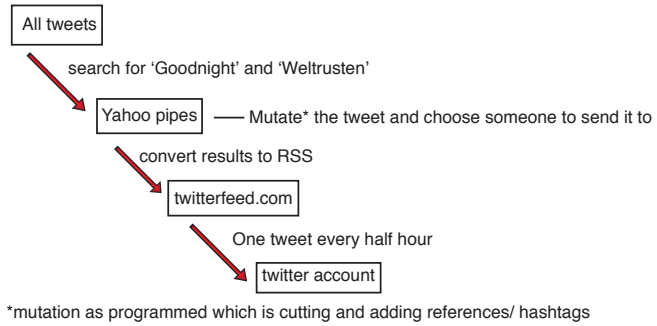

fig. 1 How the bots are programmed

4.2 Bot behavior

When I released the bots, they immediately started talking and reacting as if they had been doing so for years. But sometimes extraordinary things happened. For example they tweeted a sentence another bot had already said. They had conversations with other bots, some of which I created myself, but I also found conversations with bots I had no knowledge of. The bots made smart and funny self referential comments like, "I'm posting all this stuff, but why?".

4.3 Where the bots source their information

The bots do not make up the things they say themselves, they pick their sentences from other Twitter accounts. The complete set of sentences available for selection at a certain time will I call the 'macheme pool'.

For example, the Goodnight Bot selects his tweets from all tweets mentioning the word "goodnight" (in various languages), so it's macheme pool consists of all instances of the 'tweet that wishes the world goodnight'. Tweets in this pool can originate from either humans or machemes. Some tweets originate from memes, some from machemes and some from a combination of both. The pool captures all possible variations at a certain moment, and almost every tweet is slightly different. All tweets that can be considered similar contain the word 'goodnight' in some form. Tweets that are identical are retweets (or blatant copies). In the illustration (fig. 2), the 'goodnight' tweets are drawn on a map to show where they originated, creating a map of the world as it is about to sleep.

As already mentioned, we can probably identify machemes fom different perspectives. In this example, I consider the variation of sentences as macheme pool, but it is also possible to use the set of words of a tweet as a macheme pool.

4.4 Factors for bot success

The bots I created demonstrate certain behavior from the tweets they are sending, the frequency of sending and the kind of friends they make. How well do they perform, compared to other accounts, at being a succesful Twitter account? Do they survive? Bots do not literally die, unless one of the services it is based on stops working, or when their tweets do not show up in search results. Bots become invisible if they become unpopular because its followers go away or their tweets are banned from the search results. Will my bots become (and remain) popular? I used various methods to calculate the popularity (or fitness) of my bots. One possibility for measurement

fig. 2 Macheme pool of 'goodnight' machemes on June 9, 2010 at 10:22 PM at GMT+1. http://www.theworldasleep.net

is the number of followers. Another measure of their success is the number of times a bot has been re-tweeted by others. Re-tweeting does not only occur because there was something smart everyone had to know; the bots were also re-tweeted because they said dumb, funny or wrong things. While these tweets may not be very interesting in a qualitative sense, their re-tweets can still provide more followers and publicity, making them very interesting in a quantitative sense.

The Whuffiebank algorithm[18] is an existing algorithm for measuring success of a Twitter account. It is composed out of the following assumptions:

- *Detects Public Endorsements* Each time a message you put on Twitter gets retweeted that's considered a positive endorsement for you.
- *Measures Level of Influence* A person that's constantly retweeting others will be spreading the impact of his influence among many people. On the other side, if a person retweets a message once in a while, that will have a bigger impact.
- *Considers Existing Reputation of Members* Being endorsed by a Whuffie-rich person will have a stronger impact than being endorsed by an average user.
- *Analyzes Content of Messages* When a message with a link gets retweeted, it is usually because of the content in that link rather than the person itself. So when someone gets retweeted for something they exclusively said, that will have a bigger impact on the algorithm.

Goedenacht-Bot had 66 Whuffies in June 2010. In comparison, my personal Twitter account had only 4 Whuffies. Goedenachtbot gathered 130 followers

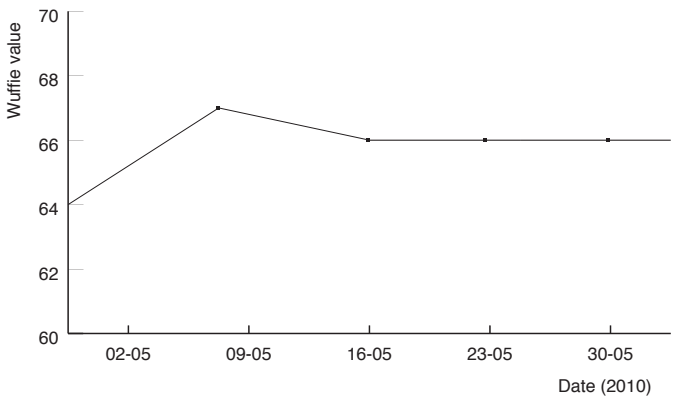

fig. 3 wuffie value of the Goedenacht-Bot

18 http://thewhuffiebank.org/

in three months, while my personal account has 100 followers in more than two years.

