Rotations for Ancient Egyptian – a critical analysis

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November 10, 2023

We critically analyze the use of variation selectors to achieve rotations of Ancient Egyptian hieroglyphs. We find that there is a substantial risk that rotations are encoded that are not meaningful within the framework of Unicode. Our investigations mainly focus on potential future rotations that are not multiples of quarter turns, but we also express grave reservations against a number of quarter-turn and half-turn rotations that were previously added to StandardizedVariants.txt. The main objection against such rotations is that they suggest a level of palaeographic accuracy that Unicode cannot deliver.

1 Introduction

Ancient Egyptian hieroglyphs can be rotated by the use of variation selectors. VS1 – VS3 have been assigned to achieve rotation by respective multiples of (clockwise) 90°, as described by L2/21-248. The same document also reserved VS4 – VS7 for the remaining multiples of 45°, but did not specify further details about how this would be done.

Rotations entail a stark increase in the size of OpenType fonts, as such fonts cannot dynamically rotate glyphs, and therefore need to store rotated copies. To avoid the blow-up in size that would result if all rotations for all signs were included, a selection of rotations for a selection of signs is registered, and fonts would only be expected to implement those. Next to considerations about implementation, there may also be conceptual reasons why certain rotations for certain signs are not meaningful.

L2/22-012R listed rotations found in a (non-Unicode) corpus of hieroglyphic encodings. On the basis of this list, a number of rotations were added to StandardizedVariants.txt that are multiples of a quarter turn. Work is in progress to also add rotations that are not multiples of 90°.

The aim of this document is to critically analyze the encoding of rotations in Unicode, to develop a better informed perspective of what rotations are meaningful in Unicode. From the outset, we clearly state that we in no way wish to make claims about what palaeographic research is meaningful. We acknowledge that any nuance of appearance of graphemes, including infinitesimal differences in angles, could serve valid palaeographic purposes, for dating, for identifying hands, and more. Our arguments are directed towards Unicode, what can and cannot be achieved in Unicode without violating common assumption and generally accepted practice concerning Unicode characters, Unicode fonts, web search with regular expressions of Unicode characters, and so on.

In Section 2 we aim to first develop a coherent view of what kinds of rotations may be appropriately expressed on the level of Unicode using variation selectors. In Section 3 we give a number of examples that illustrate the high variability in angles of rotation of Ancient Egyptian hieroglyphs. Section 4 discusses a number of highly questionable rotations that have slipped into StandardizedVariants.txt, which were apparently motivated by a desire to express fine palaeographic distinctions. A few other problems of the current rotations are listed in Section 5. For a number of proposed changes, there appears to be unanimous support, and for the sake of completeness these are documented in Section 6.

2 What is a meaningful rotation of a hieroglyph in Unicode?

A first attempt to delineate what are meaningful rotations in Unicode is by looking at encodings created by tools that were frequently used in the past for typesetting hieroglyphic texts, such as JSesh [13], which builds on the Manuel de Codage [7], and PLOTTEXT [15, 16]. Such tools typically allow rotation by any integer angle from 1° to 359°. If one finds a certain rotation for a certain sign in an existing JSesh encoding, one could assert that this means the rotation is by definition meaningful for Unicode as well.

This way of thinking about rotations in Unicode suffers from several flaws however. First, rotations in Unicode are expressed in terms of variation selectors, and there are not 359 variation selectors, with one for every integer angle, and even if there were, it would likely lead to a blow-up of the font size if it were permitted that multiple, very similar rotations of one and the same sign were registered, by say 20°, 21°, 22°, ..., according to what happens to be found in different JSesh encodings, which in turn may be attributable to the whims of the respective JSesh encoders at the time, rather than to any meaningful, discernible distinctions between different angles.

Second, the main goal of hieroglyphic typesetting tools has traditionally been to produce printed publications, allowing the encoding to be discarded after the article or book had appeared. As such, these tools have never been concerned with issues such as standardization, normalization, and text search. The main concern was to create a satisfactory appearance, for a given fixed font specific to the tool, without worrying too much about the underlying encoding. For Unicode however, the underlying form of encoding is of central importance, as it needs to allow effective text search, and allow encodings to remain valid if a font is replaced by another.

Third, and related to the above point, encoders who contributed to large corpora of hieroglyphic texts in the past, often students, may have understood their task to be different from correctly identifying characters, choosing different characters instead, with different meanings, solely because their appearance in the given font was closer to the appearance of the glyphs in the hieroglyphic text that they were told to encode. In the same vein, they may also have used rotations to fine-tune the appearance of glyphs, under the assumption that the font was fixed once and for all. In other words, the question whether an occurrence of a rotation was an independently meaningful feature of a sign occurrence in a text may never have been asked.

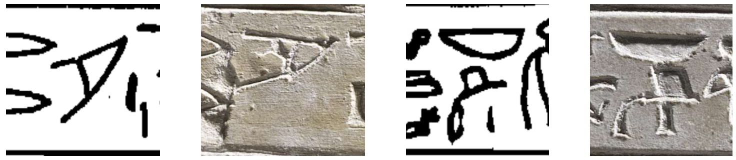
Connected to this, hand-written hieroglyphic transcriptions can themselves be rather unreliable, and give a false impression of a glyph having been rotated; cf. Figure 1. Moreover, a hieroglyph may appear slanted without the ancient artist having intended it to be rotated. This could be because of unevenness of the writing surface or because of poor workmanship; cf. Figure 2. In both cases, it may not necessarily be desirable to express the rotations in Unicode, as these rotations are mere accidental features of the appearance.

Altogether, there are at least three, possibly compounding, sources of questionable rotations found in existing non-Unicode encodings of hieroglyphic texts:

- slant due to poor workmanship of the original inscription,
- slant due to inaccuracies of the modern transcription,
- an overinterpretation of slant by the encoder.

For these reasons, one cannot take rotations in existing hieroglyphic corpora at face value and in the worst case, one may need to go back to the original artefact to ascertain that a rotation is a genuine element of the inscription.

There are rotations that are uncontroversial, in particular for signs that in their natural form (in which they occur in normalized fonts) are perfectly horizontal or perfectly vertical. Such signs are often rotated by a quarter turn, either clockwise or counterclockwise. A frequent motivation for such rotation was to make better use of available space. For example, consider a sign that is tall and narrow while remaining



(a) (b) (c) (d)

Figure 1: The drawing in (a) from in [2, Plate 5] suggests that  (U6) appears slanted with the right tip pointing up. A photograph of the stela reveals this is misleading and the tip actually points slightly down. Similarly, (c) suggests that  (F39) is rotated counterclockwise, but this is refuted by the photograph (BM EA567 © The Trustees of the British Museum).

