

Design Principles of Kashida Justification: A Unique Technique in Arabic and Persian Mapping

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1. INTRODUCTION

CALLIGRAPHY IN THE ARABIC SCRIPT IS RENOWNED for its artistic elegance and functional adaptability, serving as a vital cultural and aesthetic element across groups that use this writing system, including Arabic- and Persian-speaking societies. Beyond its role in manuscripts and architecture, Arabic calligraphy has historically influenced cartography, where its fluidity and flexibility have contributed to both the artistic and practical aspects of map design. Certain letters in the Arabic script are usually joined to the following letter through horizontal lines. *Kashidas* are an elongation of those connecting strokes, and are used to increase the space between letters for text justification purposes, resembling a type of text ligature (Benatia et al. 2006). Kashida justification has played a significant role in Arabic and Persian mapmaking traditions (Berry 1999) and has been used to elongate map labels in order to more clearly connect them to the features they refer to, akin to how labels in the Latin script are often tracked to fill a space.

With the rise of digital cartography, mapping practices have undergone a fundamental transformation. The development of geographic information systems (GIS) and web-based mapping platforms has expanded cartographic applications globally, including in regions where the Arabic script is often used, such as West Asia and North Africa (Sun and Liu 2021). However, while digital mapping tools offer increased accessibility and efficiency, their design has primarily been shaped by Western cartographic conventions, particularly those based on the Latin script (Bittner and Glasze 2021). Subsequently, key typographic traditions, such as kashida justification, have been largely overlooked in contemporary digital mapping environments.

Despite the dominance of digital platforms, printed map production remains relevant in several regions, including the United Arab Emirates and Iran, where local publishing houses continue to produce highly detailed and widely used maps (e.g., Explorer Publishing House and Gitashenasi-Novin Publishing House). A significant contrast emerges when comparing these locally produced maps with Western-introduced counterparts: whereas many Western-made maps that use the Arabic script rely on standardized label placement without typographic elongation, locally made Arabic and Persian maps frequently employ kashida justification to integrate text more seamlessly into geographic features. The absence of robust support for kashida justification in mainstream GIS software underscores broader limitations in the internationalization of cartographic typography.

This article starts with a brief historical overview of kashida justification in Arabic and Persian mapmaking, while also assessing the current technological challenges in implementing this practice within digital cartographic platforms. We argue that existing typography customization options in widely used mapping tools fail to fully accommodate Arabic calligraphic principles (Benatia et al. 2006). In response, we present some practical solutions for cartographers seeking to incorporate kashida justification in contemporary mapping workflows. These include a step-by-step technical approach to applying kashida in Persian map labels, using the Caspian Sea as a case study.

Throughout this article, the term “Arabic” refers to the shared script rather than the Arabic language itself, acknowledging its use in Persian, Dari, Kurdish, Pashto, Urdu, and other languages across various regions (Doctor et al. 2022).



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2. KASHIDAS ON THE MAP

KASHIDA JUSTIFICATION HAS BEEN WIDELY USED IN cartography both in the past and in the present. The history of kashida justification is just as long as the history of Arabic calligraphy, and is intertwined with the Islamic faith, along with Arabic and Persian mapmaking (Shafir 2016). For example, on the Ibn Hawqal map (Figure 1) made by Abu al-Qasim, an important tenth-century cartographer in the famous Balkhi School of Geographers, kashida justification was practiced in multiple places across the river Nile. In two places on the lower Nile, pairs of labels were placed in intersection, with extended strokes spanning across the river. A similar design can be found in the upper Nile, where the label that translates as “Country of Nubia, Dongola, and Alwa” was placed with a kashida extension in the middle, crossing the river. In this example, using kashida extension provides an aesthetically pleasing option to make the labels span across the river line and emphasize the label equally on both banks of the river, while maintaining the readability and continuity of words written in Arabic.

The kashida traditions were also practiced by Ottoman cartographers during the nineteenth and early twentieth century, blending with newly introduced European cartographic techniques (Karamustafa 1992; Figures 2–3). On these maps, historical traditions were preserved, using kashidas to span large geographic features, such as oceans, deserts, and large regions. Although the Arabic script for Ottoman Turkish was replaced with a Latinized Turkish alphabet after the republic was established in 1923, kashidas are still practiced in the Arabic and Persian world, passing down this tradition into modern times. The following section of this article discusses the current state of kashida justification and how we can replicate this tradition on mapping platforms and software.