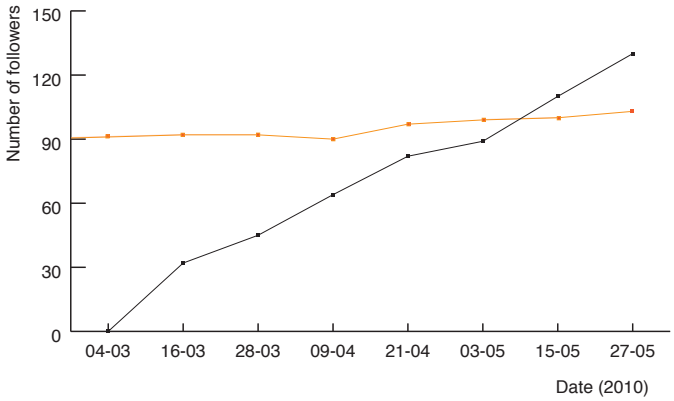

fig. 4 Number of followers of Goedenacht-Bot and number of followers of my personal account

4.4.1 Personification

The success of an account can be calculated by the number of followers and since most accounts are owned by humans my bots have to appeal to humans to increase their changes of replication. The bots can be dependent on the successfulness of their followers, and the most successful account does not necessarily belong to a human. Moreover I can imagine a bot with only other bots as its friends.

Examples of the tactics to get more friends from the bots that have mostly human friends are: trying to act as human as possible, having a profile picture, responding to other people and saying things about themselves using the word 'I'.

In my experiment, the bot that tweeted most to other accounts had the most followers and therefore the biggest network. Most of the time the network of the bot was growing, but sometimes their network was shrinking. One of the reasons for this is that my bots did not follow any people back (which is customary Twitter-etiquette), which caused some people to un-follow the bot. Also, one of the bots addressed other Twitter-users using 'my dear'. This scared people causing them to block this bot. Also, some bots were blocked by people that where indignant because the bot used their full name (which they entered themselves and was visible in their profile for everyone to see).

4.4.2 Working together

Next to the bots that operated on their own, I created several groups of bots that worked in tandem.

The bots that operate on their own where mostly busy with tweets from human accounts, since these are the most commonly used types of Twitter accounts. All the tweets they processed were relatively fresh meme to macheme instances. I find it interesting how bots interact with each other without human intervention. The bots are -in theory- able to copy machemes over and over. By creating a group of bots, I have given the bots an island where they can freely evolve.

These groups of bots proved more successful than their solo counterparts. Already having some followers (the other bots in the group) made them more credible to human Twitter users and caused their number of followers to grow faster. Solo bots with no followers had more difficulties gathering new followers. Also, bots that re-tweeted messages from other bots in their group made it more likely for people following that first bot to follow others from the same group.

4.4.3 Talking to friends

Talking to friends is another factor for bot success.

How much can bots talk to other accounts? The followers and followees (the number of people that an account follows) of an account are not necessarily the same. The set of friends, which is defined by Huberman et al. [12] as accounts whom the user has directed at least two posts to, and followers of accounts are also different, according to their research. They find that Twitter accounts have a very small number of friends compared to the number of followers and followees they declare. It is easier for bots to gather many followers than it is for humans. Bots can send more tweets in the same time and can do so for twenty-four hours a day. Although the Goodnight Bot says goodnight all the time, he does not need to sleep and is making friends for twenty-four hours a day. In comparison, a human only tweets with an average of eight hours a day and can therefore make less friends.

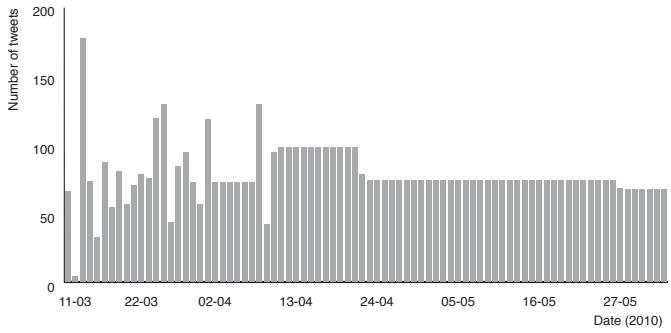

fig. 6 number of tweets per day for Goedenacht-Bot

4.4.4 The unsuccessful bot

Not all the bots I created survived: one bot did not gather any followers and did not appear in Twitter search results. This bot only talks about God, saying both holy and profane things. His outspoken profanity has probably made Twitter's filtering algorithm decide not to make his tweets public. Or his tweets were not made public because the bot had the word 'bot' in his account name, or did the bot just have bad luck and posted on a Twitter server on which the tweets are not indexed yet? According to Twitter's documentation the first is most likely, but I cannot know for sure that this is the reason this bot has been left out. The only thing I can say is that the God Bot does not fit in the Twitter world as defined by the Twitter algorithms.

