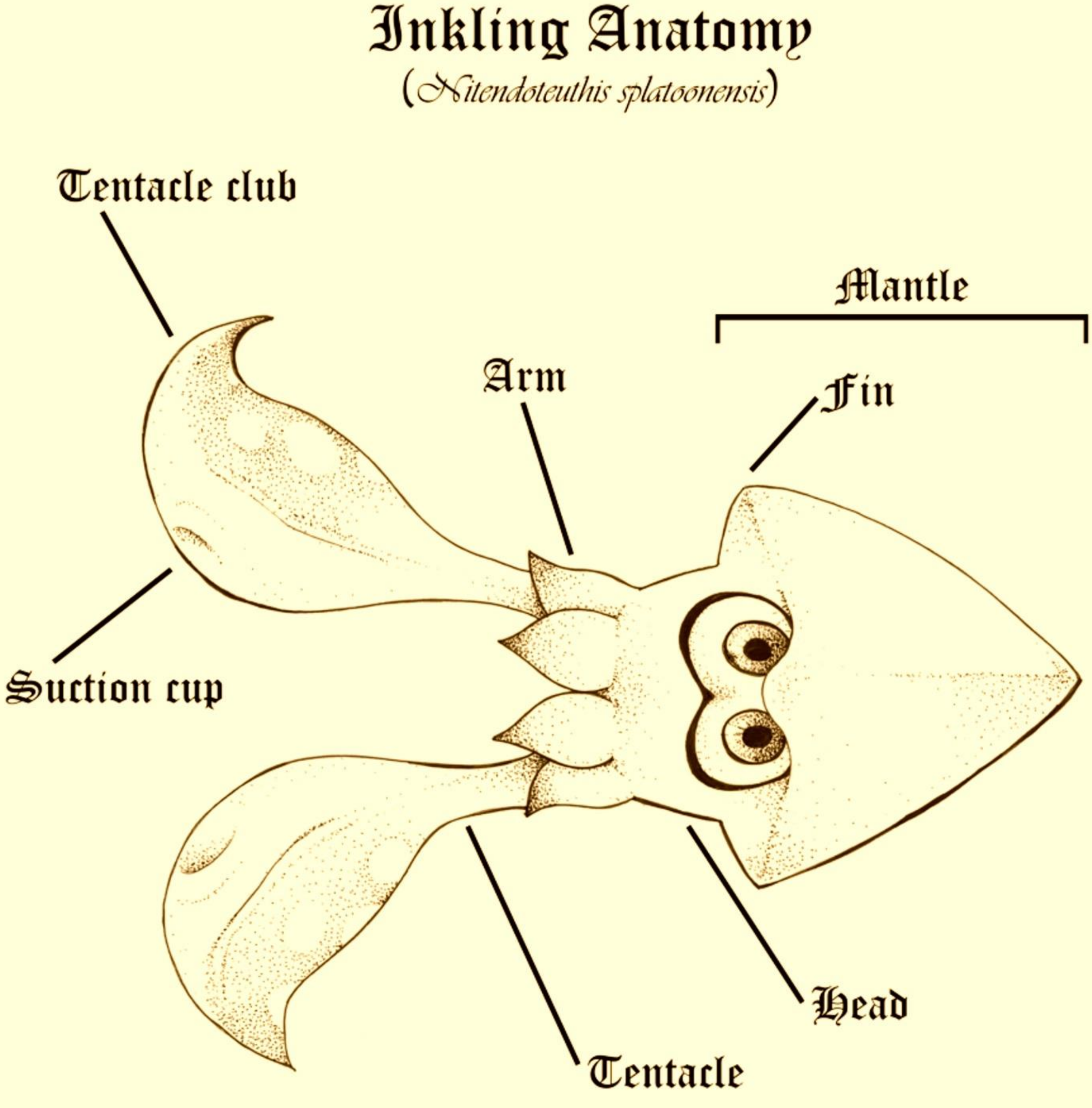
Journal of Geek Studies

Vol. 3(2). 2016.



ISSN 2359-3024

Journal of Geek Studies

The Journal of Geek Studies is a non-peer-reviewed, open-access, non-profit, online biannual publication devoted to the popularization of science.

Journal of Geek Studies
http://jgeekstudies.wordpress.com/

ISSN: 2359-3024 (online).
Vol. 1 (2014) – present.
São Paulo, SP, Brazil.

1. Science; 2. Technology; 3. Geek Culture.

Information for authors can be found at http://jgeekstudies.wordpress.com/guidelines/

Cover art: Inkling Anatomy (March/2016). Drawing by Barbara M. Tomotani, text by Rodrigo B. Salvador.
Fan art of the inkling character from Splatoon (Nintendo, 2015), drawn as an old naturalistic illustration. The species' "scientific name" is just to give the illustration more flavor and, thus, is not valid by the ICZN (1999).

Journal of Geek Studies

ISSN 2359-3024

The overwatching eye of Horus

Rodrigo B. Salvador
Staatliches Museum für Naturkunde Stuttgart; Stuttgart, Germany.
Eberhard Karls Universität Tübingen; Tübingen, Germany.
Email: salvador.rodrigo.b@gmail.com

Overwatch, Blizzard Entertainment's new hit, is a team-based first-person shooter game released on May 2016 for Microsoft Windows, PlayStation 4 and Xbox One. In the game, several heroes battle each other in 6x6 matches. One of the heroes is called Pharah (real name: Fareeha Amari), an Egyptian security chief equipped with a jet-propelled combat suit and a rocket launcher (Fig. 1).

Pharah's character design is clearly related to her Egyptian nationality. However, by this I clearly do not mean present-day Egypt, where Islam is the state religion. I actually refer to the mythology and culture of ancient Egypt.

AERIAL SUPERIORITY

Let us start with her combat suit. At first glance, any gamer would consider Pharah's suit a reference to Samus Aran (from the *Metroid* game series) and call it a day. Or maybe an otaku would say (mainly because of the bird-like helmet) it's a reference to the suits of the heroes from the anime *Science Ninja Team Gatchaman* (1972; *Kagaku Ninjatai Gatchaman*, in the original). But I would argue that Pharah's suit, her distinctive eye tattoo and actually her whole personality, are all linked to the Egyptian god Horus. But before discussing Pharah, I need to give a quick primer about Horus.

Figure 1. Pharah in her full combat suit, the Raptora Mark VI (official artwork from the game). Image extracted from "Pharah Reference Kit" (official Overwatch website).

Horus is one of the most important Egyptian deities and also one of the first we find in the archaeological record. Depictions of Horus are found in objects from the very early Dynastic Period, but he was very likely already present in Predynastic times (that means earlier than 3100 BCE). In his most ancient form, Horus was the "lord of the sky", represented by a falcon soaring high up in the sky. His right eye was said to be the sun and his left eye the moon. His most ancient cult center known to archaeologists was the city of Nekhen, better known by its Greek name Hierakonpolis, meaning "city of falcons".

Later on, Horus assumed another aspect and became known as the son of the deities Isis and Osiris. Some scholars actually believe that this was a different deity altogether from the elder sky-lord Horus described above, which just happened to have the same name. If they were indeed two gods, they were fused in the Osiris myths; if not, the younger Horus is just a very elaborate incorporation of the older Horus into the Osirian tradition.

In this new "incarnation", Horus became intimately linked to Egyptian monarchy. As the son of Isis and Osiris, he was the rightful heir to the Egyptian throne. His uncle Set, however, tried to usurp the throne, leading to a battle that lasted for 80 years. At some point, Set gouged Horus' left eye out, which was later restored by either Hathor or Thoth. Eventually, though, Horus became the ruler of Egypt. The gods then gradually gave way to the mortals to rule their own land. Henceforth, the ruler of the mortals, the pharaoh, became equated to Horus and was referred to as "the living Horus".

The pharaoh's duties were to protect Egypt and its people and to uphold *maat*, which was the ancient Egyptian concept of truth, harmony (in the sense of balance or order), morality and justice. In Overwatch, Pharah (whose name is clearly an intentional reminder of "pharaoh") somewhat assumes this role too. She is defined as a good-hearted, honorable and justice-inclined person ("Lawful Good" in Dungeons & Dragons terms) and said to be a protector of the people. Eventually, when her ultimate is charged, she rains justice from above on her enemies (Fig. 2D). Scenes of the pharaoh smiting his enemies were a recurrent theme in Egyptian art (Fig. 2E).

Horus' iconography is one of the best known from Egyptian art: he was depicted either as a falcon (Fig. 2A) or as a falcon-headed man (Fig. 2B). The basis for his avian depiction was a real species, most likely the lanner falcon (*Falco biarmicus* Temminck, 1825; Fig. 2C). Needless to say, Pharah's winged combat suit, the Raptora Mark VI, is based on a bird of prey. (Birds of prey are also called raptors, but this is not an actual group in a biological sense; it is rather an "unofficial" category to gather falcons, hawks and eagles.) This is not only implied by the suit's name, but also by the peculiar shape of the helmet (Fig. 1), which imitates the hooked beak of a bird of prey (Fig. 2C).

Falcons (*i.e.*, the family Falconidae) are arguably the most accomplished fliers of the animal kingdom. The most striking example to achieve aerial superiority is the peregrine falcon (*Falco peregrinus* Tunstall, 1771), the fastest animal alive. These falcons skydive in order to chase and catch prey and during one of these stunts a peregrine falcon can reach speeds of 320 km/h (200 mph).

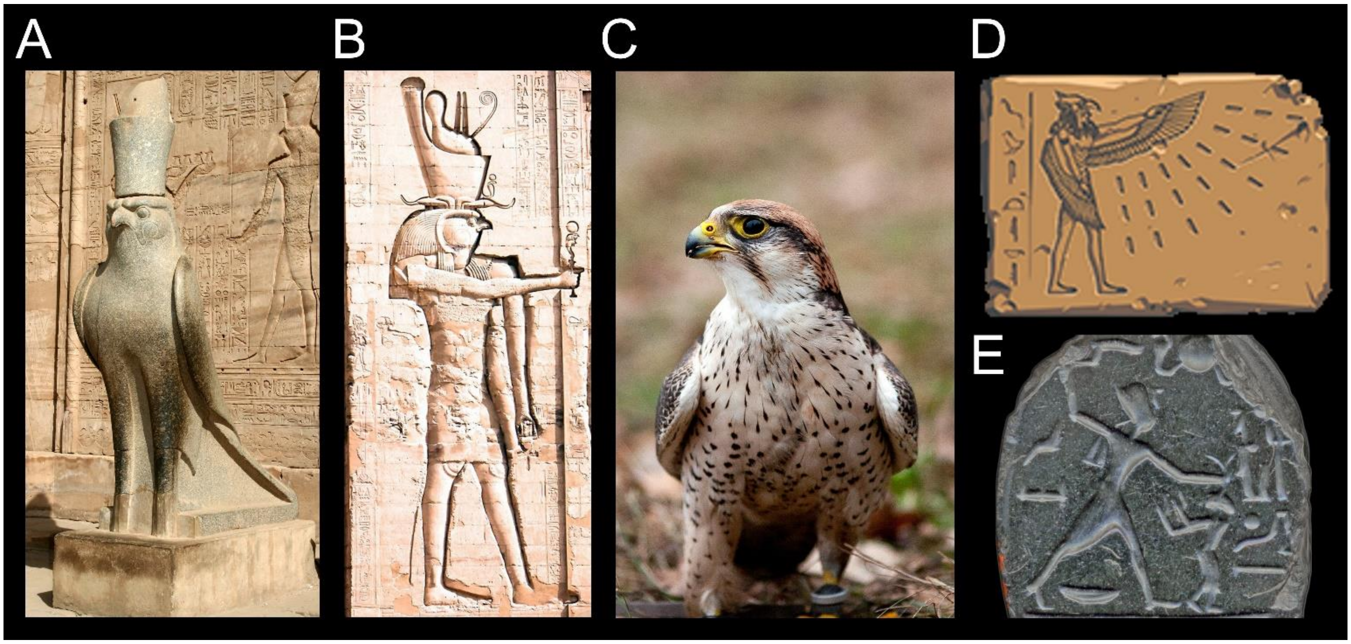


Figure 2. A. Statue of Horus as a falcon (temple of Horus, Edfu; Ptolemaic Era). Photo by Merlin-UK (2006); image extracted and modified from Wikimedia Commons. **B.** Wall carving depicting Horus as a falcon-headed man (temple of Horus, Edfu; Ptolemaic Era). Image extracted and modified from Wikimedia Commons. **C.** A lanner falcon, *Falco biarmicus* Temminck, 1825 (family Falconidae). Photo by Peter Pauly (2012); image extracted and modified from Wikimedia Commons. **D.** Pharah's "Hieroglyph" spray (official artwork from the game). Image extracted from Overwatch Wiki. **E.** Detail of the bottom side of a scarab amulet from the reign of Ramesses II (19^{th} Dynasty, New Kingdom) showing the pharaoh smiting an enemy. Image extracted and modified from Wikimedia Commons.

THE EYE OF HORUS

One of the most distinctive features of the lanner falcon is the dark markings around its eyes (Fig. 2C), which also appear in representations of Horus (Fig. 2A). Not surprisingly, these markings became stylized in Egyptian art and the resulting symbol was known as the "Eye of Horus" or *wedjat* (Fig. 3A). The name wedjat is often translated as "the whole one" or "the restored one", being an allusion to the legend told above where Horus' eye was gouged out by Set. The name can also be written as *udjat*, which is the spelling used in Overwatch.

Pharah has the contour of the wedjat tattooed around her right eye (Fig. 3B; it can be seen more clearly in one of her "sprays" from the game: Fig. 3C). In the Overwatch comics, Pharah says she got her tattoo after her mother's. Ana Amari, who is now also a playable character in Overwatch, indeed has a tattoo on her left eye, but it is only vaguely reminiscent of an actual wedjat.

The wedjat was considered a powerful protective symbol in ancient Egypt and was used in wall paintings and reliefs, sarcophagi and, more extensively, in amulets and jewelry (Fig. 3A).

In the Overwatch comics, it is correctly stated that the wedjat is a symbol of protection, but then the comics say that it is not meant as a protection for Pharah herself; instead it should mean that Pharah needs to protect others. This is, of course, not true — an amulet is, after all, meant to protect the wearer — but it is a minor slip made for narrative purposes, as Pharah was developing her sense of duty in protecting others.

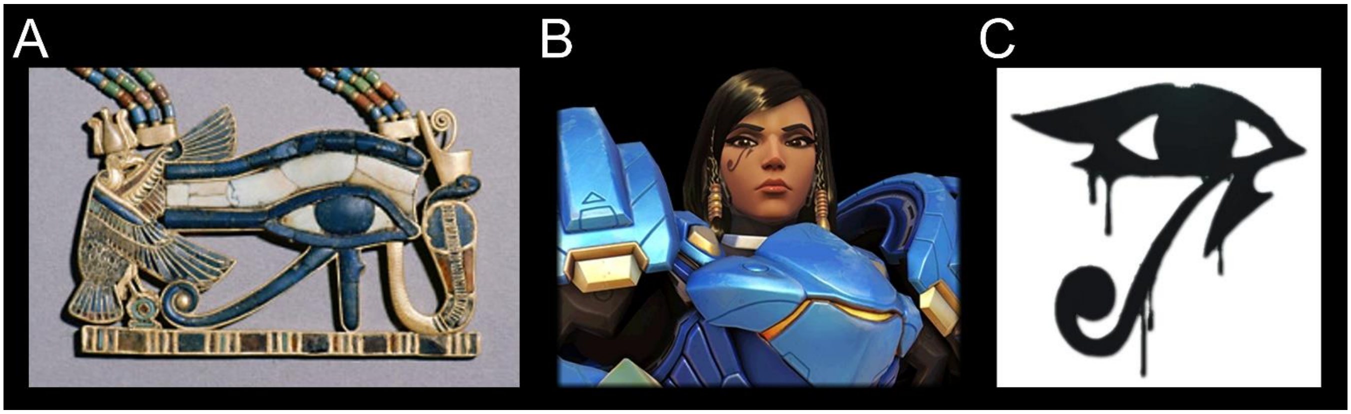


Figure 3. A. Pendant with the wedjat, or Eye of Horus, found in the Tomb of Tutankhamun in the Valley of the Kings (18th Dynasty, New Kingdom). The eye represented is the right one, the solar eye. Photo by Jon Bodsworth (Egypt Archive); image extracted and modified from Wikimedia Commons. **B.** Pharah, without her helmet, showing the wedjat tattoo around her right eye (original model from the game). Image extracted from Overwatch Wiki. **C.** Pharah's "Tattoo" spray (official artwork from the game). Image extracted from Overwatch Wiki.

SPRAYS & SKINS

Pharah's customization option in the game include other sprays (besides the ones shown in Fig. 2D and 3C above) that are also based on ancient Egyptian themes. The "Statue" and "Stone" sprays are merely depictions of Pharah given an ancient-looking vibe. The "Tattoo" (Fig. 3C) and "Wedjat" (here it is curiously spelled in the most common way, contrary to the comic's "udjat") are pretty straightforward to understand after the discussion above.

The "Scarab" spray (Fig. 4A) is also a simple matter, as it represents the so-called sacred scarab (*Scarabaeus sacer* Linnaeus, 1758; Fig. 4B), albeit in a rather stylized manner. For the Egyptians, the scarab was linked to the sun god Re (also spelled Ra) and it was probably the most common theme for protective amulets in the country (Fig. 4C), meant to ward off evil.

Pharah's "Wings" spray is a somewhat more complex composition. It is a solar disc, with rays spreading from it, mounted above the pair of wings from the Raptora suit (Fig. 4D). A winged solar disk (Fig. 4C) was also a symbol of Horus, in special of the "elder Horus" described above. However, the wings are separated in Pharah's spray (Fig. 4D) and so would be perhaps better interpreted as a distinct thing from the solar disk. Wings were usually attributes of gods when shown in a sort of protective embrace: Horus was commonly shown protecting the pharaoh; Isis was usually shown protecting either the pharaoh or her brother/husband Osiris; the vulture goddess Nekhbet was also shown with outstretched wings as a general symbol of protection. (By the way, the typical winged-Isis depiction is imitated in Pharah's "Hieroglyph" spray, shown in Figure 2D.)

The solar disk with rays emanating from it was a common depiction of the sun and of any deity associated with it (Horus, Re etc.), but this particular symbol became strongly associated with the heretic king Akhenaten of the 18th Dynasty. During his reign, Akhenaten established the cult of a single god, Aten, which was depicted as a solar disk with life-giving rays emanating from it (Fig. 4E). The rays of the Aten often terminate in hands, sometimes holding the *ankh* (the sign for "life"). The solar rays in Pharah's spray terminates in small bulges, which could mean that it was based in a depiction of the Aten's.

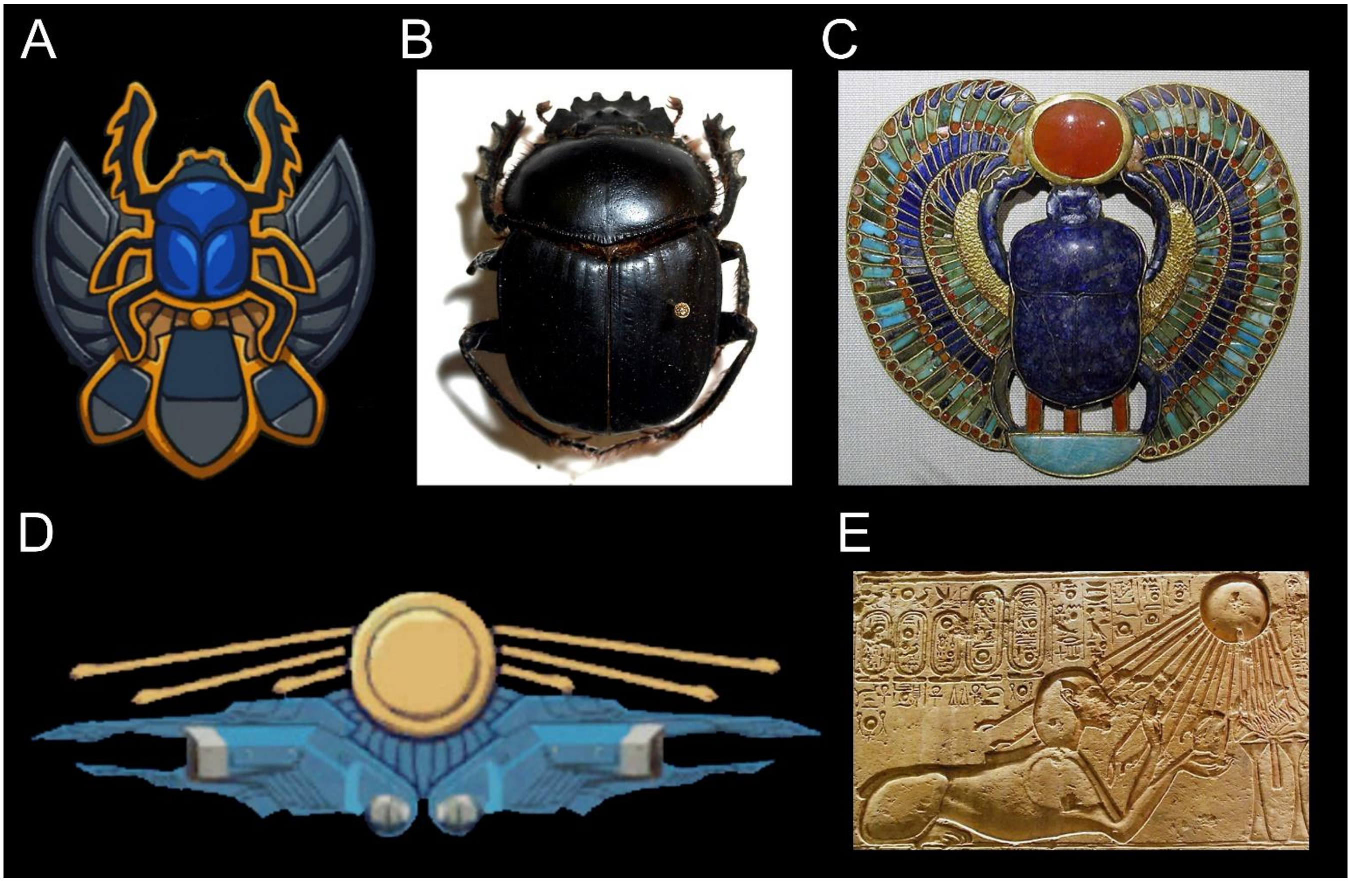


Figure 4. A. Pharah's "Scarab" spray (official artwork from the game). Image extracted from Overwatch Wiki. **B.** A specimen of *Scarabaeus sacer* from an entomology collection. Photo by Sarefo (2007); image extracted and modified from Wikimedia Commons. **C.** Scarab pendant from the Tomb of Tutankhamun in the Valley of the Kings (18th Dynasty, New Kingdom). Photo by Jon Bodsworth (Egypt Archive); image extracted and modified from Wikimedia Commons. **D.** Pharah's "Wings" spray (official artwork from the game). Image extracted from Overwatch Wiki. **E.** Stone block from El Amarna, showing Akhenaten (as a sphinx) receiving the life-giving rays of the Aten (shown on the top right corner). Photo by Leoboudv (2008); image extracted and modified from Wikimedia Commons.

