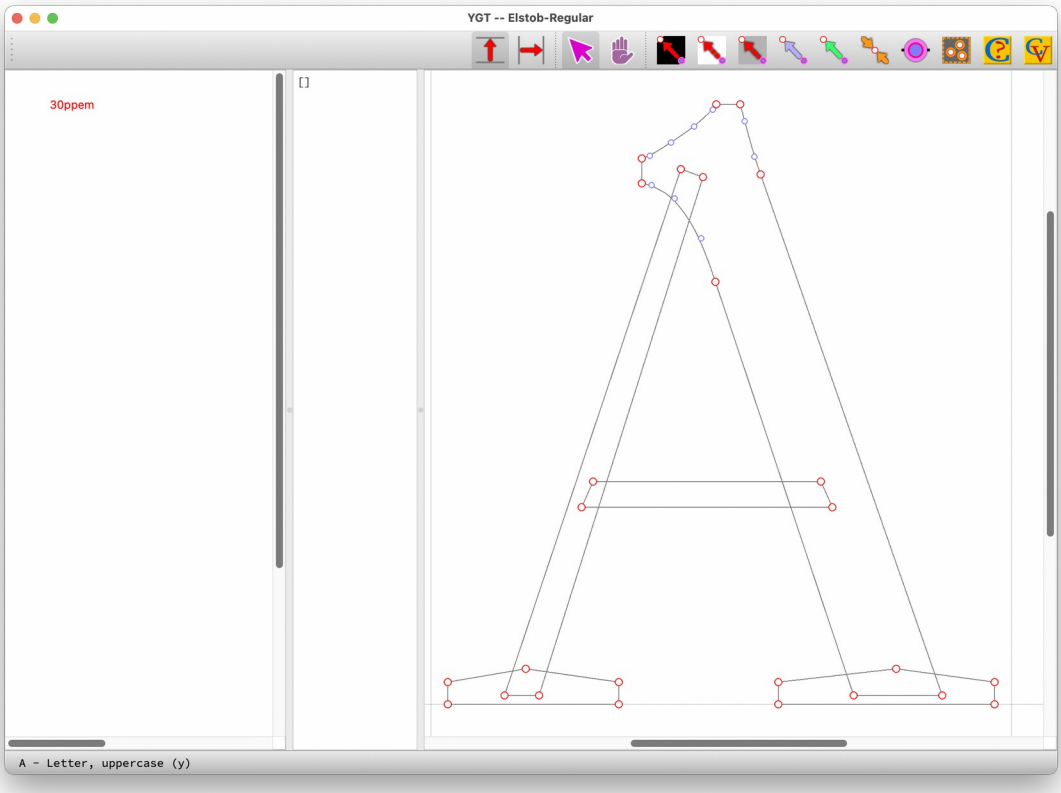
Ygt: A graphical hinting program (a quick-and-dirty guide)

Ygt is a program for hinting TrueType fonts. Its interface is similar to those of VTT and Glyphs, but it has somewhat different aims:

- Being written in Python, with PyQt6 and fontTools, it runs on all major platforms.
- It is independent of any font editing program.
- It can either output a hinted font itself or produce a script that can be run from makefiles and the like: it is perfect, for example, for use with fontmake.
- In addition to the kinds of hints that other programs generate, it provides an interface for user-written functions and macros, which can greatly simplify the handling of repeated features of glyphs, like serifs.
- It works only with hints and does not touch any other features of a font (for example, it doesn't reposition components the way VTT does).

Getting started

To get started on a project, launch Ygt (by typing "ygt" on the command line) and open the TrueType (.ttf) font you want to add hints to. (Any hinting already in the font will be ignored, and later on will be discarded in favor of the hints you add with Ygt.) You will see a screen like this one:



On the left is the preview panel. A preview of the hinted glyph is not shown initially; to see it, select “Update Preview” from the “Preview” menu, type Ctrl-U (Cmd-U for the Mac), or simply start hinting the font.

In the middle is the code panel, which displays the source code for either the y or the x axis of the current glyph. This source code is in YAML, a very simple data serialization language. Ygt uses YAML instead of a programming language because it is meant to be descriptive, not imperative: it describes the positions of the points that make up a glyph outline rather than dictating the commands that will position them. The Ygt hinting language will be described in detail below. You can edit the code in this panel: when you have done so, type Ctrl-R to compile it and display the results in the editing panel to the right.

The editing panel displays an outline of the current glyph with the points that define it. On-curve points are displayed as red circles and off-curve points as smaller blue circles. As hints are mostly applied to on-curve points, you may wish to hide the off-curve points. To do this, right-click anywhere in the panel and select “Hide off-curve

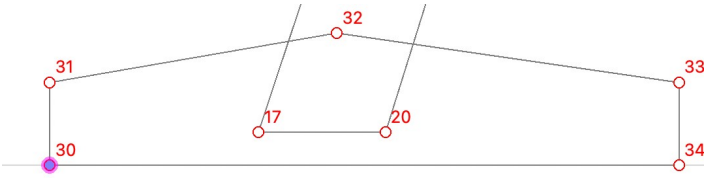
points" from the context menu. On the same context menu you can decide whether or not to display point numbers.