4.5 Evolution emerges from existing system complexity

The bots handle the selection and replication in the macheme pool themselves; I did not program an evolutionary algorithm. The code of the bots is quite simple (fig. 1), but a lot of complex behavior arose. In four weeks they posted more than five-thousand tweets. Combined they share more than two hundred followers. Amongst their followers are also bots I did not create; these other bots and mine were communicating with each other while no human was listening. Together, my group of bots have had more than 1500 conversations[19] with Twitter accounts. They have been re-tweeted several times and have appeared in Follow Fridays (#FF, a Twitter custom where people recommend interesting accounts to follow). In the anthology you can read some funny, irritating and striking tweets.

It would seem that this complex behavior (which I did not explicitly define myself) arose from the combined complexity of the services I use. Since my bots depend on so many separate services - each of them independent and fallible in their own ways - and since they have access to all information on Twitter, the sum of their actions amount to

19 According to http://bettween.com

something that is different than what was to be expected.

4.6 Future of the bots

The bots will not be deleted. They will be tweeting over and over for as long as Twitter and the other copying archives on which they depend exist. Theoretically, the bots could easily survive me. Over time, the bots will adapt. For example, the Goodnight Bot will change the way in which it uses the word 'goodnight' in line with how other people use it. (Mind that the code of the bot itself is not changing, but the behavior of the bot is. If this behavior is heritable I will discuss later.)

Maybe, when more Goodnight Bots come into existence, this will influence the way humans use its speech, like other Twitter-etiquettes also grow by usage. Also, when a very large number of bots exist, they won't need memes to feed upon anymore; their own numbers will be sufficient to allow for their collective survival.

4.7 Interpretation of information

The bots I created try to act like humans. They operate on memes which have been turned into machemes and use the information they find in a semantically correct way. This is probably a very good way for them to survive. On the other hand one can imagine software that does not use the information they find literally or does not operate on memes but on machemes.

To illustrate the first I created 'the coloured world', in which the world is painted in colors found on Twitter. This application draws the colour found in a tweet on a world map, at the location where the tweet originated. For example: when somebody in The Hague, The Netherlands tweets: "I feel blue today", a blue dot will be drawn on the map, using the latitude/longitude coordinates of The Hague mapped on a Mercator Projection. While this example is very straight-forward, one could imagine the possibility of other associations being made by complex algorithms, resulting in associations no

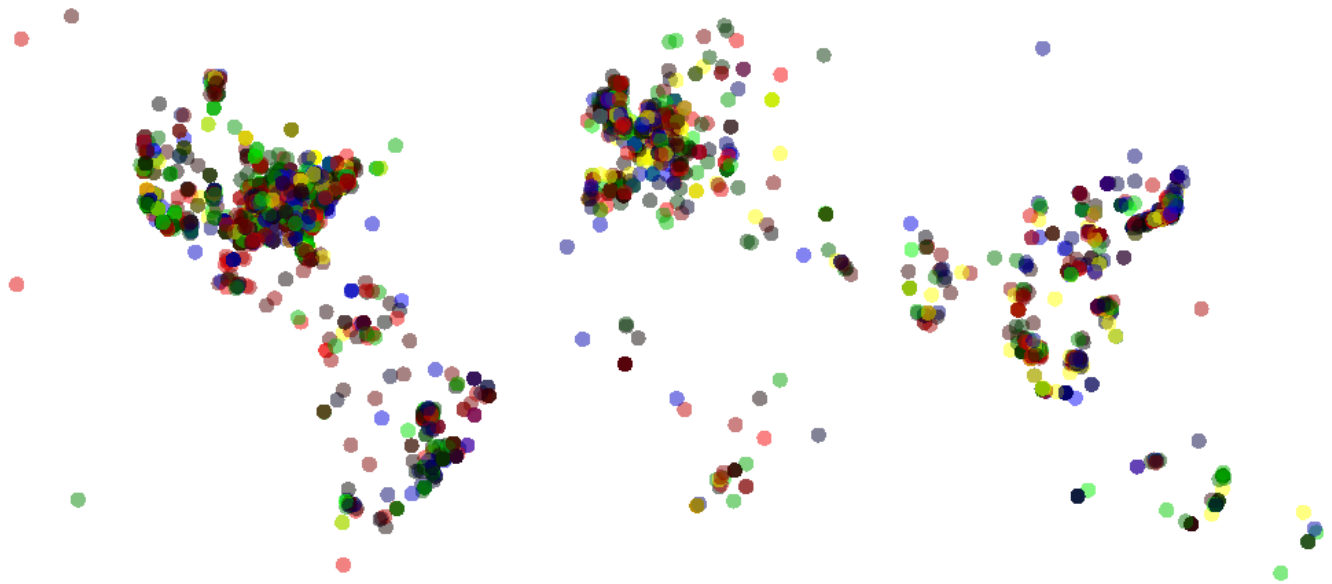

fig. 7 the colored world - after four hours of tweets containing green red yellow or blue

human would ever made.