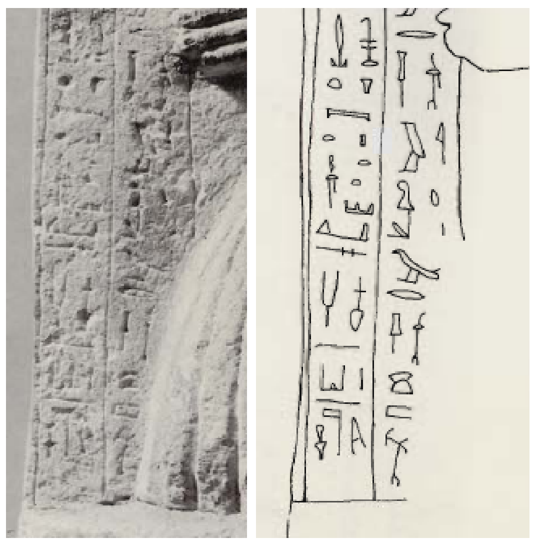
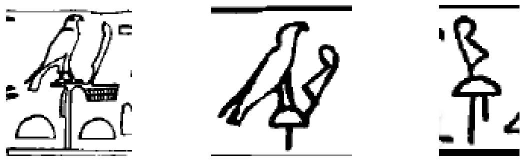


Figure 2: Slanted signs in a sloppily carved inscription [1, Plate 36, 37]. An overenthusiastic encoder could well have chosen to include rotations for a few of the sign occurrences.

empty space, next to other signs, is low and wide. A rotation by a quarter turn could make that sign fit within the available space. This also made the introduction of rotation primitives into Unicode essential, as most users would not find an encoding of a text acceptable if the appearance of a group of signs completely changes due to a tall and narrow sign being displayed in the wrong orientation (cf. Table 20 of L2/21-248 for examples). Other signs may occur upside down, without this changing the meaning. It is for such cases that the three variation selectors VS1 – VS3 were intended, to rotate signs by 90°, 180°, 270°, respectively, going around the circle once, in steps of one quarter turn clockwise (assuming the text direction is left-to-right, and counterclockwise for right-to-left text).

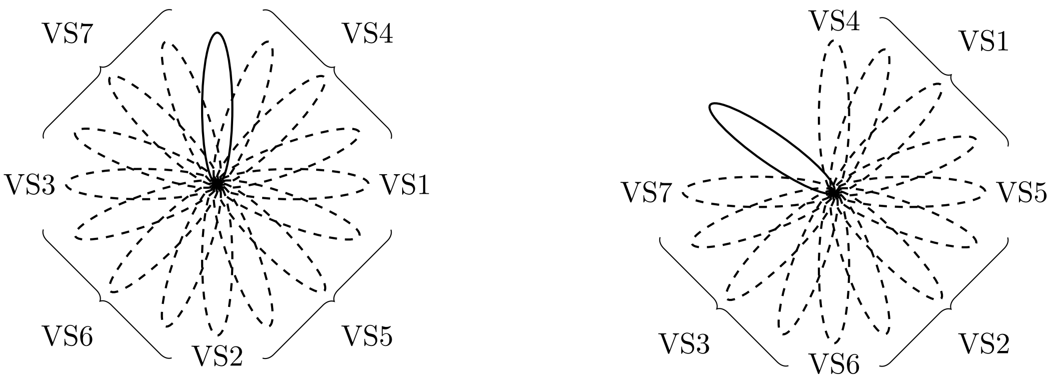
Some signs that in their natural form are perfectly horizontal or perfectly vertical may also be rotated to become 'slanted', that is, they appear at an angle which is neither horizontal nor vertical. A common example is  (H6), which may be rotated by about 25° clockwise or counterclockwise, according to L2/22-

RTL



[10, Plate 15] [3, Plate 40] [5, Plate 6]

Figure 3: Undisputed occurrences of slanted (H6) as part of compositional signs.



(a) (b)

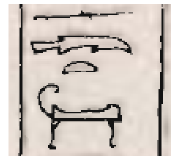
Figure 4: (a) Use of variation selectors for a ‘straight’ sign. The base sign is suggested by the solid lines and the rotated signs by the dashed lines. (b) Use of variation selectors for a ‘slanted’ sign.

012R. Although I personally have not been able to track down stand-alone rotated forms of on original artefacts, it is very plausible that they exist, in the light of rotated forms in compositional signs (cf. Figure 3), and stand-alone occurrences listed by [8, bd. I, p. 570].

The obvious solution to handle such rotations is to use the further variation selectors VS4 – VS7 that we had already anticipated needing in L2/21-248, going around the circle once more. However, rather than fixing specific angles to VS4 – VS7, it may be more appropriate to associate them with a range of ‘slanted angles’ that lie somewhere between the ‘straight’ multiples of 90 degrees. Hence, one could use VS7 to rotate by 25° counterclockwise, and the same VS7 could be used to rotate another sign by say 50° counterclockwise. Graphically, this is expressed in Figure 4(a). It would also not be unreasonable to leave some discretion to font designers to choose an appropriate slanted angle as long as it is in the correct quarter of the circle.

The alternative of having many more variation selectors, say one for rotation by 30° and another by 35° and another by 40°, etc., is that such distinctions quickly become meaningless, and would contrast with the fact that Unicode is not suitable for expressing fine palaeographic detail. In particular, Unicode code points of hieroglyphs abstract away from the considerable graphical variation that one will find in actual inscriptions of one and the same sign. See also Section 3 for a discussion about small differences in the angle of rotation and whether these are meaningful.

To broaden the discussion, now consider signs that in their most frequent form are already slanted but occasionally appear in a horizontal or vertical form. A typical example is (U6), which may also occur in a form where the top segment is almost perfectly horizontal. However, this form already exists as an

LTR  RTL 

[11, Plate 19A] [11, Plate 45A]

Figure 5: The more usual slanted appearance of (K4) and an occurrence that is almost horizontal.

independent code point (U7) and so no variation selector is needed here. A slightly better example may be (K4), which normally occurs slanted but may also occur in an almost horizontal orientation, as illustrated by Figure 5.

We can now use the same four variation selectors VS4 – VS7, with similar angles of rotation, but this time, they are meant to turn 'slanted' signs into 'non-slanted' forms. This is expressed by Figure 4(b), which also allows for the possibility that a slanted sign is rotated by approximately 90°, or a multiple thereof, to remain slanted, but in a different quarter of the circle. For (K4), a (weak) case can be made for use of VS7 to turn this into a horizontal form.

One remaining case is if slanted signs are rotated by a small angle, say around 20°, to remain slanted, in a similar orientation. We would argue against such attempts to express minute differences in appearance that are meaningless on the level of Unicode, just as earlier we argued against distinguishing a 30° from a 40° rotation of one and the same horizontal or vertical sign.

We have thereby arrived at the view that VS4, VS1, VS5, VS2, VS6, VS3, VS7 'go around the circle', and alternately achieve 'straight' and 'slanted' forms. If the base sign is 'straight', then VS4 achieves a 'slanted' form, and VS1 achieves a 'straight' form again, etc. If the base sign is 'slanted', then VS4 achieves a 'straight' form, and VS1 achieves a 'slanted' form again, and VS5 achieves the next 'straight' form, etc. However, we do not wish to distinguish various slanted forms that are in the same quarter of the circle, between two 'straight' forms, as this risks bringing undue palaeographic detail into Unicode.

Even with such a conservative starting point, many questions will remain hard to resolve. Consider for example (T7) exemplified in Figure 6. The first two examples appear at a slightly slanted orientation that is close to that of most fonts. The third example appears to show T7 in a slightly downward orientation. If this can be confirmed by closer study of the original inscription, then it is still not clear whether use of VS7 (to turn a slanted shape into a horizontal shape) or VS3 (to turn a slanted shape into a slanted shape in the next quarter of the circle) would be appropriate. The differences in angle are small, and one could well choose to encode all three examples as unrotated T7. Similarly, for Figure 7, it seems futile to ask which of the examples of (D52) are horizontal and which are slanted enough to warrant use of a variation selector to achieve rotation. (L22/22-012R suggests introducing a 25° rotation for this sign.)