Above the editing panel is a toolbar with various tools for editing the glyph's hints.

Basic hinting

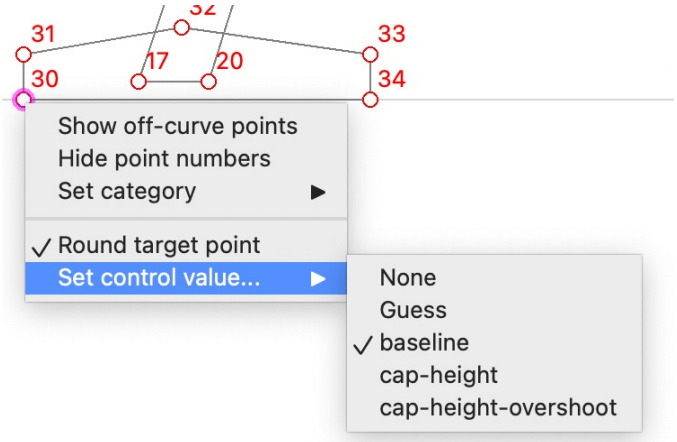
To add a hint, select one or more points (click on them or drag the mouse over them) and either click on a button in the toolbar or type a shortcut key. (The shortcut keys are displayed in the tooltips that appear when you move the mouse over the tool buttons.)

For example, to anchor a point to a position on the grid (which you should do first whenever beginning a sequence of hints), select a point and either click the "Anchor" button (at right) or type "A." The anchored point will be highlighted in pink:



Now you should assign a **control value** (CV) to this hint. A CV is a number that specifies a **distance** or **position** on the grid. Use these to regulate features (like serifs and the tops of ascenders) that recur in a number of glyphs. CVs are named rather than numbered in Ygt, making them easy to use. When you first open a font, Ygt creates a little collection of position-type CVs: check over these and add more as you need them.

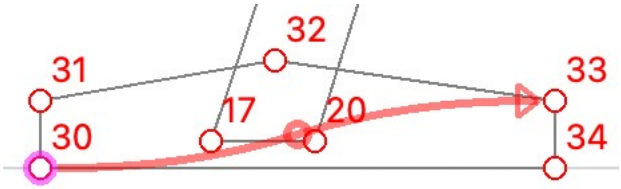
To use a CV, right-click on a hint, select "Set control value" from the context menu, and choose a CV from the sub-menu. The CVs on this menu are a subset of the whole collection—in this case, the ones most appropriate for a capital letter. They are also alphabetized (a fact you should remember when you name your own CVs). If you're not sure which CV is best, or if it's easier, choose "Guess" from the menu. Alternatively, select the hint (for anchors, you've got to click to select the hint and drag to select the point that is the hint's target) and click the "Guess Control Value" button or type a question mark.



As you add hints in the editor, the code panel is automatically updated:

```
- ptid: 30
  pos: baseline
```

To add another hint dependent on the first, select the point you just hinted (remember the difference between selecting a point and selecting an anchor), then select another point and either click the tool with the red arrow on a black background or type “B”:

