GAME-ON®'2013

14TH INTERNATIONAL CONFERENCE ON INTELLIGENT GAMES AND SIMULATION

NOVEMBER 25-27, 2013

The Hotel
BRUSSELS

THE HOTEL BRUSSELS, BELGIUM

EDITED BY
ANTON ELIËNS
AND
WIM LAMOTTE

ORGANIZED BY

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European Technology Institute

A PUBLICATION OF

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AVATARS AND THE "IMITATION GAME" - CAN MACHINES SMILE?

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KEYWORDS

ABSTRACT

Considering Alan Turing's challenge in «Computing Machinery and Intelligence» (1950) – can machines play the «imitation game»? – it is proposed that the requirements of the Turing test are already implicitly being used for checking the credibility of virtual characters and avatars. Like characters, Avatars aim to visually express emotions (the exterior signs of the existence of feeling) and its creators have to resort to emotion codes. Traditional arts have profusely contributed for this field and, together with the science of anatomy, shaped the grounds for current Facial Action Coding System (FACS) and their databases. However, FACS researchers have to improve their «instruction tables» so that the machines will be able, in a near future, to be programmed to carry out the operation of recognizing human expressions (face and body) and classify them adequately. For the moment, the reproductions have to resort to the copy of real life expressions, and the present smile of avatars comes from mirroring their human users.

INTRODUCTION

The Turing test, being the final verisimilitude barrier in the humanization of machines, is already being used implicitly as an assessment rule when it comes to visual representations of human realistic figures, and credibility of virtual characters and avatars. These latter are already being evaluated in terms of the «imitation game». But human emotion's virtual representations and their databases are still in an embryonic state. New software and larger databases, complete enough, together with a global cooperation, will be needed; and new developments are in order to reach the goal of creating the best avatars and synthetic characters, and make them express emotions in a way that can engage (or fool) human users. In order to do so, the relationship between physical external expression and inner feeling will have to be better cleared and explained.

Trying to systematize the larger picture of the issues relating to virtual characters – Avatars, personas – this paper will focus on some of the turning points in a path that is far from complete or faultless. It will address only non-invasive studies, and try to explore the state of the art concerning external face movements as metaphors for feelings (mechanical/electrical research as Duchenne's, brain studies and invasive procedures will be addressed in future work).

The word Avatar is new, but it has been invested with the meaning of its other synonyms; the theorizations on character can superimpose on it, and contribute to enrich a future avatar taxonomy, and vice-versa. Being the fate of Avatars to visually express emotions – the exterior signs of the existence of a conscience, a soul, a feeling – its creators will have to resort to an emotion code. The traditional arts (painting, sculpture, and mainly theatre) have profusely contributed with studies on human emotions representation. Together with the science of anatomy, they have shaped the foundations for the current Facial Action Coding System (FACS) and their databases. These could avail themselves from other research areas, i.e., as Forensic Anthropology, to create a global human expression all-inclusive catalogue.

The last section will focus on how, at this moment, Avatars are expressing emotions. Mainly their creators resort to facial recognition tools, and real life capture of individual features. Some new techniques, like 3D scans, are contributing to a better quality in emotion representation, and allowing the exploration of close-up practices, but are still relying on all kind of human actors to produce a smile.

THE IMITATION GAME

Alan Turing, in his ground-breaking paper «Computing Machinery and Intelligence» (Turing 1950), opens up with a provocative question: «Can Machines Think?»; and immediately reformulates it into a wider and more inclusive problem: can machines play the «imitation game»? The «imitation game» became known as the «Turing Test»: it experiments a computer's ability to exhibit intelligent behaviour equivalent to, or indistinguishable from, that of a human. This year's *Loebner Prize*, in honour of Alan Turing [http://www.paulmckevitt.com/loebner2013/], was proof that machines cannot yet fool judges into thinking that they were speaking with a real life person. The Turing test is aimed only at written conversations, but it is tacitly in mind as an assessment rule when it comes to visual presentations of human beings, and to verisimilitude of virtual characters and avatars. These too are being evaluated in terms of the «imitation game».