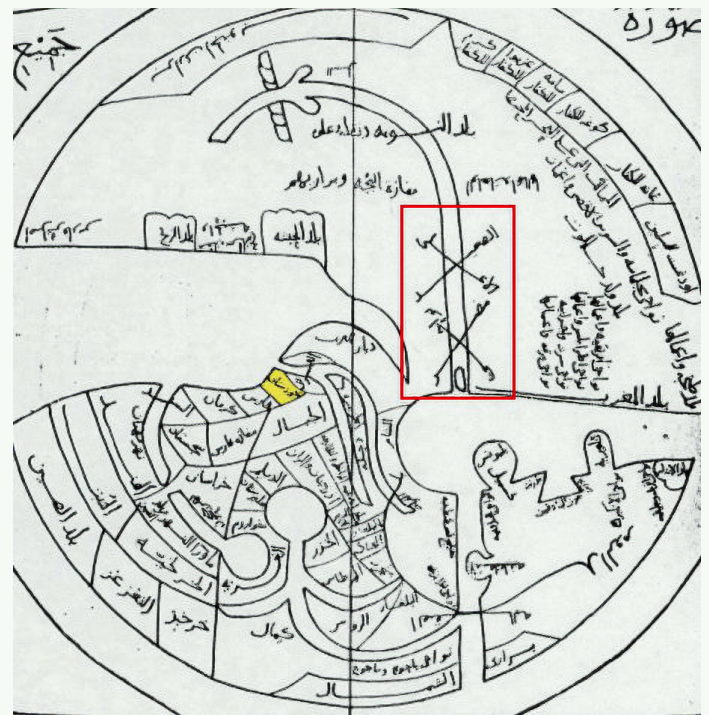


Figure 1. Ibn Hawqal Map, tenth century. Some of the kashida-justified labels are shown across the River Nile in the red box of the figure. From the National Museum of Iran Library, via [Wikimedia Commons](#).