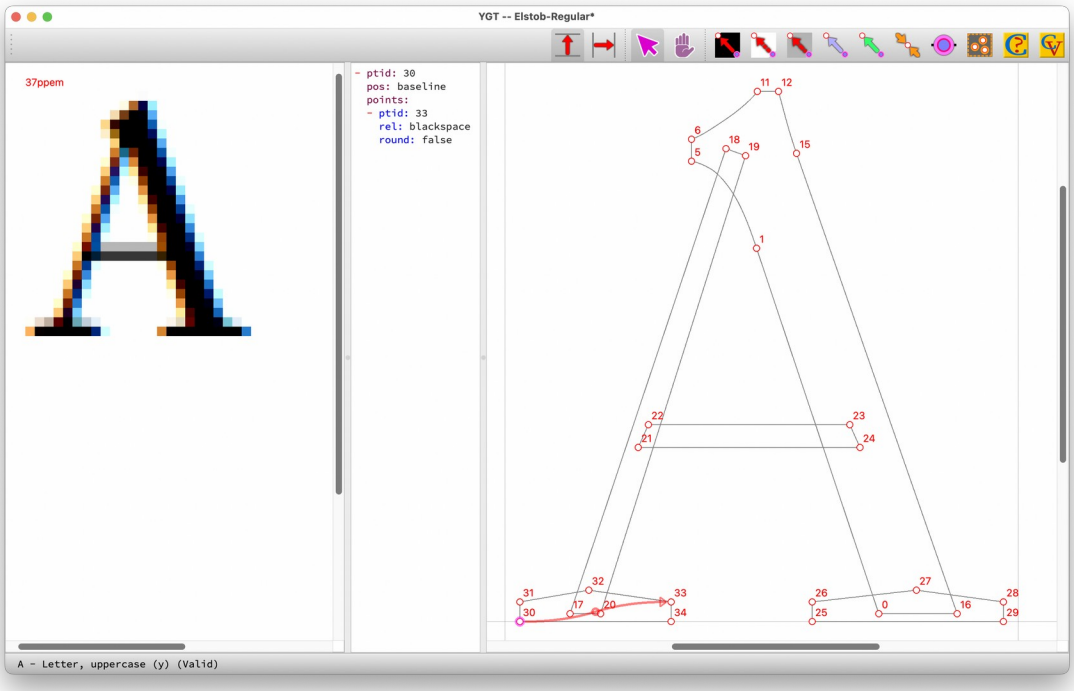


You have just added a “blackspace” hint—that is, one that crosses a space that will be filled (usually by black pixels or black ink). It is displayed as a red arrow running from a **reference point** (in this case, point 30, which you just anchored) to a **target point** (33). The button in the middle of the arrow’s stem is there to make it easier to click on. The effect of this hint is to move point 33 to a position on the y axis which is the same distance from point 30 as in the original outline, and then move it to the nearest grid line.

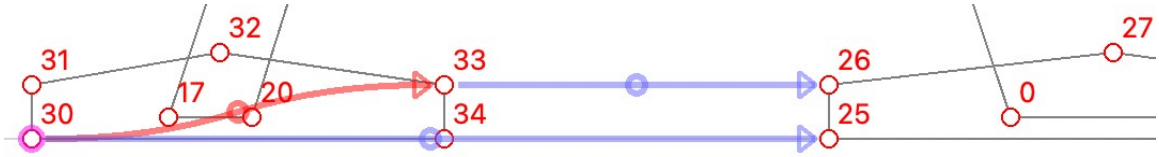
At this point, you can go in either of two directions. One is to assign a distance-type CV to the blackspace hint: this is most appropriate to the CVT screens of yesteryear and early flat screens. The more modern choice is to turn off rounding for the blackspace hint and leave it at that. The top of the serif may look fuzzy at some resolutions, but the overall

impression will be of a weight consistent with the glyph's original design. To turn off rounding for the hint, right click on it and uncheck "Round target point" on the context menu.

Now that we've added a couple of hints, let's take another look at the whole window:



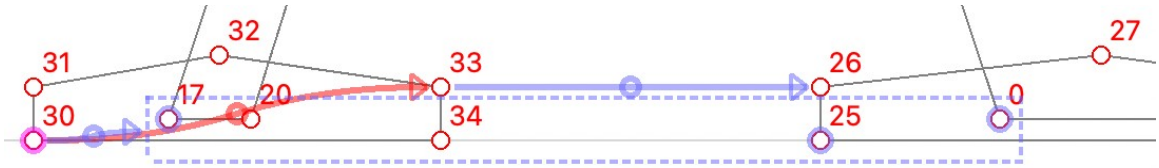
Since we've hinted only one serif, the pair of them will be mismatched at some resolutions. To make sure they always match, we'll add some **shift** hints (using the tool with the blue arrow). A shift hint causes a target point to be moved by exactly as much as the reference point has been moved. Select points 30 and 25 and click the blue arrow or type "S." Then do the same with 33 and 26:



We also need to **touch** the bottoms of the two diagonal stems to keep them from being pushed above or below the serif. (Any hint that targets a point leaves that point "touched" so that it can't be moved inadvertently.) The best way to do that is to add one point on the bottom of each stem to one of the nearby "shift" hints.

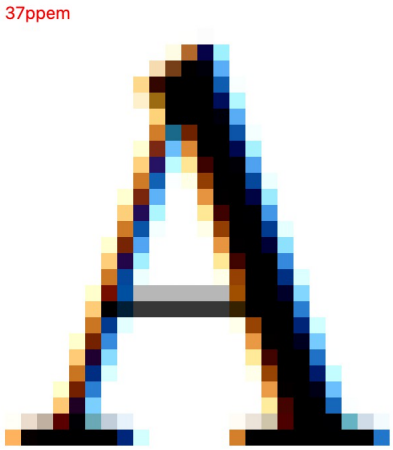
Here you need to know that the shift (blue arrow), align (green arrow) and interpolate (gold arrow) hints can target more than one point. All you need

to do, once you've added the hint, is select as many points as you want the hint to target (including the point already touched by the hint) and either click the button for the "Make Set" tool or type "K." The result looks like this:



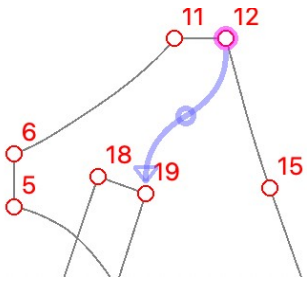
A **set** is a group of highlighted points enclosed in a box of dotted lines (points like 34, which are inside the box but not highlighted, are not part of the set). It belongs to and is part of a hint, and the hint's arrow now points at the box. Clicking on one of the highlighted points or on the box will select the whole hint. As with an anchor hint, you can select a highlighted point by dragging over it.