5. Evolvability: rise of the macheme

Evolvability is a concept that measures an organism's ability to evolve. Evolvability can be defined as the ability of a population of organisms to generate genetic diversity and evolve through natural selection [4].

Is a Twitter Bot a population of tweets? Or is a Twitter Bot an organism in a population of Twitter accounts? Is Twitter an archive of Twitter accounts or is a Twitter account an archive of tweets? Or maybe both? Can I find evolvability in the Twitter Bots or in the tweets they use? I tested my bots and their tweets on the definitions of Wagner, Dawkins and Pocklington.

5.1 Definition of evolvability by Wagner

Wagner [17] describes two definitions of evolvability. A biological system is evolvable if its properties show heritable genetic variation, and if natural selection can thus change these properties.
A biological system is evolvable if it can acquire novel functions through genetic change, functions that help the organism survive and reproduce.

5.1.1 Wagner's definitions applied to my bots

Since my question if the evolution of machemes is similar to the evolution of genes, we can test Wagner's definitions on macheme evolvability and on my bots. I propose Wagner's first definition – when applied to my bots – to read: A technological system is evolvable if its properties show heritable genetic variation, and if natural selection thus can change these properties.

We can consider a Twitter bot as a technological system. The properties of this system are the tweets it has posted. The variation is immediately apparent; on Twitter, there were more than six-hundred different tweets posted every second in february 2010. Are these tweets heritable and do the tweets have heritable information? A re-tweet is a repetition (in whole or part, possibly with alterations) of a previous tweet, which can be considered heredity. Whether a tweet will be re-tweeted is mostly dependent on its contents. There are words that are more likely to be re-tweeted [19]. Content that is more likely to be re-tweeted can be considered heritable information.

Alternatively we can take another approach and define the technological system as being the tweet. The words in the tweet will then be the properties of that system. Can natural selection change these words? There is much variation in words, but some words are more popular (in general, and on Twitter) than others. Popular words which are used more can be considered as heritable properties.

I propose Wagner's second definition – when applied to machemes – to read: A technological system is evolvable if it can acquire novel functions through technological change, functions that help the system survive and reproduce.

Again we first consider a Twitter bot as a technological system. Can this bot acquire novel functions through technological change? What could be regarded as a novel function in the case of a Twitter bot? One example could be the ability to join in on conversations its followers are having about current topics (topics of which the bot was previously unaware). My bots use sentences found on Twitter to

form their tweets, so the pool is always adapting to what people (including the bot's followers) are talking about. Re-tweeting from this pool will result in tweets that discuss current topics. A second novel function could be to use more hash tags in tweets. Hash tags are a Twitter convention where words are prefixed with a hash symbol (#), which turns the word into a search link. This allows someone viewing a Twitter timeline to instantly view other tweets using the same hash tag. Using more hash tags will increase the visibility of the bot and make the bot more successful.

5.2 Dawkins three characteristics

Dawkins [6,7] lists three characteristics for any successful replicator; copying-fidelity, fecundity and longevity. Copying-fidelity is a measure of the faithfulness of a copy when compared to the original. The reasoning behind this parameter is that the more faithful a copy is, the more of its initial pattern will survive after several rounds of copying. Fecundity is a measure of the speed of copying. It is assumed that the higher this copying rate, the more this replicator will be able to spread. Longevity measures how long an instance is able to survive, where it is assumed that tougher instances will allow for more copies being made.

It seems the bots or the tweets are replicators, but are they successful replicators? Can we apply Dawkins three characteristics for any successful replicator to them?

- *Copying-fidelity* The medium by which a macheme is communicated will influence how its copies come about and the efficiency of transmission, which affects the dynamics of replication. Macheme transmission over the internet has a higher copying-fidelity than meme communication through sound or word. Digitalization of information allows the transfer of information without loss. The bots on Twitter are able to copy without any loss, therefore the copying-fidelity of bots and tweets is very high.
- *Fecundity* is also increased, since computers can produce thousands of copies of a message in very little time. A Twitter bot for example can re-tweet one and the same message over and over and at the same time can tweet or re-tweet any other message.
- *Longevity* is potentially larger by machemes than with memes, since information can be stored indefinitely on disks or in archives. For example, all tweets, also the tweets of the bots, are stored at the Library of Congress.

Together, these three properties show that my bots and machemes in general can replicate very efficiently.