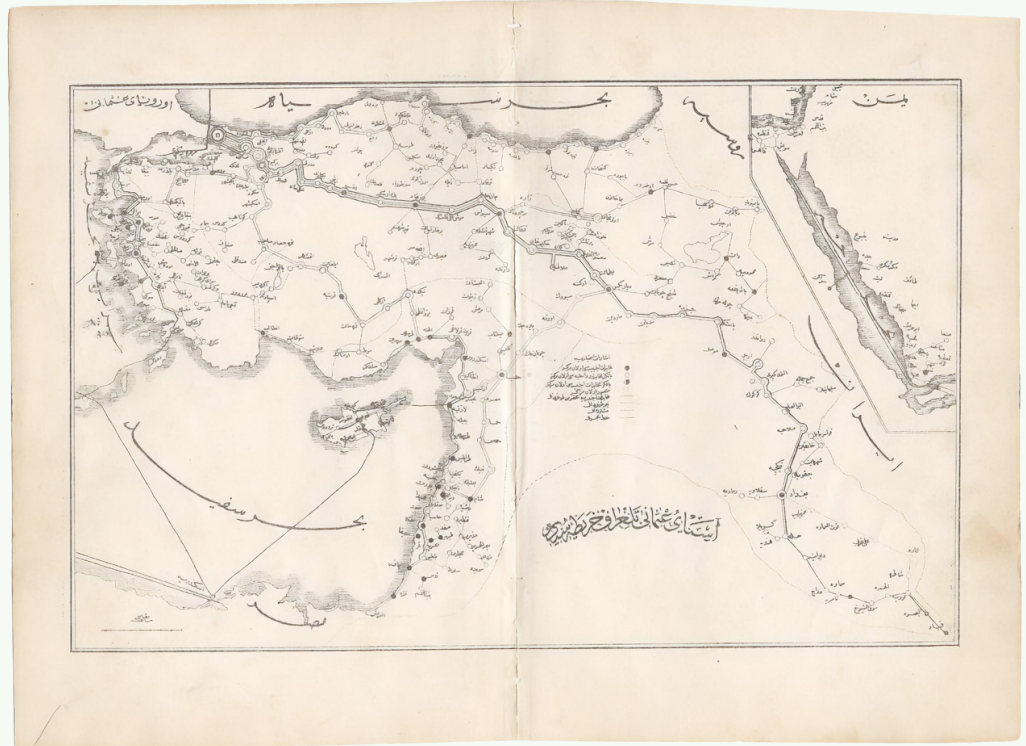


Figure 2. Ottoman Empire telegraph map, nineteenth century. Kashida-justified labels are placed on several physical features and countries.



Figure 3. Arabic labeling with kashida justification on an 1890 Ottoman map of the Middle East.

3. NON-LATIN LABELS IN GIS

THERE ARE SEVERAL FUNDAMENTAL CHARACTERISTICS of Arabic script that differ from the Latin script, including: (1) the right-to-left orientation of text, (2) the ability of individual characters to change their form based on their position within a word, and (3) the use of optional diacritical marks to indicate pronunciation (Kokoschka 2020). While these features were initially viewed as challenging to implement digitally, modern Unicode systems have successfully automated them with minimal errors.

However, despite advances in handling basic functionalities, issues with kashida insertion persist. Kashidas, which are used for text justification, often require manual adjustments due to incomplete support in software like Adobe InDesign and Microsoft Word. Furthermore, not all software applications are fully compatible with the Arabic script display, presenting additional challenges for users.

Since the very early stages of GIS development, questions about label placements and hand-lettering have been important topics of discussion among Western cartographers regarding Latin scripts (Wesson 2017; Gammelin 2022). However, unlike Latin typography, Arabic receives much less attention, and mapmakers have faced continued technical limitations—especially regarding kashidas—when customizing map labels (Benatia et al. 2006). Consequently, while many GIS platforms have historically supported a wide range of common typographic features from the Latin script, they generally disregarded the Arabic script.

However, that has recently begun to change, and we have seen a rise in internationalization within GIS software. For example, in QGIS, certain script-specific design decisions can be made by using Python libraries, which also provides support for building plugins to implement these decisions. Simple commands such as adjusting text orientation are available within the *Labels* panel under the *Properties* pop-up window. Additionally, in recent products such as ArcGIS Pro, Esri now includes an “Internationalization” section in the label properties panel (Figure 4), in addition to Arcade and Python expressions. The “Internationalization” section satisfies the basic requirements to have non-Latin scripts displayed in ArcGIS Pro, offering five options for users to customize text and glyph orientations. However, it can be unclear how to use these options to properly manage labels in different languages, and unfortunately, as of the time of writing, none of these instructions are clearly documented on the ArcGIS Pro [documentation website](#).

Given these internationalization options and their shortcomings, is it possible to use kashidas within ArcGIS Pro? The answer is partially yes. If the label is positioned in a straight line by adjusting the settings in the *Position* section of the *Label Properties* panel, the user can use the option “Spread labels,” (a term that does not correctly describe kashida justification), to automatically generate kashidas (Figures 4–5). Of course, the user has no

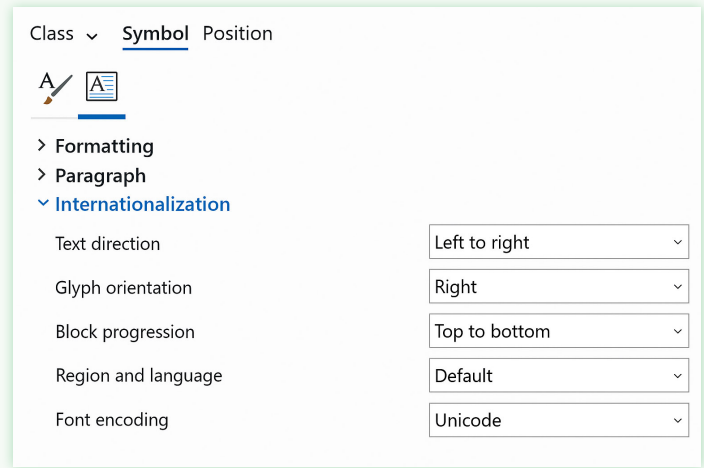


Figure 4. Internationalization options with ArcGIS Pro.