Turing did not address the question of emotion representation, but there are two moments where his vision anticipates some of the problems being faced now. One has to do with the needlessness to emulate the human: «No

engineer or chemist claims to be able to produce a material which is indistinguishable from the human skin. It is possible that at some time this might be done, but even supposing this invention available we should feel there was little point in trying to make a "thinking machine" more human by dressing it up in such artificial flesh.» (p.2); the second shows the procedure for any attempt to replicate human behaviour: «If one wants to make a machine mimic the behaviour of the human computer [man as a machine] in some complex operation one has to ask him how it is done, and then translate the answer into the form of an instruction table. Constructing instruction tables is usually described as "programming". To "programme a machine to carry out the operation A" means to put the appropriate instruction table into the machine so that it will do A.» (p.5). The obvious conclusion is that, with enough storage capacity [available now], all machines can emulate whatever the programmer is able to design. And this means not only to create software and databases large and complete enough to enfold all possible human emotion representations, as well as, with time, to create the best avatars and synthetic characters, and make them express emotions in a way that can engage (or fool) human users.

AVATAR, CHARACTER, PERSONA

The word "avatar" has its roots in the Sanskrit "avatarana" (descent), in Hinduism referring to a bodily manifestation of a deity when coming to Earth in order to aid humans. Its original meaning has slowly downgraded. In his book *Biographical and Critical Essays* (1856) the poet David Masson connected the word Avatar with the notion of "ethos" alluding to the 'Scottish Influence in British Literature' (Masson 1856); in *The Life of John Milton* (Masson 1859), the term reoccurs at least four times, the last one referring to a person: «As we regard Spenser's genius […] we must be glad that the avatar of Donne […] was so brief and partial».

The first appearance of the term Avatar denominating a digital human representation showed up in the 1985 computer role-playing game *Ultima IV: Quest of the Avatar* (Apple II). In this game users tried to achieve the honorific designation of Avatar in the world of Sosaria, which implied conquering "eight virtues". From *Ultima V: Warriors of Destiny!* onwards, it became a synonym for the user's digital persona. In primitive gaming, the term was also used in *Habitat* (Lucasfilm, Ltd./LucasArts), a first large scale commercial multi-user RPG (Commodore 64). The players were represented by Avatars:

Figure 1: *Ultima IV: Quest of the Avatar* (1985)

In 1992 Neal Stephenson recasted the term in his science fiction novel, *Snow Crash*. In it computer users were able to enter a virtual 3D world (Metaverse) where each was represented by an avatar, a human-like simulation made up of only pixels.

Commonly defining a computer (animated) character representing a real life person, a concept or an artificial entity, the term avatar became interchangeable with the older notions of mask, persona and character. Character classification is an historical as well as theoretical problem, and so will be any avatar taxonomy. Meanwhile, whatever the theory, they have in common the fact that character is defined either from an exterior standpoint (action, drama, gestures, behaviour) or from an internal/psychological perspective (language, emotions, stream of consciousness, *qualia*). In Aristotle's *Poetics* (1447.a), character is defined by its own actions, and the meaning of action is "drama": the outcome of the movement of a body in space and time. Initially associated with theatre, it enriches itself with new considerations when entering the fields of interactive narrative, multimedia and games. The main objective of this action was (and still is) to awaken emotions in the audience; its main goal to encourage (a then medicinal) *catharsis*. The situations presented on stage sought to create empathy between the heroes and the common man; the latter could safely, from his spectator seat, experience the tragic events. Other requisite pervading all character studies is the need for verisimilitude: to win at the «imitation game».

Posterior studies can be summarized in E. M. Forster interpretation of Henry James literary terminology: characters can be "flat" and/or "round"; and he also emphasizes that these are not real people: «they are like real people. Characters' lives are different from real lives, and common activities such as sleeping and eating occupy little space in novels…» (Forster 2005) – or, for what matters, in virtual worlds and games.

EARLY EMOTIONAL CODES

In opposition to metaphors and *qualia* in Literature, to visually represent emotions – the exterior signs of the existence of a conscience, a soul, feelings – any creator has to resort to a code. In Classical Rhetoric the problem was solved because Poetics provided clear instructions for this purpose. In medieval drama characters were reduced to types (the villain, the hero) who also obeyed quite strict (non-written) rules (the colour of clothing, how to enter the stage – the bad ones from the left, good ones from the right, etc.). All this knowledge has been successively condensed in a catalogue of behaviours, Cesare Ripa's *Iconography* (1593), which aspires to be a kind of encyclopaedia of each physical expression corresponding to each of the several human emotions or feelings, to be used by painters and sculptors.