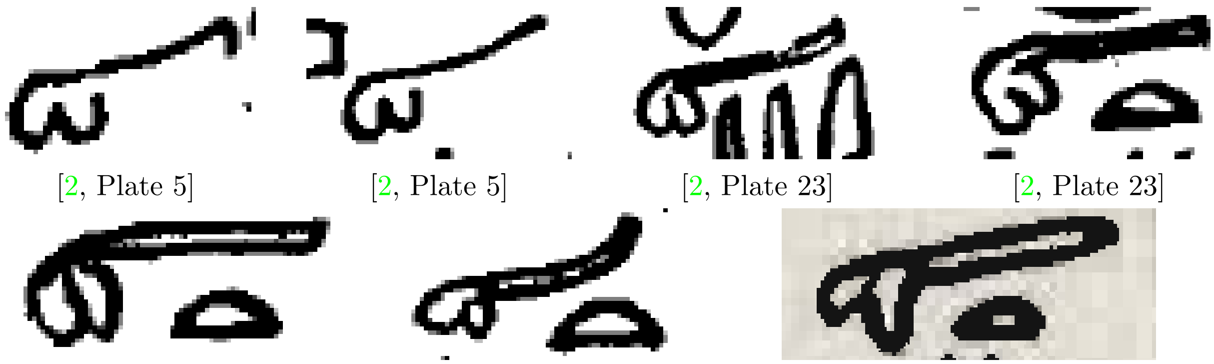
We should also point out that genuine, unmistakable rotations other than by 90°, 180° and 270° angles are extremely rare to begin with. If one sets oneself the task to compile a comprehensive list of such rotations, there may be a tendency to include far-fetched cases. We advise against this temptation, and would recommend to only include rotations that were unquestionably intended to be rotations by the ancient artists.

RTL

[10, Plate 1] [6, Plate 19] [10, Plate 21]

Figure 6: Occurrences of (T7).

RTL



[2, Plate 5] [2, Plate 5] [2, Plate 23] [2, Plate 23]

[2, Plate 23] [2, Plate 23] [1, Plate 60]

Figure 7: Occurrences of (D52).

3 Rotations in a continuum

We contend that if a sign can be rotated by an angle other than a multiple of 90°, then there is generally a continuum of possible angles of rotation. In other words, no particular angle has a status that sets it apart from similar angles. Because for most signs slanted rotations are infrequent, it is not so easy to gather enough data to illustrate this. One exception is the hoe (U6), for which many examples can be found; cf. Figure 8. In both text directions, right-to-left and left-to-right, there are examples of about every conceivable angle from horizontal to vertical. By looking at context, we get the impression that there was a tendency to rotate this sign to make it narrower if horizontal space was limited, and to rotate it to make it lower if vertical space was limited. The more limited the space was, the more the sign was rotated. Undoubtedly there are other aesthetic considerations at play that are not yet fully understood, but there are almost certainly no semantic differences between different angles.

As already mentioned, the horizontal form (U7) already has its own code point, and so does the (almost) vertical form (U006A). In our opinion, it was unjustified that also the 90° rotation of U7 was added to StandardizedVariants.txt:

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1333B FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH U007
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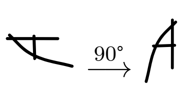

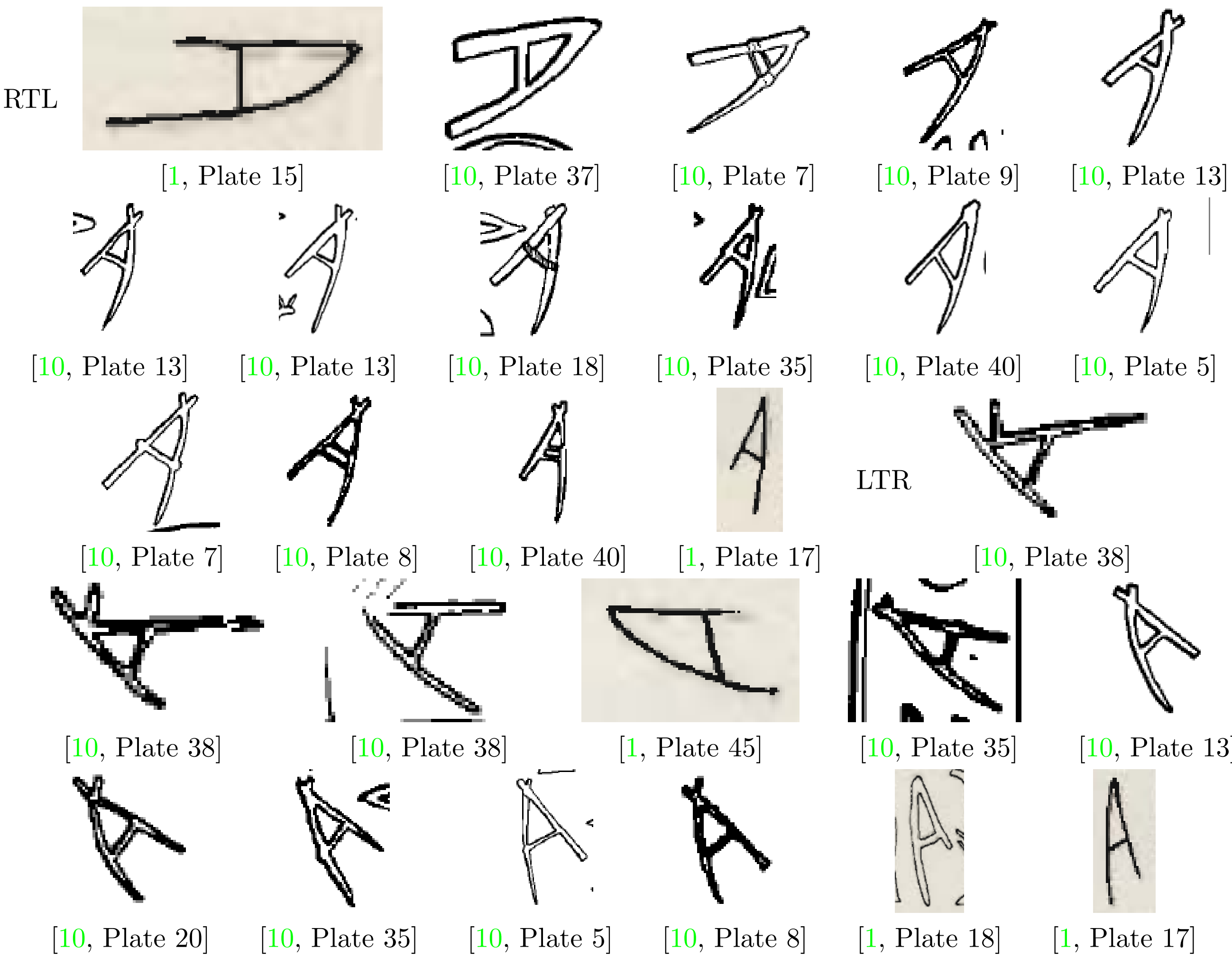

Figure 8: Examples of (U6).

