to be published in: *Ars Electronica Catalogue*, Ingrid Fischer (ed.) (Springer, Vienna/New York, 1996)

Evolution of Memes on the Network: from chain-letters to the global brain

Francis Heylighen

Center "Leo Apostel", Free University of Brussels,

Pleinlaan 2, B-1050 Brussels, Belgium

fheyligh@vnet3.vub.ac.be

Memes as Replicators

An essential characteristic of genes, the units of biological information, is that they *replicate*: they produce copies of themselves, and thereby spread and increase in numbers. Sometimes mutations or copying errors are introduced, producing different variants. Only the best or "fittest" will manage to spread widely. This is the process of *natural selection*, which weeds out inadequate genes. Variation and selection together produce evolution, the perpetual creation of new, better adapted genes.

Richard Dawkins (1976) suggested that a similar mechanism applies to cultural information. Ideas, habits and traditions are communicated from individual to individual. This can be interpreted as a replication: a copy (possibly with errors) of the information is made in the memory of a second individual. Dawkins called the units of this cultural replication process "memes". Practically all cultural entities are memes: images, books, poems, theories, religions, language, melodies, rumours, etc. It suffices that the underlying informational or behavioral pattern is copied, e.g. when people imitate other people's habits or styles, when they learn other's ideas, or reproduce works of art. Like genes, cultural variants can be more or less successful in spreading through the population. They therefore undergo natural selection, and thus evolution.

Dawkins listed the following three characteristics for any successful replicator: 1) *copying-fidelity*: the more faithful the copy, the more will remain of the initial pattern after several rounds of copying. If a painting is reproduced by making photocopies from photocopies, the underlying pattern will quickly become unrecognizable. 2) *fecundity*: the faster the rate of copying, the more the replicator will spread. An industrial printing press can churn out many more copies of a text than an office copying machine. 3) *longevity*: the longer any instance of the replicating pattern survives, the more copies can be made of it. A drawing made by etching lines in the sand is likely to be erased before anybody could have photographed or otherwise reproduced it.

In these general respects, memes are similar to genes and to other replicators, like computer viruses or crystals. The genetic metaphor for cultural transmission is limited, though. Genes can only be transmitted from parent to child. Memes can be transmitted between any two individuals ("multiple parenting"). For genes to be transmitted, you need a generation. Memes only take minutes to replicate. On the other hand, the copying-fidelity of memes is in general much lower. If a story is spread by being told from person to person, the final version will be very different from the original one. It is this variability or fuzziness that perhaps distinguishes cultural patterns most strikingly from DNA structures: every individual's version of

an idea or belief will be in some respect different from the others'. That makes it difficult to define or delimit memes.

There are several selection criteria which determine in how far a particular meme will be successful. The more of these criteria a meme satisfies, the more likely it is that it will maintain and spread (Heylighen, 1993). Objective criteria determine whether the knowledge conveyed by a meme can reliably predict events in the outside world. Subjective criteria determine in how far an individual is willing to assimilate a particular meme. They include: 1) *coherence*: the meme is internally consistent, and does not contradict other beliefs the individual already has; 2) *novelty*: the meme adds something new, something remarkable, that attracts the person's attention; 3) *simplicity*: it is easy to grasp and to remember; 4) *individual utility*: the meme helps the individual to further his or her personal goals.

Intersubjective criteria determine how easily memes travel from subject to subject. They include: 5) *salience*: the meme is easily noticed by others, e.g. because it is shouted out loud, or printed on big posters; 6) *expressivity*: the meme is easily expressed in language or other codes of communication; 7) *formality*: the interpretation of the meme's expression depends little on person or context; 8) *infectiveness*: the individuals who carry the meme are inclined to "spread the word", to teach it to other people or to convert them to the belief; 9) *conformism*: the meme is supported by what the majority believe; 10) *collective utility*: the meme is useful for the group, without necessarily being useful for an individual (e.g. the traffic code).

The information in the genes of an organism constitutes its genotype. Its body, developed through the interaction of genotype with environment, constitutes its phenotype. The equivalent of a phenotype for memes is the *sociotype*, the concrete organization of the group of people carrying a collection of memes or *memotype*. For example, if the memotype is the whole of Mormon beliefs, then the sociotype is the group of all Mormons. As a meme is more fuzzy than a gene, a sociotype is likewise more fuzzy than a phenotype: it is in general not clear how a group of meme carriers can be delimited (Heylighen & Campbell, 1995).