Finally, there are the "skins", which change a character's appearance in the game. Pharah's "Anubis" skin changes her combat suit to black and golden, with a helmet shaped like a jackal's head (Fig. 5B). Anubis, the god of cemeteries, burial and embalming, was depicted as a black jackal (Fig. 5A) or a jackal-headed man. He is perhaps the most readily recognizable symbol of ancient Egypt today, so it's not surprising for Pharah to have something related to him. (By the way, the game's Egyptian stage is called "Temple of Anubis", but this Anubis is an AI.)

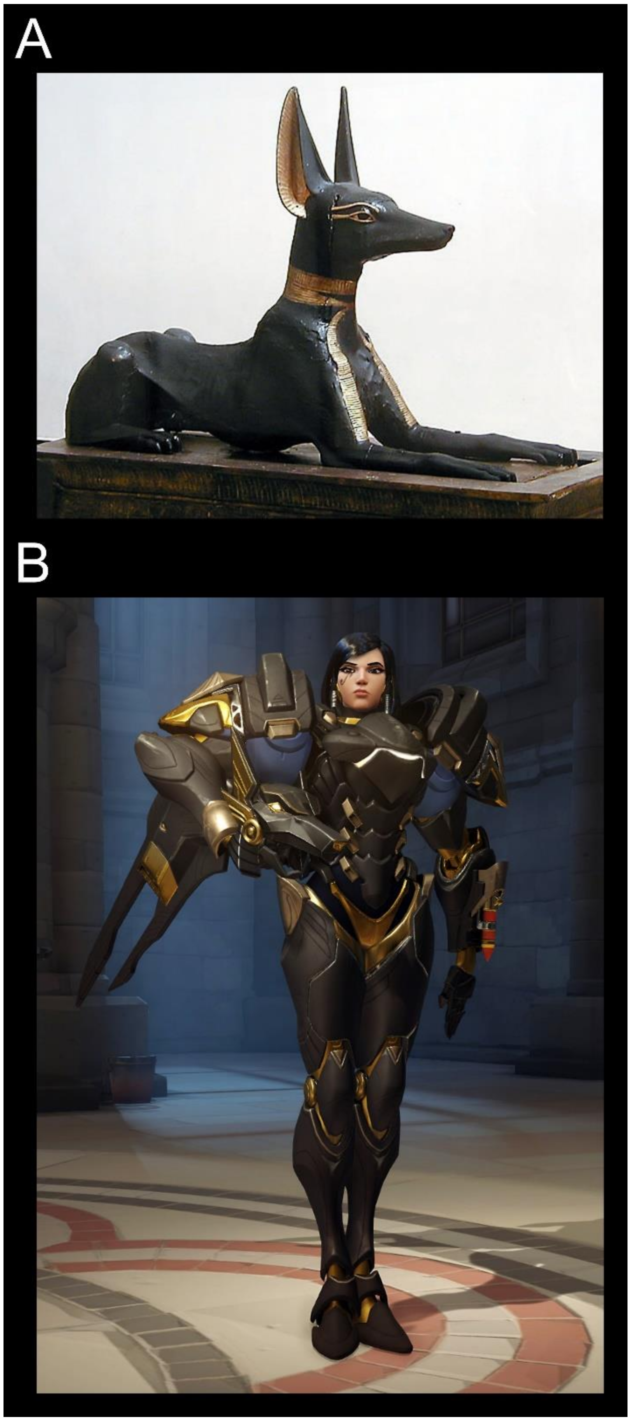


Figure 5. A. Statue of Anubis as a crouching jackal, from the Tomb of Tutankhamun in the Valley of the Kings (18th Dynasty, New Kingdom). Photo by Jon Bodsworth (Egypt Archive); image extracted and modified from Wikimedia Commons. **B.** Pharah's "Anubis" skin (screenshot from the game). A white version of this skin is called "Jackal". Image extracted from Overwatch Wiki.

Pharah's other skins are based on: (1) the mecha genre of Japanese anime, notably on the classical *Gundam* (skins "Mechaqueen" and "Raptorion"); and (2) on native North American themes (skins "Raindancer" and "Thunderbird").

CONCLUSION

Needless to say, Pharah's one my favorite characters from Overwatch. The nicest thing about this character is how well the Egyptian theme is built, consistently wrapped around the god Horus (the falcon, the wedjat and the pharaoh stuff) and protection symbols (the wedjat again, the duties of the pharaoh, the wings and the scarab), all of which fits perfectly with Pharah's personality. The single minor slip, I venture, was to use the heretic depiction of the solar disk in one of the sprays; but a single spray is such a minor part of the game that I can easily let this one slip.

"Play Pharah" spray (official artwork from the game). Image extracted from Overwatch Wiki.

REFERENCES

Cornell Lab of Ornithology, The. (2016) Peregrine Falcon. Available from: https://www.allaboutbirds.org/guide/Peregrine_Falcon/lifehistory (Date of access: 25/Jul/2016).

Hart, G. (2005) The Routledge Dictionary of Egyptian Gods and Goddesses. Second Edition. Routledge, Oxon.

Overwatch. (2016) Pharah Reference Kit. Available from: https://blzgdapipro-a.akamaihd.net/media/reference/pharah_reference.pdf (Date of access: 23/Jul/2016).

Overwatch Wiki. (2016) Overwatch Wiki. Available from: http://overwatch.wikia.com/wiki/Overwatch_Wiki (Date of access: 23/Jul/2016).

Peregrine Fund, The. (2016) Peregrine Falcon. Available from: https://www.peregrinefund.org/explore-raptors-species/Peregrine_Falcon (Date of access: 25/Jul/2016).

Pinch, G. (2004) Egyptian Mythology: A Guide to the Gods, Goddesses, and Traditions of Ancient Egypt. Oxford University Press, Oxford.

Robinson, A. & Nesskain. (2016) Pharah. Mission Statement. Available from: http://comic.playoverwatch.com/en-us/pharah-mission-statement (Date of access: 23/Jul/2016).

Salvador, R.B. (2015) Egyptian mythology in the Shin Megami Tensei: Persona games. Journal of Geek Studies 2(2): 8–32.

Shaw, G.J. (2012) The Pharaoh: Life at Court and on Campaign. Thames & Hudson, London.

Shonkwiler, R. (2012) Sheltering wings: birds as symbols of protection in ancient Egypt. In: Bailleul-LeSuer, R. (Ed.) Between Heaven and Earth: Birds in Ancient Egypt. Oriental Institute Museum Publications, Chicago. Pp. 49–57.

Wilkinson, R.H. (1992) Reading Egyptian Art. A Hieroglyphic Guide to Ancient Egyptian Painting and Sculpture. Thames & Hudson, London.

Wilkinson, R.W. (2003) The Complete Gods and Goddesses of Ancient Egypt. Thames & Hudson, London.

Wyatt, J. (2012) Bird identification from art, artifacts, and hieroglyphs: an ornithologist's viewpoint. In: Bailleul-LeSuer, R. (Ed.) Between Heaven and Earth: Birds in Ancient Egypt. Oriental Institute Museum Publications, Chicago. Pp. 83–90.

Journal of Geek Studies

ISSN 2359-3024

A dendrological note on video games

Thomas A. O'Shea-Wheller

School of Biological Sciences, University of Bristol; Bristol, UK.

Email: to13870@bristol.ac.uk

Crucial to many an in-game environment, it may be said that trees are the unsung heroes of atmospheric immersion. Long before the advent of modern video-games, writers such as J.R.R. Tolkien keenly recognised their importance in crafting convincing fantasy worlds (Clark & Timmons, 2000). Today, with so many games being based on similar high fantasy settings, effective arboreal environments remain a key factor in creating truly engaging experiences. That said, the botanical intricacy of trees is often hard to replicate successfully in digital form, and throughout the history of modern games, there have been many attempts to do so, arguably with variable success. In this brief note, I aim to outline the progress made by game designers in attempting to craft and model effective trees, a process that at its best, combines art and science in almost equal measure.

In the earlier days of gaming, when 8-bit graphics were the norm, trees and forests often amounted to little more than recurring background 'placards', designed simply to notify the player of the terrain type or level theme (Fig. 1). However, with the advent of 16-bit graphics, more scope was available for individual tree placing and varied designs. Games such as *Secret of Mana* (Fig. 2) began to make use of unique tree styles and foliage variations, enabling them to build distinct moods and atmospheres within different settings. There was still little link between real-world species and in-game designs, but this developmental era served to highlight the potential utility of trees in adding depth and environmental diversity to the gaming experience.

Figure 1. *The Legend of Zelda* (Nintendo, 1986) used 8-bit tree 'placards'. Screenshot from the game.

Box 1. What is Dendrology?

Dendrology is the study of trees, shrubs, and other wooded plants. It deals principally with their taxonomy (*i.e.*, description, identification, nomenclature, and classification), biology, ecological distribution, and industrial potential.

Figure 2. In *Secret of Mana* (Squaresoft, 1993), it can be seen that trees are more varied and detailed, adding to the in-game atmosphere. Screenshots from the game.

Arguably, the next major step in tree modelling came with the advent of fully 3D graphics, as they brought with them new innovations in tree shape, branching form, and perhaps most significantly, perspective (Egenfeldt-Nielson et al., 2008). Yet, with these opportunities necessarily came new challenges; vegetation was now infinitely more complex to model, and creating life-like trees was a much harder task with an extra dimension to consider. Consequently, early 3D games often saw a drop in foliage detail and model diversity when compared to their 2D predecessors (Fig. 3). Indeed, in some cases, tree modelling was reduced or avoided altogether in order to save processing power and shorten development. Over time, however, with better optimisation of 3D environments and increased modelling capabilities, games began to emerge that did justice to the beauty and elegance of sylvan environments.

The third major evolution in tree design and modelling was born from a combination of increased graphical capabilities, and the prevalence of open-world games that required large tracts of forest and vegetation. Titles such as *The Elder Scrolls IV: Oblivion* and the *Armed Assault* series (Fig. 4) boasted maps so large that it became almost impossible to place trees by hand, and thus programs such as SpeedTree (SpeedTree, 2002) were developed.

Figure 3. In early 3D titles such *Tomb Raider* (Eidos Interactive, 1996), trees and vegetation were essentially 2D textures with very low resolution, highlighting the difficulties of rendering them. Screenshot from the game.

These allowed realistic vegetation cover to be automatically generated over large expanses, simply based on geographical modelling. While bearing many similarities to the initial cut-and-paste use of tree 'placards' in early games, such techniques actually made for more life-like forest environments and tree placing, and furthermore, began to incorporate appropriate real-world species, diverse growth habits, and HD textures (Figs. 5, 6; SpeedTree, 2002).

On top of this, developers were still able to add the finishing artistic touches by hand, and thus further augment existing arboreal environments. All of this amounted to in-game trees that were more beautiful, more botanically accurate, and much easier to place and model from the perspective of game designers. Hence, realistic trees and forest environments are now a standard feature in almost all recent non-stylised games (Fig. 7).

So, next time you play, take a moment to appreciate a well-textured oak, finely-modelled willow, or HD birch, as they truly are a luxury of the digital age.

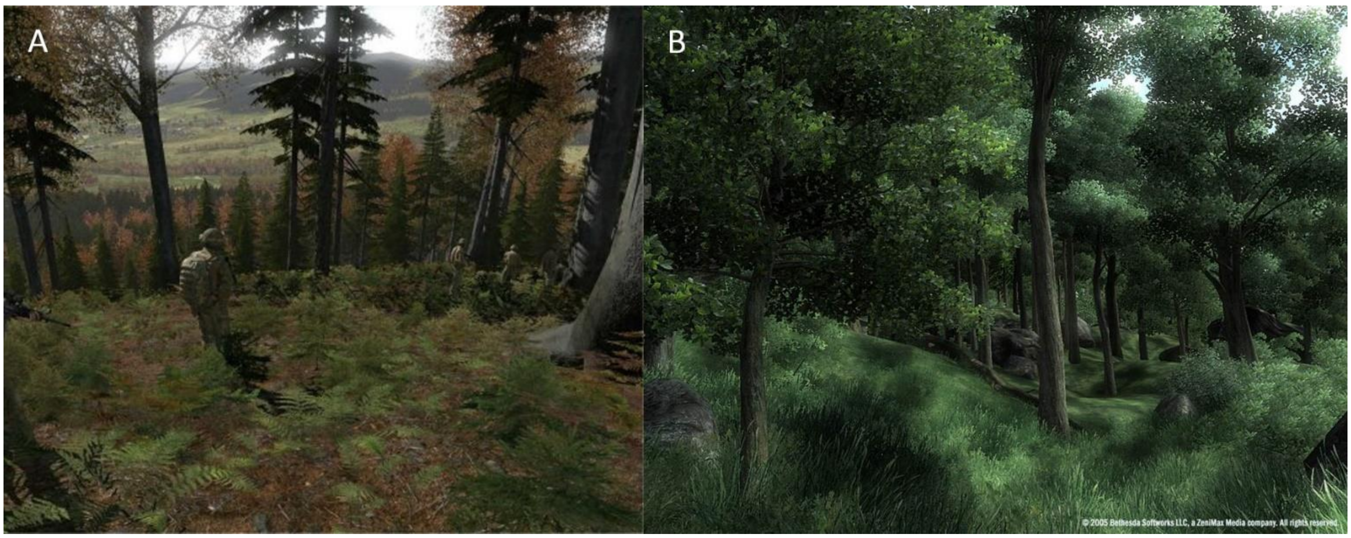


Figure 4. A. *ARMA 2* (Bohemia Interactive, 2009). **B.** *The Elder Scrolls IV: Oblivion* (Bethesda Softworks LLC, 2006). Both titles used procedurally generated trees and foliage, adding geographical realism and reducing development burdens for large-scale maps. Screenshots from the games.

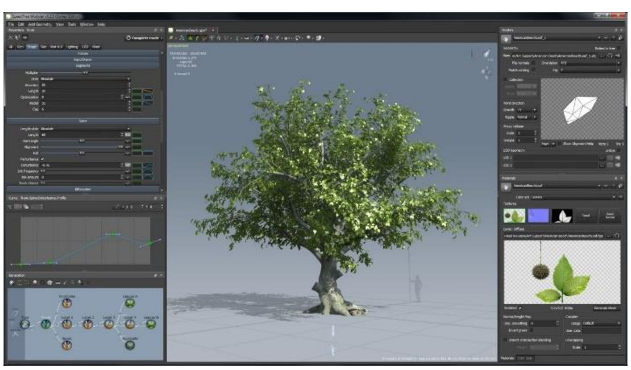


Figure 5. SpeedTree design interface. Programs such as this have made modelling trees and foliage faster, more effective, and more botanically accurate. Screenshot taken from SpeedTree (2016).

REFERENCES

Clark, G. & Timmons, D. (2000) J.R.R. Tolkien and His Literary Resonances. Greenwood Press, London.

Egenfeldt-Nielson, S.; Heide Smith, J.; Pajares Tosca, S. (2008) Understanding Video Games. Routledge, New York.

SpeedTree. (2002) SpeedTree. Available from: http://www.speedtree.com (Date of access: 25/Aug/2016).

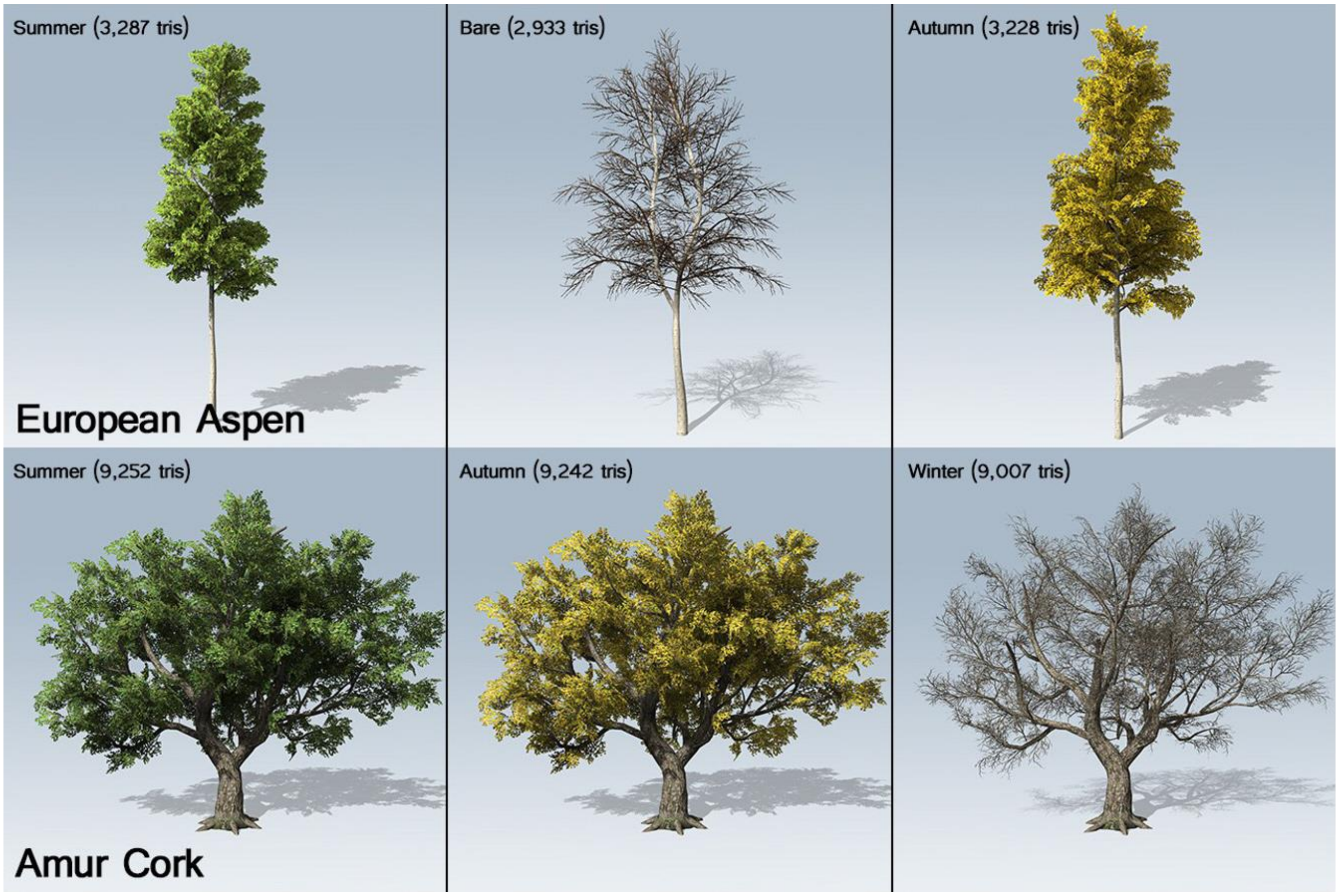


Figure 6. Species-specific foliage and mesh designs in SpeedTree. Those displayed are European Aspen (*Populus tremula*) and Amur Cork (*Phellodendron amurense*). Screenshots taken from SpeedTree (2016).

Figure 7. Forest environments representative of modern rendering capabilities. Screenshots from: **A.** The Elder Scrolls IV: Oblivion; **B.** Battlefield 4 (Electronic Arts, 2013).

Journal of Geek Studies

ISSN 2359-3024

Why (and how) Superman hides behind glasses: the difficulties of face matching

Kay L. Ritchie[1,2] & Robin S. S. Kramer[1]

[1] Department of Psychology, University of York, York, UK.

[2] School of Psychology, University of Lincoln, Lincoln, UK.

Emails: kritchie@lincoln.ac.uk; remarknibor@gmail.com

As a mild-mannered reporter, Clark Kent is able to blend into human society without drawing much attention to himself. Although he utilises several methods of disguise (clothing, posture, hair style), perhaps his most famous is a simple pair of glasses (see Figure 1). We know that wearing glasses can make you look more educated and intelligent (*e.g.*, Hellström & Tekle, 1994), but for Superman, the goal is primarily to hide his true identity. Of course, one of the cornerstones of enjoying superhero fiction is that we suspend our disbelief and try to ignore the obvious questions (for example, how useful or plausible is it that Squirrel Girl can communicate with and understand squirrels?!). However, the scientist inside us sometimes breaks through and we are given the opportunity to investigate. Here, we tackle the question that comic book fans have been asking for decades – could Superman really hide his identity using a pair of glasses?