Following Andreas Vesalius, *On the Fabric of the Human Body* (1543) the greatest sculptors of the Renaissance like Leonardo da Vinci (1452-1519) or Michelangelo (1475–1564), are known to have themselves dissected corpses in order to study anatomy. In case of the latter, even so, he had difficulty in representing the female form (anatomically,

some of his sculptures – as *Night* – and paintings present a male torso, to which breasts were added).

In all arts – all artists of all times have the need to represent the human figure as their concern and, at least in European tradition, the urge to humanize that figure by making it externally convey emotions. All artists have sketch books and draw all the time. Some of these representations were summarized and recorded in syllabus for students or followers. As an example, the book *Methode pour apprendre à dessiner les Passions… par Monsieur Le Brun, premier peintre du Roi…* (1702) can be referred which exhibits the author's scientific knowledge of anatomy, exploring it to practice the art of resemblance to a point where the affections, and all their representations, almost become excessive:

Figure 2: *Terror* by Charles LeBrun (1702)

This wish to pedagogically compile all the possible or necessary expressions of emotion has a gap in what concerns theatrical theories and practices (Vicentini 2012). Acting took time to freed itself from oratory: «the study and complex taxonomies of the passions and increasingly subtle forms of expression, from the voice and face to the body and limbs» so that «a conception of the actor's art as a discrete form, with its own specific properties, was able to develop, and at various levels including the doctrinal». The treatises evolve into descriptive works of psychological nature (Archer 1888), de par with others more empirical and duly illustrated (Anon. 1807), here representing the passions of joy, fear, pity, hatred, wonder, grief, anger, scorn, jealousy and love:

Figure 3: *The Theatrical speaker – or an elucidation of the Whole Science of Acting* (1807)

Before Darwin there are numerous other scholars studying the subject of human emotion and its expressions. In the case of artists, the best examples come from sculpture, which continues the par with anatomical medicine. The consolidation of the relationship between the arts and medical science converge in the writings of the Swiss poet and physiognomist Johann Kaspar Lavater (1741-1801). As his mentors and inspiration are the works of the Italian (also playwright) Giovanni Battista Della Porta (Della Porta 1586) and the English author Thomas Browne (1605-1682).

Lavater's book on physiognomy (Lavater 1775), with 68 plates etched by Thomas Holloway (1748-1827) represents a turning point. The word Physiognomy (from the Greek *physis*/"nature" and *gnomon*/"judge" or "interpreter") is the assessment of a person's character, or personality, from his outer appearance, especially the skull and the face. The human features become the symbol of psychological assets, moral qualities or flaws.
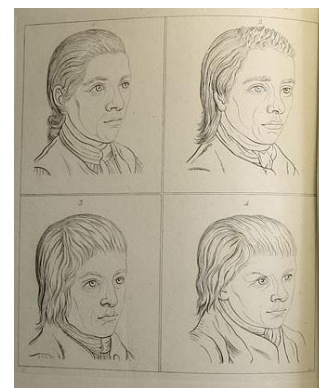

Figure 4: Portrait of two brothers, Lavater (1975), III, p.157

Lavater's works and images, his studies of the human face, were used broadly by painters and psychologists – the first to better portray the emotions, the latter to diagnose misbehaviour in humans by appearance and features.

The Austrian physician Franz Joseph Gall (1758-1828) establishes a direct link between the morphology of the skull and human character – all well explained in the title of his book: *The functions of the brain and those of each of its parts with observations on the ability to recognize the instincts, propensities, talents, or the moral and intellectual dispositions of men and animals, by the configuration of their brains and their heads* – launching the «scientific Phrenology»: an anatomic study and justification of character.
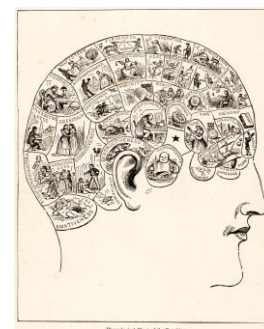

Figure 5: Phrenologic Chart of the Faculties

The success of Phrenology is undisputable: Lavater and Gall are going to be paired and studied together in a book full of images and exercises (Ysabeau 1909), some giving examples of racial characteristic differences. For his part, taking advantage of the recently invented art of photography, the Italian criminologist Cesare Lombroso (1835–1909) establishes the use of facial recognition for forensic or criminal purposes. His contemporaries' the English Pre-Raphaelites also resort to photography as preliminary study for some of their paintings. The main predicament with these perspectives is the idea that behaviour can be read – literally – as a sign of an interior way of feeling, or pathology.