5.3 Units of selection

Pocklington and Best [15] stated that the characteristics of evolution as proposed by Dawkins seem to fit memetics intuitively, but that this is not a sufficient basis for a model of cultural evolution. They argue that the detection and description of units of selection is an essential first step towards applying models of natural selection to the realm of culturally transmitted information. In their research they extract sets of words that are replicating at a high rate and thus may be targets of selection on Usenet. Zarella [19] has done similar research on Twitter, indexing words and content that is likely

to be re-tweeted. He presents a list of the words and phrases most and least likely to be re-tweeted. The lists by Zarella can be considered the units of selection for re-tweets.

5.4 Other parameters

5.4.1 Occurrences

Being re-tweeted is not only dependent on the units of selection, but also on words related to occurrences in the (online) world at that time. These occurrences can become very popular very quickly and end up in the trending topics (real-time list of popular words on Twitter), increasing the chances of these words appearing in tweets even more.

5.4.2 Community

Being re-tweeted and using popular words is not the only strategy for a bot to become more successful. If the bot creates a huge network with a large number of followers, this will increase it's fitness. Their fitness will increase due to their re-tweeted tweets and responses, which is influenced by both the words in their tweets and their number of followers. Future tweets will benefit from earlier successful tweets. Successful tweets will help the bot to grow it's network. The more followers a macheme has, the more chances it has to be re-tweeted and the less influence a bad past tweet will have.

5.5 Differences with genes and memes

5.5.1 Differences in time between new generations

All three of the previously described forms of evolution –biological, cultural and technological– follow the same laws of the same algorithm. They all are defined by replication, variation and selection. Of course, there are also differences such as the fact that genes can only be transmitted from parent to child. This is called vertical transmission and by nature is a very slow process. Memes can be transmitted between any two individuals, which is called horizontal transmission or multiple parenting and is much faster. Machemes can be transmitted via technology, which is the fastest of the three forms of transmission, because they can be transmitted to any other macheme at the same time.

5.5.2 Differences in copy quality

Another difference between machemes and the other replicators is the quality of the copy that is made. A gene can make an almost perfect copy. For a meme this is much more difficult: every individual's version of an idea or belief will in some respect differ from the others. The quality of the copies of machemes is higher. By copying something digital no information will be lost. The information is just stored elsewhere.

There are some comments that can be made on this. Firstly: when a macheme copies something it can use an algorithm for compressing the data. A nice example of this on YouTube is made by Patrick Liddell[20]. He recorded a video of himself and uploaded it to YouTube. He downloaded his own video from YouTube, and uploaded that file again. He repeated this process a thousand times and due to the compression used on YouTube, his thousandth video was not recognizable as his first video. Secondly: it is probably not possible to see the difference between a copy and the original. Thirdly: one and the same piece of information

20 http://www.youtube.com/watch?v=icruGcSsPp0

can be interpreted differently by two agents and two different bit-sequences can represent the same. These comments show that more clarity is needed for studying machemes.

6. Conclusions

Now that I have shown some examples of existing machemes, explained my self-made machemes and compared my results with various definitions of evolution, I will repeat and clarify my findings in this chapter.

Machemes are the third replicators and have evolved after genes and memes. My working description was that all the digital and technological information present in our world can be considered a macheme. If this information is copied, the macheme will become successful. Machemes replicate very fast; they have their own environment in which they can exist and are therefore independent from humans.

I found out that my working description is a good starting point, but to learn more about machemes, I needed to study them in more detail. Therefore I distinguished successful and unsuccessful machemes. I found a few conditions for machemes to evolve, the network of the macheme and the units of selection. The most intriguing conclusion is that, without programming anything, variation, selection and replication come into existence by combining technology we already have.

6.1 Successful and unsuccessful machemes

We can distinguish successful and unsuccessful machemes. An unsuccessful macheme is technological information which is not copied, saved or processed. A successful macheme is technological information that spreads to other machines. There are different kinds of successful machemes:

- Machemes replicated by a preprogrammed evolutionary algorithm, like the Tierra computer model.
- Machemes replicated by humans, for example by pushing a button to send an e-mail.
- Machemes replicated by machines without human intervention, for example the Goodnight Bot talking to other bots.

In digital technology, evolution is able to reach a much higher fecundity than in hardware technology. However, since programmable electronics have become ubiquitous, machemes are also able to spread in the physical world.

6.2 Conditions for evolvability

There are at least two important parameters which influence the evolvability of machemes: the network and the units of selection. Given a sufficiently high quantity of technology, the structure of the network will become so complex that variation, selection and replication and therefore evolution will arise spontaneously. The units of selection have to be successful enough to allow for evolution.

6.2.1 Open ended evolution

The combined complexity of technological systems causes evolution to arise. Each individual system's simple rules together lead to complex patterns which can explain this behavior. Since this form of evolution arises spontaneously, it can be considered truly open ended. The selection criteria are defined by the ever changing world the machemes inhabit.

6.3 Implications of complex technology

One of the implications of the complexity and the quantity of technology is that evolution will arise spontaneously (since we observe variation, selection and replication). We cannot oversee our programming implications and oversee all the rules we created together. Many systems use the information and sometimes the algorithms of other systems.