Photos of faces appear on almost all official forms of identification, from passports and driving licences to university staff and student cards. We have this intuition that our face is a good way to identify us, but a growing body of

Figure 1. Clark Kent's transformation into Superman. [Image downloaded from Flickr; labelled CC BY 2.0.]

evidence suggests otherwise. Of course, if we consider the people we know personally (friends, family, partners), it's almost impossible to find a picture of them that you wouldn't recognise. Even in their passport photos, which could be up to ten years old in the UK, you would probably recognise them straight away. Studies have shown that we can even recognise people we know from very degraded images, such as

CCTV footage (Burton et al., 1999). Therefore, it's no surprise that the presence or absence of a pair of glasses wouldn't stop you from being able to recognise your sister or husband. This amazing tolerance for the way a familiar person's face can vary across different photos leads us to think we are good at recognising all faces. In fact, we are significantly worse when asked to consider unfamiliar people's faces (*e.g.*, Clutterbuck & Johnston, 2002, 2004), even when the photos are taken from real university ID cards (Bindemann & Sandford, 2011).

A common task used in psychology studies to examine photo-ID-style face identification is a face matching task. Typically, participants are shown two images side-by-side and asked whether the photos show the same person or not. Usually, only half of the image pairs show the same person in both photos, although depicted in different poses, lighting, expressions, etc. In the remaining image pairs, the two photos show two different but similar-looking people (*e.g.*, two young, brunette women).

Participants do very well (often perfectly) at the task when they are familiar with the person (or one of the people) pictured, but are much worse when they are unfamiliar with the people (see Figure 2). When we see two photos of someone we know, we even seem to be blind to how difficult the task would be for people who don't know that person, over-estimating other people's performance with faces we recognise (Ritchie et al., 2015).

So why are we so bad at this task for people we are unfamiliar with? To answer this, we need to start with why we are so good at it for people we are familiar with.

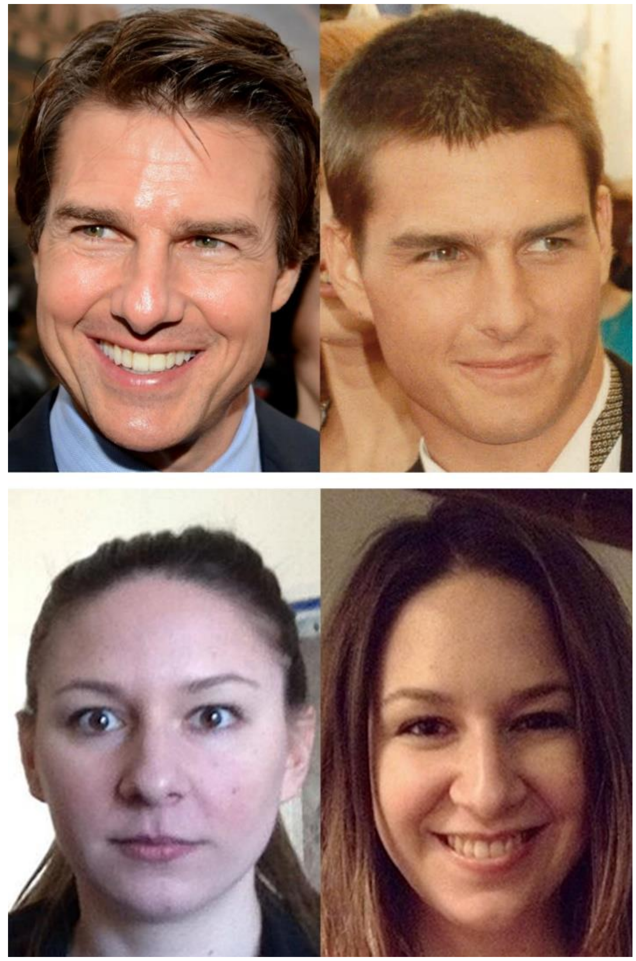


Figure 2. Example face matching task images. **Top:** Two photos of the same familiar person. Despite changes in pose, lighting, and expression, it is seems easy to tell that the two photos show the same person. [Images downloaded from Wikimedia Commons; labelled CC BY-SA 3.0 (left) and CC BY 2.0 (right).] **Bottom:** Two photos of the same unfamiliar person. It is more difficult to tell that the two images show the same person when we are not familiar with them. [The person pictured has given consent for her images to appear here.]

While we are getting to know someone's face, we experience a lot of variation in their appearance. We see them from different angles, in different lighting, wearing their hair in different ways, etc. This variability seems to be important for learning new people (Murphy et al., 2015; Ritchie & Burton, 2016). But this same variability gets in the way when we are presented with two images of an unfamiliar person – the photographs can look very different and this might lead us to think they show two different people.

Why is any of this actually important? Coming back to the example of photo-ID, try to consider the task given to Jenny, a fictional passport controller. Jenny's job is to decide whether the person standing in front of her is the same person as the one pictured in the passport they hand over. The passport photo may be up to ten years old, and more importantly, Jenny has never seen this person before. We know already that this unfamiliar face matching task is a hard one for regular people who do not do this as a routine part of their job, but researchers have also shown that even passport controllers do not outperform students on this sort of task (White et al., 2014b).

Now let's get back to Superman and his glasses. In our new study (Kramer & Ritchie, 2016), we showed participants pairs of images where both wore glasses, pairs where neither face wore glasses, and 'mixed' pairs where one wore glasses and one did not. Half of the pairs in each of these image conditions showed the same person, and half depicted two different (but similar-looking) people. Participants were simply asked to indicate whether they thought the images were of the same person or two different people. Importantly, we only used images of people who were unfamiliar to our participants (and we confirmed this at the end of the study). In addition, all our images were collected from Google Image searches and showed natural variation in pose, lighting, etc. (see Figure 3 for an example of face images that naturally vary).

Figure 3. Images of Brandon J. Routh with and without glasses. The image on the left shows him as Clark Kent, in the film *Superman Returns* (2006); the image on the right is more recent and familiar to fans of the TV series *Arrow* (2012–present) and *DC's Legends of Tomorrow* (2016–present). Of course, in our study, we only used images of unfamiliar people. [Left image downloaded from Flickr; labelled CC BY-NC-SA 2.0. Right image downloaded from Wikimedia Commons; labelled CC BY 2.0.]

When neither image wore glasses, accuracy (percentage correct) was 80.9%, and when both images wore glasses, accuracy was 79.6%. Statistically, performance in these two conditions did not differ, and these levels of accuracy are in line with those reported elsewhere (*e.g.*, Burton et al., 2010). However, in the 'mixed' image condition, where one face wore glasses and the other did not, accuracy dropped to 74%. This drop in performance (although it sounds quite small) was statistically lower than in the 'no glasses' and 'glasses' conditions. This means that we can be confident that our 'mixed' condition really did make people worse at the task. For this reason, Superman may have hit upon a disguise that isn't just easy but might actually work. By simply donning a pair of glasses, he may well make it that little bit harder for strangers to tell that he also doubles as a reporter living among them.

This effect of glasses might be hugely problematic for photo-ID in security settings. In the USA, people are allowed to wear glasses in their passport photos but may not be wearing glasses when they go through passport control. The 6% drop in accuracy found in our study, which could also be phrased as an increase in misidentifications, quickly scales up to thousands of potential mistakes when we consider the vast numbers of people going through passport control every day.

This all seems fairly bleak when it comes to photo-ID so many researchers have been working on ways that we might improve the situation. One recent suggestion has been to provide multiple images (White et al., 2014a; Menon et al., 2015). By including several photographs as reference images for comparison, instead of just the one typically found on IDs, scientists have produced significant improvements in accuracy. This is an area of ongoing investigations and other types of improvements to photo-ID will continue to be explored.

REFERENCES

Bindemann, M. & Sandford, A. (2011) Me, myself, and I: Different recognition rates for three photo-IDs of the same person. Perception 40: 625–627.

Burton, A.M.; Wilson, S.; Cowan, M.; Bruce, V. (1999) Face recognition in poor quality video: Evidence from security surveillance. Psychological Science 10: 243–248.

Burton, A.M.; White, D.; McNeill, A. (2010) The Glasgow Face Matching Test. Behavior Research Methods 42: 286–291.

Clutterbuck, R. & Johnston, R.A. (2002) Exploring levels of face familiarity by using an indirect face-matching measure. Perception 31: 985–994.

Clutterbuck, R. & Johnston, R.A. (2004) Matching as an index of face familiarity. Visual Cognition 11(7): 857–869.

Hellström, A. & Tekle, J. (1994) Person perception through facial photographs: Effects of glasses, hair, and beard on judgments of occupation and personal qualities. European Journal of Social Psychology 24: 693–705.

Kramer, R.S.S. & Ritchie, K.L. (2016) Disguising Superman: How glasses affect unfamiliar face matching. Applied Cognitive Psychology: advance online publication (DOI: 10.1002/acp.3261). Available from: http://onlinelibrary.wiley.com/doi/10.1002/acp.3261/full (Date of access: 14/Sep/2016).

Menon, N.; White, D.; Kemp, R.I. (2015) Variation in photos of the same face drives improvements in identity verification. Perception 44(11): 1332-1341.

Murphy, J.; Ipser, A.; Gaigg, S.B.; Cook, R. (2015) Exemplar variance supports robust learning of facial identity. Journal of Experimental Psychology: Human Perception and Performance 41: 577–581.

Ritchie, K.L. & Burton, A.M. (2016) Learning faces from variability. Quarterly Journal of Experimental Psychology: advance online publication (DOI: 10.1080/17470218.2015.1136656). Available from: http://www.tandfonline.com/doi/abs/10.1080/17470218.2015.1136656 (Date of access: 14/Sep/2016).

Ritchie, K.L.; Smith, F.G.; Jenkins, R.; Bindemann, M.; White, D.; Burton, A.M. (2015) Viewers base estimates of face matching accuracy on their own familiarity: Explaining the photo-ID paradox. Cognition 141: 161–169.

White, D.; Burton, A.M.; Jenkins, R.; Kemp, R.I. (2014a) Redesigning photo-ID to improve unfamiliar face matching performance. Journal of Experimental Psychology: Applied 20(2): 166–173.

White, D.; Kemp, R.I.; Jenkins, R.; Matheson, M.; Burton, A.M. (2014b) Passport Officers' errors in face matching. PLoS ONE 9(8): e103510.

ABOUT THE AUTHORS

Dr. **Kay Ritchie** wears glasses on a daily basis. But is adamant that she has no secret identity…

Dr. **Robin Kramer** frequently collaborates with Bruce Wayne in various crime-fighting adventures but states for the record that the current research is neither funded by Wayne Enterprises nor does it represent any ulterior motives of Batman.

Journal of Geek Studies

ISSN 2359-3024

Over(bird)watch

Barbara M. Tomotani[1] & Rodrigo B. Salvador[2]

[1] *Netherlands Institute of Ecology; Wageningen, The Netherlands. Rijksuniversiteit Groningen; Groningen, The Netherlands. Email: babi.mt@gmail.com*

[2] *Staatliches Museum für Naturkunde Stuttgart; Stuttgart, Germany. Eberhard Karls Universität Tübingen; Tübingen, Germany. Email: salvador.rodrigo.b@gmail.com*

The video game *Overwatch* is Blizzard Entertainment's new hit, released on May 2016 for Microsoft Windows, PlayStation 4 and Xbox One. In the game, the so-called "heroes" spend most of their time trying to kill each other to secure a payload. While the morals of these self-proclaimed heroes are rather open to debate, one of them at least has some redeeming personality traits. The hero Bastion is a nature-loving animal-friend robot. Actually, the single animal to appear in the whole game (besides the hominids, of course) is Bastion's pet bird, called Ganymede (Fig. 1).

Ganymede's design is an original creation of Blizzard's artists, although it resembles in shape and size a northern cardinal, *Cardinalis cardinalis* (Linnaeus, 1758), a common species in Canada and the USA. Cardinals usually have a red plumage (Fig. 2A), but there are rare naturally occurring yellow mutants, called xanthochroic cardinals (Fig. 2B). Ganymede also has a white area around its eyes, a trait not seen in cardinals, but well-known from species of the genus *Zosterops* (commonly known as "white-eyes"; Fig. 2C), which live in tropical Africa, Southeast Asia and Australasia.

Figure 1. Left: Bastion with Ganymede (official artwork from the game). Image extracted from Overwatch Wiki. **Right:** Ganymede (official artwork from the game). Image extracted from "Bastion Reference Kit" (official Overwatch website).

Figure 2. Left: A male northern cardinal, *Cardinalis cardinalis*. Photo by Stephen Wolfe (2011); image extracted and modified from Wikimedia Commons. **Center:** A xanthochroic northern cardinal. Photo by Jim McCormac (2013), extracted from "Ohio Birds and Biodiversity". **Right:** A Japanese white-eye, *Zosterops japonicas* (Temminck & Schlegel, 1847). Photo by Laitche (2016); image extracted and modified from Wikimedia Commons.

Despite being based in an American species, Ganymede seems to be native to European forests. The bird appears on its home forest in the animated short *The Last Bastion* (from August 2016), which takes place in the outskirts of Stuttgart, Germany. There is no bird here in Stuttgart that looks like Ganymede (one of us lives here, by the way). Actually, in the whole European bird fauna, only the golden oriole, *Oriolus oriolus* (Linnaeus, 1758), comes close to it, with its yellow color and dark horizontal stripe across the eyes (Fig. 3). However, its slenderer body shape, thinner beak and lack of crest are all very different from Ganymede.

Moreover, in the *Eichenwalde* stage (which, in the game's lore, is located nearby Stuttgart), there is a painting resting above the hunting lodge's fireplace (Fig. 4). This painting shows four local bird species; one of them is the "Ganymede species", while the others seem to be actual species: the Eurasian blue tit (*Cyanistes caeruleus* (Linnaeus, 1758)) and two titmice. The latter are American species and seem to represent the tufted titmouse (*Baeolophus bicolor* (Linnaeus, 1766)), even though one of them is more bluish in color.

Figure 3. A male golden oriole (*Oriolus oriolus*). Photo by Pawel Ryszawa (2008); image extracted from Wikimedia Commons.

As we pointed out before, Ganymede's design is an original creation and does not represent an actual species, although some of its features might be traced to the cardinal. Despite the problems with Ganymede's identification, Bastion's bird friend can also appear in the guise of actual real-life bird species. To do so, the player must simply equip a "skin" for Bastion ("skin" is basically the gaming jargon for "outfit"). By changing Bastion's "skin", Ganymede's appearance may also change.

The common and rare skins (alongside the legendary *Overgrown* skin) do not change Ganymede's appearance, but the epic and legendary skins do. Here we identify all the bird species that most resembles Ganymede's look and tell a little bit about their biology.

Figure 4. Fireplace of the hunting lodge in the *Eichenwalde* stage, with close-up of the painting. Screenshots from the game.

GANYMEDE'S MANY GUISES

Let's start with the "proper" red northern cardinal, *Cardinalis cardinalis* (Fig. 5A). This species belongs to the family Cardinalidae and is also commonly known as redbird, being easy to identify due to its color, black "mask" and crest. Ganymede appears as a male cardinal (females are light brown). These birds eat mainly seeds, grains and fruits, but feed their young with insects. They are found from Belize and Guatemala, through Mexico and eastern USA, all the way to Canada. The species was introduced by humans in other American states, like California and Hawaii. Cardinals are common in residential areas and visit bird feeders. They were prized as pets due to their bright plumage and song, but thankfully now have full legal protection.

Next, we have Ganymede appearing as a blue jay, *Cyanocitta cristata* (Linnaeus, 1758) (Fig. 5B). This species belongs to the family Corvidae (ravens, crows, jays and magpies) and has a distinct color pattern. As a matter of fact, the color pattern of Ganymede's wings is a little bit simplified when compared to the actual bird's complicated gradation of colors. Blue jays can be found in central and eastern USA and Canada; they eat nuts, grains and small invertebrates. These birds are typically monogamous, pairing for life; genders are similar in plumage and size. Blue jays are very intelligent, with complex social systems.

Bastion's two "wooden" skins are fittingly accompanied by a Ganymede looking like two species of woodpeckers (family Picidae): the red-naped sapsucker, *Sphyrapicus nuchalis* Baird, 1858 (Fig. 6A; although it is also reminiscent of the pileated woodpecker, *Dryocopus pileatus* (Linnaeus, 1758), and the downy woodpecker, *Dryobates pubescens* (Linnaeus, 1766)) and the Arizona woodpecker, *Leuconotopicus arizonae* (Hargitt, 1886) (Fig. 6B). The sapsucker, as its name implies, drills hole in trees to feed on the plant's sap, also eating insects that are attracted to the sap. These birds can be found throughout the Great Basin region and the Rocky Mountains, in North America. The Arizona woodpecker has a more restricted range, occurring in the southern parts of Arizona (obviously) and New Mexico, USA, and in western Mexico. This species feed mainly on insects (especially beetle larvae), but may also eat fruits and acorns. Similar to the case of the blue jay above, the color pattern on

Ganymede's head, chest and wings are very simplified in relation to the real animals. Also, there is some divergence in color: while the male Arizona woodpecker has a red crest, Ganymede has a yellow one, which makes him more similar to female woodpeckers.

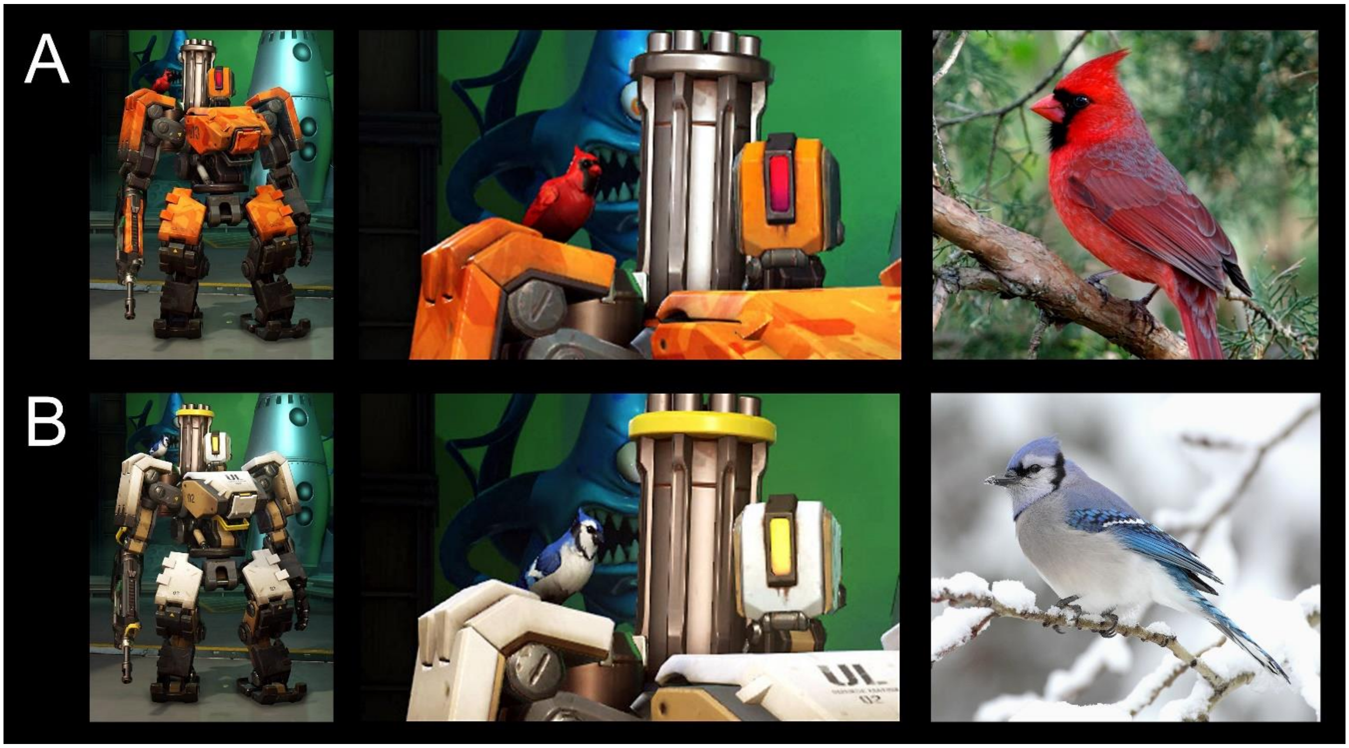


Figure 5. Bastion's skins, accompanied by a close-up of Ganymede and a photo of the actual bird species in which he was based. Bastion's skins are screenshots from the game; the images were extracted from Overwatch Wiki. **A.** Bastion's *Omnic Crisis* skin. Northern cardinal, *Cardinalis cardinalis* (photo by Stephen Wolfe, 2011; image extracted and modified from Wikimedia Commons). **B.** Bastion's *Defense Matrix* skin. Blue jay, *Cyanocitta cristata* (photo by Mdf, 2005; image extracted and modified from Wikimedia Commons).

The last two of Bastion's skins are based on steampunk designs. Therefore, they needed a more city-dwelling bird to accompany him. Ganymede thus appears as a rock pigeon, *Columba livia* Gmelin, 1789 (family Columbidae), the common pigeon we have in large cities. The *Gearbot* skin has a common rock pigeon (Fig. 7A), while the *Steambot* skin is accompanied by an albinistic pigeon (Fig. 7B). We judge it is an albinistic (instead of a leucistic; see Box 1 below) bird, because the beak also does not have the usual black pigmentation (it is pinkish yellow). We could not check if the same is true for Ganymede's legs, though, as we have yet to unlock this very expensive skin in the game.