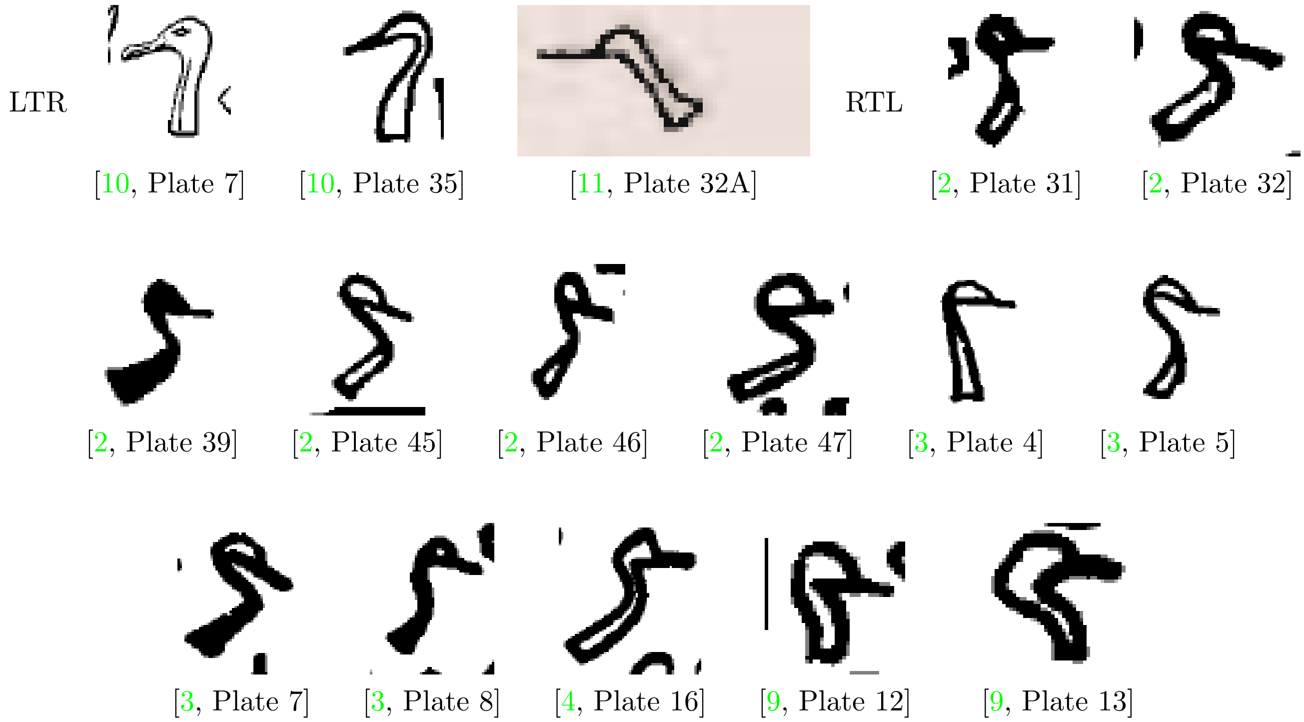

Figure 9: Examples of (H1).

The difference between this and U006A is too small to be meaningful. In particular, there is no evidence that the 'perfectly' vertical orientation of U7 VS1 sets it apart from the 'almost' vertical orientation of U006A.

Proposal: Remove this rotation of U7.

Perhaps nowhere is the futility of small rotations better demonstrated than for the 30° rotation counterclockwise suggested by L2/22-012R for (H1). Figure 9 illustrates that this shape varies widely. In terms of angles, it is impossible to tell which of these shapes if any is 'unrotated' or by how much one shape is rotated with respect to any other, because we have the angle of the beak, the shape and angle of the neck, and the angle of the bottom edge of the neck, which can all vary independently. Therefore encoding a rotation of by less than say 90° makes absolutely no sense.

Similarly, for (D45) there is a large variety of shapes, exemplified by Figure 10. In principle, one could take either the angle of the upper arm as reference, or take the angle of the lower arm as reference (sometimes two lower arms can be discerned), or possibly the angle of the wand, and determine relative rotation based on one of these three reference angles. One would then have to posit that 'correct' fonts have particular angles for these three elements. But because the angles of the three elements seem to vary almost independently, it is an illusion to think one could get much closer to describing shapes of sign occurrences in actual original inscriptions by small rotations relative to a single normalized glyph in a font. This awareness about D45 undermines the motivation for many of the small rotations suggested by L2/22-012R, even though D45 itself is not included in that document.

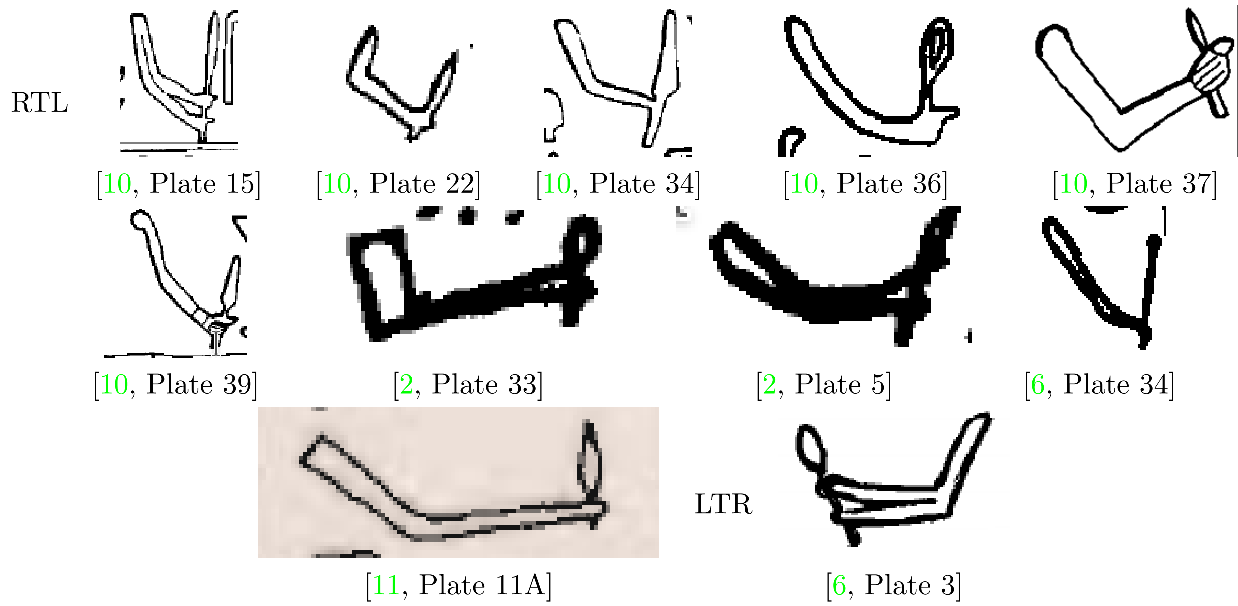

Figure 10: Examples of (D45).

What is mentioned in L2/22-012R is a 30° rotation clockwise of (N21), a sign that itself already appears slanted in fonts, albeit by differing angles in different fonts. In actual inscriptions, there appears to be a continuum of angles, as exemplified in Figure 11. This makes it problematic to argue that any particular rotation deserves to be singled out and be treated as a distinct graphical entity next to the 'unrotated' normalized glyph in some standardized font. At best, one could single out the rotations that make N21 almost perfectly horizontal or perfectly vertical, but even this could be open to debate considering how close N21 is to being horizontal in many fonts. (Should one consider making N21 more slanted in the code charts, to make the horizontal form more clearly distinct?)