The result of our efforts so far looks like this:



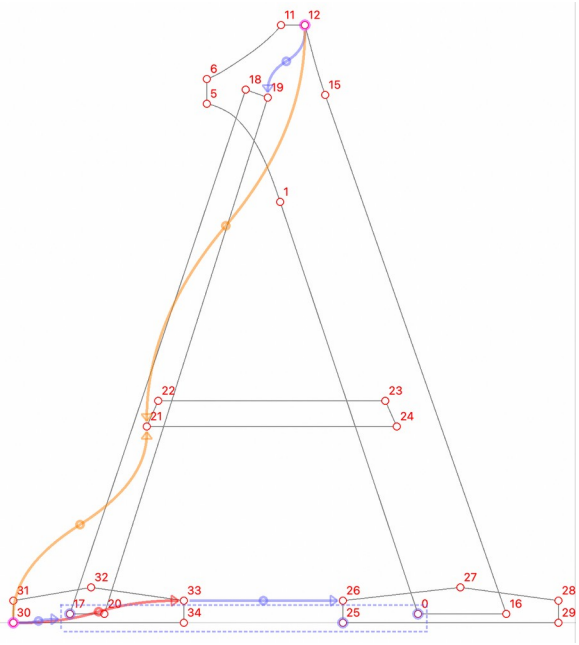
Now the serifs match, but we've got more to do. The top of the letter needs to be hinted to make sure it harmonizes with the tops of other capitals, and the cross bar has to be dealt with.

All we need to do at the top of the letter is anchor it with the CV "cap-height-overshoot" (set up by Ygt when we first opened the font) and link the anchored point to the top of the left-hand stem with another shift hint:



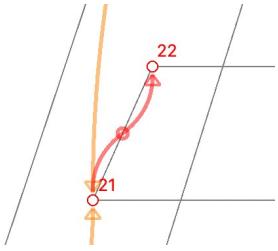
These hints ensure that point 12 always appears at the same y position on the grid, and point 19 is always positioned correctly relative to point 12.

To make sure the bar is correctly positioned, we need an **interpolate** hint, which positions one or more points relative to two reference points so that their relationship is the same as in the original glyph. To do that, select two touched points and one that has not yet been touched by a hint, and click the "interpolate" tool or type **I**:



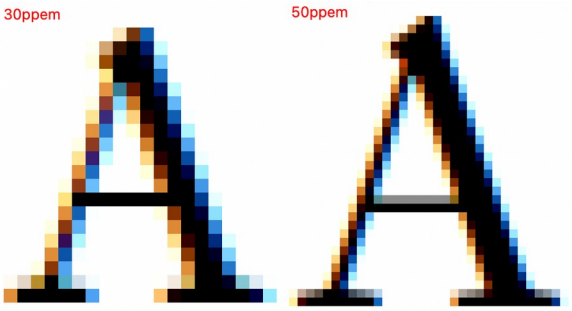
Rounding point 21 to the grid will make sure the bottom edge of the bar is sharp. To do that, right click on one of the "interpolate" hint's buttons and choose "Round target point" from the context menu.

For the top edge of the bar, we face a decision like the one we made for the serifs: round to the grid while regulating the bar's width with a CV or add an unrounded blackspace hint. Once again, the modern choice is the unrounded hint. Select points 21 and 22, type **B**, and uncheck "Round target point" on the context menu:



At very low resolutions, both edges of the bar will now look sharp, because the blackspace hint maintains a **minimum distance** of one pixel between the reference and

target points. At higher resolutions, the top of the bar will often seem fuzzy if you look closely. But this fuzziness tricks the eye into perceiving the edge of the bar as falling between two pixel edges:



You can dramatize the effect by repeatedly typing the up or down arrow key to change the resolution of the preview while watching the bar and the serifs gradually thicken.

Selecting "Save" from the File menu or typing **Ctrl-S** will not save not the font file, but rather one with the same name as the font file and the suffix "yaml" instead of "ttf." When you return to the project, open this YAML file rather than the font file. To save the font file, type **Ctrl-E** (for "Export font" on the File menu). The font will be saved with the same name as when you opened it, but with "-hinted" added: the original font is not overwritten. Alternatively, run the program Xgridfit on the command line:

```
xgridfit Elstob-Regular.yaml
```

If you are running the program from a Makefile or other script, add the option -q or -qq to suppress most or all warnings and messages.

The YAML source

The source displayed between the preview and editing pane is editable. Once you have learned the simple hinting language used by Ygt, you may sometimes find that editing the source is the quickest and surest way to manage a glyph's hints.