In *The expression of the emotions in man and animals* (1872) Darwin demonstrates the obvious deficiencies of the method of physically decoding emotions: «Although most of our expressive actions are innate or instinctive, as is admitted by everyone, it is a different question whether we have any instinctive power of recognizing them». And adds: «M. Lemoine argues that, if man possessed an innate knowledge of expression, authors and artists would not have found it so difficult, as is notoriously the case, to describe and depict the characteristic signs of each particular state of mind.» and proposes that faces be studied from an anatomical perspective, from the inner working of the face muscles, which had good fortune and has been used for some of the present researchers.

TAXONOMIES OF EMOTIONS

To clearly state what emotions are, how many, and what kind of emotions are being expressed, recorded and analysed, it would be necessary to have a previous map of the human mind and its functions as background. Albeit the recent development in cognitive sciences, we are still very far from dominating the "computational architecture of a mind" (Sloman Croucher 1981). However, thirty years of systematic research have contributed to the assemblage of considerable human expression/emotion databases, and, through statistical accumulation – and (future) machine learning – there might be some hope of progress towards a reliable 'catalogue'.

Facial Action Coding System (FACS) – and its flaws

FACS aim to objectively describe and measure facial expressions and movements. Based on an anatomical analysis of facial action, it offers an advanced method for describing facial movements, and relate them to emotions. A Facial Expression is defined as visible manifestation of the affective state, cognitive activity, intention, personality and psychopathology of a person. Movements of individual facial muscles are encoded, as well as slight different instant changes in facial appearance (micro-expressions).

In 1978, Paul Ekman [http://www.paulekman.com/] launched his Facial Action Coding System, which is still the most widely used method available and followed. In a Darwinian approach (subsequently inspired by Guillaume-Benjamin Duchenne - 1806-1875), Ekman created an "atlas of emotions" with more than ten thousand facial expressions. He had a corpus of six basic emotions (Anger, Disgust, Fear, Happiness, Sadness, Surprise) which, in the nineties, was

enlarged to encompass some more (Amusement, Contempt, Contentment, Embarrassment, Excitement, Guilt, Pride in achievement, Relief, Satisfaction, Sensory pleasure, Shame). For his tests he used Pictures of Facial Affect (POFA), consisting of a hundred and ten black and white images of Caucasian actors portraying the six universal emotions plus neutral expressions. It was studied how the contraction of each facial muscle, both singly and in unison with other muscles, changed the appearance of the faces. Each change was called an Action Unit (AU). His first enquiry aimed to evaluate emotion recognition rates in normal and psychiatric populations around the world.

His work is considered seminal on the specific biological correlates of his "precise emotions", demonstrating their universality and discreteness. Recently he forwarded the concept of "micro-expression" (an idea made known and popular through the TV serial *Lie to me*). Presently Ekman offers on-line training tools and courses, useful "from animation to counter-terrorism", promising the apprentice the ability to become proficient in detecting «micro-expressions in one hour».

Due to subjectivity and time consuming issues, FACS have been established as computer automated systems that detect faces in videos, extracts their geometrical features, and then produce temporal profiles of each facial movement.

Ekman work has been followed and criticized. The main problem is that the facial expression analysis system estimates the measurement of actions and also classifies the actions. Empirically it is possible that all the human facial physical movements might be registered someday, but the coding, the relationship between physical expression and emotion will surely be more complex.