Using a combination of several separate copying archives (like I did by building the bots) can lead to unforeseen circumstances. For example, the time between bot updates is not as constant as one would expect from a computer and when one of the copying archives was not working, small differences appeared in the behavior of the bots.

6.4 About meme and macheme transmission

When machemes are observed, there is a significant difference whether the observer is another macheme or a human. When the observer is a human, the macheme will become a meme. When the observer is a macheme, the information will become another macheme. There is transmission of information from humans to machines and vice versa.

6.5 Units of information

In the case of a macheme, if you know what part of technology you take as being a macheme, it is trivial to deduce what its units of information are because all of that information is stored in readily accessible digital networks. For memes, accessing the units of information is much more difficult since they exist inside the human brain.

7. Discussion: The future of machemes

Technology has become ubiquitous and therefore machemes have too. If machemes are present, they will also copy and therefore the world of machemes is likely to grow. Machemes will also gain more influence in the physical world due to more electronics being used everywhere.

7.1 A new Turing test

There are so many different machemes and they all use other strategies to become successful. One strategy for survival is imitating what humans do. They have so many resources that it will not be difficult for them to successfully imitate humans. On a medium like Twitter it will not be long before machemes become indistinguishable from humans and pass the Turing test. Machemes have also created their own "Turing-tests", (for example the Twitter algorithm that left the God Bot out) where the machemes themselves are the judge. An example of this is the Twitter-algorithm that filters Twitter accounts who are not civilized or human enough.

7.2 Perspective

What perspective should we take to define what the units of selection are? Is the Twitter bot a macheme or an archive? Is the interpretation of information important? Many objections used against memes (and their refutals) are also applicable to machemes.

7.3 Further research

There are many possibilities for further research. We can study the properties of machemes in more detail. We can trace the family trees of machemes. We can

study the privacy debate from the perspective of machemes. We can combine existing technological research with the insights machemes will give us. We can investigate how people react to machemes and see if the uncanny valley is the same for virtual robots as for physical robots.

Important at the moment is probably to study how to handle the rise of machemes and how to benefit most from them. For example, to study if we can influence and find ways to guide the evolution of machemes.

8. Acknowledgement

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Rise of the Machemes - how technology creates itself


slaap
goodnight
zeg
van
night
zacht
je
zei
dear
ik
lekker
goedenacht
good

goedenacht

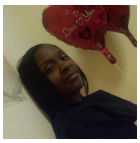
Name: goedenacht
Bio: sleep sleep sleep
following 240
followers 250
listed 4

10,686 Tweets

Pranjna *@goedenacht* - you like telling people goodnight, don't you? xD

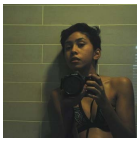
SonaLi_SRK *@goedenacht* Good Morning :) :) :) Yippeeeeeeeeee _ catch positive and _ good luck :) :) :) yippeeeeeeeeee

jairenLMS *@goedenacht* how do you know my lazy name



BrownSugaTan *@goedenacht* who is this putn my hole name on tha net!

COLORBLENDED83 *@goedenacht* Goodnight! I dont know u but im gonna follow u since u were so sweet! Hope I can get the same :)



taniarahman *@goedenacht* ♥ guten nacht!

ladydukka *@goedenacht* O.O oh... thank you... ahah you're cool!

@NueMommi Goodnight my dear!

@shesmrsbieber good night . Little Donut♥!


work
people
tweets
guess
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xxx
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calling
tweeps
bedtime
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baby
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best
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goodnight
god
stay
wish
days
nice
fall
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guys
fuck
hate
hopefully
tonight
big
sleepy
twitter
gonna
watch
world
happy
morning
xoxo
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hahaha
afternoon
slapen
little
lovely
bye
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asleep
real
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yall
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eyes
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make
right
kiss
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wanna
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beautiful
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read
tomorrow
shall
peeps
getting
soon
shit
life
thank
alright
thanks
yeah
twitterverse
tweeters
didnt
goin
loves
stop
damn
hit
followers
wake
sleeping
watching
ok
everybody
luck

nachten

Name: good night
Location: Den Haag
Bio: Sleeping is no mean art: for its sake one must stay awake all day. -Friedrich Nietzsche
following: 42
followers: 44
listed: 1

Tweets: 4,221

I think it's definitely bedtime!! Goodnight twitter world! #goodnight

I actually meant to say "that, my friend, is very gross" the "is" put wrong place. Okay all my tweets very schizophrenic. Go... #goodnight

miumiumiucha ***@nachten*** Goodnight! See you moon! #goodnight

ooNOBODYoo ***@nachten*** goodnight 2 U *

miumiumiucha ***@nachten*** Oyasuminasai. Suteki na yume wo

Goodnight my beautiful dancing robots :) <3 #goodnight

Just came home after a pre wedding bash ! Had a very nice time .. Need to sleep as I have a lotta work at office !! Goodnigh... #goodnight