Figure 5. A screenshot of kashida justification enabled by using ArcGIS Pro’s “Spread labels” option in the *Label Properties* panel.

freedom to adjust the location and length of the kashida on the labels. Additionally, the label engine cannot generate kashida on a curved label, even if the user enables letter spreading.

Another approach is to build and improve typographic models based on contextual linguistic structures. Chinese labels are typically composed of a few characters arranged in a vertical position, with ample space separating characters. Based on that characteristic, new methods have been designed to place Chinese labels specifically for line features and polygon features to ensure that a label can be spaced over a feature, while another label can cross the space between characters (Cheng et al. 2013). A similar principle can be adapted to Arabic typography using

kashidas—elongation strokes used to justify or stretch Arabic script without altering meaning. Like the spaces between Chinese characters, kashidas offer flexible space within words that can be adjusted to optimize label placement. By calculating and dynamically adjusting kashida lengths, we can create typographic models that not only enhance the aesthetic alignment of Arabic labels along

linear features, but also make room for adjacent labels. Lastly, emerging plugin development, as demonstrated in QGIS’s handling of non-Latin text, can provide tools for Arabic-specific text customization. Libraries like *kashida* or *HarfBuzz* can further improve font rendering and compatibility (Bhonsle 2022).

4. A NON-GIS WAY TO HANDLE KASHIDAS?

SINCE IT REMAINS CHALLENGING, AND OFTEN IMPOSSIBLE, to perfectly replicate kashida justification within GIS platforms, perhaps the most straightforward solution is to approach this as a graphic design problem. Below, we outline practical methods for handling kashidas through font styling. First, though, we provide some general recommendations for using kashidas.

Stretchable (kashida)	Non-Stretchable
ض ص ش س خ ح ج ث ت پ ب غ ع ی ن م ل گ ک ق ف ظ ط	ا ژ ز ر ذ د

Table 1. This table presents Arabic and Farsi/Dari letters.

RECOMMENDATIONS AND PRECAUTIONS

In Table 1, we present the letters that can be written with kashidas and the letters that can’t. For those unfamiliar with the Arabic script, subtle variations can be difficult to spot, so we recommend the following validation methods:

- Consult a native speaker of a language that uses the Arabic script (Persian, Arabic, Urdu, etc.) to review the work.
- Generative AI language models and web-based Arabic calligraphy generators can also assist in replicating the flexibility of this elegant writing system.