Memes on the Net

The above review sketches the properties of memes in general, be they scientific theories, religions, musical styles or the use of gadgets. It is obvious, though, that the media by which a meme is communicated, such as scientific journals, church preachings, or radio stations, will greatly influence its eventual spread. The most important medium at present is the emerging global computer network, which can transmit any type of information to practically any place on the planet, in a negligible time.

This highly increased efficiency of transmission directly affects the dynamics of replication. Meme transmission over the network has a much higher copying-fidelity than communication through image, sound or word. Digitalisation allows the transfer of information without loss, unlike the analog mechanisms of photocopying, filming or tape recording. Fecundity too is greatly increased, since computers can produce thousands of copies of a message in very little time. Longevity, finally, becomes potentially larger, since information can be stored indefinitely on disks or in archives. Together, these three properties ensure that memes can replicate much more efficiently via the networks. This makes the corresponding memotypes and sociotypes potentially less fuzzy.

In addition, the network transcends geographical and cultural boundaries. This means that a new development does not need to diffuse gradually from a center outwards, as, e.g., fashions or rumours do. Such diffusion can easily be stopped by different kinds of physical or linguistic barriers. On the net, an idea can appear virtually simultaneously in different parts of the world, and spread independently of the

distance or proximity between senders and receivers.

The simplest example of a meme that takes into advantage these network features is a chain-letter: a message sent to different people with the express request to copy it and distribute it further. This is motivated by anticipated rewards for those who do (and punishment for those who don't). Paper chain-letters are often poorly readable photocopies, or manuscripts retranscribed numerous times by hand or by typewriter, with the insertion of plenty of spelling and semantic errors. The effort and cost of copying and distribution moreover limit the number of copies per generation to about 20. Chain-letters distributed by electronic mail, on the other hand, can be sent to hundreds or thousands of people at once, at virtually no efforts or costs, and without information degradation.

Though I have received more chain-letters by email than by post, chain-letters on the net are still a minor phenomenon. Although their spread is very much facilitated by the net, the same applies to all other types of messages. That means that there is increased competition between all these different memes for a limited resource: the attention a user pays to the information he or she receives. Because chain-letters fulfil relatively few of the criteria that distinguish successful memes from unsuccessful ones, they are unlikely to win this competition.

The recent development from the net as carrier of email messages to the World-Wide Web as repository of interconnected documents has greatly changed the dynamics of meme replication. On the Web, information is no longer distributed by sending copies of files to different recipients. The information is rather stored in one particular location, the "server", where everyone can consult it. "Consultation" means that a temporary copy of the file is downloaded to the RAM memory of the user's computer, so that it can be viewed on the screen. That copy is erased as soon the user moves on to other documents. There is no need to store a permanent copy since the original will always be available. That does not mean that replicator dynamics no longer apply: the interested user will normally create a "bookmark" or "link", i.e. a pointer with the address of the original file, so that it can be easily retrieved later. A link functions as a *virtual copy* (also called an "alias" file), which produces real, but temporary, copies the moment it is activated.

The success of a web document can then be measured by the number of virtual copies or links pointing to it: the documents with most pointers will be used most extensively. There are already web robots, i.e. programs which automatically scan the Web, that make "hit parades" of the documents which are linked to most often. For example, it is likely that a reproduction of the works of Van Gogh on the Web will be much more popular in number of pointers than the work of some unknown 20th century painter.

Cooperating Memes: towards a Global Brain?

Discussions about memes, and about evolutionary systems in general, usually emphasize *competition*, i.e. the "survival of the fittest" at the expense of the less fit. However, in biological evolution, *cooperation* between evolving systems, in the sense of symbiosis and mutual support, is at least as important. Multicellular organisms, in which the individual cells cooperate for the collective good, are a prime example.

For genes, competition is limited to "alleles": alternative versions of a gene which compete for the same position on an organism's chromosome. Genes residing in different parts of the chromosome, on the other hand, do no compete but cooperate in steering the development of the organism. Each gene produces a particular type of protein, in reaction to the presence of absence of other proteins in the cell. Together, these proteins build up the cell, digest food molecules, eliminate poisonous molecules, and generally restore the cell equilibrium after different perturbations. Genes cooperate directly through their

arrangement in networks: the product of one gene can activate or deactivate a number of other genes, which in turn may activate further genes, and so on.

Similarly, memes can be said to cooperate if they are coherent or support each other. For example, the belief that the Earth is round and the belief that the Earth circles around the sun are mutually reinforcing. The "roundness" meme makes it easier to visualize the "circling" meme, and vice versa. On the other hand, the roundness meme contradicts the meme which says that the Earth is flat. Roundness and flatness behave like alleles, which compete for the same position in a person's view of the world. Though flatness does not directly contradict circling, it is clear that they fit less well together than roundness and circling. Similar examples can be found in the domains of art and fashion. Debussy's music seems to fit in much better with impressionism in painting than with expressionism. Heavy metal music seems to go together with riding motor bikes, but not so much with bicycles.

