

# Neon2: A Verovio-based square-notation editor

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## 1 Introduction

Neon2<sup>1</sup> is a web-based square-notation music editor designed for human verification and correction of the output of optical music recognition (OMR) systems. It is one of the few editors dedicated to neume notation. It is entirely web based and uses Verovio<sup>2</sup> to render and edit MEI files that follow the MEI 4.0 neume standard. In this paper we will provide a brief overview of the editing features of Neon2 and explain how Verovio was used to create a fast and responsive application.

## 2 Background

Neon2 is a successor to Neon.js.<sup>3</sup> Both focus on correcting MEI documents that encode square-notation music by rendering musical symbols as vector graphics layered over the original image. This layering provides easy visual comparison between the image and encoded version to aid in OMR error correction (Burlet et al. 2012).

The original Neon.js relied heavily on server-side functions, particularly in editing, introducing undesirable latencies over slow connections. Neon2 addresses this problem by using Verovio as a Javascript toolkit local to the client that processes MEI documents and renders vector graphics.

By enabling local editing, the server exists to provide content and update documents, greatly reducing latency and improving user experience. The simplified server allows Neon2 to be distributed as a self-contained bundle that is only directed to resources.

## 3 Supported Elements

Neon2 supports the essential elements of square-notation music. Supported neumes are punctums, virgas, and inclinatum. There is also support for C and F clefs and custos. Basic neume groupings (e.g., pes, clivis, torculus, and others) are rendered based on their contours. The spacing between glyphs is not fixed so users can modify their position within the grouping. More complex neume groupings are labeled as compound neumes. Labelling of neume groupings is based solely on the contour of neume components and is handled entirely by Neon2; it is not present in MEI 4.0 or Verovio.

## 4 Editing Features

Neon2 is equipped with the basic editing tools of music editing software. These are conveniently organized in the Neon2 editing panel and include: zooming; opacity of glyphs and image; inserting, selecting, dragging, and deleting musical elements; undoing/redoing; and saving. Many of these functions are visible in Figure 1.

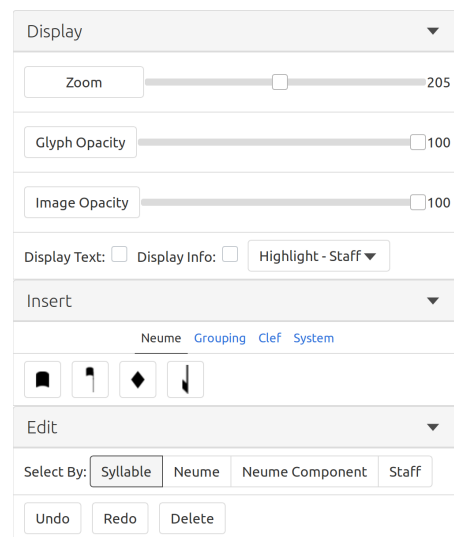


Figure 1: Neon2 editing panel. A number of features for easy visualization, insertion, or editing of neumes and other musical elements is conveniently organized in each of the submenus: “Display”, “Insert”, and “Edit”.

Neon2 also offers features specific to the MEI file structure in order to facilitate the correction process. For example, users can select or highlight musical symbols based on specific XML tags, such as `<staff>`, `<syllable>`, `<neume>`, and `<nc>`. Each successive tag is a child of the former, providing selection and highlighting by logical layer. Coloured highlighting, as seen in Figure 2, helps to quickly identify errors such as elements being on the wrong staff or the misclassification of complex neume groupings. Selection by tag is particularly useful with regards to the correction of the latter, as it allows users to group or ungroup a selection of elements. For example, since MEI 4.0 specification establishes that the `<neume>` element is a child of `<syllable>`, a user can select several neumes and group them into the same syllable.

Neon2 also offers a tool for merging staves. Users can highlight two portions of a split staff and merge them together, internally moving all elements into a single `<staff>` tag.

<sup>1</sup><https://ddmal.github.io/Neon2/>

<sup>2</sup><http://www.verovio.org/>

<sup>3</sup><https://github.com/DDMAL/Neon.js/>



Figure 2: Neon2 rendering an MEI file over the source image with each `<staff>` element's contents highlighted in different colours. Image taken from the Salzinnes Antiphonal (CDM-Hsmu 2149.14) manuscript.<sup>5</sup>

## 5 Verovio-based editing

Neon2 uses the functionality of Verovio (Pugin, Zitellini, and Roland 2014) for manipulating, validating, and rendering MEI documents in the browser. Since the software architecture of Verovio closely follows the MEI format—and since Verovio already comes with an experimental editor toolkit—developing editing features for Neon2 was a straightforward process.

We made use of the currently available interface of Verovio for calling and adding actions to extend the editing functionalities with a number of convenient actions. Such actions are `drag` and `insert`, which shift the position of and insert musical elements, respectively, upon user interaction in the browser. These actions are available when compiling Verovio into a Javascript toolkit with Emscripten, which conveniently achieves a performance near that of a native application (Zakai 2011). The extended editing functionality is available in a custom version of Verovio.<sup>6</sup>

As a result of the additions, we can use Verovio not only as the Neon2 engraver, but also as its editing backend. All in all, the size of the Verovio toolkit, which comes with Neon2, is less than 4 MB. This very compact size is one order of magnitude smaller than most high-resolution digitized images of music score documents, and so it has little impact in bandwidth in comparison to the images.

## 6 Moving Forward

In the future, the Neon2 project has goals to improve usability and flexibility. Currently, downloading the images occurs

before any editing and is the main source of delay. To rectify this, `Diva.js`, a viewer for high resolution images (Hankinson et al. 2011), will be used to display the manuscript pages used in the OMR process. This will also allow Neon2 to support editing multiple pages of a manuscript at once, instead of editing one page at a time. Page images could also come from a IIIF<sup>7</sup> server instead of being stored on the Neon2 server.

Another challenge is the presence of curved or inconsistent staff lines on a page. Currently Neon2 only renders staff lines that are straight and parallel to the top and bottom of the page; this is often not the case of staff lines in handwritten manuscripts, and Neon2 should be able to support this.

Furthermore, Neon2 lacks complete support for certain elements. It allows viewing of lyrics present in `<syll>` tags, but does not provide a robust mechanism for editing them or adding them to a file that did not initially include them. It also does not support liquescent neumes, ornaments, and divisions. However—as Verovio uses the Standard Music Font Layout<sup>8</sup>—their inclusion should be straightforward.

## 7 Conclusion

The use of Verovio and the inclusion of other modern tools, such as `Node.js`<sup>9</sup> and the `Pug`<sup>10</sup> templating tool, have made Neon2 into a useful tool to correct MEI 4.0 Neume files directly in the web browser, according to user testing throughout development. Neon2 itself serves to correct OMR-generated documents, but also demonstrates potential non-engraving applications of Verovio.

## References

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<sup>7</sup><https://iiif.io/>

<sup>8</sup><https://www.smuffl.org/>

<sup>9</sup><https://nodejs.org/>

<sup>10</sup><https://pugjs.org/>

<sup>5</sup><https://cantus.simssa.ca/manuscript/133/>

<sup>6</sup><https://github.com/DDMAL/Verovio/>