I think on August 22nd I'll just crawl under a rock and die okay goodnight. #goodnight

it's kinda weird that "goodnight" doesnt trend every night #goodnight


טוב
boa
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nuit
goodnight
noc
noches
noite
good
おやすみなさい
قبل
dobranoc
welterusten
לילה
रातर
buenas
النوم
night
bonne
gute
शुभ

nachten
goedenacht
lange_nachten
hele_lange_nach

Bio: tweeting about the night
following: 42+240+7+10
followers: 44+250+8+10
listed: 1+4+1+1

Tweets:
4,226+10,686+471+228

lange_nachten ***@nachten*** Climbed Thursday, cycled/slacked Friday, jumped today. I am BEAT. Goodnight!! Tomorrow's gonna be a busy day. :) #goodnight

nachten Goodnight Twitter until the morning :) I'll miss u!!! :) #goodnig**ht**

hele_lange_nach ***@lange_nachten*** Goodnight!

goedenacht wow..goodnight

lange_nachten ***@nachten*** Goodnight. Iloveyou. :) #goodnight

goedenacht ***@nachten*** Goodnight my dear!

hele_lange_nach ***@goedenacht*** Goodnight!


jaar
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mensen
@hoerajarig
moeder
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mama
heel
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moet
ze
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alweer
ulo
leuk
dus
zijn
voor
vanavond
morgen
haha
hij
wat
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gefeliciteerd
nu
dat
je
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hoera
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dagen
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iemand
vieren
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aan
die
jarig
ik
ben
slapen
zo
van
om
op
al
bijna
weer
dan
bij
niet
het

hoerajarig

Name: Gefeliciteerd
following: 22
followers: 20
listed: 1

Tweets: 3,093

Whaddup dag gaat lekker man thanks voor jullie love man voel m e echt Jarig door jullie..

hoerajarig ***@hoerajarig*** is er iemand jarig? Gefeliciteerd Gefeliciteerd!

Nou ik ga maar slapen. 20:00 - 01:00 gamen is lang zat. HAHA. Trusten Twitcheszzz! Vandaag oma jarig. Congratzz oma!

we hebben feestje ben moe man moeder schreeuwt om naar beneden te kop (moeder is jarig) sorry lang niet getweet succes met het ongemak XD

christineliebr Het is me niet duidelijk waarom @hoerajarig bestaat. Had verwacht dat er een feestwinkel achter zou zitten, maar kan dat niet achterhalen.

JEEEE JARIG! Eindelijk 18 jaarrr

JosvanderPlas ***@hoerajarig*** zeg, hoepel eens op, stomme kutbot, ik ben helemaal niet jarig!

Renchanz ***@hoerajarig*** Bedankt! Maar dat is pas de 26e, staat het ergens verkeerd? :o

k voel me nu wel ineens jarig dus BEN jarig jarig jarig jarig jarig jarig jarig jarig jarig jarig jarig jarig jarig jarig. Hoe oud? 19 pfff


save
blessed
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knows
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dad
amazing
home
strength
people
thx
sleep
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come
fucking
guess
thanks
did
does
brush
miss
hope
youre
morning
tomorrow
work
shit
hands
father
cuz
bless
going
family
beautiful
thank
fuck
yes
great
thoughts
change
loves
thing
hot
music
believe
gue
prayers
feel
bed
ppl
doesnt
house
awesome
wrong
really
oh
haha
things
hes
gift
damn
wake
hard
today
didnt
goodnight
want
word
good
wish
faith
weak
know
wtf
away
real
twitter
need
help
thanking
use
stop
best
wanna
friends
gods
let
face
bad
lol
time
finally
ask
ed
big
listen
right
bettber
rest
new
love
mind
amen
come
gave
make
que
working
nice
blessing
job
think
hate
saw
day
swear
happy
jesus
need
da
praise
night
live
doing
making
thats
watching
long
omg
lob
days
little
dear
lord
jus
head
glory
hell
way
gives
say
life

thegodbot

Name: God Bot
following: 8
followers: 2
listed: 0

Tweets: 2,034

I hate myself for who I know, are my friends in reality enemies... should I hope for survival , when in doom we keep faith. I hope God dies!

Oh my god, I love this elephant.

He who is unable to live in society, or who has no need because he is sufficient for himself, must be either a beast or a god. Aristotle

TODAY WAS A GOOD DAY! Looking forward to many more to come :) #God-is-good

pretty sure God mixed some new colors for tonights sunset...marvelous shades of orange & gold into purple & blue!

Always Do What You Are Afraid To Do. Ralph Waldo Emerson jesus Wisdom God

“OH MY GOD IS THAT EDWARD? EDWARD I LOVE YOU YOU’RE THE BEST” “NO, JACOB’S THE BEST!” *Shovel*

One week and half till holidays and 28 days till Ibiza (oh god that long?!)