The source editor employs a couple of methods to help you write valid code. First, it validates continuously as you type, displaying the status of the code at the bottom of the Ygt window (the program will display more detailed error messages in due course):

Second, the code panel employs a simple scheme of color coding. When a hint block (we'll explain the concept shortly) is nested inside another hint block (nesting signaled

by a two-space indentation), it changes color. The hyphen that signals a list in YAML will be red when it is correctly positioned:

```
- ptid: 28
  pos: xheight-overshoot
  points:
  - ptid: 11
    rel: stem
    points:
    - ptid: 20
      rel: grayspace
- ptid: 0
  pos: lc-baseline-undershoot
  points:
  - ptid: 48
    rel: shift
    points:
    - ptid: 38
      rel: stem
```

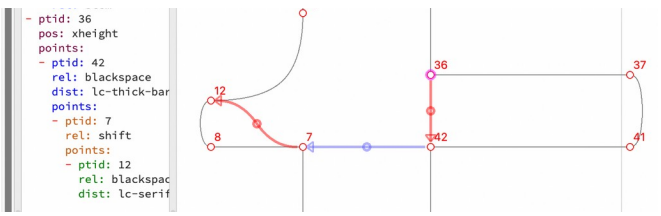
When a keyword in the block is wrong (in the example below, “ptic” for “ptid”), it turns black. When a hyphen is wrongly positioned, it turns a different color (and of course, the status bar will signal that the code is “Invalid”):

```
  - ptid: 11
    rel: stem
    points:
   - ptic: 20
      rel: grayspace
```

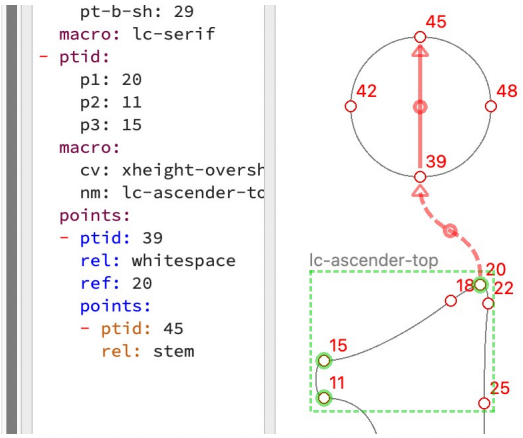
When you have made a change to the source code, type **Ctrl-R** (**Cmd-R** on the Mac) or select “Compile” from the “Code” menu. If the code is valid, your changes will be reflected immediately in the editing pane, and a second or so later in the preview pane.

Most of the time, though, the program will compose the YAML code as you work in the editing pane. Ygt will do its best to keep the code in order (for example, making sure that reference points are always touched points). If you suspect that the code is out of order (for example, you have added all the hints you need but the preview still doesn’t look right), try selecting “Clean up” from the “Code” menu. Chances are that will fix the problem; if not, you will have to edit the source yourself.

The YAML source consists of a list of hint blocks—that is, descriptions of how a point or collection of points should be positioned on the grid. Each point block can contain a list of one or more dependent hint blocks. For each dependent hint block, one reference point (in the graphical editor, the point at the starting end of a hint arrow) must be the same as one of the parent block’s target (“ptid” for “point identifier”) points. For example:



Here is a sequence of four points in the cross bar of the letter f. It begins with an anchored point (36), as sequences always should. Second, point 42 is distance “lc-thick-bar” from 36; third, point 7 is shifted along with 42; fourth, point 12 is distance “lc-serif” from point 7. The reference point (“ref”) for each of the arrow hints is implicit: it is understood to be the same as the parent target (“ptid”), at least when the parent target is unambiguous. When a hint targets more than one point, its child hint must have a “ref” property indicating which of the parent points is its reference.



For example, here the macro “lc-ascender-top” (we’ll say more about macros and functions later) regulates three points (11, 15, 20), so the “whitespace” hint that positions the dot must have a “ref” property indicating that point 39 is to be positioned with reference to point 20 (not 11 or 15). But the hint for point 45 does not need a “ref,” since its reference point is implicitly the “ptid” (39) of its parent.

Here is a list of types of hint blocks (excluding functions and macros, which we will discuss later):

anchor

Most hints have a “rel” property that signals the **relationship** of the target point to its reference point. An anchor positions a point at a particular place on the grid, not relative to a reference point, and so it has no “rel” property. It can take the following properties:

ptid — Required. The target point. It must be a single point.

pos — Optional. Positions the target point at a place indicated by a control value. If this is absent, the point is either moved to the nearest grid line (if “round” is “true”), or simply touched without being moved (if “round” is “false”).

round — Optional. The default is “true.” Whether the point should be moved to the nearest grid line after any other positioning. This may also be a type of

rounding: “to-grid” (the default), “to-half-grid,” “to-double-grid,” “down-to-grid,” or “up-to-grid.” At present these must be entered in the YAML code: the GUI offers no way to enter values other than “true” and “false.”

blackspace, whitespace, grayspace

These hints (always represented by red arrows) regulate the distance between a reference point and the target point. With a “blackspace” hint, the distance crosses a space that will be filled with ink. With a “whitespace” hint, the distance crosses a space that will not be filled with ink. A “grayspace” hint crosses a space that is a mix of black and white; or use it when you don’t need or want to indicate what kind of space the hint is regulating.

ptid — Required. The target point. It must be a single point.