Mutually supporting memes will tend to group together in larger cooperating ensembles, like ideologies, theories or religions. Mutually exclusive ensembles, like Catholicism and Protestantism, the Copernican and Ptolemaic views of the solar system, or the hippie and punk movements, will compete for converts. It is here that the "multiple parenting" issue, distinguishing memes and genes, comes into play. Since many different people ("parents") can try to convert the same individual, that individual will need to make a choice between the different memes presented to her. (In contrast, you cannot choose from which parents you inherit your genes). For two otherwise equivalent memes, the determining characteristic will be the number of already existing converts: the more people try to convince you of something, the more likely it is that you will follow the lead. If slightly more people believe in one meme, that meme will make more new converts, and thus increase its lead over the competition. This is a self-reinforcing evolution, where success breeds success. As confirmed by a mathematical model of meme transmission (see Heylighen & Campbell, 1995), the result will be that everyone in a group ends up believing the same things. This is what I called earlier "conformist" selection. However, different groups, with little communication between them, will generally believe different things, since conformist transmission tends to amplify small differences in initial distribution of beliefs.

Let us now see how these mechanisms of cooperation and competition are affected by the global network. Like genes, memes on the web are arranged in networks, where one document points to a number of supporting documents, which in turn link to further supporting documents. Linked documents cooperate, in the sense that they support, confirm or extend each other's ideas. Competing documents, such as announcements of commercial competitors, will not link to each other, or only refer to each other with a phrase like "you should certainly not believe what is said there".

Assuming that two competing documents are equally convincing otherwise, the competition will be won or lost by the number of links that point to each of them. The more pointers to a document can be found, the more people will consult it, and the more further pointers will be made. This is the same kind of self-reinforcing process that leads to conformism, to all members of a group settling on the same meme ensemble. The difference is that now there are no separate groups: on the global network, everyone can communicate with everyone, and every document can link to every other document. The end result is likely to be the emergence of a globally shared ideology, or "world culture", transcending the old geographical, political and religious boundaries. (Note that such homogeneization of memes only results for memes that are otherwise equivalent, such as conventions, standards or codes. Beliefs differing on the other dimensions of meme selection will be much less influenced by conformist selection.)

Such a networked ideology would play a role similar to that of the genome, the network of interconnected genes that stores the blueprint, and controls the physiology, of a multicellular organism. The corresponding "organism" or sociotype for this meme network would be the whole of humanity, together with its supporting technology. Individual humans would play a role similar to the organism's

cells, which in principle have access to the whole of the genome, but which in practice only use that part of it necessary to fulfil their specific function.

There is a better metaphor for the emerging global network. Rather than comparing it to an organism's genome, which is normally static and evolves only because of random copying errors, it can be likened to the organism's brain, which learns and develops in a non-random way. The network functions like a nervous system for the social *superorganism* (Stock, 1993), transmitting signals between its different "organs", memorizing its experiences, making them available for retrieval when needed, and generally steering and coordinating its different functions. Thus, it might be viewed as a *global brain* (Russell, 1995).

The learning of new associations can be implemented by automating the evolutionary process which creates new links. We have set up an experiment in which a hypertext network adapts its links to the pattern of its usage by "learning" the implicit semantics of its users. Such a learning web can be made more intelligent by implementing the equivalent of "thoughts": software agents, which search the net by spreading out while following associative links, collecting information that answers the user's questions (Heylighen & Bollen, 1996). Such brain-like networks may seem far removed from our initial meme model, but they are still based on the same dynamics of variation and selection of (real or virtual) copies of information.

References

Dawkins R. (1976): *The Selfish Gene* (Oxford University Press, New York).

Heylighen F. (1993): "Selection Criteria for the Evolution of Knowledge", *Proc. 13th Int. Cong. on Cybernetics* (Int. Ass. of Cybernetics, Namur), p. 524-528.

Heylighen F. & Bollen J. (1996): "The World-Wide Web as a Super-Brain", in: *Cybernetics and System '96* (Austrian Society for Cybernetic Studies), p. 917-922.

Heylighen F. & Campbell D.T. (1995): "Selection of Organization at the Social Level", *World Futures:*45, p. 181-212.

Russell P. (1995): *The Global Brain Awakens: Our Next Evolutionary Leap* (Miles River Press).

Stock G. (1993): *Metaman: the merging of humans and machines into a global superorganism* (Simon & Schuster, New York).