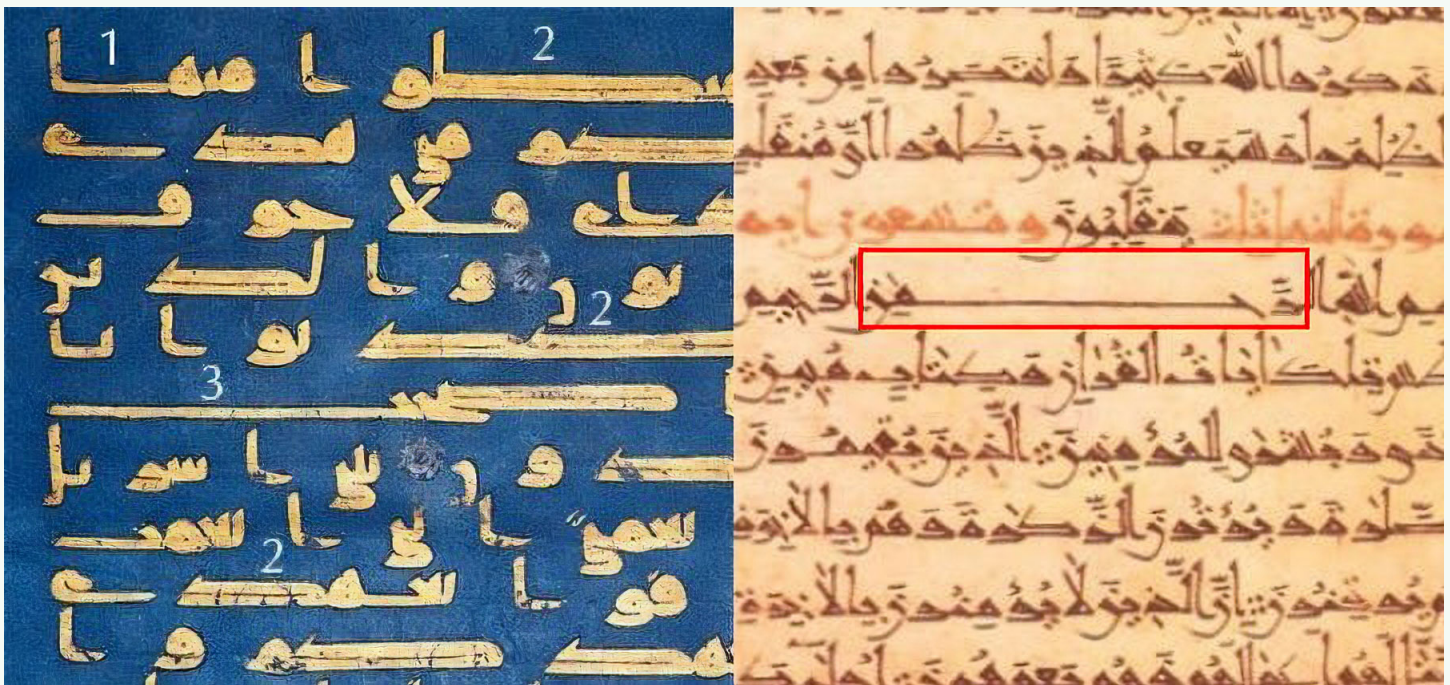


Figure 6. Kashida justification is more commonly found in the Kufic script (left, *Blue Qur’ân*), but it can also appear in other scripts. On the right, in the Naskh script, a kashida is inserted into the word *Rahmân* (red box), a sacred title of Allah, to indicate the beginning of a new chapter (*sura*) in the *Qur’ân* (Medlej 2021).

- Check similar maps with the same keywords in Arabic styles and carefully examine their kashida placements.

As we previously discussed, automatically placing kashidas can be challenging due to several characteristics. First, certain letters, such as **ب**, **و**, and **ر**, cannot be elongated with kashidas. Second, kashida placement should not be over-used: it is important not to use kashidas in every potential place that it can be added. Adding kashidas to very short words or in positions that do not represent a natural break is not recommended, as this can reduce readability. Third, the use of kashidas is heavily dependent on calligraphic styles. They are more commonly found in texts written in the Thuluth and Kufic styles, both of which are often used

in ornamental religious contexts. However, kashidas are rather uncommon in Nastaliq, Diwani, and Naskh styles (Figure 6), as these scripts rely on smooth and flowing strokes (Naeem et al. 2021). Fourth, it is also important to remember that kashidas must be placed within words, not between words, and they should not be used on isolated letters.

MANUAL PRACTICES

Technically, there are ways to manually overcome the limitations of ArcGIS, which does not automatically include kashidas on curved labels. One approach is to use Adobe Illustrator. By using the pen tool to draw a curve, cartographers can easily apply Arabic text along curved