First, physical expression only contributes in 55% for the understanding of the message (Verma Kumar 2013). Some other issues have come up related to the quality of retrieval. FACS ignore face asymmetry and, not only all human faces are asymmetric (as every classical artist knew), but asymmetry of expression «helps to convey complex emotional feelings such as conflicting and/or hidden emotions due to social conventions» (Ahn et al. 2013). It does not yet contemplate body position and gestures, and «posture also affects the perception of emotion» (Normoyle et al. 2013). Also, there is not yet an agreement as to the nomenclature: kinds, names and types of emotions to be analysed. Some have been discarded, as Laughter, one of the conventionally primary ones, and the most difficult to understand (Freud *dixit*). Recent studies on laughter (Ruch et al. 2013), or on the human smile (Freitas-Magalhães 2006), are being carried out mainly by psychologists, both resorting to pictorial representations.

The other is a double question, and concerns the fact that the expression of facial emotions is culturally determined, (Jacka et al. 2012), and there are different assessments of emotions output mainly in European and Asian countries. The code for emotion representation has also evolved in time: we now might not recognize the expression (callisthenics) in a painting, or sculpture, that were surely evident for their contemporaries. The acting theories and manuals for aspiring actors have progressed and changed

with the fashions, and evolved in space – the expression of emotions can vary from country to country, what makes them also nurtured by education.

Concerning the tests themselves, the great majority of researchers resort to professional theatre or cinema actors, rehearsed to prepare their images. Actors, whatever the media, are the great fakers of emotions' expression, they exhibit them in every drama, every night on stage, without actually experiencing them; they exercise and exhibit them, some to perfection (the best actors are the most sincere in showing the emotions they are not feeling). This issue seems scientifically precarious, because the image of the emotions evaluated has been purified, mediatized; something similar happens when researchers resort to painting or staged photographic images.

In the technical component part, the majority of the present databases are composed of 2D scans, and will have to be upgraded to comply or accept 3D scans.

Empirically it will be possible to create a global database of human face expressions, (following the example of The Human Genome Project) including all races, ages and times, all disciplines. But the emotional meaning attributed to each one of those expressions, the coding, cannot rely upon present human external hapazardous readings.

Forensic Anthropology – Contributions

The construction of such a global database could avail itself from other practices. Forensic facial approximation, or craniofacial reconstruction, involve «building a likeness of the head and face on the skull of an unidentified individual, with the aim that public broadcast of the likeness will trigger recognition in those who knew the person in life.» (Hayes et al. 2005).

Virtual approximations typically encompass scanning the skull, producing a grid image, and then applying soft-tissue depths at appropriate points to achieve the representation of a face. It can be applied in many multimedia services such as forensic medicine, archaeology, face animation etc. (Duan et. al. 3013). 3D scanning methods more directly and properly reflect the shape relationship between the skull and the face and, avoiding the sculptor manual intervention, it can better contribute to machine learning (Xu et al. 2013).

Experiences have been made with Egyptian mummies (i.e. Tutankhamun, *National Geographic* cover in 2005) or other famous people, like Johan Sebastian Bach's original skull [http://www.conradaskland.com/blog/2008/03/modern-reconstruction-of-js-bachs-face/]:

Figure 6: Johan Sebastian Bach's cranial reconstruction

HOW AVATARS ARE EXPRESSING EMOTIONS

Software to create fictional characters has evolved attaining some perfection, faster in exploring quantity than quality. *Monsters Inc. I* (2001, Pixar) boasted about its technical achievements, namely: «the breakthrough depiction of fur and hair, which has the shadowing, density, lighting, and movement consistent with the real thing. This is seen to best advantage with Sulley's feathery blue-green and purple spotted coat that includes nearly 3 million individual hairs, and with Boo's hair and pigtails». (VV.AA. 2001). The great software design achievement was the program allowing to multiply to perpetuity the representation of one hair and its movements.

Microsoft launched an testing platform called *Personas* (2002), now available as *Persona* through Mariner [https://www.marinersoftware.com/products/persona/]. It's a database of characters, pigeonholed into archetypes, a background which would signal each one more particular motivations and allow to predict their behaviour. The software put forward several functions: create, interact and learn – a step further than the options existing in *Second life*.

Still functional and quite interesting is *ARTNATOMY* (2005) [http://www.artnatomia.net/uk/artnatomiaIng.html], a facial expression learning tool authored by the Spanish designer artist Victoria Contreras Flores, in cooperation with anatomy professor Carlos Plasencia Climent. It is intended to «facilitate the teaching and learning of the anatomical and biomechanic foundation of facial expression anatomy». It shows a complete list of the face muscles, their graphic location and their functions, as well as their combined interrelation forwarding a series of corresponding emotions.