For signs that largely consist of curves, it is generally hard to tell whether any glyphs are rotated relative to any other. Consider for example (M2), with glyphs exemplified by Figure 12. It is not possible to justify the 15° rotation counterclockwise of this sign suggested by L2/22-012R, which would be drowned out by even the smallest freedom that font designers should be permitted to draw a shape according to their best judgement.

The same holds almost by definition for the spiral shape of (Z7), with glyphs exemplified in Figure 13. How would one measure the degree of rotation of one spiral relative to another? In terms of the inner start of the spiral? In terms of the outer end of the spiral? Or a midpoint somewhere on the spiral? Thereby the 25° rotation counterclockwise suggested by L2/22-012R makes little sense. One could argue about the 90° rotation of this sign if it can be confirmed by investigating original inscriptions that this is not an error.

4 Misuse of rotation to alter appearance on a palaeographic level

Following on from Section 1, we reiterate that in no way do we wish to detract from the merits of the field of palaeography. The question is however whether Unicode is an appropriate tool for encoding nuances of

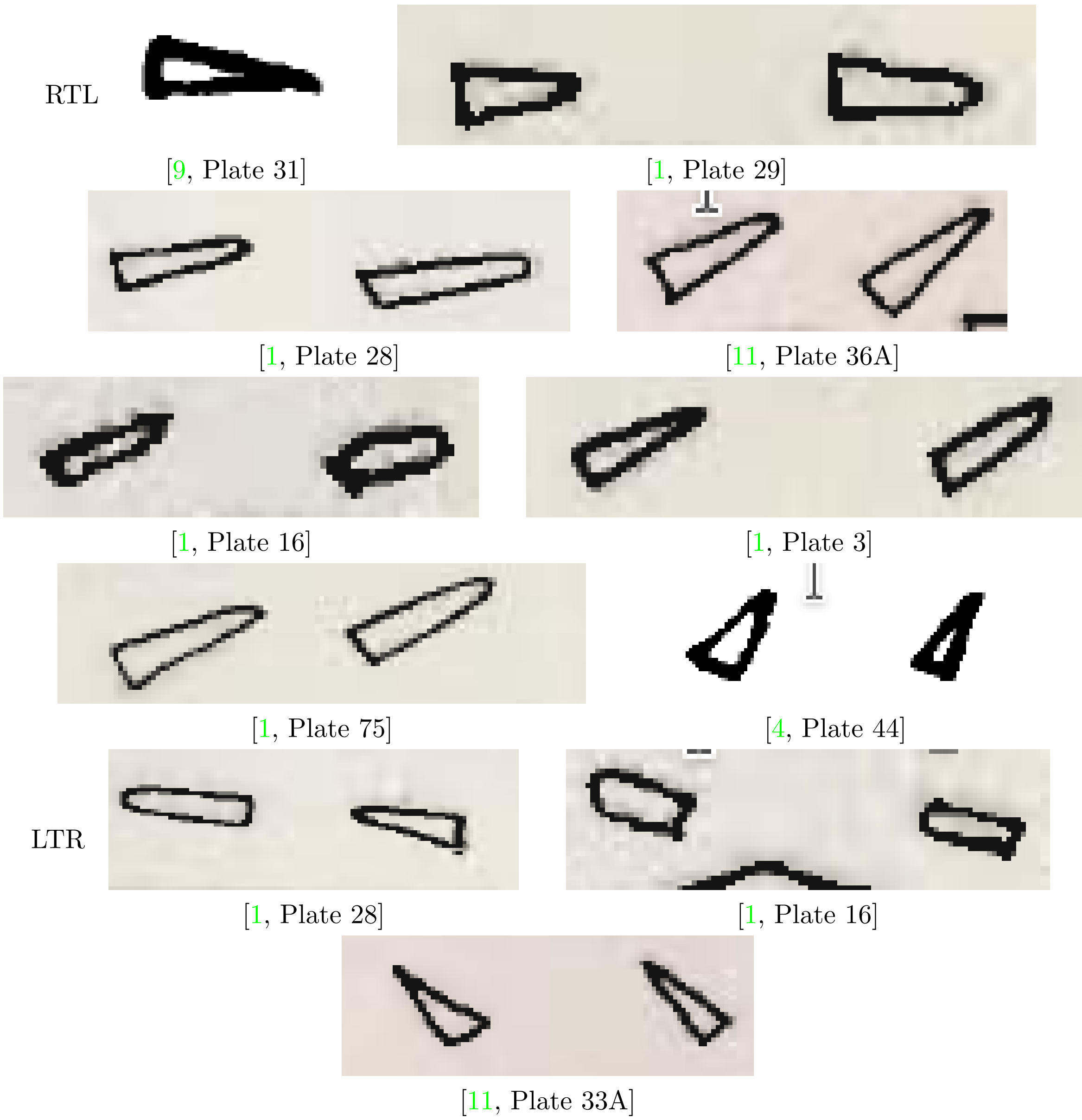

Figure 11: Examples of (N21).

appearance at a palaeographic level, considering Unicode is meant to be about characters and graphemes, as opposed to glyphs. Also the control characters for Ancient Egyptian that currently exist in Unicode do not allow fine-tuning of relative positioning of hieroglyphs, nor absolute scaling of hieroglyphs, and are thereby unsuitable for expressing appearance at a palaeographic level.

Variation selectors can be used to indicate glyph variants, and are used for this purpose for some scripts. It was unanimously decided however that for Ancient Egyptian, variation selectors would be used exclusively for rotations. In case a graphical variant of a hieroglyph is deemed to be of critical importance, it is given an independent code point. This is to avoid confusion between two distinct issues: a difference in shape and a rotation of a shape. Note that a variant shape could be rotated as well.

Nonetheless, a number of uses of variation selectors have slipped in that suggest they are meant to achieve

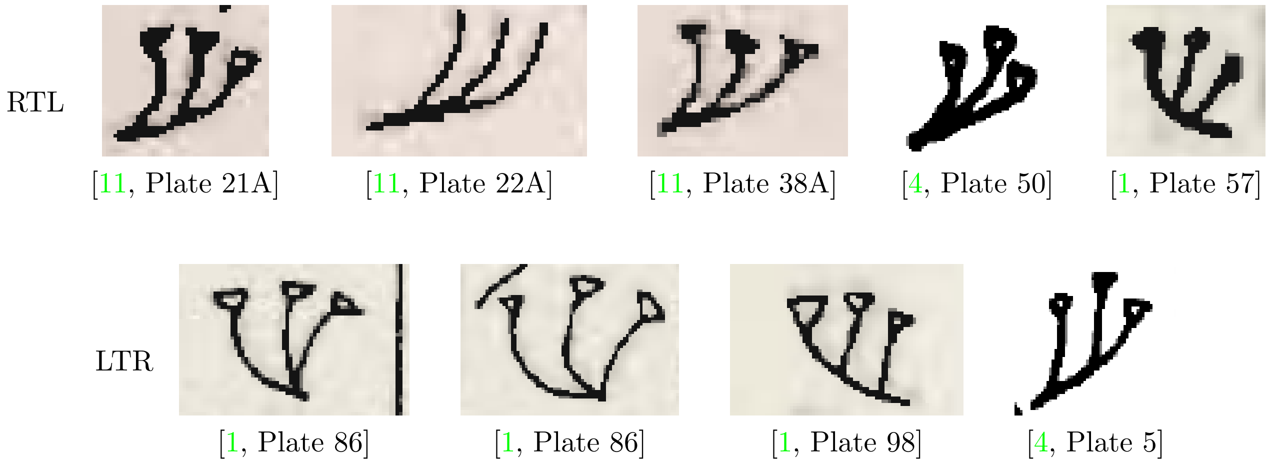

Figure 12: Examples of (M2).