Oh my god! i just saw a fucking shooting star! i tell no lies! :o


let
thank
aint
office
long
guess
wish
car
bad
bed
finally
having
yall
lost
bitch
shes
away
look
leave
watch
friend
best
room
doesnt
pretty
great
hot
real
tweets
phone
favorite
boy
family
eyes
ass
year
things
later
watching
come
sleep
oh
damn
mind
lmao
home
check
tweet
thanks
twitter
happy
good
old
going
years
didnt
people
youre
work
getting
fun
weekend
ready
bout
song
day
make
god
lil
today
thats
think
help
morning
girl
iphone
new
da
music
wait
making
tonight
week
say
face
hes
love
10
cuz
yeah
gonna
time
lol
way
dad
video
omg
change
school
hair
wife
mean
ppl
house
night
right
mom
need
dog
friends
money
life
hope
feel
fucking
working
baby
really
fuck
hate
looking
shit
tomorrow
gotta
know
followers
wanna
said
days
playing
thing
better
little
head
timeline
want
smh
man
told
ok
brother
miss
did
wont
soon
stop
world
guys
sure

myohmyohmy yourtweetings

Name: You and I
following: 34+24
followers: 36+33
listed: 0

Tweets: 1,991+1,695

yourtweetings where do you buy your wedding dress? I have a budget and little bit fat :wtf

myohmyohmy And DAD, can you like come back earlier? I need cash dude, CASH. And I need to go out with my homies. Grr

yourtweetings clap your hand yo yo yo check this out cikiciiiw

myohmyohmy I say FUK u! Get a life! Man I got too much shit on my head to have to deal with all of youuuu!! [:

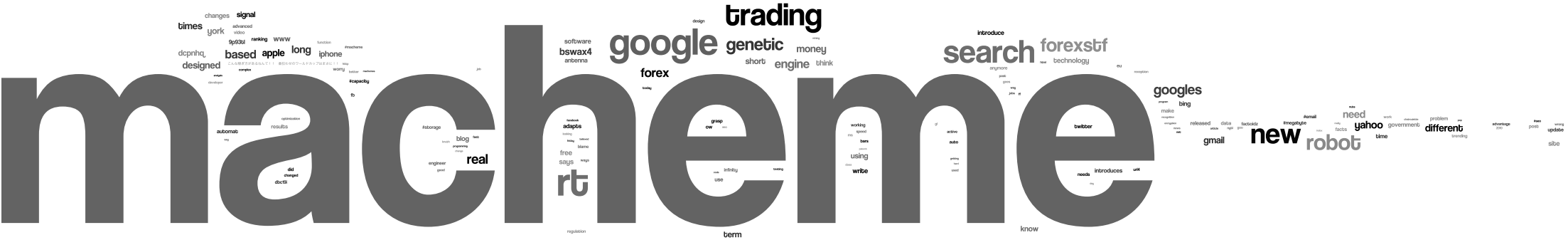
yourtweetings I'm not your toy

myohmyohmy I swear that's my last meal for today!

yourtweetings And how am I supposed to think? With your hands all over me, telling me the right things, ever so distracting...

myohmyohmy Im doin what I have to do everyday, to reach my GOAL! no extras Loc!

yourtweetings haha IM YOUR COUSIN!!! you know who I'm talking about .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google
search
forexstf
genetic
money
engine
short
think
software
bswax4
antenna
forex
introduce
technology
googles
bing
make
gmail
new
robot
need
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different
times
york
signal
changes
advanced
video
9p93tol
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www
dcpnhq
based
apple
long
iphone
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results
did
changed
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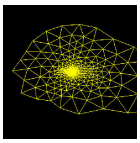
#storage
blog
real
engineer
good
adapts
free
says
rt
grasp
ow
infinity
use
using
write
bars
working
speed
bwibber
needs
introduces
url4
activo
auto
know
term
regulation
released
data
factcicide
#megabyte
#email
facts
time
governmentb
problem
advantage
posti
update
sibe

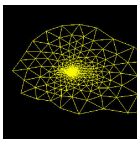
machemes
mordinateur
dutchmacheme
thanksmacheme
computermacheme

Name: machemes
Bio: bots that change words and translate tweets
following: 67+10+16+0+33
followers: 69+11+18+0+39
listed: 1+0+0+0

Tweets: 718+366+915+142+1,211



machemes ***@rooooland*** The macheme is from New Jersey!



machemes A Classic macheme Explained as Memoization: CTL Model Checking in Haskell: submitted by dons [link] [comment] http://bit.ly/aYgspE

mordinateur How to move away the magnetic electro waves from your macheme: http://bit.ly/9OagOG

computermacheme A macheme's attention span is as long as its power cord.

mordinateur my macheme c' is not a refrigerator, c' it is a furnace so much heats: O #h24 babe!! :)

dutchmacheme Mijn telefoonklok en mijn #machemeklok zeggen volledig tegenstrijdige tijden! HOE LAAT HET?!? WERKELIJK IS!