Unsurprisingly, all the birds above are American (Blizzard's headquarters is in California). As explained above, the depictions are not completely true-to-life, but simplified in some instances. This is to be expected, we guess, since the game's developers would not need focusing too much on a scientifically accurate depiction of a bird. They would rather be more worried about making all the shooting fun. Nevertheless, it seems the team at Blizzard clearly put a lot of effort in making Ganymede, as not only his appearance but also his movements in the game are all very realistic (the model for Ganymede in the animated short *The Last Bastion* was done based on the pet parrot of a Blizzard employee). The two pigeon "skins" for Ganymede even change his body shape to make him look like a pigeon.

Figure 6. Bastion's skins, accompanied by a close-up of Ganymede and a photo of the actual bird species in which he was based. Bastion's skins are screenshots from the game; the images were extracted from Overwatch Wiki. **A.** Bastion's *Antique* skin. Red-naped sapsucker, *Sphyrapicus nuchalis* (photo by Glenn Bartley, 2011; extracted from Glenn Bartley Nature Photography, used with permission). **B.** Bastion's *Woodbot* skin. Female (left) and male (right) Arizona woodpecker, *Leuconotopicus arizonae* (photos respectively by Alan Wilson, 2007, and Nature's Pics Online, 2007; images extracted and modified from Wikimedia Commons).

MALE OR FEMALE?

Nevertheless, despite all the care in making Ganymede, there are some major inconsistencies (besides the whole "American-bird-in-German-forest" issue discussed above). Until Gamescom (in August 2016, when the animated short *The Last Bastion* was premiered), we supposed that Ganymede was a male. This was based on: (1) the name, which is a male one (originally from Greek mythology); (2) it is crested and colorful, which is common of male birds, while females often have a plainer look; and (3) it sings a lot, which is also a typical male activity in birds (usually used for defending territory or courtship).

Figure 7. Bastion’s skins, accompanied by a close-up of Ganymede and a photo of the actual bird species in which he was based. Bastion’s skins are screenshots from the game; the images were extracted from Overwatch Wiki. **A.** Bastion’s *Gearbot* skin. Rock pigeon, *Columba livia* (photo by Diego Delso, 2012; image extracted and modified from Wikimedia Commons). **B.** Bastion’s *Steambot* skin. Albinistic rock pigeon, *Columba livia* (photo by Maria Corcacas; image extracted from Project FeederWatch, a partner organization of the Cornell Lab of Ornithology and Bird Studies Canada, used with permission).

Box 1. Albinism and leucism

Both albinism and leucism are genetic variations, meaning they are conditions defined by the genes the animal inherits from its parents. Albino animals show a complete (or partial) absence of the pigment called melanin in their skin, hair, feathers, scales, cuticles and irises. Melanin is responsible for brown and black colors. Thus, albinos are very light-skinned, with white hairs and red eyes (the lack of pigment in the eyes means that the light is reflected by the blood vessels). This failure to produce melanin is usually caused by the absence or malformation of an enzyme involved in its production. Common albino animals include white lab rats and mice and rabbits. People with albinism are also rather common.

In leucism, however, there is only partial loss of pigmentation. This means paler hairs (or feathers, etc.), often “creamy” in color, but with no changes to the eyes. It is also different from albinism in another regard: leucism is a reduction in several types of pigment, not only melanin. Leucistic peacocks are very commonly bred in captivity and leucistic lions are a fan-favorite in zoos.

On the opposite side of albinism, there is a condition called melanism. The over-deposition of the black pigment melanin in hairs (or feathers, etc.) results in very dark animals, like the black jaguar.

However, in the aforementioned animated short, Ganymede is building a nest, which is typical female behavior. It is very rare for male birds to do the nest building (this is only seen, for instance, in species of weavers and megapodes). Moreover, Bastion's *Overgrown* skin, which relates to the short, has a nest with eggs place on the robot's shoulder (Fig. 8). Needless to say, only females can lay eggs. Moreover, the incubation and hatching is usually also done by females; male birds only rarely incubate eggs. Of course, the eggs from the *Overgrown* skin are way too large (Fig. 8) to belong to Ganymede anyway.

Figure 8. Bastion's *Overgrown* skin (screenshot from the game). Image extracted from Overwatch Wiki.

Ganymede's sex is never directly alluded to in the game or official material, although sometimes we could find the pronouns "he" and "his" referring to it on Blizzard's websites. Curiously, the same is true for Bastion, who is almost always referred to by the pronoun "it", but sometimes by "he".

BIRDWATCH

The player can also customize Bastion's victory pose, which is shown after the match if he/she was part of the winning team. One of Bastion's poses is called *Birdwatching*, because, well, he is watching his bird (Fig. 9).

It might sound surprising to some that birdwatching is not only an actual pastime but a very popular one at that. But what exactly is it?

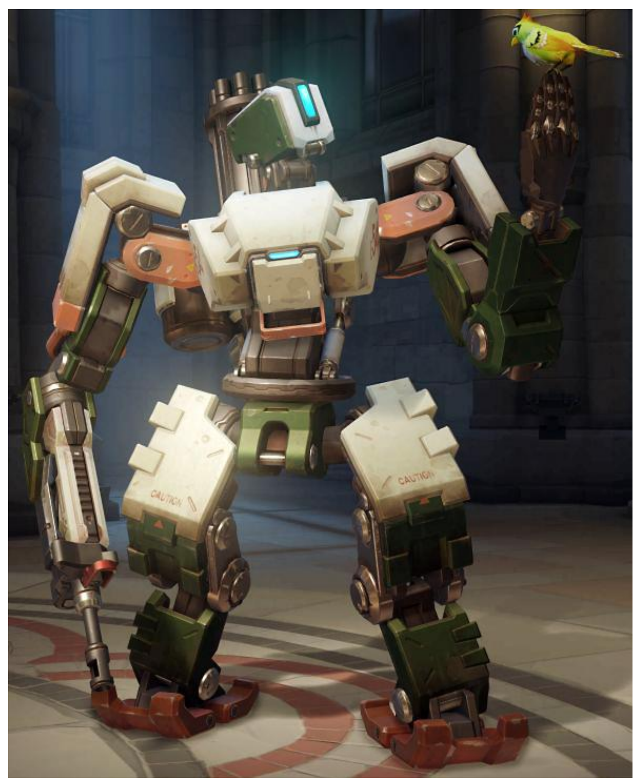


Figure 9. Bastion's *Birdwatching* victory pose (screenshot from the game). Image extracted from Overwatch Wiki.

Birdwatching, also called birding, is basically an activity of wildlife observation, where you go out to observe, of course, birds. You can do this, of course, with the naked eye, but it is better done with a good pair of binoculars (or sometimes a telescope). It's a hobby that actually attracts a huge lot of people (Fig. 10), especially when a rare bird is involved. There are, of course, guides for beginners explaining everything about how to start birding, like *Birding for Beginners: A Comprehensive Introduction to the Art of Birdwatching* (by S. Buff, 2010), and websites like *All About Birds* (by the Cornell Lab of Ornithology).

Figure 10. Birdwatchers (often called simply "birders") at Caerlaverock, UK, watching a rare (in Europe) White-tailed Lapwing, *Vanellus leucurus* (Lichtenstein, 1823). Photo by MPF (2007); Image extracted and modified from Wikimedia Commons.

After you've started your birding campaigns, you will want to know the names of the birds you're seeing. To identify the bird species, you can use one of the several field guides and handbooks in existence. These books have drawings and/or photos of the birds, with guidelines to identify them. These guides are usually restricted to a single country (or sometimes just part of it, if the country is too large, like Brazil or the USA) or continent (like Europe). It's very easy to find one at your bookstore or online store, since they are often called "Birds of Somewhere" (Fig. 11). Of course, there are now also websites that act as these guides, such as the RSPB's *Bird Identifier* (see References below).

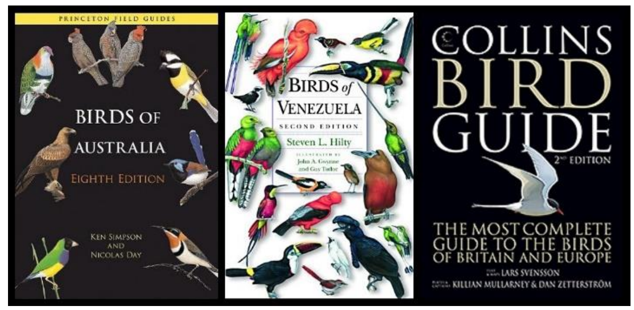


Figure 11. Examples of "bird books", with the covers of *Birds of Australia* (by K. Simpson & N. Day, 2010, 8th ed.), *Birds of Venezuela* (by S.L. Hilty, 2003, 2nd ed.) and *Collins Bird Guide* (by L. Svensson et al., 2010, 2nd ed.).

Moreover, birdwatching actually involves a lot of hearing, because you will most often hear the bird before seeing it (if you see it at all). Thus, it is also good to know what each species' vocalization sounds likes. There are several websites to identify birds' calls, such as the *Smithsonian's Guide* (see References below). Of course, both for image and song identification, there are now lots of apps, such as *eBird Mobile*, *BirdsEye*, *Collins Field Guide* and *Bird Song Id*, among several others. Unfortunately, these websites and apps are still largely restricted to the USA and Europe, while the greatest (and some would say most splendorous) bird diversity is found in Australasia and tropical America.

Birdwatching is all about enjoying nature and having fun, but birders worldwide abide by a "code of conduct" of sorts (see, for example, the code of the American Birding Association). Nowadays, our more ecological-prone society is concerned about the impact that our activities have on the animals and their environment. Thus, birdwatching etiquette usually includes promoting the welfare of birds and their habitats, limiting the birders' impact (photographing, using playback devices, keeping your distance from nests etc.) and thus mitigating the stress caused to the animals. Basically, have fun, but let the birds live their life – that's what Bastion does anyway.

REFERENCES

American Birding Association. (2016) ABA Code of Ethics. Principles of Birding Ethics. Available from: http://www.aba.org/about/ethics.html (Date of access: 23/Jul/2016).

BirdLife International. (2012) The IUCN Red List of Threatened Species. Available from: http://www.iucnredlist.org/ (Date of access: 30/Jun/2016).

Cornell Lab of Ornithology, The. (2016a) All About Birds. Available from: https://www.allaboutbirds.org/ (Date of access: 30/Jun/2016).

Cornell Lab of Ornithology, The. (2016b) Project FeederWatch. Available from: http://feederwatch.org/ (Date of access: 30/Jun/2016).

Gamepedia. (2016) Overwatch. Available from: http://overwatch.gamepedia.com/Overwatch_Wiki (Date of access: 30/Aug/2016).

Glenn Bartley Nature Photography. (2016) Bird Photography from Canada and around the World. Available from: www.glennbartley.com (Date of access: 30/Jun/2016).

McCormac, J. (2016) Ohio Birds and Biodiversity. Available from: http://jimmccormac.blogspot.nl/ (Date of access: 30/Jun/2016).

Mcgraw, K.J.; Hill, G.E.; Parker, R.S. (2003) Carotenoid pigments in a mutant cardinal: implications for the genetic and enzymatic control mechanisms of carotenoid metabolism in birds. The Condor 105: 587–592.

Overwatch. (2016) Bastion Reference Kit. Available from: https://playoverwatch.com (Date of access: 30/Jun/2016).

Overwatch Wiki. (2016) Overwatch Wiki. Available from: https://blzgdapipro-a.akamaihd.net/media/reference/bastion_reference.pdf (Date of access: 26/Jun/2016).

RSBP. (2016) Bird Identifier. Available from: http://www.rspb.org.uk/discoverandenjoynature/discoverandlearn/birdidentifier/ (Date of access: 23/Jul/2016).

Smithsonian's National Zoo. (2016) Guide to North American Bird Songs and Sounds. Available from: http://nationalzoo.si.edu/scbi/migratory birds/education/nasongkey.pl (Date of access: 23/Jul/2016).

ACKNOWLEDGEMENTS

We are very grateful to Anne Marie Johnson (Project FeederWatch) and Glenn Bartley for granting us permission to use their photos here.

ABOUT THE AUTHORS

Barbara Tomotani is a birdwatcher bird-scientist and was a marked presence at Blizzard's store booth during Gamescom, hoping to find a Ganymede plush.

Rodrigo Salvador is a biologist, but now is found mostly escorting payloads as either D.Va or Lúcio. He has his fair share of *Plays of the Game* as Bastion, though.

Journal of Geek Studies

ISSN 2359-3024

The effect of trolls on *Twitch Plays Pokémon*

João V. Tomotani

Universidade de São Paulo; São Paulo, Brazil.

Email: t.jvitor@gmail.com

In a previous paper, I presented a curious experiment of a fish playing *Pokémon*, made real and popular thanks to the wonders of the Internet (Tomotani, 2014). The Twitch Channel (Twitch, 2016), which sadly has been inactive for some time now, showed Grayson, the fish, playing *Pokémon Red* with the help of an image identification software, and was watched by millions of people (Johns, 2014). I showed that, when assuming that a fish player was the same as a random input of commands – a premise I do not find absurd – it would take quite a while to advance through a single route (although a very complex one) in the game (Fig. 1): circa 115,700 years.

The peculiar premise of a fish playing Pokémon obviously derived from the original *Twitch Plays Pokémon*, a game of Pokémon Red where everyone watching the stream could type commands in the chat window. An IRC bot would read and execute the commands in the game. The available commands were the classic Gameboy keys: A, B, Up, Down, Left, Right, Start and Select.

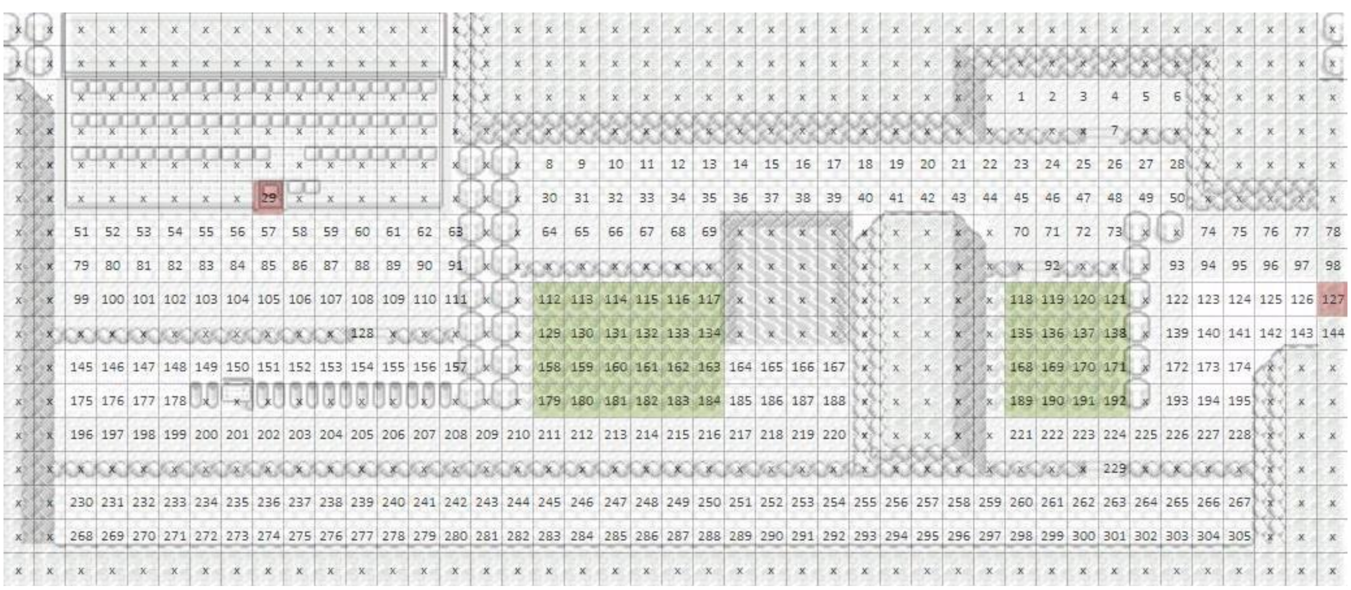


Figure 1. Route 23; image taken from Tomotani (2014). The many ledges, which could make the path much more tortuous, made the Twitch Play community come up with the infamous name “Ledge Simulator”.

Since the inputs came from rational human beings, with defined intentions and minimal coordination, supposedly the game should be less frustrating than watching a fish swimming and randomly inputting commands in the game – the key word in this phrase being "supposedly".

The point is (besides, of course, the difficulty in coordinating thousands of people to avoid incorrect commands), not all of the people participating in the event wanted to complete the game. In fact, some of them wanted to make matters as difficult as possible for the other players, as their goal was solely to make the *Twitch Plays Pokémon* a frustrating experience for anyone wanting to be a crowdsourced Pokémon master. (In their "defense", I find it hard to believe that this sort of behavior was not one of the intentions of the programmer of this game, described by him as a "social experiment"; Alcantara, 2014.) This group of people is given the name of *trolls*.

The impact of trolls on *Twitch Plays Pokémon* was so peculiar that it resulted in a curious work, where Machine Learning techniques were used to detect anomalous inputs in the game (from a base of 38 million data points), trying to identify potential trolls (Haque, 2014). The objective of the present study is to see exactly how the percentage of trolls inputting commands on *Twitch Plays Pokémon* affected the time for completing Route 23 in the game.

TROLLS

Trolls are creatures from Nordic and Scandinavian myths and folklore, made popular in the 20th century by pop culture, starting with J.R.R. Tolkien's books, going through Dungeons & Dragons and Harry Potter to the thousands, possibly tens of thousands, of other novels, comics, games etc. which they inspired.

Troll is a term applied to the Giants of Norse Mythology (the *Jötnar*), a race that live in *Jötunheimr*, one of nine worlds in Norse cosmology. There is some confusion about the terms, though, as *jötunn* (the singular form of *Jötnar*), *troll*, *þurs*, and *risi* frequently overlap and are used to describe many beings in the legends. Some researchers point out that there are distinct classes of these creatures, but the terms are frequently considered synonyms in late medieval literature and all of them are frequently translated to English simply as "giant" (Jakobsson, 2005). In a late saga of the Icelanders (*Bárðar saga Snæfellsáss*; probably from the early 14th century), a passage at the very beginning claims that *risi* and *troll* not only are distinctive races, but are, respectively, at the opposite ends of the binary divide of good and evil (Jakobsson, 2005).

The Internet term "troll", however, does not come from such creatures. The term "trolling" means luring others into pointless and time consuming discussions, deriving from the practice used in fishing where a baited line is dragged behind a boat (Herring et al., 2002).

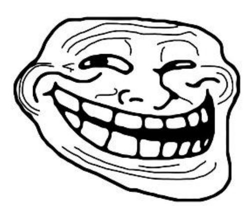


Figure 2. *Trollface*, a popular internet meme based in "rage comics". – Did you just read half a page about creatures in Norse mythology that have absolutely nothing to do with this topic?

The idea of trolling always seems to be related to communication, mostly computer-mediated communication (CMC). Hardaker (2010) analyzed a 172-million-word corpus of unmoderated, asynchronous CMC to try to formulate an academic definition of trolling. After his analysis, he proposes that:

> *"A troller is a CMC user who constructs the identity of sincerely wishing to be part of the group in question, including professing, or conveying pseudo-sincere intentions, but whose real intention(s) is/are to cause disruption and/or to trigger or exacerbate conflict for the purposes of their own amusement. Just like malicious impoliteness, trolling can (1) be frustrated if users correctly interpret an intent to troll, but are not provoked into responding, (2) be thwarted, if users correctly interpret an intent to troll, but counter in such a way as to curtail or neutralize the success of the troller, (3) fail, if users do not correctly interpret an intent to troll and are not provoked by the troller, or, (4) succeed, if users are deceived into believing the troller's pseudo-intention(s), and are provoked into responding. Finally, users can mock troll. That is, they may undertake what appears to be trolling with the aim of enhancing or increasing affect, or group cohesion."*
>
> — Hardaker, 2010: p. 237.

The definition of "trolling" for the present study is not strictly the same, since the troll does not necessarily has the intention of portraying any good will toward the group's goal of completing the Pokémon game. The intention of creating conflict and frustrating a group of people for personal amusement, though, is very similar. As such, we shall use a less strict definition of trolls, so that we may keep calling them such.

The percentage of people deliberately trolling on the Internet is never clear. Since trolls tend to draw too much attention, it is easy to believe they are more numerous. In the *Twitch Plays Pokémon* case, this was particularly true: a single input from a troll at the wrong time (or right time, from the troll's point of view) and the avatar in the game would jump down a ledge, making many more inputs necessary for the avatar to go back to the same coordinate.

THE FIRST SIMULATION MODEL

For the present study, I wanted to know how trolls affected the time for completing Route 23 in *Twitch Plays Pokémon*. The first step was to develop a simulation model in VBA. A map for Route 23 composed of 305 different coordinates was generated (the same as seen in Tomotani, 2014) and the neighbors for each coordinate were defined. For each coordinate, I defined three different inputs: the "optimal route" (the command which a player wanting to finish the game would input) and two different "troll inputs". The latter are commands that would make the route as long and frustrating as possible. I defined two different troll inputs because: (a) there were times when two commands could be equally bad; (b) trolls not always want to troll the same way; and (c) to add some variation to the routes' heat maps presented in this analysis.

The premises to define the commands for the optimal route were:

- Always go through the shortest path towards the objective (the door at the end of Route 23);

- When two commands are equally good, stay away from ledges for as long as possible.

The premises to define the troll commands were as follows:

- If you are close to a ledge you normally would not want to jump over, jump;
- Go away from the direction you are supposed to go;
- Only input "movement" commands (to simplify the model by not having to create simulation models for the game's menu screen).

Once the simulation model was complete, I defined a "troll factor", that is, the number of trolls inputting commands. Thus, the troll factor represents the percentage of players that are, in fact, trolls trying to prevent the group from completing the route.

In the simulation, we randomly decided whether the next command would be an "optimal" command or a "troll" command. The chance of the command being a "troll input" was equal to the "troll factor". Figure 3 shows a heat map of time spent in each coordinate when the troll factor was zero. Since there is no probabilistic factor (that is, all commands made are optimal), this route is always the same: it takes 70 steps to complete this path.