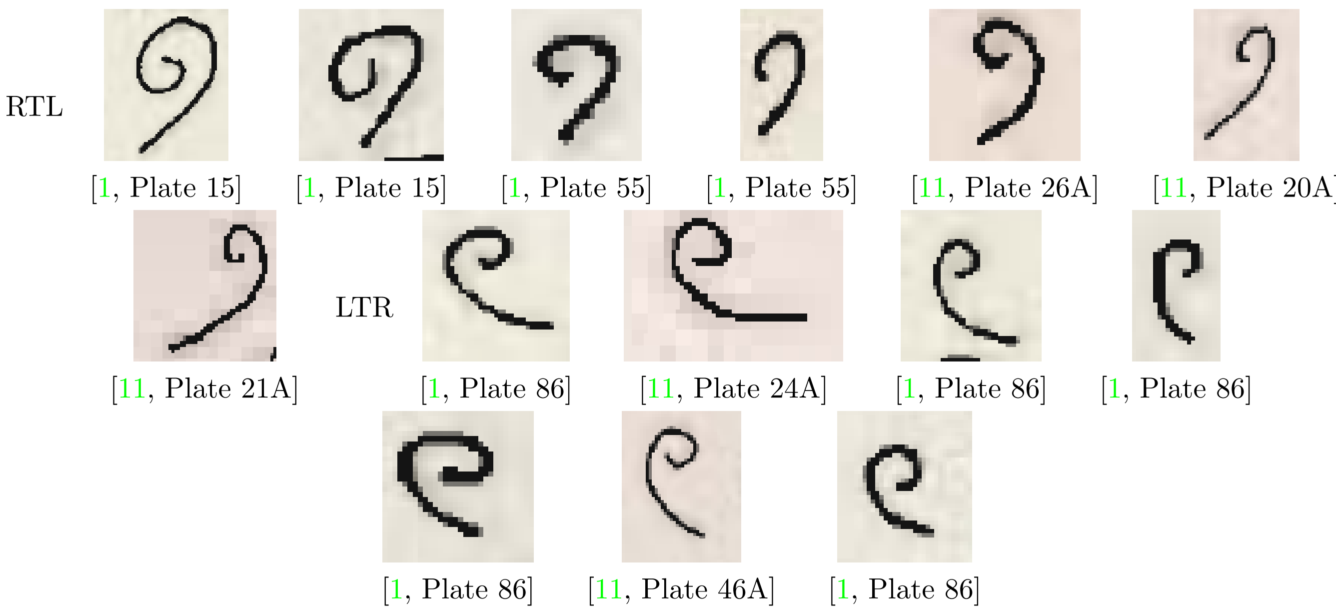

Figure 13: Examples of (Z7).

rotation, while in truth they were meant to express minute differences in appearance at a palaeographic level. Moreover, it is questionable whether the use of these variation selectors will give the expected result regardless of the choice of font. A number of cases are discussed in what follows.

```
131B1 FE01; rotated 180 degrees; # EGYPTIAN HIEROGLYPH M003
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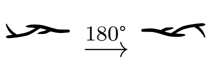

The sign represents a branch. Often the furthest tip of the branch curves upward. The 180° rotation

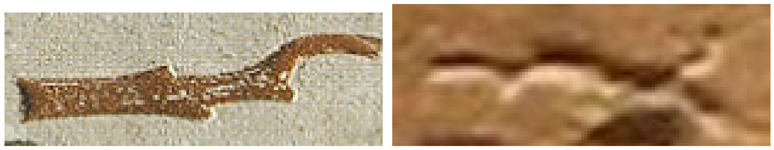

Figure 14: Two occurrences of (M3) in the Thot Sign List (https://thotsignlist.org/mysign?id=3978).

looks very similar to the horizontal mirror image . Because there is already a horizontal mirroring control, at first sight it seems puzzling that the 180° rotation was registered. However, it turns out that the purpose for this 180° rotation was exclusively to be used in conjunction with the horizontal mirroring control in order to achieve *vertical* mirroring. In other words, this is not meant to be a rotation at all. The motivation for the vertical mirroring is to be able to express that the furthest tip of the branch curves downward rather than upward.

Although it is true that more often than not the tip of M3 curves upward, the very fact that the trick with rotation and horizontal mirroring was felt to be needed by encoders in the past demonstrates that the tip sometimes curves downward, and it would therefore be a mistake to say that the upward curvature is an inalienable feature of its iconographic identity. In the Thot Sign List, there are currently 15 photographs of M3, whose shapes vary widely. For one, the tip exits the main branch at the top and then curves downward, and for another, there appear to be two tips, one curving upward and the other curving downward; cf. Figure 14. See Figure 15 for further examples of shapes of M3.

Apart from the fact that this rotation was not meant to be a rotation at all, an undue assumption is that the font depicts M3 with the tip clearly curving upward or otherwise an encoding with VS2 for 180° rotation and the horizontal mirroring control makes no sense.

Proposal: Remove this rotation.

```
132AA FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH Q003
```

▯ $\xrightarrow{90^\circ}$ ▭

This sign denotes a stool and its outlines form a rectangle. In the best inscriptions, the sign occurs with a characteristic internal texture exemplified in Figure 16(a-b). More often than not, the height of the rectangle exceeds its width, but by how much varies between inscriptions. It would be incorrect to say however that the height exceeding the width is an inalienable feature of its iconographic identity, as it is not hard to find counter-examples where the width exceeds the height, as in Figure 16(c-e).

The above rotation was introduced, not because there is any evidence that the Ancient Egyptians would have wanted to rotate this sign, but because some encoders in the past wanted to express that an occurrence of Q3 had a width exceeding the height, as in Figure 16(c-e). Of course, this only makes sense if in the chosen font the height of the unrotated Q3 noticeably exceeds its width. Moreover, if a font would add internal texture as in Figure 16(a-b), then the rotated form becomes nonsensical, with the texture in the wrong orientation.

Hence, this is misuse of rotation to express a fine palaeographic detail, and makes undue assumptions about the font.

Proposal: Remove this rotation.

```
133F5 FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH Z010
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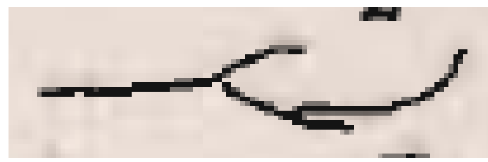
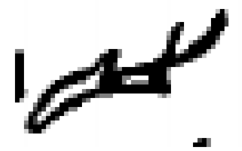
RTL 

[10, Plate 2]

[1, Plate 57]



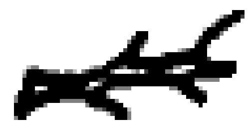
[11, Plate 43A]



[2, Plate 5]

[2, Plate 24]

[3, Plate 36]



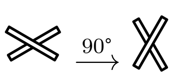
[3, Plate 37]

[5, Plate 47]

LTR 

[1, Plate 56]

Figure 15: Various shapes of  (M3).