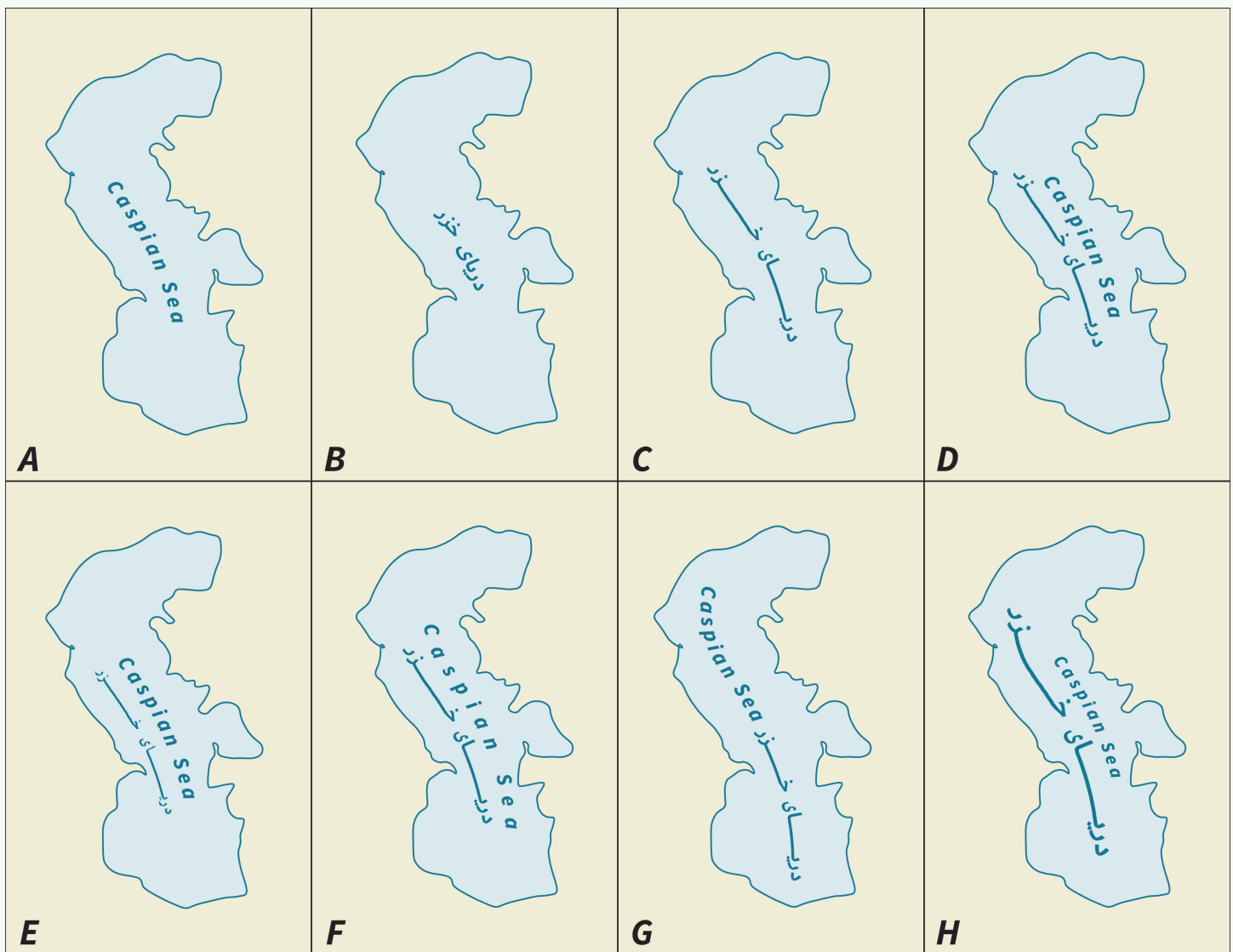


Figure 7. Variations on labeling the Caspian Sea. (A) Label in English with tracking applied, (B) label in Persian, (C) label in Persian with two kashidas, (D) label in Persian with kashidas and in English. The bottom row shows map label placement in both scripts but with a different label placement strategy in each example.

lines. They can then manually insert kashidas between letters by typing the kashida character (Shortcut: Shift + J) using an Arabic keyboard. Alternatively, the *Glyphs* panel in Illustrator may be used to locate and insert a manual kashida character from the font being used. However, the cartographer should remember to observe the precautions and recommendations mentioned earlier regarding proper kashida placement.

In Figure 7, we offer an example of labeling the Caspian Sea in Persian. In Persian, this feature is written as دریای خزر (Daryâ-ye Khazar, Khazar Sea). Thus, if we compare how the label is placed in English (Figure 7A) and in Persian (Figure 7B), we notice that it is harder to fill the vast polygon area of the Caspian Sea using the Arabic script than it is using Latin characters to which some tracking has been applied.