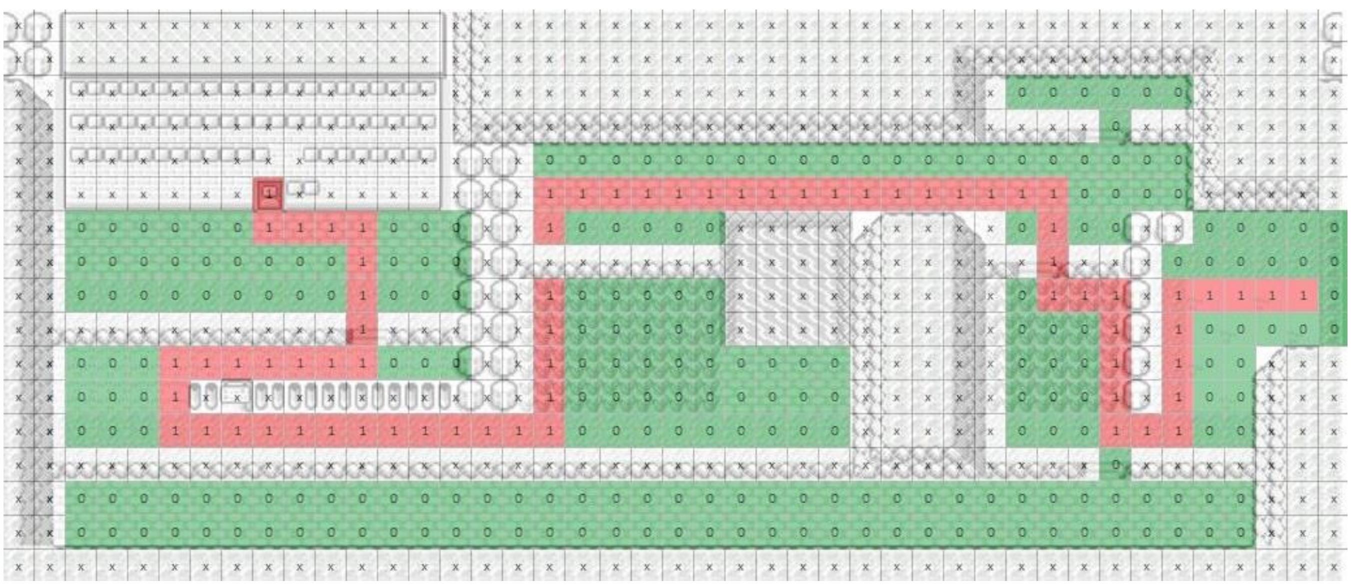


Figure 3. Optimal route, when the troll factor is zero, completed in 70 steps.

Figure 4 shows a heat map of time spent in each coordinate for a simulation run when the troll factor was 10%, that is, on average one out of every ten inputs was made by a troll. In this specific run, it took 285 steps to complete the route, more than four times longer than the optimal path. When tested with a troll factor of 20%, the number of steps necessary reaches the thousands. Figure 5 is an example, where 1,011 steps had to be taken to complete the route.

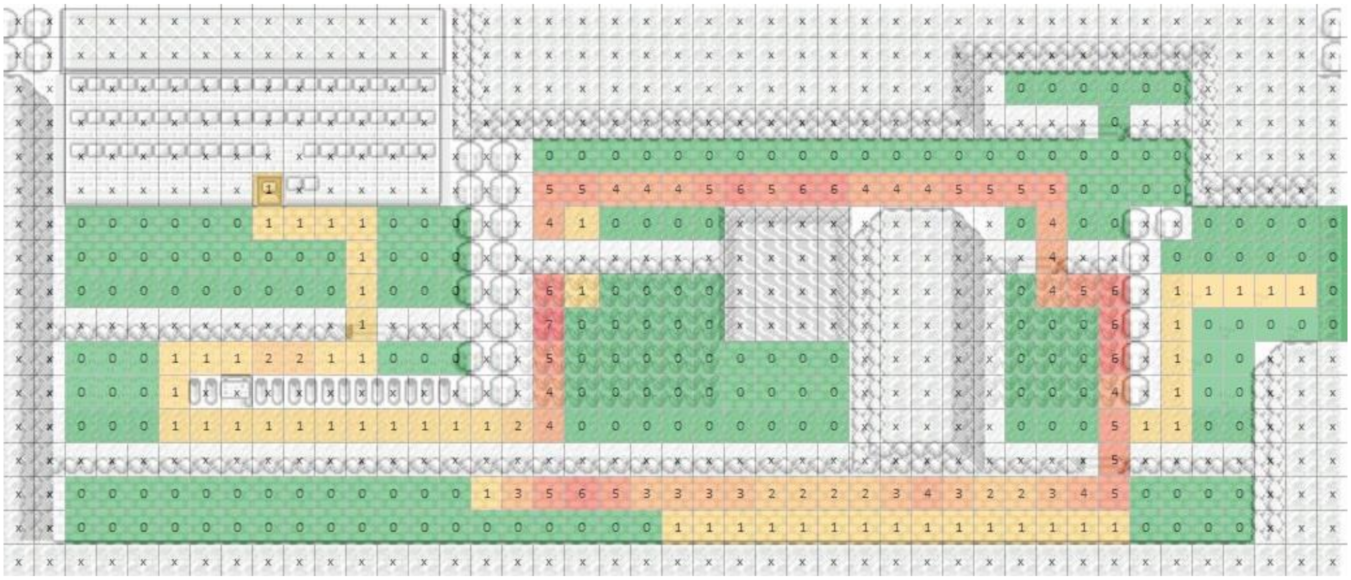


Figure 4. Simulation run with troll factor of 10%, completed in 285 steps.

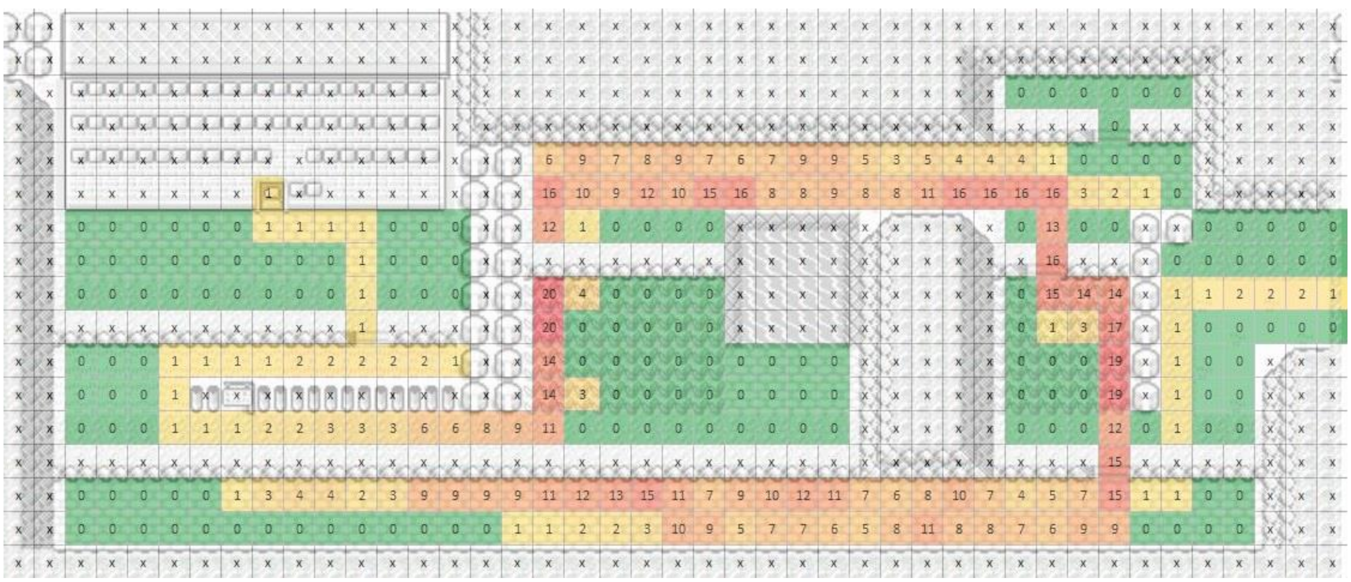


Figure 5. Simulation run with Troll factor of 20%, completed in 1,011 steps.

THE SECOND SIMULATION MODEL

The VBA model, though, proved inefficient when dealing with higher troll factors, constantly crashing or giving inconsistent results. As such, I decided to use a more appropriate tool, and developed a simple Discrete Event Simulation Model on the Rockwell Arena software (ARENA, 2016). This model can be seen in Figure 6. (For more information on simulations with this software, see Altiok & Melamed, 2007; and for more on Discrete Event Simulation, see Banks et al., 2009).

On this simulation model, the coordinates were indexed in a “305 lines x 4 columns” matrix in the software, where each line was a coordinate, and each column contained the possible neighbors. With a “Create” module, 100 entities were inserted simultaneously in the model, each representing a different simulation run. Each entity had an attribute named "position", where the current coordinate of the simulation was recorded, and a "total steps" attribute, where the number of steps necessary to finish the simulation run was recorded.

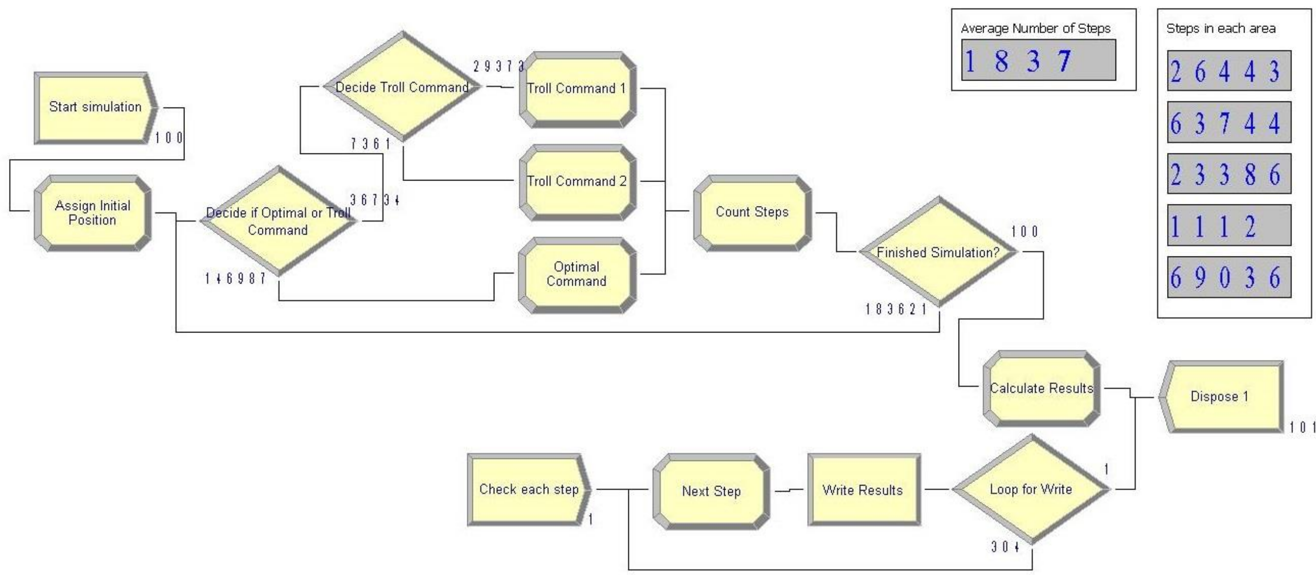


Figure 6. Simulation model on Rockwell Arena.

In each step of the simulation, a "Decide" module of the Arena decided whether the next command inserted for each run was a "normal" or a "troll" one, and the "position" attribute of each entity was updated. When the current position of an entity was the coordinate for the door at the end of Route 23, the simulation was terminated and the total number of steps to finish the route was registered. At the end of the simulation, a "Read and Write" module was used to record some additional information at an *Excel* worksheet, such as number of steps on each cell, and number of steps on each area (more of this below).

To see how the percentage of trolls ("troll factor") affected the number of steps, I made various simulations. For each troll factor used, I ran 100 simulations and calculated the average number of steps to complete Route 23 (it took a while for the 50% troll factor!). The results can be seen on Table 1 and Figure 7.

Table 1. Average number of steps (out of 100 simulations) necessary to finish Route 23.

Troll factor	Average number of steps	Vs. optimal number of steps
0%	70	1.0
5%	149	2.1
10%	317	4.5
20%	1,837	26.2
30%	18,222	260.3
40%	272,461	3,892.3
50%	18,492,842	264,183.5

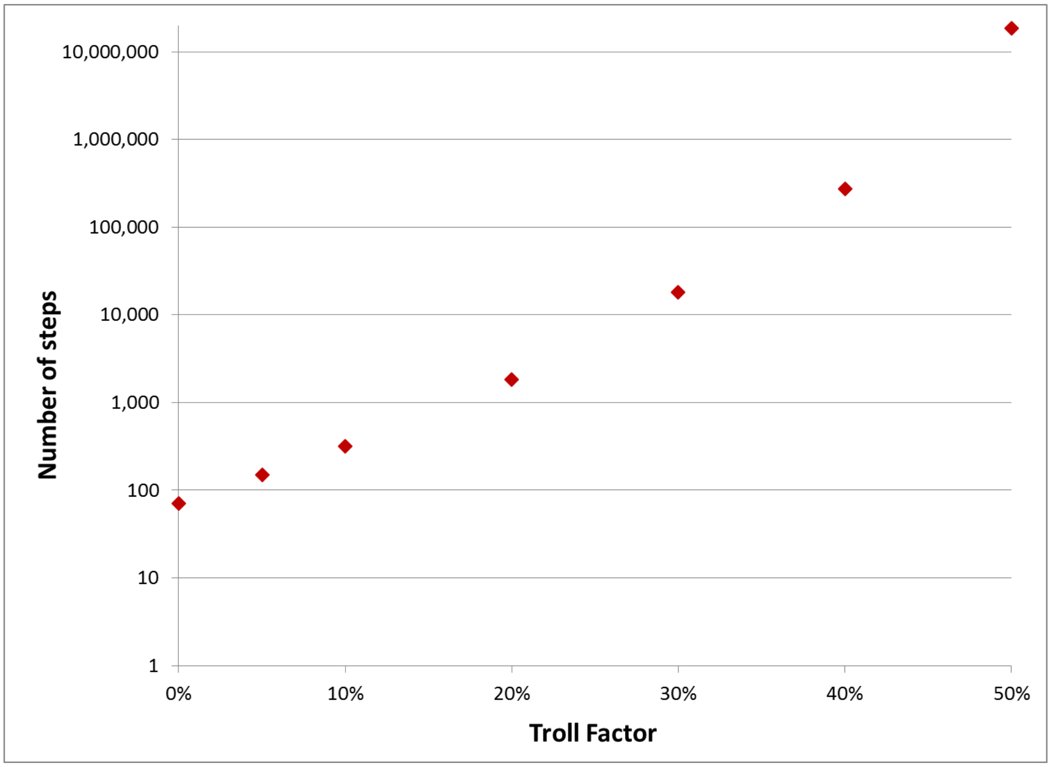


Figure 7. Well, that escalated quickly. (Keep in mind that the Y axis is in logarithmic scale.)

In other words, with a single troll command in every 20, it is already enough to make traversing this map twice as difficult, and when 50% of the inputs were made by trolls (well… in this case it is almost a philosophical question whether the trolls are the ones trying to prevent others from completing the game or the ones effectively trying to complete it), the number of steps necessary was more than 264,000 times greater than the optimal route.

Additionally, I divided Route 23's map into five different areas (Fig. 8) to analyze how much time was spent in each area for each troll factor. The results can be seen on Table 2 and Figure 9. It is clear that, the greater the troll factor, the easier it is for the avatar of the game to jump over the lower ledge and into "Area 5", where he spends most of the time. (See the Appendix for heat maps with average results.)

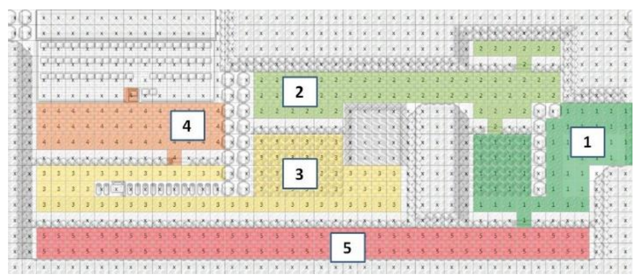


Figure 8. Division of Route 23 into five areas.

Table 2. Percentage of time spent on each of the five Areas for varying troll factors.

Troll factor	Area 1	Area 2	Area 3	Area 4	Area 5
0%	24%	29%	36%	11%	0%
5%	19%	30%	25%	6%	19%
10%	16%	32%	19%	3%	29%
20%	14%	35%	13%	1%	38%
30%	14%	36%	10%	0%	40%
40%	15%	36%	8%	0%	41%
50%	13%	35%	6%	0%	46%

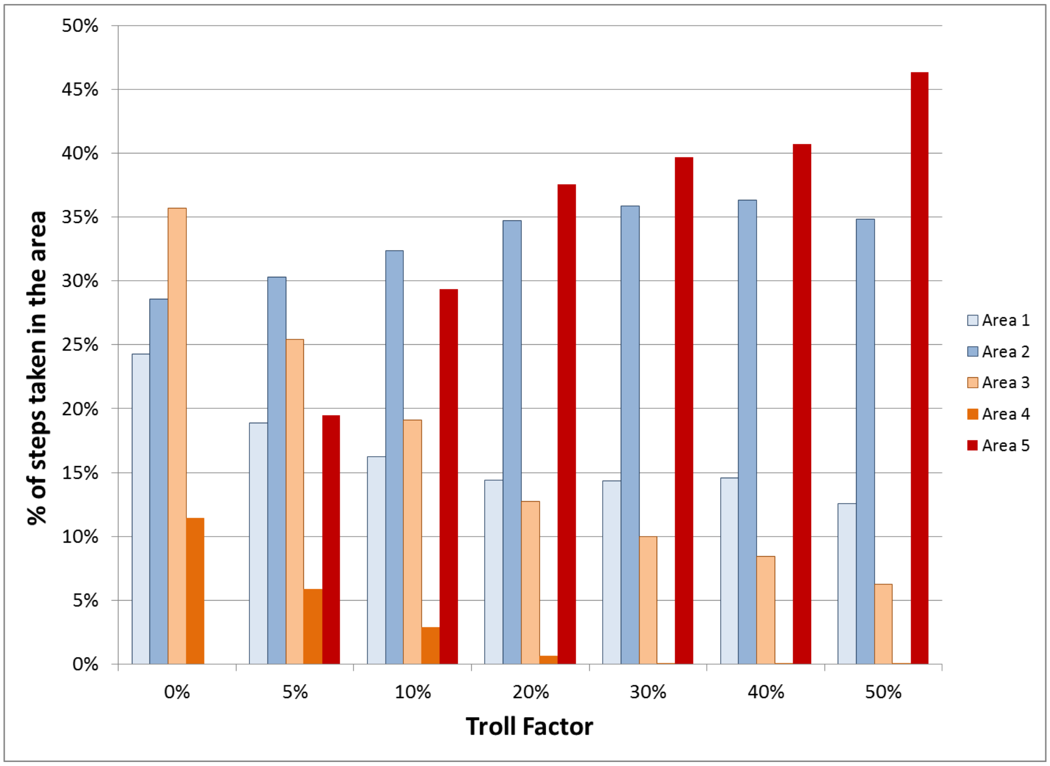


Figure 9. Percentage of time spent in each of the five Areas for varying troll factors.

With these results, it is clear that trolls can be a pain whenever you are trying to conduct some nice experiment online, or have a good argument. Herring et al. (2002) speculate about why trolls (or "trollers", as he puts it) troll, suggesting that the actions may be a result of: hatred towards people who are perceived as different or threatening by the troller (*e.g.*, women or homosexuals); sense of control and self-empowerment when groups are targeted for their vulnerability (such as disabled people or inexperienced users); or simply because trollers enjoy the attention they receive, even (and maybe especially) when it is negative. According to Herring et al. (2002), this suggests that ignoring the troller might truly be an effective way of thwarting him/her (a.k.a. "don't feed the troll"). Sadly, this is much harder to do in *Twitch Plays Pokémon*.

AND WHAT ABOUT THE FISH?

Now consider again my previous work (Tomotani, 2014), where I discussed the fish Grayson and his journey to be a Pokémon master. When you think about it, the average number of steps necessary for a simulation with 50% of trolls seems a bit underwhelming. Considering that one command was inputted every 1.5 second, the 18.492.842 steps would be made in 321 days, less than one year, while random commands made by a fish would take more than 115 thousand years.

I tried to validate this number by using my model to simulate Grayson, but it would take way too long. I adapted the model so that, instead of deciding between a "troll" and "normal" input, it chose randomly between any of the four directions (Fig. 10). After ninety minutes and 5 billion steps, the model seemed no closer to concluding its task. A simple calculation showed me it would take close to 30 days to simulate the equivalent of 115 thousand years (not that long in comparison to the 10 million years it took Earth to calculate the question to the ultimate answer).