Z10 overlaps in the range of meanings with  (Z9), but Z10 is generally larger than Z9. In most fonts Z9 has exact 90° angles, but in actual inscriptions, the angles at the top and bottom are sometimes visibly smaller than 90° and sometimes visibly greater than 90°. The angles at the top and bottom of Z10 are generally greater than 90°, at least in most fonts. In actual inscriptions, one will no doubt find forms of Z10 with different angles. If the angles at the top and bottom of Z10 were ever smaller than 90°, would this then have been seen as a *rotation* by the Ancient Egyptians, rather than as just another angle in a continuum of possible angles? This is dubious, and it appears far more likely that an encoder in the past misused a rotated Z10 to represent an occurrence of Z9 as in the first example in Figure 17, where the angles at the top and bottom are smaller than 90°, as a misguided attempt at achieving palaeographic accuracy. The burden of proof lies with those who claim this rotation is meaningful and should be kept.

Proposal: Remove this rotation.

```
133F6 FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH Z011
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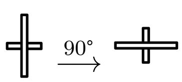
(a) (b) (c) (d)

(e)

Figure 16: Examples of texture of (Q3): (a) Hearst 6-19825 (Photograph by Bruce White), (b) Louvre E15591 (© Musée du Louvre / Christian Décamps). Examples where Q3 is wider than high: (c)-(d) BM EA567 (© The Trustees of the British Museum), (e) Metropolitan Museum of Art 545393 (© The Metropolitan Museum of Art).



The relative lengths of the horizontal segment and the vertical segment may vary, and if the horizontal segment happens to be slightly longer, should this then suddenly be seen as rotation? Another question is whether this is about relative lengths, or about whether one segment is drawn on top of, or below, the other. Much as in the case of Z9/Z10 above, it is hard to imagine a legitimate use case, and it is more likely that this rotation appeared in existing corpora as a misguided attempt at achieving palaeographic accuracy. The burden of proof lies with those who claim this rotation is meaningful and should be kept.

Proposal: Remove this rotation.

5 Further unresolved issues

For the proposed changes in this section, there is currently no unanimous support.

Many signs in the sign list are horizontally symmetric. Examples are and . For such signs, rotation by 90° looks identical to the mirror image of rotation by 270°. Because of the mirroring control, one or the other is therefore superfluous. If both rotations have been attested, or could plausibly be expected

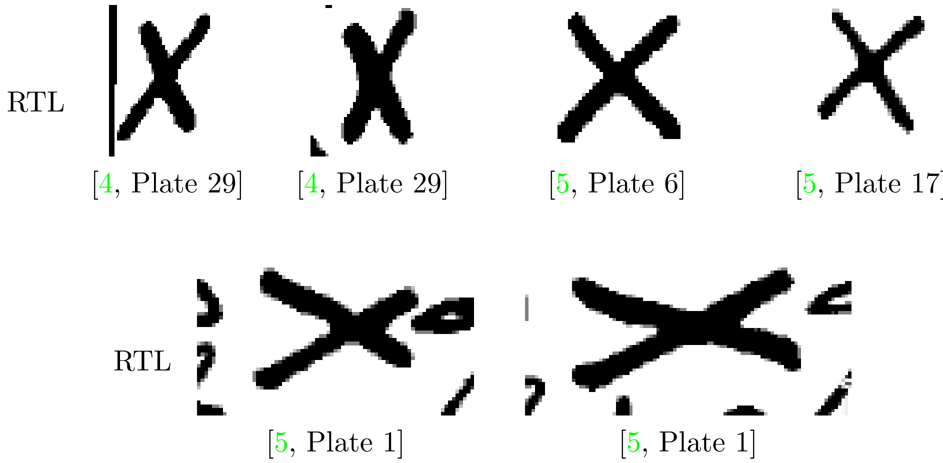


Figure 17: Occurrences of (Z9) in the top row and (Z10) in the bottom row.

to be found after more inscriptions have been studied, then one could opt to register either the 90° rotation or the 270° rotation, and the other could then be obtained in combination with the mirroring control. The choice could seem arbitrary, but consistency between signs helps font designers and simplifies user input.

For about a dozen signs, the choice that was made in StandardizedVariants.txt was to opt for the most common and natural rotation. For example, for and , the quarter-turn rotation in StandardizedVariants.txt is counterclockwise, which is by far the most plausible rotation. A rule of thumb is that for signs with an iconographic 'above', that 'above' can alternate between being at the top or being at the left. For and , a clockwise quarter-turn rotation can still be achieved, but this is then achieved in combination with horizontal mirroring.

However, this principle is not adhered to in the case of the bows (T9), (T009A), (T10):

```
13312 FE02; rotated 270 degrees; # EGYPTIAN HIEROGLYPH T009
13313 FE02; rotated 270 degrees; # EGYPTIAN HIEROGLYPH T009A
13314 FE02; rotated 270 degrees; # EGYPTIAN HIEROGLYPH T010
```

$\xrightarrow{270^\circ}$, $\xrightarrow{270^\circ}$, $\xrightarrow{270^\circ}$

Although quarter-turn rotations of down-pointing bows have been attested both in clockwise and counterclockwise direction (next to half-turn rotations), the clockwise direction is the most common and expected one, while StandardizedVariants.txt has the counterclockwise direction.[1] This is confirmed by the existence of the 'archaic bow' (Aa32) pointing to the left (with the imaginary bow string at the right). After a cursory search, I was able to find 4 vertical bows in 3 distinct texts [14, pp. 5, 9, 55, 83], all of which are left-pointing. In [8, bd. I, p. 55], there are three left-pointing bows against one right-pointing bow.

[1] Jorke Grotenhuis (p.c.) has given the following explanation for the two most common orientations of bows: when a left-facing archer has the bow at rest, it points down, and when he is about to shoot, the bow points left, with the bow string at the right.

(The reason why L2/22-012R lists 0 occurrences of left-pointing bows seems to be that the orientation was normalized, to count all vertical bows as right-pointing.)

Proposal: Change to:

```
13312 FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH T009
13313 FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH T009A
13314 FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH T010
```

One more issue concerns a recent suggestion that existing signs that are rotations of other existing signs are to be made 'non-core', while registering rotations to obtain the same shapes. For example, (Z002D) would be made non-core, while at the same time registering a 180° rotation of (Z002C).

At first sight this seems similar to making for example (G043A) non-core, with the argument that the shape can alternatively be obtained by combining (G43) and (X1) with the help of a joining control character. However, there is an important distinction. Unavoidable encoding ambiguity resulted from introducing the control characters, allowing the shape , among others, to be encoded in more than one way. Making G043A 'non-core' is a way of mitigating this encoding ambiguity by indicating to users that representation using control characters is preferred over atomic representation.

However, in the case of and , there is currently no encoding ambiguity: each shape can only be encoded in one way. The encoding ambiguity is introduced once a 180° rotation of Z002C is registered, whether or not Z002D is made 'non-core' (and whatever 'non-core' means in practice).

One may therefore well consider keeping the status quo, which has no significant downsides, other than causing minor inconveniences for design of search functionality and editors. For example, one could conceive of a user interface of a graphical hieroglyphic editor that allows to be rotated by 180° without revealing to the user whether this is internally represented as an atomic character Z002D or rather as Z002C VS2.

6 Resolved issues

There appears to be broad support for the changes below to StandardizedVariants.txt. The implementation of these changes may be taken up elsewhere. The purpose of this section is to put the motivations for the changes on record.