The reproduction of muscle movements triggered by inner feelings has to resort to the copy of real life expressions, and the present humanity of avatars come from mirroring their human user.

James Cameron's film *Avatar* (2009) could not be ignored, in particular because he announced that the making of this movie had to wait for the delivery of the technical developments he wanted to use.

Figure 7: *Avatar* (2009) by James Cameroun

Concerning his characters, he resorted to photorealistic computer-generated images; innovations include an improved method of capturing facial expressions: actors had to wear individually made skull caps fitted with a tiny camera and microphone positioned in front of their faces. The

information collected was then transmitted to computers and duly processed.

In the field of facial recognition technology, and real life capture, the Microsoft application *Avatar Kinect* (2011) [http://www.youtube.com/watch?feature=player_detailpage& v=jb4bzomm9iU] announces that: «now your Avatar can Smile, Frown, Nod and Speak like you». The virtual image will reproduce the user, and she will be able to control its movements and expressions from her living room.

A step forward has been achieved with the game *L.A. Noire* (2012, Bondi/Rockstar Games). Technically it used *MotionScan* (Depth Analysis) platform; the system captures the views from 32 cameras arrayed as stereo pairs to register the face of the actors, without having them wear any special suit. The video stream is processed in a computer using Stereo Vision techniques to produce a 3D model for each frame. This technical advance in the representation of faces and emotions, has allowed the recourse to cinematic close-up practices.

Figure 8: MotionScan in *L.A. Noire* (2012)

The plots are crime stories, happening in Los Angeles, in 1947, with the expected characters of 'film noir'. Playability consists in accompanying the work of the detective, and helping him to solve the case. But the user has to find the killer by interrogating the suspects: «When questioning any persons of interest, you will be challenged to determine the validity of their statements», analysing their emotions to decide if they are lying or not, if they are guilty or not. The expressions to be read – and their meaning – are coded in the game *Official Guide*: «**Topic: Stolen auto courier**: Cole demands Jean to tell him where she picked up the car, but she claims she can't remember. She gives you a look similar to the one you doubted before. *Correct Assessment: Doubt*» (Bogenn Barba 2012).

Face recognition software is being used to create new, external and different fictional characters and avatars. The incompleteness of the state of the art, the irregularity of representation of expressions, the impossibility of being sure when coding the represented emotion – even with 3D scans – in films, or videogames, is not so critical if applied only to stop motion and avatars for ludic purposes. But can become very serious if used on humans with any kind of evaluation intention, like lie detecting, the study of psychological reactions or "counter-terrorism".

CONCLUSION

From the evolution of the avatar word and meaning, it was established the Avatars' relationship with characters, as more traditional types of fictional representations of the human. Both these delineations (ancient and modern) require credibility and authenticity (verisimilitude), namely in what concerns the expression of emotions. A taxonomy for synthetic characters will have to go beyond the literary ones, and include visual representations (as in painting, sculpture and theatre).

Characters depict emotions. In order for avatars to duly express emotions it will be necessary a catalogue, and a proper code for their representation. The creators have profited from the existing FACS databases. These are yet faulty, and cannot clearly state what emotions are, how many, and what kind are being expressed, recorded and analysed. The necessary background, a map of the human mind and its functions, is still in the making. Like in old Phrenology, FACS maintain the idea that behaviour can be read – literally – as a sign of an inner way of feeling, or pathology. Scientifically, the corpus is poor and in constant change, and the majority of the tests have resorted to mediatized images (actors, paintings).

Empirically it is possible that all the human facial physical movements might be registered some day in a global database of human face expressions, (i.e. after the example of The Human Genome Project); but the coding, the relationship between physical expression and emotion, are surely more complex than the ones being used at present. Following Turing's proposal, the researchers of human face expressions need to know how this complex operation of human behavior works in order to translate the answer into the form of an instruction table. The present «instruction tables» – databases and software – need yet to be improved so that, in a near future, machines will be able to be programmed to carry out the operation of recognizing human expressions (face and body) and classify them adequately. Meanwhile, Avatars are (still) cheating at the «imitation game» because they only smile with the help of human actors and users.

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