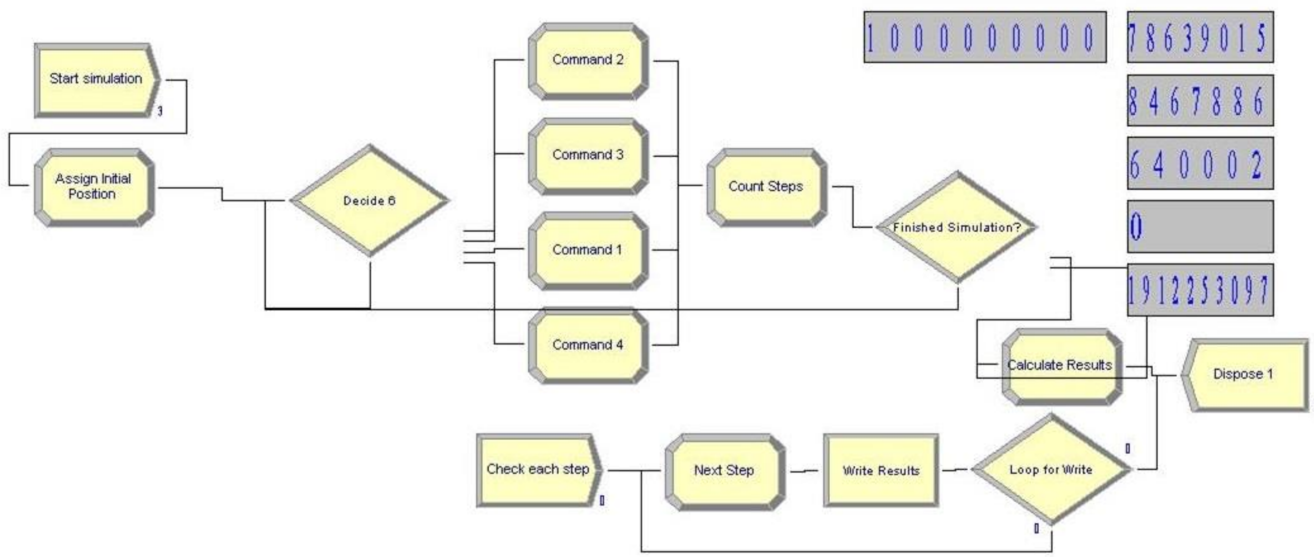


Figure 10. Adapted model for the "random" input. Here, the two "troll inputs" and the "optimal input" from the previous model are substituted by four different commands, one for each direction.

So, I aborted the idea of simulating the whole thing, and decided to limit my simulation. I made 10 simultaneous runs, each with a limit of 1 billion steps, 50 times more than the average it took for the troll factor of 50%. After this limit was reached, the simulation would stop and record the results to show how far the simulation managed to go. Spoiler alert: not a single one managed to finish the route. Figure 11 shows a heat map for this experiment, considering the sum of the 10 simulations, a total of 10 billion steps. Figure 12 gives a closer look at the hardest area to traverse (the narrow path on Area 3), where a single input "down" means lots of backtracking.

After 10 billion steps, only once the random simulation managed to get to the "signpost" coordinate, and never getting further than that (you can see the actual signpost in Fig. 12). Table 3 shows the distribution of steps in each Area (of those five defined above) by the random simulation. More than 95% of the time was spent in Area 5, the lower part of the map.

As such, the conclusion of my previous work that a random input of commands to complete the game is not a productive approach seems valid. This might be a possible explanation to the deactivation of the *Fish Plays Pokémon* channel, so that Grayson could focus his energy in activities that make better use of his skills.

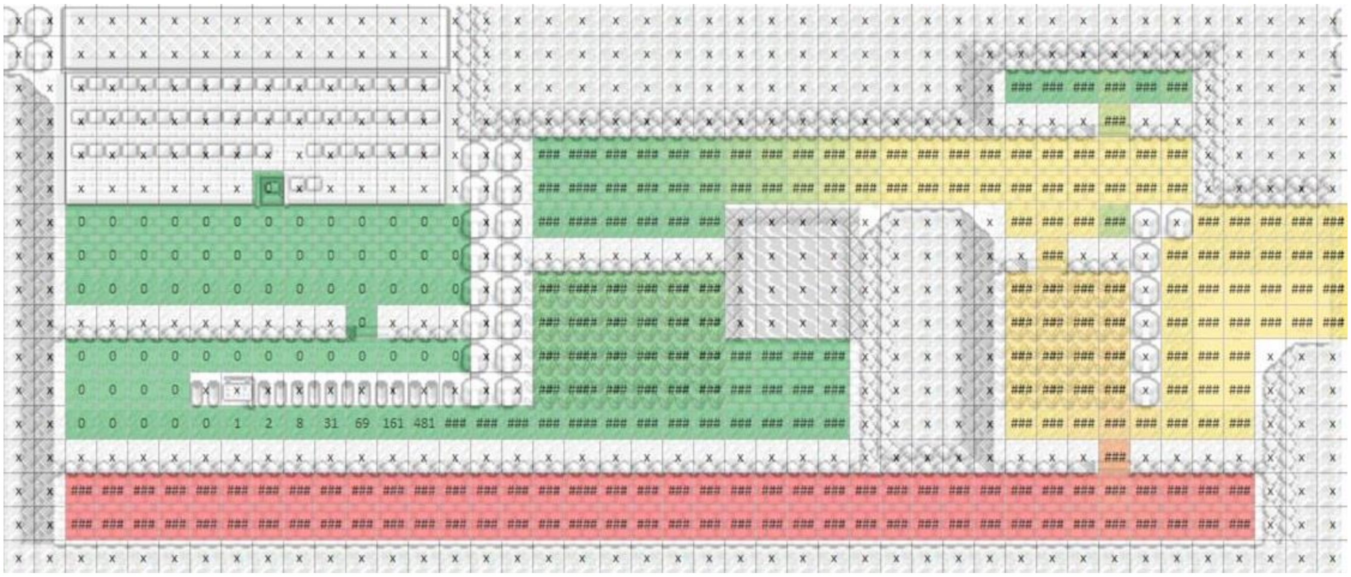


Figure 11. Heat map for the "random" simulation.

Figure 12. Closer look at the most critical part of the map, a narrow path on Area 3. The number on each coordinate represents the number of steps taken on that coordinate (the "###" represents very large numbers).

Table 3. Steps taken in each area in "random" simulation.

Area	Number of steps	%
1	393,626,719	3.9%
2	42,606,084	0.4%
3	3,244,564	0.0%
4	0	0.0%
5	9,560,522,633	95.6%
Total	10,000,000,000	100.0%

REFERENCES

Alcantara, A.M. (2014) Twitch Plays Pokémon: a social experiment from its creator. Mashable, available from: http://mashable.com/2014/02/28/twitch-plays-pokemon/#5nL.FQX07sq3 (Date of access: 11/Sep/2016).

Altiok, T. & Melamed, B. (2007) Simulation Modeling and Analysis with ARENA. Academic Press, Waltham.

ARENA. (2016) Arena Simulation Software. Available from: https://www.arenasimulation.com/ (Date of access: 17/Sep/2016).

Banks, J.; Carson II, J.S.; Nelson, B.L.; Nicol, D.M. (2010) Discrete-Event System Simulation, 5th ed. Prentice Hall, Upper Saddle River.

Haque, A. (2014) Twitch Plays Pokemon, Machine Learns Twitch: unsupervised context-aware anomaly detection for identifying trolls in streaming data. Available from: https://www.albert.cm/dl/twitch_paper.pdf (Date of access: 19/Sep/2016).

Hardaker, C. (2010) Trolling in asynchronous computer-mediated communication: from user discussions to theoretical concepts. Journal of Politeness Research 6(2): 215–242.

Herring, S.; Job-Sluder, K.; Scheckler, R.; Barab, S. (2002) Searching for safety online: managing "trolling" in a feminist forum. Information Society 18(5): 371–384.

Jakobsson, A. (2005) The Good, the Bad, and the Ugly: Bárðar saga and its Giants. Medieval Scandinavia 15: 1–15.

Johns, S. (2014) 20,000 anxiously watch a fish play Pokemon on Twitch TV. Available from: https://www.neowin.net/news/20000-anxiously-watch-a-fish-play-pokemon-on-twitch-tv (Date of access: 17/Sep/2016).

Tomotani, J.V. (2014) The infinite fish playing Pokémon theorem. Journal of Geek Studies 1(1–2): 1–8.

Twitch. (2016) Fish Plays Pokemon. Available from: https://www.twitch.tv/fishplayspokemon (Date of access: 17/Sep/2016).

ACKNOWLEDGEMENTS

I am grateful to Henrique M. Soares for proposing this nice topic to study, as well as for suggestions and comments.

ABOUT THE AUTHOR

João Vitor Tomotani is an engineer who likes to make strange models. He refuses to acknowledge any *Pokémon* game after the Gold/Silver generation.

APPENDIX

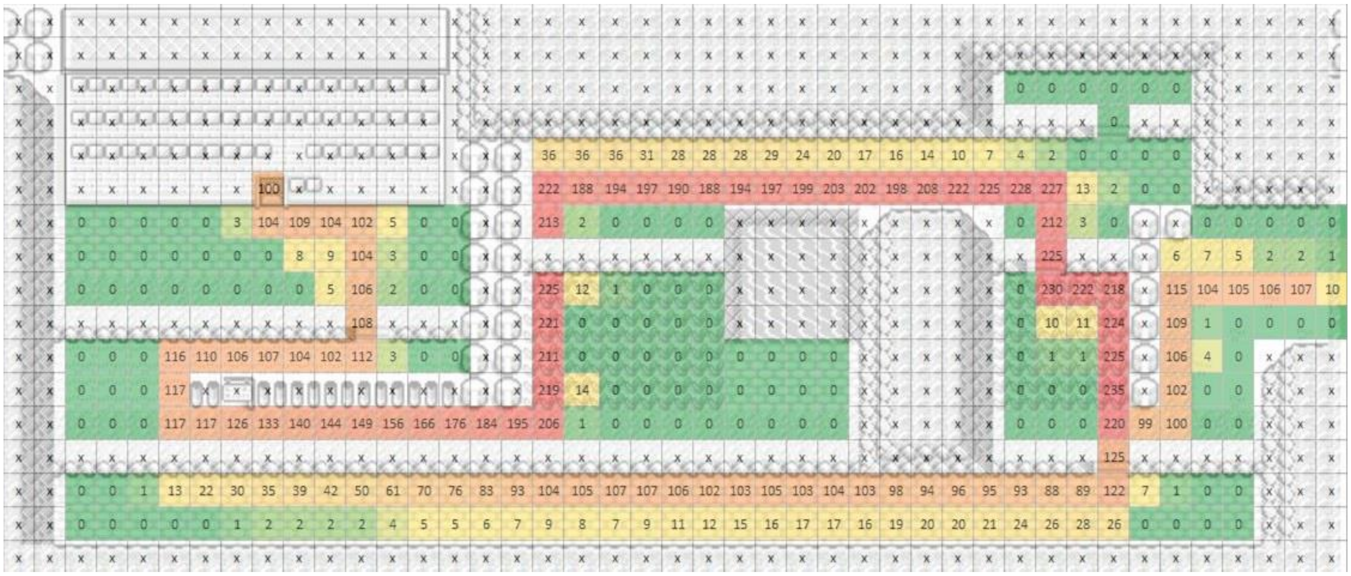


Figure A1. Heat map for the average of 100 simulation runs with a troll factor of 5%.

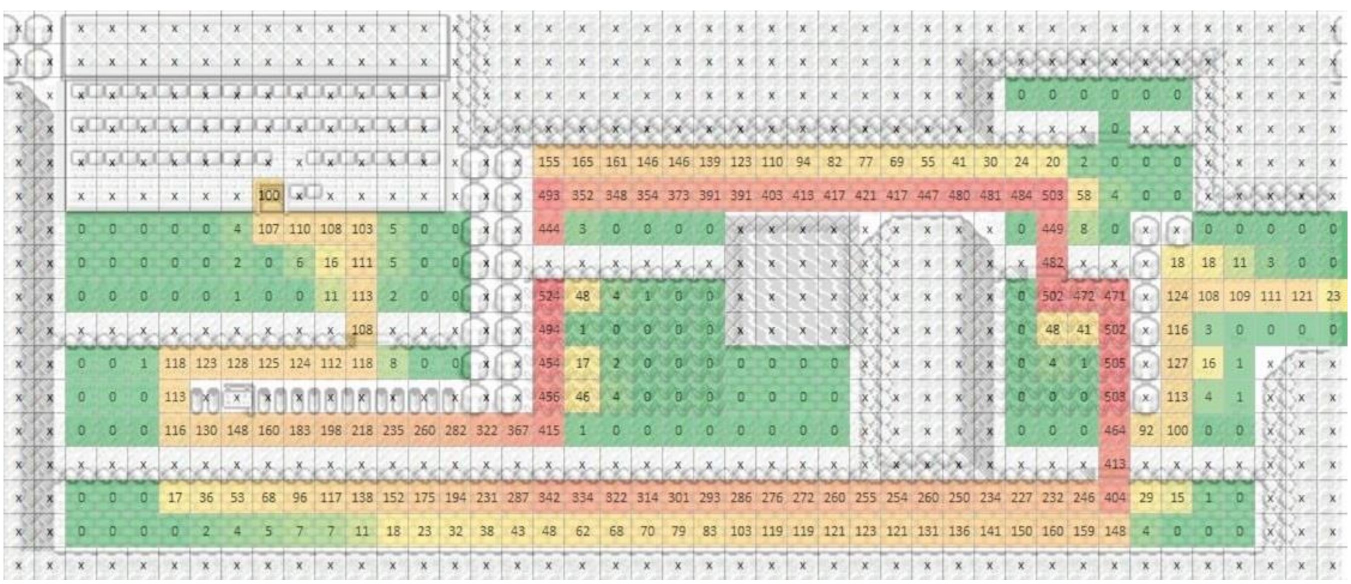


Figure A2. Heat map for the average of 100 simulation runs with a troll factor of 10%.

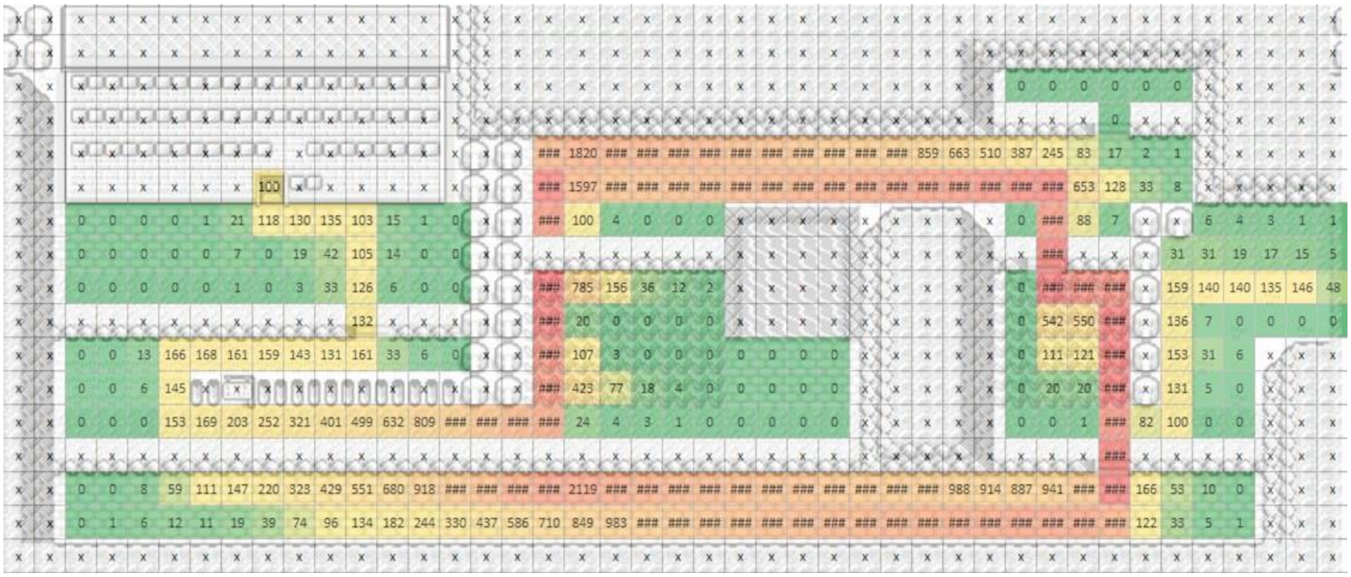


Figure A3. Heat map for the average of 100 simulation runs with a troll factor of 20%.

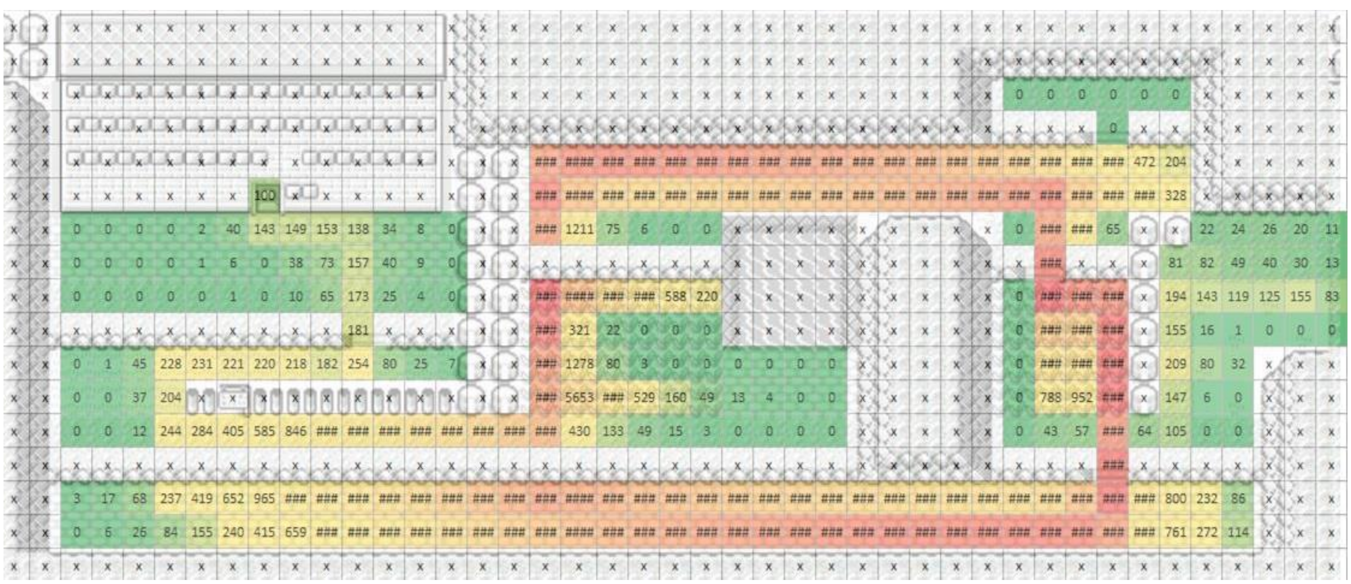


Figure A4. Heat map for the average of 100 simulation runs with a troll factor of 30%.

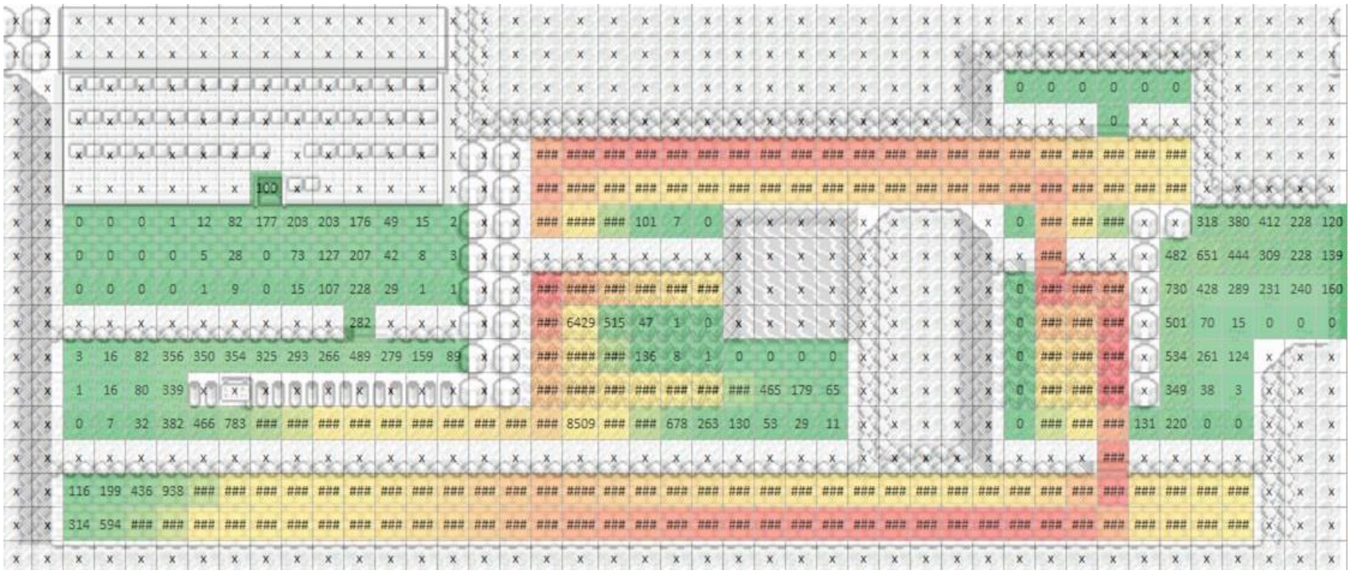


Figure A5. Heat map for the average of 100 simulation runs with a troll factor of 40%.