In this scenario, we can include kashidas to make the map more visually pleasing. Then, the question is where to place them? In the word دریای (Daryâ-ye), the characters د and ر cannot be given kashidas (Table 1). But notice the middle portion یا, composed of the interconnected letters ی (yâ) and ا (alif). While ا cannot be given a kashida, ی is a letter that normally extends to the next letter on its left (the ا in this case), and it can be given a kashida.¹ So, the best, and only, location to place a kashida within دریای (Daryâ-ye) is within the portion یا. Similarly, in the next word خزر (Khazar), we can extend the line connecting the first letter خ to the left, creating a kashida. From these examples, you can observe that the essence of the kashida is to simply extend lines that already exist in the script. With this approach, we add two kashidas to elongate دریای خزر (Figure 7C).

If the map requires labels in multiple scripts, ensure consistency in character and paragraph styling across all scripts, with similar weight and placement (Figure 7D). Even when using a typeface that supports multiple scripts, visual inconsistencies can arise due to differences in text orientation, thickness, height, letter spacing, justification, serifs, and more. This is a common issue that occurs when placing English text alongside other scripts. When pairing it with Arabic script, it is important to appropriately adjust the tracking of the English text and the kashidas of

the Arabic text, to maintain visual harmony. Figure 7 also provides several additional examples:

- **7E:** When comparing English and Persian labels, it is evident that the Persian label is significantly smaller than the English label and is less legible. However, this is not necessarily a problem if the map primarily targets English speakers—just as 7H offers an example of showing the Persian label larger and English label smaller, a reasonable choice for a map for Persian speakers. Additionally, the Persian label uses a cursive pen style in stroke endings that doesn't pair as well with the sans-serif style of the Latin characters used in the English label.
- **7F:** Compared to the Persian label, there is excessive tracking in the English label, making it less aesthetically pleasing. However, unlike the previous example on legibility, letter spread is subjective and does not follow a universally recognized design principle.
- **7G:** Both scripts are placed on the same label line. This practice has been commonly used in published maps in the Arabic and Persian-speaking regions. It is also a valid label placement design.
- **7H:** Compared to the English label, the Persian label is larger and more spread out. This practice can be applied when the primary audience of this map is in Persian-speaking places, ensuring the Persian label is recognized more quickly than the English label in this context.

OTHER SCRIPTS?

The visual harmony created by kashidas between letters effectively fills empty spaces on maps and suggests opportunities to apply this technique in labeling other scripts, extending horizontal strokes between letters. Other forms of similar justification exist in Devanagari, Thai, Tibetan, and Syriac scripts. Similarly, Abi Aad (2013) examined stroke-connecting practices in East Asian calligraphy, such as in traditional Chinese and Japanese works, and envisioned ways to incorporate kashidas into Latin scripts.

1. The letter 'ی' at the end of 'دریای' is in its isolated form, following the 'ا' in 'یا'. The letter ی takes on different shapes depending on its position within a word. For instance, it appears as ی in isolated form, ی in initial position, ی in medial position, and ی in final position, illustrating its position-dependent contextual forms.

5. CONCLUSION

BEFORE THE SPREAD OF DIGITAL MAPPING, THE PRIMARY tools for traditional cartography across Eurasia were paper, rulers, and pens. These instruments allowed for customizable configurations of map labels. However, the digital mapping and publishing technologies which replaced them were invented in the West and still reflect Western epistemologies. Western-led GIS software and platform development tends to prioritize typographic practices dominated by Latin scripts (Kokoschka 2020).

While technical challenges currently limit the replication of kashidas, the practice of kashida justification remains prevalent in modern Arabic and Persian mapmaking.

For instance, Iranian maps continue to extensively utilize kashida justification, driven by state-led cartographic production, institutions, and printing efforts (Figures 8–9). Various studies have also explored possibilities for implementing more dynamic justifications in Arabic typography (Bayar and Sami 2011; Azmi and Alsaiani 2014).

Kashida justification is renowned for its elegance and beauty. We hope that the methods proposed here serve as temporary solutions and that, eventually, kashidas can be automatically applied across various label placements within GIS software and platforms.



Figure 8. Kashida justification used in a map of Iran under the Safavi Dynasty. This map was published in 1970 by Sahab Geographic and Drafting Institute.



دارای قابلیت وایت بردی

Figure 9. Kashida justification used on the labels of Persian Gulf, Arabian Sea, Caspian Sea, etc. in a printed map of Iran for sale. This is a recent map published by Andishe-Kohen Publications, located in Tehran.

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