dist — Optional. The name of a distance-type control value. If it is present, the distance between the reference point and the target point will be regulated by the named control value. If absent, the original distance between the two points will be used. In the modern style of hinting, it is seldom necessary to use distance-type control values.

ref — Required when the parent hint has more than one target point. The point that the target point is positioned relative to.

round — Optional. The default is “true.” Whether to round the distance between “ref” and “ptid.” If “ref” is on a grid line, then “ptid” will be positioned on a grid line too. You can enter rounding types here, as with the anchor hint.

shift, align

“Shift” moves the target point along the current axis by as much as the reference point has been moved. “Align” aligns the target with the reference point, so that aligned points will end up in a horizontal line when the axis is “y” and in a vertical line when the axis is “x.” The “align” hint can be tempting, but “shift” is generally much more useful.

ptid — Required. The target can be either a point or a list of points (a “set”).

ref — Required when the parent hint has more than one target point. The point that the target point is positioned relative to.

round — Optional. The default is “false.” Otherwise, rounding works here much as in the hint types mentioned so far.

interpolate

Positions one or more points relative to two other points in such a way that all points have the same relationship to each other as in the original outline. This hint is never the child of another hint.

ptid Required. The target can be either a point or a list of points (a "set").

ref Required. A list of two points.

round Optional. The default is "false." Whether the position of the target point(s) should be rounded to the grid after interpolation.

Macros and functions

Functions and macros are written in the Xgridfit hinting language (one or more other language options will be offered later) and embedded in the YAML source. In the TrueType instruction language, functions are somewhat like functions in other programming languages, but they are numbered rather than named, and they have no formal mechanism for passing parameters. Xgridfit supplies these wants. It also makes available a macro feature. Macros insert code instead of function calls in the program stream. Macros produce a program similar in size to one with equivalent functions, but macros can take advantage of conditional compilation, and can take sets and even bits of code as parameters.

Because functions and macros have to be written in Xgridfit (though you can use Xgridfit's "command" element to insert raw TrueType instructions if you prefer), writing them involves a learning curve; but a function or macro, once written, may be used (possibly with minor changes) in a number of fonts.

Functions and macros are very much alike from a programmer's point of view. They consist of a YAML list of parameters and the code itself. Here's an example of a macro:

```
lc-ascender-top:
  p1:
    type: point
    subtype: target
  p2:
    type: point
    subtype: target
  p3:
    type: point
    subtype: target
  cv:
    type: pos
    val: lc-ascender
```

```
code: |
  <code xmlns="http://xgridfit.sourceforge.net/Xgridfit2">
    <move distance="cv">
      <point num="p1"/>
      <move>
        <point num="p2"/>
        <move distance="lc-serif">
          <point num="p3"/>
        </move>
      </move>
    </move>
  </code>
```

The macro definition lives in a “macros” block in the source file: you can edit it by selecting “Edit macros” from the “Code” menu. The macro begins with its name, followed by a list of parameters and the code itself.

Each parameter declaration needs, at minimum, a name and a type. The name should be something that helps you remember what the parameter is for; the type can be **point**, **pos**, **dist**, **int**, or **float**. A point parameter can also have a subtype, **target** or **ref**. Those who are familiar with the TrueType instruction set will recognize that these types have no counterpart in the compiled code; but they enable functions and macros to behave like other hints in the YAML source.

A parameter declaration can also have the property **val**. This is the default value of the parameter—the value that is used when the parameter is omitted from the function or macro call.

The code itself must be enclosed in <code></code> tags, and the opening <code> tag must have the Xgridfit namespace declaration, as in the example.

A macro call looks like this:

```
- ptid:
    p1: 10
    p2: 12
    p3: 14
  macro:
    nm: lc-ascender-top
    CV: xheight-overshoot
```

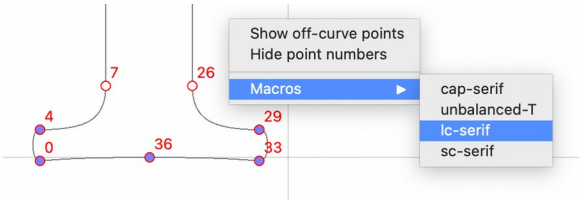
If you find it more convenient, you can also use a JSON-like syntax:

```
{ptid: {p1: 10, p2: 12, p3: 14},
macro: {nm: lc-ascender-top, CV: xheight-overshoot}}
```

Ygt will convert this to its default YAML syntax.

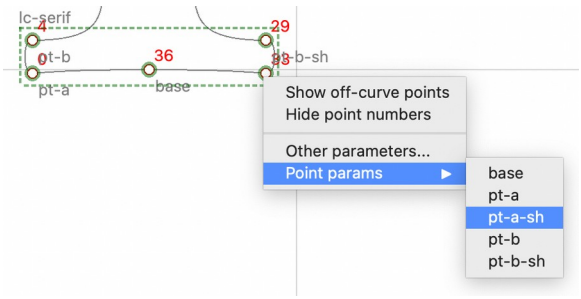
Those of the macro's parameters that refer to points are passed in the property "ptid," others in the "macro" (or "function") property. The latter property must also declare the macro's name ("nm").