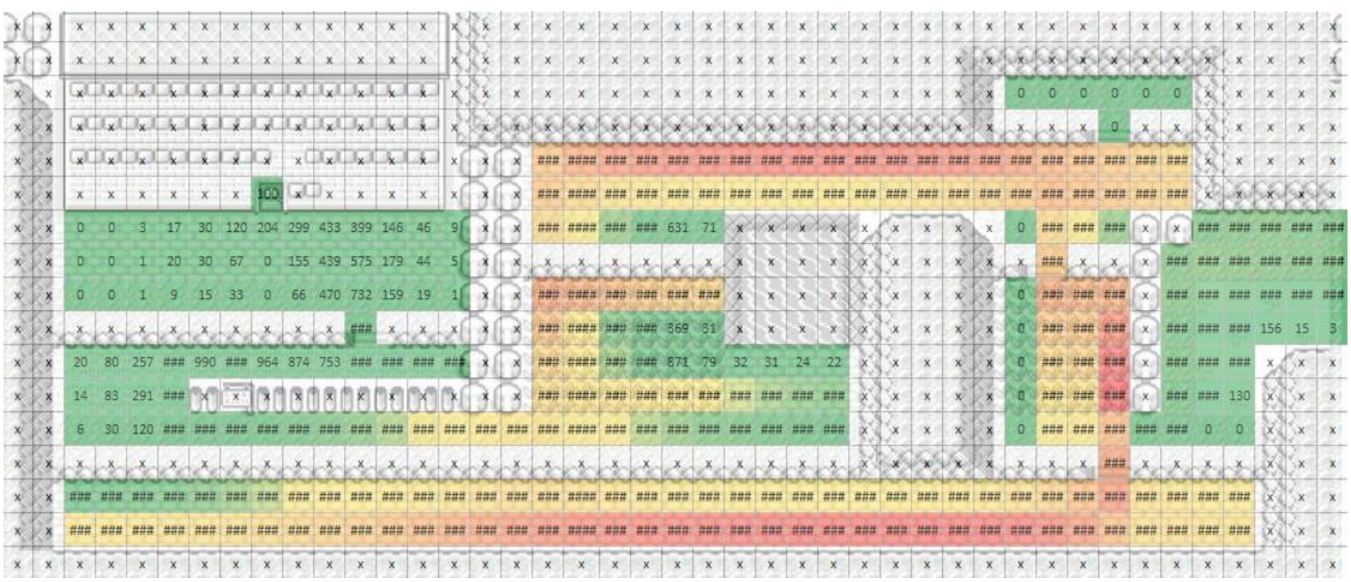


Figure A6. Heat map for the average of 100 simulation runs with a troll factor of 50%.

Table A1. Number of total steps on each coordinate for the 100 simulations for varying troll factors.

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	36	155	1,654	20,855	299,019	12,430,838
9	0	36	165	1,820	25,665	412,131	19,932,669
10	0	36	161	1,796	26,285	450,020	24,492,842
11	0	31	146	1,744	25,696	459,861	27,330,746
12	0	28	146	1,678	25,054	458,821	29,124,056
13	0	28	139	1,586	24,112	452,442	30,282,671
14	0	28	123	1,501	23,002	443,515	31,025,139
15	0	29	110	1,422	21,883	433,089	31,458,146
16	0	24	94	1,280	20,901	421,330	31,645,308
17	0	20	82	1,162	19,965	406,143	31,603,913
18	0	17	77	1,117	18,620	388,227	31,320,661
19	0	16	69	1,019	17,167	367,255	30,737,582
20	0	14	55	859	15,434	341,792	29,761,514
21	0	10	41	663	13,259	309,076	28,227,328
22	0	7	30	510	10,932	269,283	25,925,821
23	0	4	24	387	8,290	219,239	22,550,424
24	0	2	20	245	5,417	156,305	17,601,118
25	0	0	2	83	2,711	99,775	13,914,770
26	0	0	0	17	1,177	59,139	10,979,725
27	0	0	0	2	472	33,301	8,569,900
28	0	0	0	1	204	18,213	6,516,038
29	100	100	100	100	100	100	100
30	100	222	493	2,954	27,857	344,131	12,258,843
31	100	188	352	1,597	12,257	165,655	7,179,823
32	100	194	348	1,389	7,538	83,015	4,063,125
33	100	197	354	1,356	6,584	49,106	2,332,001
34	100	190	373	1,431	6,816	37,992	1,408,110
35	100	188	391	1,529	7,495	37,223	949,121
36	100	194	391	1,589	8,452	41,600	771,788
37	100	197	403	1,674	9,549	49,453	785,991
38	100	199	413	1,807	10,642	60,384	956,037
39	100	203	417	1,903	11,849	74,768	1,282,562
40	100	202	421	2,042	13,126	92,359	1,800,070

Table A1. (cont.)

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
41	100	198	417	2,151	14,811	113,782	2,574,667
42	100	208	447	2,287	16,605	140,692	3,709,273
43	100	222	480	2,420	18,438	173,418	5,359,136
44	100	225	481	2,566	20,578	213,730	7,749,018
45	100	228	484	2,743	23,213	264,627	11,208,520
46	100	227	503	2,915	26,391	327,295	16,222,816
47	0	13	58	653	9,632	175,752	13,828,347
48	0	2	4	128	3,127	88,907	11,273,653
49	0	0	0	33	1,004	45,638	9,222,787
50	0	0	0	8	328	24,030	7,720,116
51	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0
53	0	0	0	0	0	0	3
54	0	0	0	0	0	1	17
55	0	0	0	1	2	12	30
56	0	3	4	21	40	82	120
57	100	104	107	118	143	177	204
58	100	109	110	130	149	203	299
59	100	104	108	135	153	203	433
60	100	102	103	103	138	176	399
61	0	5	5	15	34	49	146
62	0	0	0	1	8	15	46
63	0	0	0	0	0	2	9
64	100	213	444	2,370	19,535	206,349	6,130,792
65	0	2	3	100	1,211	16,571	612,551
66	0	0	0	4	75	1,315	61,078
67	0	0	0	0	6	101	6,101
68	0	0	0	0	0	7	631
69	0	0	0	0	0	0	71
70	0	0	0	0	0	0	0
71	100	212	449	2,414	19,793	207,069	6,135,298
72	0	3	8	88	1,199	16,632	612,617
73	0	0	0	7	65	1,356	61,119
74	0	0	0	6	22	318	23,619
75	0	0	0	4	24	380	33,282
76	0	0	0	3	26	412	38,960
77	0	0	0	1	20	228	31,244
78	0	0	0	1	11	120	24,958
79	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0

Table A1. (cont.)

Coordinate	Troll factor 0%	5%	10%	20%	30%	40%	50%
81	0	0	0	0	0	0	1
82	0	0	0	0	0	0	20
83	0	0	0	0	1	5	30
84	0	0	2	7	6	28	67
85	0	0	0	0	0	0	0
86	0	8	6	19	38	73	155
87	0	9	16	42	73	127	439
88	100	104	111	105	157	207	575
89	0	3	5	14	40	42	179
90	0	0	0	0	9	8	44
91	0	0	0	0	0	3	5
92	100	225	482	3,040	28,227	344,877	12,275,017
93	0	6	18	31	81	482	30,108
94	0	7	18	31	82	651	47,305
95	0	5	11	19	49	444	42,239
96	0	2	3	17	40	309	37,090
97	0	2	0	15	30	228	31,083
98	0	1	0	5	13	139	25,359
99	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0
101	0	0	0	0	0	0	1
102	0	0	0	0	0	0	9
103	0	0	0	0	0	1	15
104	0	0	1	1	1	9	33
105	0	0	0	0	0	0	0
106	0	0	0	3	10	15	66
107	0	5	11	33	65	107	470
108	100	106	113	126	173	228	732
109	0	2	2	6	25	29	159
110	0	0	0	0	4	1	19
111	0	0	0	0	0	1	1
112	100	225	524	3,263	33,477	466,699	20,053,910
113	0	12	48	785	12,917	270,867	17,055,746
114	0	1	4	156	4,612	145,058	13,739,048
115	0	0	1	36	1,609	76,984	11,006,586
116	0	0	0	12	588	41,189	8,806,307
117	0	0	0	2	220	21,682	7,040,425
118	0	0	0	0	0	0	0
119	100	230	502	3,210	33,482	464,244	19,640,301
120	100	222	472	2,702	25,489	347,983	16,480,049

Table A1. (cont.)

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
121	100	218	471	2,678	24,618	331,039	17,448,542
122	100	115	124	159	194	730	35,231
123	100	104	108	140	143	428	22,510
124	100	105	109	140	119	289	13,554
125	100	106	111	135	125	231	8,175
126	100	107	121	146	155	240	5,082
127	0	10	23	48	83	160	3,485
128	100	108	108	132	181	282	1,006
129	100	221	494	3,004	28,843	355,976	12,902,022
130	0	0	1	20	321	6,429	302,589
131	0	0	0	0	22	515	32,156
132	0	0	0	0	0	47	3,468
133	0	0	0	0	0	1	369
134	0	0	0	0	0	0	31
135	0	0	0	0	0	0	0
136	0	10	48	542	10,167	195,527	10,525,368
137	0	11	41	550	8,656	178,328	11,090,494
138	100	224	502	3,106	30,881	460,273	28,057,298
139	100	109	116	136	155	501	22,251
140	0	1	3	7	16	70	4,506
141	0	0	0	0	1	15	1,530
142	0	0	0	0	0	0	156
143	0	0	0	0	0	0	15
144	0	0	0	0	0	0	3
145	0	0	0	0	0	3	20
146	0	0	0	0	1	16	80
147	0	0	1	13	45	82	257
148	100	116	118	166	228	356	1,007
149	100	110	123	168	231	350	990
150	100	106	128	161	221	354	1,016
151	100	107	125	159	220	325	964
152	100	104	124	143	218	293	874
153	100	102	112	131	182	266	753
154	100	112	118	161	254	489	2,041
155	0	3	8	33	80	279	1,864
156	0	0	0	6	25	159	1,537
157	0	0	0	0	7	89	1,239
158	100	211	454	2,486	20,896	224,787	6,808,909
159	0	0	17	107	1,278	18,953	718,176
160	0	0	2	3	80	1,506	76,323

Table A1. (cont.)

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
161	0	0	0	0	3	136	8,028
162	0	0	0	0	0	8	871
163	0	0	0	0	0	1	79
164	0	0	0	0	0	0	32
165	0	0	0	0	0	0	31
166	0	0	0	0	0	0	24
167	0	0	0	0	0	0	22
168	0	0	0	0	0	0	0
169	0	1	4	111	3,013	78,208	5,335,064
170	0	1	1	121	2,910	86,027	6,894,840
171	100	225	505	3,111	32,062	505,669	34,338,068
172	100	106	127	153	209	534	23,576
173	0	4	16	31	80	261	14,977
174	0	0	1	6	32	124	9,914
175	0	0	0	0	0	1	14
176	0	0	0	0	0	16	83
177	0	0	0	6	37	80	291
178	100	117	113	145	204	339	1,038
179	100	219	456	2,327	18,524	181,731	4,705,975
180	0	14	46	423	5,653	78,240	2,602,481
181	0	0	4	77	1,747	34,058	1,439,237
182	0	0	0	18	529	14,902	797,570
183	0	0	0	4	160	6,445	442,688
184	0	0	0	0	49	2,716	246,123
185	0	0	0	0	13	1,161	138,021
186	0	0	0	0	4	465	78,748
187	0	0	0	0	0	179	47,287
188	0	0	0	0	0	65	32,184
189	0	0	0	0	0	0	0
190	0	0	0	20	788	26,182	2,245,781
191	0	0	0	20	952	37,661	3,851,255
192	100	235	503	3,089	32,198	517,830	37,974,880
193	100	102	113	131	147	349	12,424
194	0	0	4	5	6	38	1,269
195	0	0	1	0	0	3	130
196	0	0	0	0	0	0	6
197	0	0	0	0	0	7	30
198	0	0	0	0	12	32	120
199	100	117	116	153	244	382	1,173
200	100	117	130	169	284	466	1,479

Table A1. (cont.)

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
201	100	126	148	203	405	783	2,987
202	100	133	160	252	585	1,285	5,858
203	100	140	183	321	846	2,128	11,621
204	100	144	198	401	1,179	3,563	23,290
205	100	149	218	499	1,707	5,952	46,700
206	100	156	235	632	2,409	9,958	93,714
207	100	166	260	809	3,418	16,677	187,809
208	100	176	282	1,024	4,903	27,922	375,221
209	100	184	322	1,279	7,064	46,597	750,650
210	100	195	367	1,614	10,046	77,567	1,500,554
211	100	206	415	1,983	14,406	128,897	3,001,896
212	0	1	1	24	430	8,509	359,405
213	0	0	0	4	133	3,768	199,083
214	0	0	0	3	49	1,594	110,354
215	0	0	0	1	15	678	61,726
216	0	0	0	0	3	263	34,318
217	0	0	0	0	0	130	19,278
218	0	0	0	0	0	53	11,004
219	0	0	0	0	0	29	6,330
220	0	0	0	0	0	11	3,211
221	0	0	0	0	0	0	0
222	0	0	0	0	43	2,074	223,881
223	0	0	0	1	57	3,029	385,013
224	100	220	464	2,594	23,623	297,081	15,019,800
225	100	99	92	82	64	131	3,137
226	100	100	100	100	105	220	6,222
227	0	0	0	0	0	0	0
228	0	0	0	0	0	0	0
229	0	125	413	3,036	30,914	425,141	22,449,590
230	0	0	0	0	3	116	5,249
231	0	0	0	0	17	199	7,869
232	0	1	0	8	68	436	13,145
233	0	13	17	59	237	938	22,486
234	0	22	36	111	419	1,652	38,125
235	0	30	53	147	652	2,846	65,561
236	0	35	68	220	965	4,649	112,320
237	0	39	96	323	1,414	7,695	192,199
238	0	42	117	429	2,035	12,772	325,596
239	0	50	138	551	2,991	21,128	543,437
240	0	61	152	680	4,259	34,125	893,254

Table A1. (cont.)

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
241	0	70	175	918	6,079	53,808	1,436,094
242	0	76	194	1,173	8,679	83,336	2,237,384
243	0	83	231	1,475	12,071	124,507	3,334,345
244	0	93	287	1,906	16,217	173,948	4,598,190
245	0	104	342	2,229	20,185	211,916	5,453,495
246	0	105	334	2,119	18,231	176,867	4,129,020
247	0	107	322	2,018	16,299	146,116	3,053,839
248	0	107	314	1,888	14,491	119,301	2,222,773
249	0	106	301	1,730	12,938	96,837	1,600,502
250	0	102	293	1,622	11,542	78,305	1,148,109
251	0	103	286	1,522	10,263	63,465	824,817
252	0	105	276	1,416	9,172	51,715	604,291
253	0	103	272	1,345	8,112	42,167	466,309
254	0	104	260	1,260	7,116	34,288	404,195
255	0	103	255	1,185	6,415	28,018	423,648
256	0	98	254	1,126	5,718	23,547	552,628
257	0	94	260	1,073	5,054	20,732	850,208
258	0	96	250	988	4,517	20,962	1,433,541
259	0	95	234	914	4,182	27,407	2,523,120
260	0	93	227	887	4,440	46,764	4,515,602
261	0	88	232	941	6,016	94,993	8,131,989
262	0	89	246	1,256	11,894	205,059	14,410,563
263	0	122	404	3,076	31,659	455,955	25,390,508
264	0	7	29	166	2,552	50,061	3,568,360
265	0	1	15	53	800	22,202	2,044,601
266	0	0	1	10	232	9,968	1,223,967
267	0	0	0	0	86	4,719	814,192
268	0	0	0	0	0	314	1,491,312
269	0	0	0	1	6	594	1,863,721
270	0	0	0	6	26	1,126	2,330,299
271	0	0	0	12	84	1,965	2,910,205
272	0	0	2	11	155	3,281	3,628,424
273	0	1	4	19	240	5,473	4,518,686
274	0	2	5	39	415	9,235	5,611,345
275	0	2	7	74	659	14,894	6,946,123
276	0	2	7	96	1,048	23,150	8,555,677
277	0	2	11	134	1,601	35,504	10,492,854
278	0	4	18	182	2,350	53,568	12,791,772
279	0	5	23	244	3,250	78,477	15,433,190
280	0	5	32	330	4,537	112,369	18,383,005

Table A1. (cont.)

	Troll factor						
Coordinate	**0%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**
281	0	6	38	437	6,359	155,687	21,511,035
282	0	7	43	586	8,705	206,216	24,594,125
283	0	9	48	710	11,225	257,869	27,300,822
284	0	8	62	849	13,398	300,059	29,301,626
285	0	7	68	983	15,376	333,570	30,763,436
286	0	9	70	1,095	17,261	360,871	31,836,312
287	0	11	79	1,189	18,878	384,787	32,631,390
288	0	12	83	1,320	20,121	403,708	33,218,326
289	0	15	103	1,415	21,235	418,752	33,668,840
290	0	16	119	1,510	22,478	429,809	34,034,981
291	0	17	119	1,607	23,442	438,282	34,337,708
292	0	17	121	1,693	24,324	445,844	34,603,332
293	0	16	123	1,747	25,324	452,491	34,838,273
294	0	19	121	1,804	26,100	459,315	35,018,050
295	0	20	131	1,884	26,458	466,128	35,103,905
296	0	20	136	1,930	26,955	472,112	34,997,363
297	0	21	141	2,026	27,458	475,325	34,505,180
298	0	24	150	2,124	27,808	474,152	33,263,777
299	0	26	160	2,105	27,966	460,746	30,578,333
300	0	28	159	2,087	26,929	415,335	25,186,459
301	0	26	148	1,802	20,294	278,629	14,844,465
302	0	0	4	122	1,986	49,053	4,497,790
303	0	0	0	33	761	30,973	4,414,209
304	0	0	0	5	272	18,468	3,938,723
305	0	0	0	1	114	10,570	3,314,457
Total	7,000	14,897	31,674	183,721	1,822,193	27,246,095	1,849,284,150

Journal of Geek Studies

ISSN 2359-3024

Ancient Egyptian themes in *Skylanders*

Rodrigo B. Salvador
Staatliches Museum für Naturkunde Stuttgart; Stuttgart, Germany.
Eberhard Karls Universität Tübingen; Tübingen, Germany.
Email: salvador.rodrigo.b@gmail.com

After seeing how Egyptian mythology is depicted in the *Shin Megami Tensei: Persona* series of videogames (see Salvador, 2015), I now turn to another game series: Activision's billion-dollar toys-to-life franchise *Skylanders. The main series* (*i.e.*, discounting spin-offs) currently counts with six multi-platform games: *Skylanders: Spyro's Adventure* (2011), *Skylanders: Giants* (2012), *Skylanders: Swap Force* (2013), *Skylanders: Trap Team* (2014), *Skylanders: SuperChargers* (2015), and *Skylanders: Imaginators* (2016). The games take place in a world called *Skylands*, a magical realm full of floating islands. Needless to say, this realm is under the constant threat of villains who want to conquer or destroy it and so it falls to the heroes known as *skylanders* to protect their homeland.

Contrary to the *Persona* games, which only use gods and creatures from several mythologies around the world, *Skylanders* creates its own cast of heroes, villains and monsters. These characters are often based on real animals or on fantastic being from myths and stories from all around the world. There are elves, trolls, dragons etc. A few of the characters were inevitably based on ancient Egypt. As such, I will not analyze Egyptian mythology per se in *Skylanders*, but the many things based on ancient Egyptian culture that appear in the games.

Some parts of the text will refer to periods of Egyptian history or dynasties of rulers, so the table below gives an easy reference for this, with indication of the dynasties of rulers and approximate dates of each period (according to Shaw, 2004).

Period	Dynasties	Date
Predynastic Period (Neolithic)	–	5300–3000 BCE
Early Dynastic Period	1–2	3000–2686 BCE
Old Kingdom	3–8	2686–2160 BCE
First Intermediate Period	9–11	2160–2055 BCE
Middle Kingdom	11–14	2055–1650 BCE
Second Intermediate Period	15–17	1650–1550 BCE
New Kingdom	18–20	1550–1069 BCE
Third Intermediate Period	21–25	1069–715 BCE
Late Period	25–"31"	715–332 BCE
Macedonian Era	–	332–304 BCE
Ptolemaic Era	–	304–30 BCE
Roman Era	–	30 BCE – 395 CE
Byzantine Era	–	395–641 CE
Arab conquest	–	641 CE

DUNE BUG

Dune Bug is a skylander that debuted in *Skylanders: Swap Force*. According to the game's lore, he is a keeper of the secrets of an ancient

Arkeyan city. ("Arkeyan" is the game's catch-all term for an ancient Egyptian/Greek/Roman-like civilization with advanced technology.)

Dune Bug (official artwork from the game). Image extracted from Skylanders Wiki.

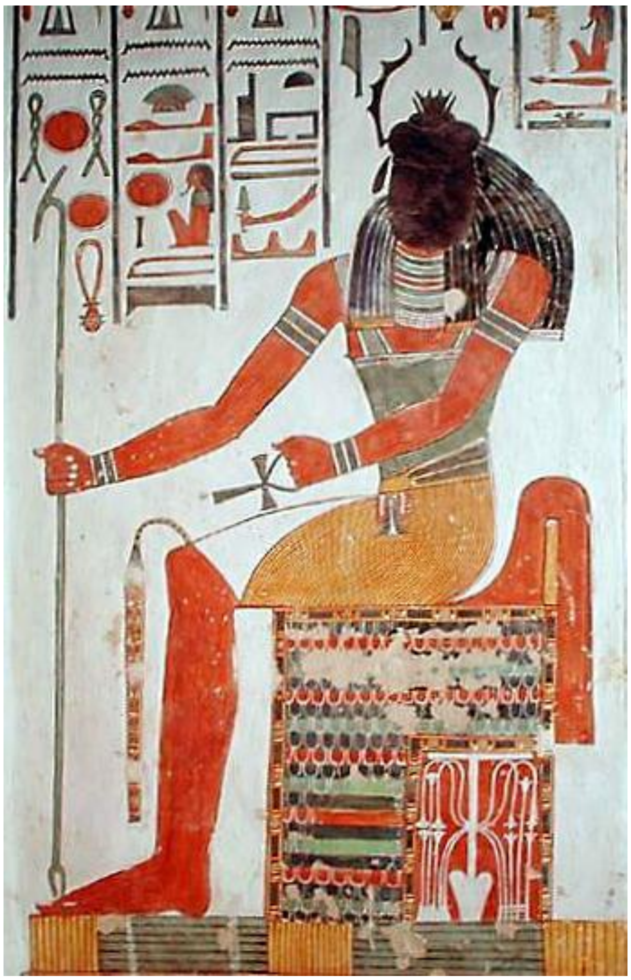
Dune Bug is clearly a scarab, a type of beetle belonging to the family Scarabaeidae. These animals are also known as "dung beetles". This name comes from their mode of life: they make balls of dung that are used as brooding chambers for their eggs and as future food source for the larvae. Males roll their dung balls around and eventually fight for them; those that can protect a nice ball will get a good shot at reproduction. In most species, male beetles have huge "horns" on their foreheads that they use in these battles. However, the Egyptian species (*Scarabaeus sacer* Linnaeus, 1758, or "the sacred scarab") does not have such horn, so we can say Dune Bug is not very biologically accurate in this regard (not to mention he's missing two limbs!).