```
130A9 FE01; rotated 180 degrees; # EGYPTIAN HIEROGLYPH D047
```

It seems this rotation, in combination with horizontal mirroring, was intended to achieve (D064), which looks like the *vertical* mirroring of D47; note that there is no single control character for vertical mirroring. D064 however has a range of meanings independent from D47; see for example under *kp* [8, bd. V, p. 118]. Therefore D064 will remain a core sign in the Unicode sign list, making this rotation of D47 redundant.

Action item: Remove this rotation.

```
13403 FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH Z015I
```

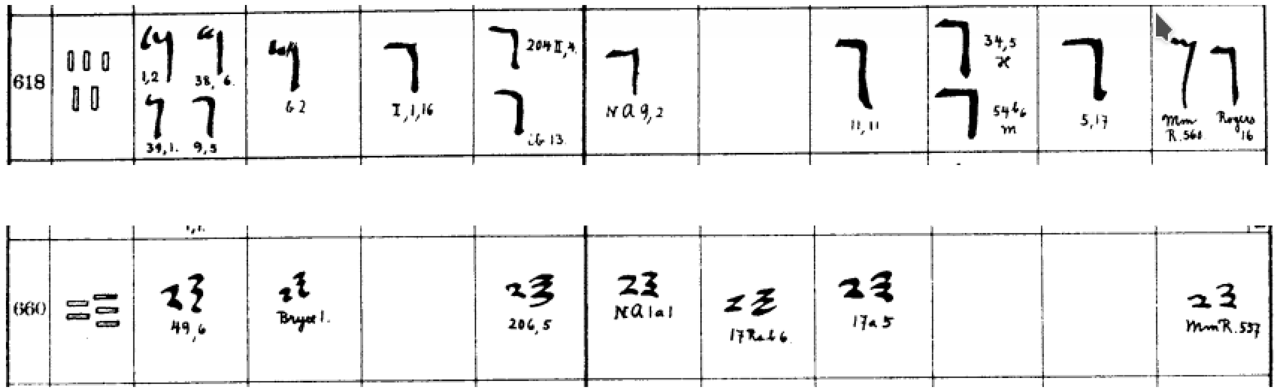
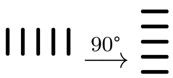


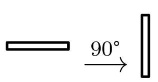
Figure 18: The numeral 5 in hieratic for general use [12, p. 55] and for day of the month [12, p. 60].



Unicode 5.2 introduced (Z015B), (Z015C), (Z015D), ... next to (Z016B), (Z016C), (Z016D), ... The rationale is that the second series has a form in hieratic that is not straightforwardly compositional and that is distinct from rotation of the hieratic form of the first series (cf. Figure 18). The second series is specifically used for numerals that denote days of the month, as opposed to counting any other kind of object. In other words, these two series of numerals are functionally distinct. This precludes simply treating Z016B, ... as rotated variants of Z015B, ... Against this background, it is preferable to also introduce an atomic code point for the above, rather than treat it as rotation.

Action item: Remove this rotation, and add the shape as code point to the sign list.

```
1341A FE00; rotated 90 degrees; # EGYPTIAN HIEROGLYPH AA012
```



Since (Aa11) is rotated far more often counterclockwise than clockwise, it seems more appropriate to rotate Aa12 counterclockwise as well. We can apply a rule of thumb that signs with an iconographic 'above' at the top are normally rotated counterclockwise. Both Aa11 and Aa12 are 'platforms', and so have a clear 'above'.

Action item: Change to:

```
1341A FE02; rotated 270 degrees; # EGYPTIAN HIEROGLYPH AA012
```

7 Conclusions

The use of rotations in Unicode deserves reconsideration. Some of the rotations that have already been added to StandardizedVariants.txt undermine common assumptions about Unicode and Unicode fonts, one of which is that the validity of an encoding does not depend on the choice of font. New rotations that have recently been proposed also have the potential to misrepresent what may be mere inaccuracies in modern handwritten transcriptions, and suggest a level of palaeographic detail that Unicode cannot deliver.

This said, the use of four variation selectors VS4 – VS7, for the purposes indicated in Figure 4, seems justifiable in individual cases where such rotations can be confirmed by investigating good photographs of original artefacts, rather than through data mining of existing corpora of hieroglyphic encodings created for very different purposes.

Acknowledgements

On a selection of issues in this document, the author acknowledges helpful comments from Peter Dils, Andrew Glass, Jorke Grotenhuis, Stéphane Polis, Bob Richmond, and Daniel Werning. No claim is made however that all viewpoints represented here have unanimous support.

References

[1] M.L. Bierbrier. *Hieroglyphic texts from Egyptian stelae, etc., Part 10.* British Museum, 1982.

[2] E.A. Wallis Budge. *Hieroglyphic texts from Egyptian stelae, etc., Part II.* British Museum, 1912.

[3] E.A. Wallis Budge. *Hieroglyphic texts from Egyptian stelae, etc., Part III.* British Museum, 1912.

[4] E.A. Wallis Budge. *Hieroglyphic texts from Egyptian stelae, etc., Part IV.* British Museum, 1913.

[5] E.A. Wallis Budge. *Hieroglyphic texts from Egyptian stelae, etc., Part V.* British Museum, 1914.

[6] E.A. Wallis Budge. *Hieroglyphic texts from Egyptian stelae, etc., Part VI.* British Museum, 1922.

[7] J. Buurman, N. Grimal, M. Hainsworth, J. Hallof, and D. van der Plas. *Inventaire des signes hiéroglyphiques en vue de leur saisie informatique – Informatique et Égyptologie 2.* Institut de France, Paris, 3rd edition, 1988.

[8] A. Erman and H. Grapow. *Wörterbuch der Ägyptischen Sprache.* Akademie-Verlag, Berlin, 1926–1961.

[9] H.R. Hall. *Hieroglyphic texts from Egyptian stelae, etc., Part VII.* British Museum, 1925.

[10] T.G.H. James. *Hieroglyphic texts from Egyptian stelae, etc., Part I.* British Museum, 2nd edition, 1961.

[11] T.G.H. James. *Hieroglyphic texts from Egyptian stelae, etc., Part 9.* British Museum, 1970.

[12] G. Möller. *Hieratische Paläographie — zweier Band: von der Zeit Thutmosis' III bis zum Ende der einundzwanzigsten Dynastie.* Otto Zeller, Osnabrück, 1927.

[13] S. Rosmorduc. JSesh. `http://jseshdoc.qenherkhopeshef.org`, 2020.

[14] K. Sethe. *Urkunden der 18. Dynastie, Fascicle 1.* Hinrichs, Leipzig, 1927.

[15] N. Stief. Hieroglyphen, Koptisch, Umschrift, u.a. – ein Textausgabesystem. *Göttinger Miszellen*, 86:37–44, 1985.

[16] N. Stief. PLOTTEXT – ein Programmsystem zur Ausgabe von Texten. Version 4.09, Regionales Hochschulrechenzentrum (RHRZ) der Universität Bonn, 2001.