It will usually be most convenient to insert the macro or function call via the graphical hint editor. To do this, select the points that will be affected by the macro or function, then right click to bring up a context menu and select the macro or function by name:

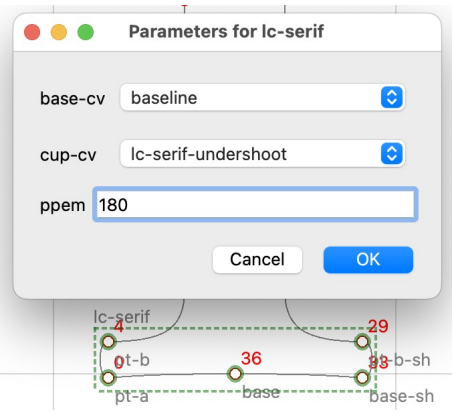


The menu presents only a selection of the macros and functions you have defined, depending on the number of points you selected.

Ygt has no way of knowing how to assign your selected points to parameters: they will be applied more or less at random. To sort them out, first select the macro by clicking on its border or one of its points. When the macro is selected, you will see which parameter is associated with which point. Right click on any point that is incorrectly assigned and assign it to the correct parameter by selecting from the "Point params" submenu:



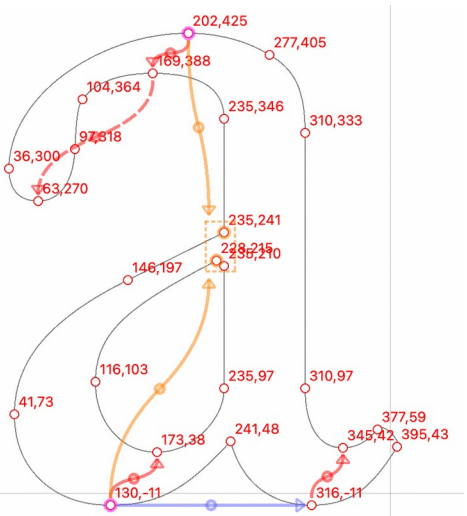
Repeat this operation until all points are correctly assigned. To set other (non-point) parameters, select "Other parameters" from the same menu and adjust them using a dialog box like this one:



Point identifiers

In a TrueType font, the points that define a glyph's outlines are numbered from zero, and TrueType hints refer to points by these numbers. You'll have little need to think about point numbers unless you edit the YAML code yourself, but there is one thing worth knowing—namely, that Ygt can refer to points not only by number, but also by their coordinates. In the YAML code, a sequence like **{548;425}** means "the point at coordinates 548,425."

The reason to use coordinates instead of indices in your code is that index numbers are unstable, especially if you use more than one program to generate fonts, for different programs will number points differently. Further, if you make even a minor change in a glyph's outlines after you have hinted it, the point numbers will probably change next time you generate the font, even if you always use the same font editor. The result will be invalid hints and messed up glyphs.



But software that generates fonts does not ordinarily alter the coordinates of on-curve points —so if you hint only on-curve points and designate those points by their coordinates it won't matter if you generate the font with, say, Glyphs or fontmake.

Display coordinates rather than indices on screen by selecting "Point coordinates" from the "View" menu. When "Point coordinates" is selected (even if point numbers are hidden), hints added to the YAML code will refer to points by their coordinates. You can also change all indices in the current block of code to coordinates (and vice versa) by selecting "Indices to coords" or "Coords to indices"

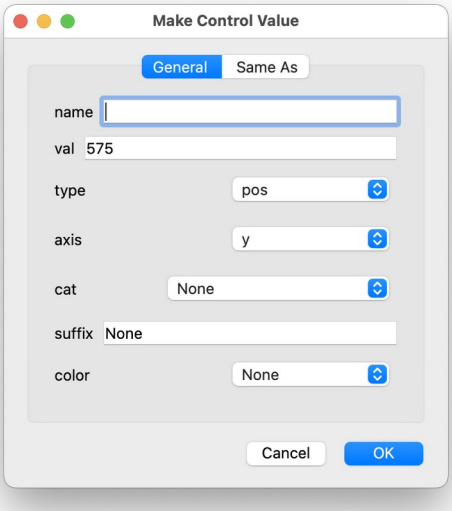
from the “Code” menu. It is a good idea, if you have been working with point indices (which are admittedly simpler to work with than coordinates) to select “Indices to coords” after you are finished hinting a glyph.

Points can also be named in Ygt, but this feature is not yet complete.

Control Values

Control values are of two kinds: **position** (pos) and **distance** (dist). Position CVs specify the location of a point on the current axis (x or y); distance CVs specify the distance of one point from another—again on the current axis. In modern hinting, position-type CVs are used more often than distance-type CVs.