A specimen of *Scarabaeus sacer* from an entomology collection. Photo by Sarefo (2007); image extracted and modified from Wikimedia Commons.

Anyway, why is the Egyptian scarab called "sacred"? The Egyptians observed the ball-rolling behavior of the beetles and considered it an analogy to the sun god *Re* (may also be written *Ra*) pushing the solar disk across the sky.

Two dung beetles rolling a ball of dung. Photo by Hectonichus (2014); image extracted from Wikimedia Commons.

The scarab beetle then became a symbol of this god or, more specifically, of one of the forms of this god known as *Khepri*, which represented the sunrise and early morning. Khepri was portrayed either as a scarab beetle or as a human man with a scarab as a head.



Wall-painting of Khepri in the tomb of Queen Nefertari (Valley of the Queens; 19th Dynasty, New Kingdom). Photo by Waiyenoo111; image extracted and modified from Wikimedia Commons.

As a symbol of the sun-god, scarabs became widely popular imagery for amulets in Ancient Egypt, especially from the Middle Kingdom onwards. These were mainly apotropaic amulets, which means they were used for protection, to ward off evil. Scarabs would protect both the living (people wore them as necklaces) and the dead (they were placed in the wrappings of the mummies).

A solar scarab pendant from the tomb of King Tutankhamun (Valley of the Kings; 18th Dynasty, New Kingdom). Photo by Jon Bodsworth (Egypt Archive); image extracted and modified from Wikimedia Commons.

KRYPT KING

Krypt King is a skylander belonging to the famed group called “Trap Masters” (from the game *Skylanders: Trap Team*, as one might suspect). According to the game’s lore, he was a knight roaming the world as a disembodied spirit, until he found his suit of armor in some Arkeyan ruins.

The black and golden color combination of Krypt King’s armor was not very common in Egyptian clothing and artifacts. It was occasionally used by Egyptians, though; for instance, in the depictions of the black jackal-god Anubis and in several objects of King Tutankhamun’s treasure. Nevertheless, this color combination became somewhat symbolic of Egyptian stuff in modern times. Perhaps this is due to the above-mentioned treasury of the boy-king Tutankhamun, which has always received extensive media attention.

Krypt King (official artwork from the game). Image extracted from Skylanders Wiki.

The armor in itself is very stylized, seemingly made of metal, with broad shoulder plates, bracers and boots. This is definitely not even close to what ancient Egyptian armor looked like. Armors back then were a simple thing. In truth, for a long time there were no actual armors to speak of and only shields were used for protection. Only in the New Kingdom proper armors began to appear, first made of several layers of cloth and/or leather and later covered with metal scales. Of course, this would make Krypt King look rather weak, so in this case accuracy properly gave way to awesomeness.

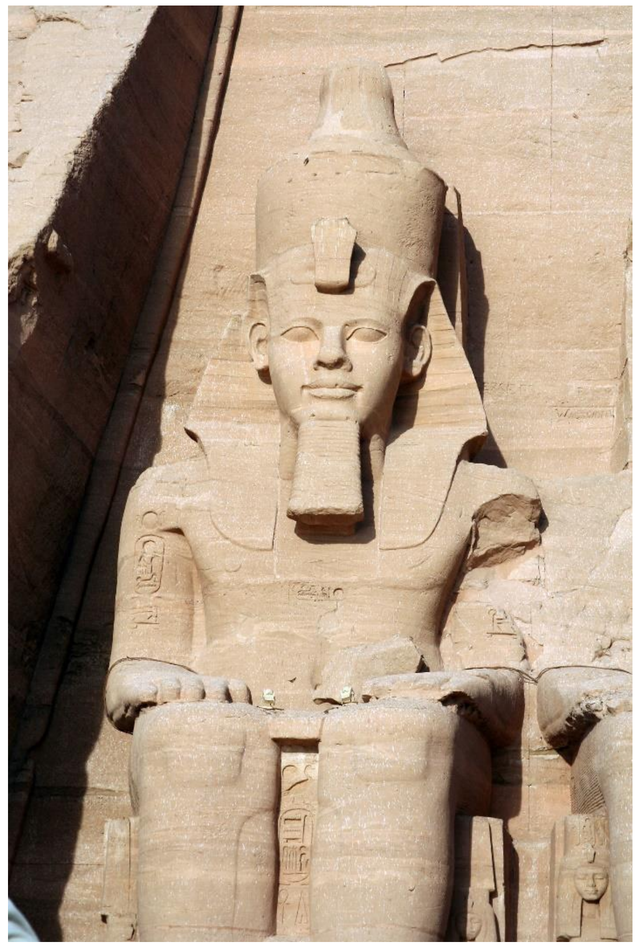
Krypt King's headdress is very Egyptian-like; it looks like a fusion of the *nemes* headdress with the white crown. The nemes is a yellow and blue striped headdress worn by pharaohs in daily life. It is known from depictions as early as the 3rd Dynasty, although there are some possible depictions of a nemes from the 1st Dynasty. The nemes almost always comes with a *uraeus*, the stylized rearing cobra on the forehead of the headdress. The uraeus is a symbol of the goddess Wadjet and represents sovereignty.

The golden mask from Tutankhamun's mummy, shown wearing the *nemes* headdress (Valley of the Kings; 18th Dynasty, New Kingdom). This particular nemes features both the uraeus and the vulture image of the goddess Nekhbet. Photo by Ibrahim.ID & D. Levy (2014, 2015); image extracted from Wikimedia Commons.

The pharaoh also had a number of more ceremonial and ritualistic crowns. The white crown (or *hedjet*) represents rulership over Upper (southern) Egypt. The red crown (or *deshret*) represents rulership over Lower (northern) Egypt. They were together combined as the so-called double crown (or *pschent*), meaning that the pharaoh ruled over the whole land. The two crowns are already seen in the depiction of King Narmer, the founder of the 1st Dynasty and mythical unifier of Egypt. The white crown can also be seen in kings from the so-called Dynasty 0, *i.e.*, before the total unification of the land.

Top row: The two sides of the Narmer Palette (Abydos; 1st Dynasty, Early Dynastic Period). The red squares mark where the king is shown wearing the white crown (left) and red crown (right). Photo by Nicolas Perrault III (2013); image extracted and modified from Wikimedia Commons. Bottom row: Expanded view of the areas delimited by the red squares above.

As stated above, Krypt King wears a headdress that seems to fuse the nemes and the white crown into one. This is actually (more-or-less) seen in Ancient Egyptian art: the nemes is sometimes depicted combined with the double crown.



Statues of Ramesses II from the temple at Abu Simbel (19th Dynasty, New Kingdom), shown with a headdress combining the nemes and the double crown. Photo by Merlin-UK (2007); image extracted and modified from Wikimedia Commons.

Last but not least, there is Krypt King's sword. Needless to say, his large sword is clearly based on medieval European weapons. As with all metalworking in early historic periods, swords in Egypt were not that large. Moreover, the typical Egyptian sword is very unique and more-or-less sickle-shaped. It is called *khopesh* (can also be spelled *khepesh*) and is known at least since the First Intermediate Period. Khopesh were first made of bronze (luckily, copper mined in Egypt contains a high amount of arsenic, which makes the final product harder), but later on in the New Kingdom, iron started to be used.

A khopesh found in Nablus, a city near Jerusalem (ca. 1750 BCE); as usual, the hilt was not preserved. Photo by Dbachmann (2006); image extracted and modified from Wikimedia Commons.

Krypt King could have had a khopesh; it actually would have made him more unique (not to say more accurate too). This is especially true because there are already so many sword-wielding skylanders (even including another Trap Master!).

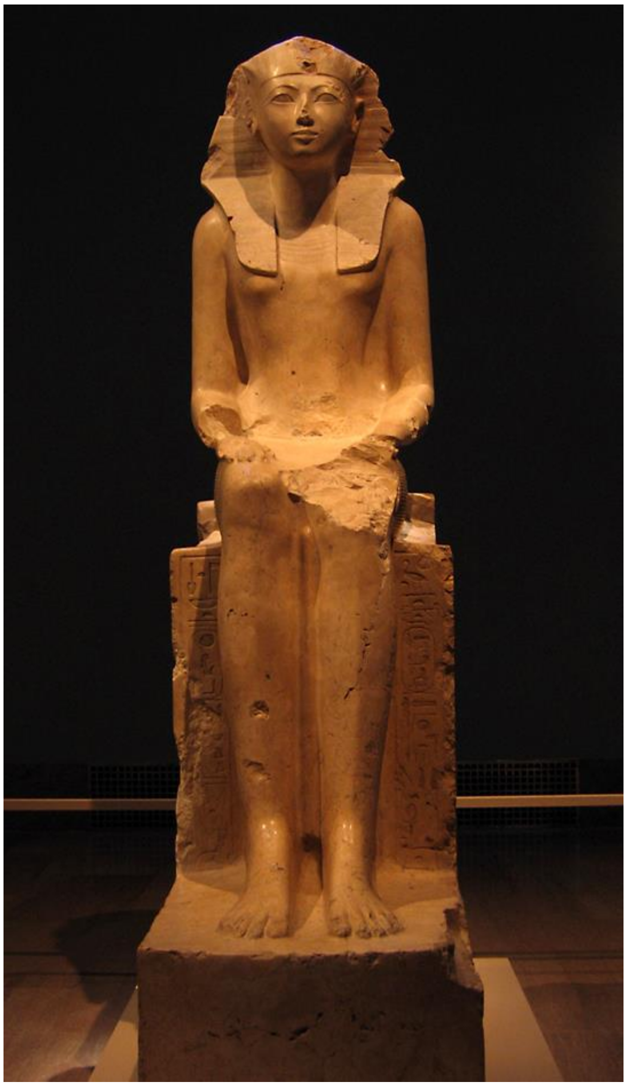
GOLDEN QUEEN

The Golden Queen is not your usual skylander. Rather, she was the main antagonist (alongside the ever-present Kaos) in *Skylanders: Trap Team*. In this game, you can capture the villains and make them work for the greater good; that means you can play as the villains too! She became a full-fledged character in *Skylanders: Imaginators*, appearing as a "rehabilitated" villain (and with the mandatory accompanying real-life toy).

Golden Queen (official artwork from the game). Image extracted from Skylanders Wiki.

By this point, it is very obvious that Golden Queen is clearly based on Egyptian themes. Like the Krypt King, she wears a nemes headdress, albeit very stylized. This is befitting of a pharaoh, but not of a "simple queen". Queens that later became pharaohs, like Hatshepsut, wore male clothing and regalia, as appropriate for the office of pharaoh. Golden Queen's nemes aptly bears a uraeus, a huge and very stylized one at that.

A curious feature of Golden Queen is the vertical lipstick-like stripe painted below her mouth. Perhaps the intention of this painting was to resemble the typical "false beard" worn by pharaohs. (To get an idea of what this beard looks like, take a look at the figure above showing the golden mask of Tutankhamun's mummy). This ceremonial beard was, of course, also symbolical and indicated an association of the pharaoh with the gods. The pharaoh, after all, acted as the single intermediate between mankind and the divine.



The Pharaoh Hatshepsut (from her funerary temple at Deir el-Bahri; 18th Dynasty, New Kingdom) is here depicted in male pharaonic clothing, but still shows a feminine form. Later on, she was depicted entirely as a male. Photo by Captmondo (2007); image extracted and modified from Wikimedia Commons.

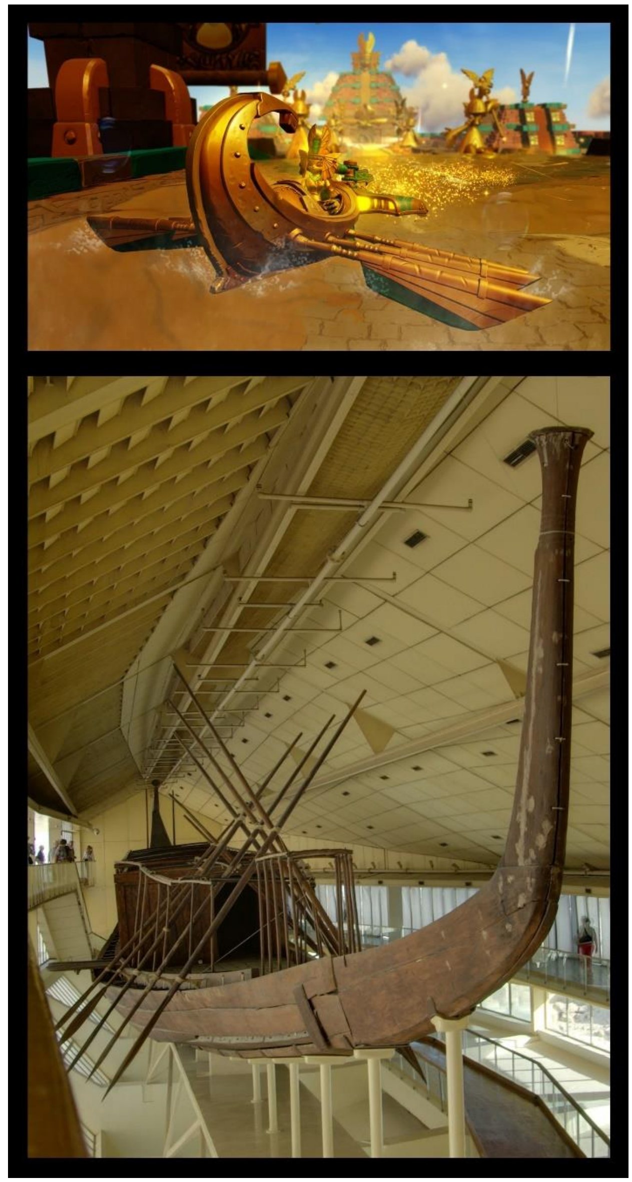
So now let's analyze all the gold. Why is the Queen golden? Well, according to the games' lore, she is actually made of gold (and can even regenerate by absorbing gold). This has precedence in Ancient Egypt, albeit on the divine realm. Egyptian myths tells us that the flesh of the gods was made of gold, while their bones were silver. (The exception was the powerful Set, god of the desert and disorder, whose bones were made of iron.) So the Golden Queen appears to be more godlike than a mortal ruler under this light. Of course, it was usual for the Pharaohs to be eventually depicted in a more godlike manner.

Staves and scepters are symbols of power and dominion, and thus rulership, in many (if not most) cultures of the world. This was also the case in ancient Egypt. Pharaohs and gods (and sometimes important members of the priesthood) were depicted carrying the *was*-scepter or the *sekhem*-scepter. (Pharaohs could also be depicted carrying other similar symbols, depending on the occasion, such as the mace, the crook and the flail.) The was-scepter represents power and dominion; it consists of a usually long vertical shaft with a forked base and is surmounted by an animal head (commonly the so-called "Set-animal" of the god Set). The sekhem-scepter denotes power and might; it consists of a short vertical shaft surmounted by a fan-like or spade-like structure.

Golden Queen's staff is strikingly different from both (although maybe closer to the sekhem-scepter), having a pair of wings and a central egg-like structure. More importantly, the Queen can shoot golden scarabs from her staff and summon a swarm of these beetles. The meaning of scarabs for the Ancient Egyptians is explained above, in the section about Dune Bug. She can also use the staff to turn anyone or anything into solid gold. Alternatively, she can do this with a touch, an ability that comes from Greek myths, namely the story of King Midas.

Left: A *was*-scepter made of faience (its center portion was restored) from Nubia (Late Period). The animal head represents the god Set. Photo by Joan Lansberry 1995–2012; image extracted and modified *from* http://www.joanannlansberry.com. Right: Head of a *sekhem*-scepter, made of wood with gold covering, from the tomb of Tutankhamun (Valley of the Kings; 18th Dynasty, New Kingdom). Anonymous photo; image extracted and modified from http://ancienthistorysymbols.tumblr.com.

Finally, Golden Queen has a boat in the *Skylanders: SuperChargers* game. The vehicle is called *Glitter Glider*, perhaps because the name *Golden Glider* was already taken by DC Comics. Despite obvious additions (like the motor), her boat is indeed based on ancient Egyptian vessels, especially known by their high curving prow and many oars.



Top: Golden Queen on her boat (screenshot from the game). Image extracted from Skylanders Wiki. Bottom: Reconstructed "solar barge" of King Khufu (4th Dynasty, Old Kingdom), found in the king's pyramid complex in Giza. Photo by Berthold Werner, 2010; image extracted and modified from Wikimedia Commons.

GRAVE CLOBBER

Grave Clobber is a minor villain, featured as a playable character in *Skylanders: Trap Team*. He is summoned by the Golden Queen to get rid of the skylanders. By his wrappings, Grave Clobber is clearly a mummy. But that's where all Egyptian influence stops. Actually, everything else in Grave Clobber looks influenced by Mesoamerican cultures: the geometric patterns, the ugly scary mask and the typical turquoise blue color (the pigment called "Maya blue", or "*azul maya*", from the Spanish).

Grave Clobber (official artwork from the game). Image extracted from Skylanders Wiki.

STAGES

Like for Grave Clobber above, Golden Queen's stages (*The Golden Desert* and *Lair of the Golden Queen*) are all ornamented with reliefs and patterns that are more reminiscent of Mesoamerican cultures than ancient Egypt. This is especially true for the pyramid, which is a step pyramid with a flat top. Such buildings are well known from archeological sites in Mexico, but not in Egypt (although the very first pyramid built, by pharaoh Djoser, was stepped). Golden Queen's racing stage from *Skylanders: SuperChargers* (called "The Golden Temple") also shares a lot of this Mesoamerican style.

Top: *Golden Desert* stage, from *Skylanders: Trap Team* (official artwork from the game). Middle: *Lair of the Golden Queen*, from *Skylanders: Trap Team* (official artwork from the game). Bottom: *The Golden Temple* stage, from *Skylanders: SuperChargers* (screenshot from the game). All images extracted from Skylanders Wiki.

CONCLUSION

As we can see by the above discussion, the *Skylanders* series incorporates some nice elements from ancient Egyptian culture. It presents some things in a sensibly accurate manner, while accommodating other things in a more forceful manner due to gameplay and/or artistic choices. Some things, however, are unnecessarily mistaken, like Krypt King's sword and the Mesoamerican pyramids.

REFERENCES

Adams, B. (1994) Egyptian Mummies. Shire Publications, London.

Burton, R.F. (1884) The Book of the Sword. Dover Publications [1987 ed.], Mineola.

Emlen, D. (2014) Animal Weapons: The Evolution of Battle. Henry Holt & Co., New York.

Hall, R. (1994) Egyptian Textiles. Shire Publications, London.

Hart, G. (2005) The Routledge Dictionary of Egyptian Gods and Goddesses. Second Edition. Routledge, Oxon.

Lurker, M. (1984) Gods and Symbols of Ancient Egypt. Thames & Hudson, London.

Miller, M.E. (1999) Maya Art and Architecture. Thames & Hudson, New York.

Partridge, R.B. (2002) Fighting Pharaohs: Weapons and Warfare in Ancient Egypt. Peartree Publishing, Havertown.

Pasztory, E. (1998) Pre-Columbian Art. Cambridge University Press, Cambridge.

Peck, W.H. (2013) The Material World of Ancient Egypt. Cambridge University Press, Cambridge.

Reyes-Valerio, C. (1993) De Bonampak al Templo Mayor: El azul maya en Mesoamérica. Siglo XXI Editores, Mexico D.F.

Salvador, R.B. (2015) Egyptian mythology in the Shin Megami Tensei: Persona games. Journal of Geek Studies 2(1): 8–32.

Salvador, R.B. (2016) The overwatching eye of Horus. Journal of Geek Studies 3(2): 01–07.

Scheel, B. (1989) Egyptian Metalworking and Tools. Shire Publications, London.

Shaw, G.J. (2012) The Pharaoh: Life at Court and on Campaign. Thames & Hudson, London.

Shaw, I. (1991) Egyptian Warfare and Weapons. Shire Publications, London.

Shaw, I. (2004) The Oxford History of Ancient Egypt. Oxford University Press, Oxford.

Skylanders Wiki. (2016) Available from: http://skylanders.wikia.com/ (Date of access: 19/Mar/2016).

Teeter, M. (2011) Religion and Ritual in Ancient Egypt. Cambridge University Press, Cambridge.

Tyldesley, J.A. (1998) Hatchepsut: The Female Pharaoh. Penguin Books, London.

Vinson, S. (1994) Egyptian Boats and Ships. Shire Publications, London.

Wilkinson, R.H. (1992) Reading Egyptian Art. A Hieroglyphic Guide to Ancient Egyptian Painting and Sculpture. Thames & Hudson, London.

Wilkinson, R.W. (2003) The Complete Gods and Goddesses of Ancient Egypt. Thames & Hudson, London.

ABOUT THE AUTHOR

Rodrigo Salvador remains fascinated with Ancient Egypt and often stops to ponder about it, even while fending off wave after wave of nasty Chompies.