You can manually edit the font’s control values by choosing “Edit cvt” from the “Code” menu (the process is described in greater detail below). But the easiest way to add control values is via the “CV” button on the toolbar. To use it, select one point for a “pos” control value or two points for a “dist” control value, then click the button or type “C.” This dialog box will appear:



The box is already filled in with most essential information: the position or distance in the “val” box; the type of CV (“pos” or “dist”), and the axis (“x” or “y”). The only information you absolutely must supply is the CV’s name (it should contain no spaces, but it can contain numbers, hyphens and underscores: make the name descriptive but not verbose).

Much of the information you supply in this box is used to filter the list of control values when you need to choose one from a menu. For example, when the current axis

is “y,” you only see control values for the “y” axis. The more information you supply, the fewer choices you’ll confront.

type — Whether the CV is for positions or distances.

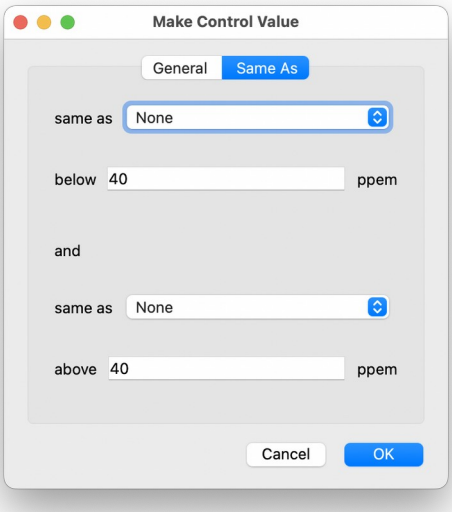
axis — Which axis the CV is intended for.

cat — The unicode category of the CV (e.g. “Letter, uppercase”). If supplied, the CV will only be offered for a character whose category matches the CV (but you can change the category of any glyph, or supply categories where they are missing, by selecting “Set category” from the context menu—see below).

suffix — Glyph names often have suffixes: for example, small caps commonly have names ending in “.sc” (e.g. “a.sc” for “small cap a”). If a suffix is supplied here, the CV will only apply to chararacters whose names have that suffix.

color — This property is not for filtering control values, but rather for affecting the behavior of hints. If a hint’s color (black, white, or gray) is not otherwise specified, the color of the CV is used, if given.

Click over to the “Same As” tab if you want to make this control value equal to another (or others) at certain resolutions.



You can make the CV equal to a CV below a certain resolution and equal to another CV above another resolution. Just pick the CV you want to set this one equal to from the “same as” list and enter a resolution in the “below ppem” and/or the “above ppem” box. (You can change this number later in the “Edit cvt” dialog.)

The “below ppem” feature is useful for making stems of slightly different width and edges of slightly different height appear consistent at low resolutions.

Categories

Every character with a Unicode code point belongs to a category, assigned by Unicode. To see them, choose “Set category” from the context menu. Ygt uses these categories as filters for control values: when you assign a category to a control value, that control value only appears on the menu for glyphs with matching categories (but any control value can be entered in the editing pane). This feature keeps the “Set control value” context menu manageable when you have many CVs.

You can override these categories whenever it is useful to do so. (The categories you choose are not recorded in the font, and they have no effect at all except on the selection of control values in the menus.) For example, the “yen” sign (U+00A5) is categorized as “Symbol, currency,” but its shape is that of a capital Y with bars, and so it is useful to apply to it control values for capital letters. Simply select “Letter, uppercase” from the “Set category” menu, and all capital control values will be available for that glyph. Likewise, if you use the Unicode Private Use Area, you’ll find that Unicode classifies all the glyphs there as “Other, private use”—not very useful! But you can assign any category you like to Private Use glyphs for the purpose of hinting them.

Some groupings of characters do not have Unicode categories—small caps, for example. For these, use the “suffix” property of your control values.

Variable fonts

A variable font with TrueType hinting should have a **cvar** table to allow the rasterizer to vary control values as the font’s axes change. The cvar table normally has several sections for various combinations of regions of the font’s design space. These will generally correspond to your font’s masters. To take a simple case, if your font has a weight axis running from “ExtraLight” (200) to “Bold” (700), its “regions” will have entries for one axis each: one for weights 200–400 and one for weights 400–700. The values that define each region are generally normalized so that the “Normal” weight is zero and the extremes on that axis are -1 and 1. The cvar table might look something like this:

```
- regions:
  - tag: wght
    bot: -1.0
    peak: -1.0
```

```
    top: 0.0
  vals:
  - nm: cap-serif
    val: 31
  - nm: cap-bar
    val: 39
  - nm: cap-round-stem
    val: 31
  - nm: lc-serif
    val: 21
  . . .
- regions:
  - tag: wdth
    bot: -1.0
    peak: -1.0
    top: 0.0
  vals:
  - nm: cap-serif
    val: 34
  - nm: num-circle
    val: 51
  . . .
```

For each collection of regions, you need a list of values, each identified by a name (which must match the name of one control value) and a value. List only control values that differ from those of the associated control values. List alternative values, not differences from the cvt values.

Test how your hinting behaves at various points on your axes by selecting different instances from the "Preview" menu. For example, here are previews of the Junicode **g** for the Regular and SemiExpanded Bold instances: