List design

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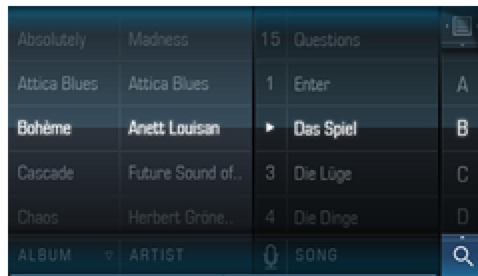
List design

The goal of this list design document is to establish an appropriate architecture and API design for the list widgets in the Apertis platform.

Historically, the roller widget has provided a list widget on a cylinder with no conceptual beginning or end and is manipulated naturally by the user. For non-cylindrical lists there was a separate widget with a different API and different usage. The goal is to consolidate list operations into a base class and be able to use the same simple API to use both cylindrical lists and non-cylindrical lists.



The above shows an example of the roller widget in use inside the music application. There are multiple roller widgets for showing album, artist, and song. Although they are manipulated independently, their contents are linked.

Terminology and concepts

Vehicle

For the purposes of this document, a *vehicle* may be a car, car trailer, motorbike, bus, truck tractor, truck trailer, agricultural tractor, or agricultural trailer, amongst other things.

System

The *system* is the infotainment computer in its entirety in place inside the vehicle.

User

The *user* is the person using the system, be it the driver of the vehicle or a passenger in the vehicle.

Widget

A *widget* is a reusable part of the user interface which can be changed depending on location and function.

User interface

The *user interface* is the group of all widgets in place in a certain layout to represent a specific use-case.

Roller

The *roller* is a list widget named after a cylinder which revolves around its central horizontal axis. As a result of being a cylinder it has no specific start and finish and appears endless.

Application author

The *application author* is the developer tasked with writing an application using the widgets described in this document. They cannot modify the variant or the user interface library.

Variant

A *variant* is a customised version of the system by a particular system integrator. Usually variants are personalised with particular colour schemes and logos and potentially different widget behaviour.

Use cases

A variety of use cases for list design are given below.

Common API

An application author wants to add a list widget to their application. At that moment it is not known whether a simple list widget or a roller widget will suit the application better. Said application author doesn't want to have a high overhead in migrating code from one widget to another.

152 **MVC separation**

153 A group of application authors wants to be able to split the work involved in
154 developing their application into teams such that, adhering to the interfaces
155 provided, they can develop the different parts of the application and easily put
156 them together at the end.

157 **Data backend agnosticity**

158 An application author wishes to display data stored in a database, and does not
159 want to duplicate this data in an intermediary data structure in order to do so.

160 **Kinetic scrolling**

161 The user wants to be able to scroll lists using their finger in such a way that the
162 visual response of the list is as expected. Additionally, the system integrator
163 wants the user to have visual feedback when the start or end of a list is reached
164 by the list bouncing up and back down (the *elastic effect*). However, another
165 system integrator wants to disable this effect.

166 The user expectations include the following:

167 • The user expects the scroll to only occur after a natural threshold of
168 movement (as opposed to a tap), for the list to continue scrolling after
169 having removed their finger, and for the rate of scroll to decrease with
170 time.

171 • The user expects to be able to stop a scroll by tapping and holding the
172 scrolling area.

173 • The user expects a flick gesture to re-accelerate a scroll without any visible
174 stops in the animation.

175 • The user expects video elements to continue playing during a scroll.

176 • When there are not enough items to fill the entire height of the list area
177 the user expects a scroll to occur but using the elastic effect fall back to
178 the centre.

179 • The user expects a horizontal scroll gesture to not also scroll in the vertical
180 direction.

181 **Roller focus handling**

182 In the roller widget, the user wants the concept of focus to be highlighted by
183 the list scrolling such that the focused row is in the vertical centre.

184 Additionally, the user wants to be able to easily focus another unfocused visible
185 item in the list simply by pressing it.

186 **Animations**

187 The user wants to have a smooth and natural experience in using either list
188 widget. If the scrolling stops half-way into an item and it is required that one
189 item is focused (seeroller focus handling), they want the list to bounce a small
190 scroll to focus said item.

191 **Item launching**

192 An application author wants to be able to perform some application-specific
193 behaviour in response to the selecting of an item in the list. However, they
194 want to provide some confirmation before launching an item in a list. They
195 want the two step process to be:

196 1. The desired item is focused by scrolling to it or tapping on it.

197 2. The focused item is tapped again which confirms the intention to launch
198 it.

199 **Header and footer**

200 The application author wants to add a header to the column to make it clear
201 exactly what is in said column. (An example can be seen in List design in the
202 music application.)

203 Another system integrator wants the column names to be shown above the
204 widget in a footer instead of a header.

205 **Roller rollover**

206 In the roller widget, by definition, the user wants to scroll from the last item in
207 the list back to the first without having to go all the way back up.

208 Additionally, the user wants the wrap around to be made more visually obvious
209 with increased resistance when scrolling past the fold between end and start
210 again.

211 **Widget size**

212 The application author wants any list widget to expand into space allocated to
213 it by its layout manager. If there are not enough items in the list to fill all
214 available space said application author wants the remaining space to be blank,
215 but still used by the list widget.

216 **Click activation**

217 A system integrator wants to choose between single click and double click ac-
218 tivation (seeitem launching) for use in the list widgets. This is only expected
219 once the item has already been focused (see alsoroller focus handling).

220 The decision of single or double click is given to the system integrator instead
221 of the application author in order to retain a consistent user experience.

222 **Consistent focus**

223 The user focuses an item in the list and a new item is added. The user expects
224 the new item not to change the scroll position of the list and more importantly
225 not to change the currently focused row.

226 **Focus animation**

227 An application author wants an item in the list to be able to perform an anima-
228 tion after being focused.

229 **Mutable list**

230 An application author wants to be able to change the contents of a list shown
231 in the user interface after having created the widget and shown it in the user
232 interface.

233 **UI customisation**

234 A system integrator wants to change the look and feel of a list widget without
235 having to change any of the application code.

236 **Blur effect**

237 A system integrator wants items in the list to be slightly blurred when scrolling
238 fast to exaggerate the scrolling effect. Another system integrator wants to dis-
239 able this blur.

240 **Scrollbar**

241 A system integrator wants a scrollbar to be visible for controlling the scrolling
242 of the list. Another system integrator doesn't want the scrollbar visible.

243 **Hardware scroll**

244 A system integrator wants to use hardware buttons to facilitate moving the
245 focus up and down the list. The system integrator wants the list to scroll in
246 pages and for the focus to remain in order. For example, a list contains items
247 A, B, C, and D. When the *down* hardware button down is pressed, the page
248 moves down to show items E, F, G, and H, and the focus moves to item E as it
249 is the first on the page.

On-demand item resource loading

The music application lists hundreds of albums but the application author doesn't want the album art thumbnail to be loaded for every item immediately as it would take too long and slow the system down. Instead, said application author wants album art thumbnail to load only once visible and have a placeholder picture in place until then.

Scroll bubbles

A system integrator wants bubbles[1] to appear when scrolling and disappear when scrolling has stopped.

Item headers

An application author wants to display items in a list but have a logical separation into sections. For example, in a music application, listing all tracks of an artist and separating by album.

Another application author wants said headers to stick to the top of the widget so they are always visible, even if the first item has been scrolled past and is no longer visible.

List with tens of thousands of items

An application author wants to display a list containing thousands of items, but does not want to incur the initial cost of instantiating all the items when creating the list.

Flow layout

An application author wants the list widget to render as a grid with multiple items on the same line. The following video shows such a grid layout.

Concurrent presentation of the same model in different list widgets

An application author wants to present the same model in two side-by-side list widgets, possibly with different filtering or sorting.

Non-use cases

A variety of non-use cases for the list design are given below.

Tree views

An application author wants to show the filesystem hierarchy in their application. They understand that multi-dimension models (or trees) where items can

[1] http://i.stack.imgur.com/YyRtC.png

281 be children of other items are not supported by the Apertis list widgets (hence
282 the name list).

283 List widget without a backing model

284 An application wants to display a list of items in the list widget, but does not
285 wish to create a model and pass it to the list widget, and would rather use
286 helper functions in the list widget, such as `list_add_item(List *list, ListItem`
287 `*item)`.

288 Such an interface is not considered necessary, at least for this version of the
289 design document, because we want to encourage use of models so that the UI
290 views themselves can be rearranged more easily.

291 If, in the future, such an interface was considered desirable, its API should be
292 similar to the `GtkListBox`[2] API, such as `gtk_list_box_row_changed()`.

293 Sticky header and footer

294 An application developer wants an actor to stick to the top or the bottom of
295 the list widget, and always be visible regardless of scrolling.

296 This is best handled as a separate actor, sharing a common parent with the list
297 widget.

298 Requirements

299 Common API

300 There should be a common API between both list widgets (seecommon api).
301 Changing from a list widget to a roller widget or the other way around should
302 involve only trivial changes to the code leading to a change in behaviour.

303 MVC separation

304 The separation between components that use the list widgets should be func-
305 tional and enable application authors and system integrators to swap out parts
306 of applications easily and quickly (seemvc separation).

307 The implementation of the model should be of no impact to the functionality
308 of the widget. As a result the widget should only refer to the model using an
309 interface which all models can implement.

310 Data backend agnosticity

311 The widget should not require application authors to store their backing model
312 in any particular way.

[2] https://developer.gnome.org/gtk3/stable/GtkListBox.html

Kinetic scrolling

Both list widgets should support kinetic scrolling from user inputs (seekinetic scrolling). That is, when the user scrolls using their finger, he or she can *flick* the list up or down and the scroll will continue after the finger is released and gradually slow down. This animation should feel natural to the user as if he or she is moving a wheel up or down, with minimal friction. The animation should also be easily stopped by tapping once.

Elastic effect

In the list widget with a defined start and finish, on trying to scroll there should be visual feedback that the start or finish of the list has been reached. This visual feedback should be accomplished using the *elastic effect*. That is, when the bottom is reached and further downward scrolling is attempted, an empty space slowly appears with resistance, and pops back when the user releases their finger.

This is not necessary on the roller widget because the list loops and there is no defined start and finish to the list.

It should be easy to turn this feature off as it may be undesired by the system integrator (seekinetic scrolling).

Item focus

In both list and roller widgets there should be a concept of focus which only one item has at any one point. How to display which item has focus depends on the widget.

Roller focus handling

In the roller widget the focused item should always be in the vertical centre of the widget (seeroller focus handling). The focused item should visually change and even expand if necessary to demonstrate its focused state (see alsofocus animation).

Changing which item is focused should be possible by clicking on another item in the list.

Animations

It should be possible to add animations to widgets to allow for moving the current scroll location of the list up or down (seeanimations). This should be customisable by the system integrator and application author depending on the application in question but should retain the general look and feel across the entire system.

Item launching

Focused items (see Item focus) should be able to be launched using widget-specific bindings (clicks or touches) (see Click activation).

Header and footer

It should be possible to add a header to a list to provide more context as to what the information is showing (seeheader and footer and the screenshot in List design). This should be customisable by the application author and should be consistent across the entire system.

Roller rollover

The rollover of the two list widgets should be different and customisable by the system integrator (seeroller rollover andui customisation).

The roller widget should roll over from the end of the list back to the beginning again, like a cylinder would (see List design and Roller). Additionally the system integrator should be able to customise whether they want extra resistance in going back to the beginning. This is visual feedback to ensure the user knows they are returning to the beginning of the list.

The non-roller list widget should not have a rollover and should have a well-defined start and finish, with visual effects as appropriate (see Elastic effect).

Widget size

The list widgets should expand to fill out all space that has been provided to them (seewidget size). They should fill any space not required with a blank colour, specified by the variant UI customisation (seeui customisation).

Consistent focus

The focus of items in a list should remain consistent despite modification of the list contents (seeconsistent focus). Adding items before or after the currently focused item shouldn't change its focused state.

Focus animation

The application author and system integrator should be able to specify whether there is an animation in selecting an item in a list (seefocus animation andui customisation). This could mean expanding an item to make the item focused larger vertically and even display extra controls which were previously hidden under the fold.

During this animation, input should not be possible.

Mutable list

The items shown in the list widgets and their content should update dynamically when the model backing the widget is updated (seemutable list). This should require no extra effort on the part of the application author.

UI customisation

Both list widgets should be visibly customisable in the same way the rest of the system is and should honour UI customisations made by the system integrator (seeui customisation). In this way, the list widgets should use CSS (see the UI Customisation Design document) for styling.

Blur effect

The list widget should support slightly blurring list items only when scrolling (seeblur effect). It should be easily to disable this feature by another system integrator who doesn't want the blur.

Scrollbar

The list widget should support showing and hiding a scrollbar as necessary (seescrollbar). It should be easy to disable this feature by another system integrator who doesn't want to display a scrollbar.

Hardware scroll

The list widget should support scrolling using hardware buttons and therefore always have one item focused hardware scroll). Hardware button callbacks should use the adjustments[3] on the list widget to change the subset of visible items and the appropriate list widget function for moving the focus to the next item. Hardware button signals are generated as described in the Hardkeys Design.

On-demand item resource loading

Items in the list need to know when they are visible (and not past the current scroll area) so they know when to load expensive resources, such as thumbnails from disk (see On-demand item resource loading).

Scroll bubbles

The scrollbar (see alsoscrollbar) should support showing bubbles to show the scroll position (seescroll bubbles). It should be possible to disable the bubble and change its appearance when necessary.

[3] https://github.com/clutter-project/mx/blob/master/mx/mx-scrollable.h

Item headers

It should be possible to add separating headers to sets of items in the list widgets (seeitem headers). Said headers should also be sticky if specified.

Lazy list model

It should be possible to provide a 'lazy list store' to the widget, in which items would be created on demand, when they need to be displayed to the user.

This model could make memory usage and instantiation performance independent of the number of items in the model.

See List with tens of thousands of items

Flow layout

It should be possible for n items, each of the same width and height, to be packed in the same row of the list, where n is calculated as the floor of the list width divided by the item width. There is no need for the programmer to set n manually.

Reusable model

The underlying model should not have to be duplicated in order to present it in multiple list widgets at the same time.

See Concurrent presentation of the same model in different list widgets

Approach

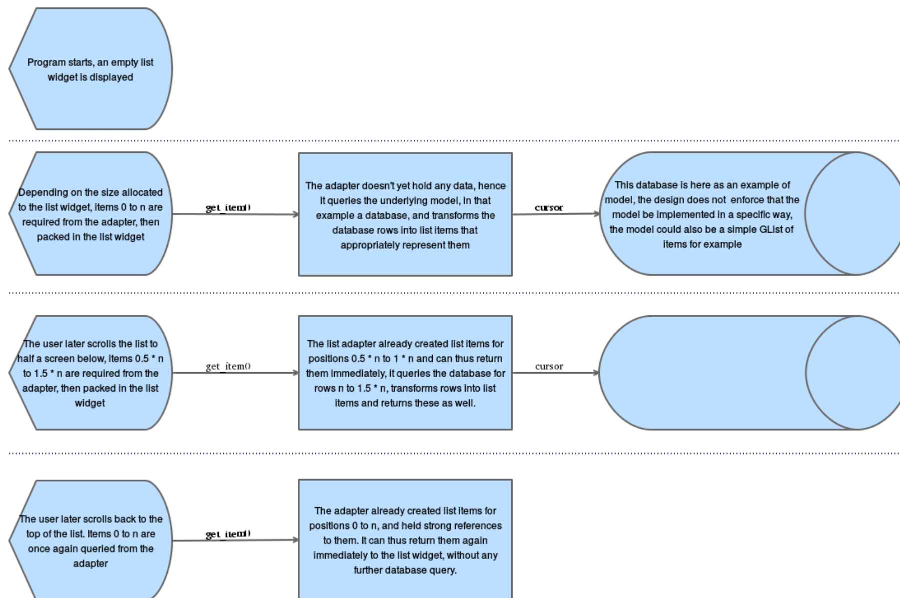
Adapter interface

As required bydata backend agnosticity1, the backing data model format should not be imposed by the list widget upon the application developer.

As such, an 'adapter' is required, similar to Android's `ListAdapter`[4], this adapter will make the bridge between the list widget and the data that backs the list, by formatting data from the underlying model as list item widgets for rendering.

The following diagram illustrates how this adapter helps decoupling the list widget from the underlying model.

[4] https://developer.android.com/reference/android/widget/ListAdapter.html



440

441 In the above example, we assume a program that simply displays a
442 list widget exposing items stored in a database, and an adapter that
443 stores strong references to the created list items, and will eventually
444 cache them all if the list widget is fully scrolled down by the user.
445 This is as opposed to the approach presented in Lazy list model
446 where memory usage is also taken into account.

447 The 'cursor' is a representation of whatever database access API is
448 in use, as most databases use cursor-based APIs for reading.

449 An interface for this adapter (the contents of the list widgets) is required such
450 that it can be swapped out easily where necessary (seemvc separation, Lazy list
451 model).

452 GLib recently (since version 2.44) added an interface for this very task. `GList-
453 Model`[5] is an implementation-agnostic interface for representing lists in a single
454 dimension. It does not support tree models (see Tree views) and contains ev-
455 erything required for the requirements specified in this document.

456 It should be noted that `GListModel`, which is for arbitrary containers, is entirely
457 unrelated to the `GList` data structure, which is for doubly linked lists.

458 In addition to functions for accessing the contents of the adapter, there is also an
459 `items-changed` signal for notifying the view (the list widget and list item widgets
460 it contains; seemvc separation) that it should re-render as a result of something
461 changing in the adapter.

[5]https://developer.gnome.org/gio/stable/GListModel.html

462 **GtkListBox**

463 GtkListBox[6] is a GTK+ widget added in 3.10 as a replacement for the very
464 complicated GtkTreeView[7] widget. GtkTreeView is used for displaying complex
465 trees with customisable cell renderers, but more often lists are used instead of
466 trees.

467 GtkListBox doesn't have a separate model backing it (but one can be used), and
468 each item is a GtkListBoxRow (which is in turn a GtkWidget). This makes using
469 the widget and modifying its contents especially easy using the GtkContainer[8]
470 functions. Items can be activated (seeitem launching or selected (see Item focus).

471 GtkListBox has been used in many GNOME applications since its addition and
472 has shown that its API is sufficient for most simple use cases, with a limited
473 number of items.

474 However GtkListBox is not scalable, as its interface requires that all its rows be
475 instantiated at initialisation, in order for example to add headers to sections,
476 and still be able to scroll accurately to any random position in the list (random
477 access).

478 As such, its API is only of a limited interest to us, particularly when it comes
479 toitem headers orfiltering.

480 **GtkFlowBox**

481 [GtkFlowBox] is a GTK+ widget added in 3.12 as a complement to GtkListBox.
482 Its API takes a similar approach to that of GtkListBox: it doesn't have a separate
483 model backing it – but one can be used – and each item is a GtkFlowBoxChild
484 which contains the content for that item.

485 As with GtkListBox, its API is interesting to us for its approach to reflowing
486 children; see Column layout.

487 **Widget size**

488 The list widgets should expand to fill space assigned to them (seewidget size).
489 This means that when there are too few items to fill space the remaining space
490 should be filled appropriately, but when there are more items than can be shown
491 at one time the list should be put into a scrolling container.

492 In Clutter, actors are made to expand to fill the space they have been assigned
493 by setting the x-expand and y-expand properties on ClutterActor. For example:

[6]https://developer.gnome.org/gtk3/stable/GtkListBox.html
[7]https://developer.gnome.org/gtk3/stable/GtkTreeView.html
[8]https://developer.gnome.org/gtk3/stable/GtkContainer.html

```
1   /* this actor will expand into horizontal space, but not into vertical
2    * space, allocated to it. */
3   clutter_actor_set_x_expand (first_actor, TRUE);
4   clutter_actor_set_y_expand (first_actor, FALSE);
5
6   /* this actor will expand into vertical space, but not into horizontal
7    * space, allocated to it. */
8   clutter_actor_set_x_expand (second_actor, FALSE);
9   clutter_actor_set_y_expand (second_actor, TRUE);
10
11  /* this actor will stretch to fill all allocated space, the
12   * default behaviour. */
13  clutter_actor_set_x_align (third_actor, CLUTTER_ACTOR_ALIGN_FILL);
14
15  /* this actor will be centered inside the allocation. */
16  clutter_actor_set_x_align (fourth_actor, CLUTTER_ACTOR_ALIGN_CENTER);
```

494 More details can be found in the `ClutterActor`[9] documentation.

495 The list item widgets (as described inadaptermodel implementation) are packed
496 by the list widget and so application authors have no control over their expand-
497 ing or alignment.

498 A suitable scrolling container to put a list widget into is the `MxKineticScrol-`
499 `lView`[10] as it provides kinetic scrolling (seekinetic scrolling and Elastic effect)
500 using touch events. Additionally, the `MxKineticScrollView` should be put into an
501 `MxScrollView` to get a scrollbar where appropriate (seescrollbar).

502 For support of `MxKineticScrollView` the list widgets should implement the
503 `MxScrollable` interface, which allows getting and setting the adjustments, and
504 is necessary in showing a viewport into the interface

505 The exact dimensions in pixels for the widget shouldn't be specified by the
506 application author as it means changes to the appearance desired by a system
507 integrator are much more difficult to achieve.

508 Adapter/Model implementation

509 As highlighted before (in Adapter interface), the list widget should make no
510 assumption about how the backing data is stored. An adapter data structure
511 should be provided, making the bridge between the backing data and the list
512 widget, by returning list item actors for any given position.

[9] https://developer.gnome.org/clutter/stable/ClutterActor.html
[10] https://github.com/clutter-project/mx/blob/master/mx/mx-kinetic-scroll-view.h

The `GListModel` interface requires all its contained items to be `GObject`s with the same `GType`[11].

It is suggested that the items themselves are all instances of a new `ListItem` class, which will inherit from `ClutterActor`, and implement selection and activation logic.

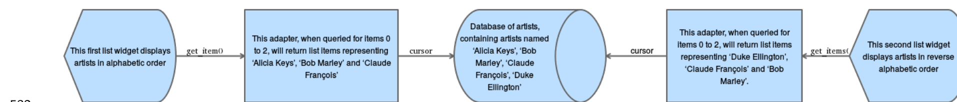
`GListStore`[12] is an object in GLib which implements `GListModel`. It provides functions for inserting and appending items to the model but no more. For small lists, it is suggested to either use `GListStore` directly or implement a thin subclass to give more type safety and better-adapted function signatures.

In these simple cases, `GListStore` will act as both the adapter *and* the backing model, as it is storing `ListItem` widgets. For more complicated use cases (where the same data source is being used by multiple list widgets), the adapter and backing model must be separated, and hence `GListStore` is not appropriate as the adapter in those cases. See Decoupled model.

Decoupled model

As shown in Adapter interface, the list widget will not directly interact with the underlying data model, but through an 'adapter'.

The following diagram shows how the same underlying model may be queried by two different list widgets, and their corresponding adapters.



> List widgets are the outermost boxes in the diagram; the adapters are the next boxes inwards; and the middle box is the shared data model (a database).
>
> The 'cursors' in the above diagram are a representation of whatever database access API is in use, as most databases use cursor-based APIs for reading.

Lazy object creation

`GListModel` allows an implementation to create items lazily (only create or update items on screen and next to be displayed when a scroll is initiated) for performance reasons. This is recommended for applications with a very large number of items, so a new ListItem isn't required for every single item in the list at initialisation.

[11] https://developer.gnome.org/gio/stable/GListModel.html#GListModel.description
[12] https://developer.gnome.org/gio/stable/GListStore.html

GListStore does not support lazy object creation so an alternative model will need to be implemented by applications which need to deal with huge models.

An example for this is provided in Alternative list adapter.

High-level helpers

Higher-level API should be provided in order to facilitate common usage scenarios, in the form of an adapter implementation.

This adapter should be instantiatable from various common data models, through constructors such as: `list_adapter_new_from_g_list_model` or `list_adapter_new_from_g_list`.

This default adapter should automatically generate an appropriate UI for the individual objects contained in the data model, with the only requirement that they all be instances of the same GObject subclass. This requirement should be clearly documented, as it won't be possible to enforce it at instantiation time for certain data models, such as `GList`, without iterating on all its nodes, thus forbidding the generic adapter from adopting a lazy loading strategy.

The default behaviour of the adapter should be to provide a UI for all the properties exposed by the objects (provided it knows how to handle them), but much like the Django admin site[13], it should be easy for the user to modify which of these properties are displayed, and the order in which they should be displayed, using a `set_fields()` method. The suggested `set_fields()` API would take a non-empty ordered list of property names for the properties of the objects in the model which the adapter should display. For example, if the model contains objects which represent music artists, and each of those objects has `name`, `genre` and `photo` properties, the adapter would try to create row widgets which display all three properties. If `set_fields (['name', 'genre'])` were called on the adapter, it would instead try to only display the name and genre for the artist (name first, genre second), and not their photo. The layout algorithm used for presenting these properties generically in the UI is not prescribed here.

This generic adapter should expose virtual methods to allow potential subclasses to provide their own list item widgets for properties that may or may not be handled by the default implementation, and to provide their own list item widgets for each of the GObjects in the model. These are represented by `create_view_for_property()` and `create_view_for_object()` on the API diagram.

The adapter should use weak references on the created list items, as examplified in Alternative list adapter.

Filtering and sorting should be implemented by this adapter, with the option for the user to provide implementations of the sorting and filtering methods, and to trigger the sorting and filtering of the adapter. It should be clearly

[13] https://docs.djangoproject.com/en/1.10/ref/contrib/admin/#django.contrib.admin.ModelAdmin.fields

583 documented that these operations may be expensive, as the adapter will have
584 no other option than iterating over the whole model.

585 If developers want to use the list widget with an underlying model that allows
586 more efficient sorting and filtering (for example a database), they should imple-
587 ment their own adapter.

588 Refer to the API diagram for a more formal view of the proposed API, and to
589 the Generic adapter section for a practical usage example.

590 UI customisation

591 The list and list item widgets should be `ApertisWidget` subclasses (which are
592 in turn `ClutterActor`s) to take advantage of the `GtkApertisStylable` mixin that
593 `ApertisWidget` uses. This adds support for styling the widget using CSS and
594 other style providers[14] which can be customised by system integrators.

595 As the list item widgets are customisable widgets, they can appear any way the
596 application author wants. This means that it is up to the application author
597 to decide on theming decisions. Apertis-provided list item widgets will clearly
598 document the CSS classes that affect their appearance.

599 Sorting

600 Sorting the model is built into the `GListStore`. When adding a new item to the
601 adapter `g_list_store_insert_sorted` is used with the third argument pointing to
602 a function to help sort the model. All items can be sorted at once using the
603 `g_list_store_sort` function, passing in the same or different sorting function.

604 When using an Alternative list adapter, sorting will need to be implemented on
605 a case-by-case basis.

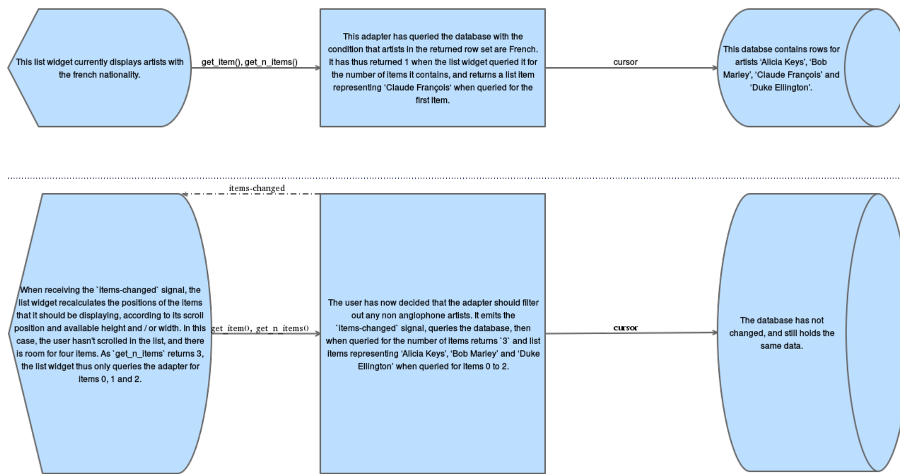
606 Filtering

607 As with `GtkListBox` when bound to a model, filtering should be implemented by
608 updating the contents of the adapter.

609 The list widget will be connected to the adapter, and will update itself appro-
610 priately when notified of changes.

611 An example of this is shown in the next section, the following diagram illustrates
612 the filtering process.

[14] https://developer.gnome.org/gtk3/stable/GtkStyleProvider.html



> The 'cursors' in the above diagram are a representation of whatever database access API is in use, as most databases use cursor-based APIs for reading.

Header and footer

The header should be a regular `ApertisWidget`, passed to the list widget as a `header` property. It will be rendered above the body of the list widget. Similarly, an `ApertisWidget` passed to a `footer` property will be rendered below the body of the list widget. Using arbitrary widgets means the header's appearance is easily customisable. Passing them to the list widget means that the list widget can set the widgets' width to match that of the list.

Applications can set either, both, or neither, of the `header` and `footer` properties. If both are set, both a header and a footer are rendered, and the application may use different widgets in each.

Selections

As with `GtkListBox`, it should be possible to select either one or many items in the list (see Item focus). The application author can decide what is the behaviour of the list in question using the "selection mode". The values for the selection mode are none (no items can be selected), single (at most one item can be selected), and multiple (any number of items can be selected). A multiple selection example can be found in the Multiple selection section.

The `ListItem` object has a read-write property for determining it can be selected or not. An example that sets this property can be found in the Non-selectable items section.

The selection signals exposed by the list widget will be identical to those exposed by `GtkListBox`, namely `item-selected` when an item is focused, `item-activated`

when the item is subsequently activated, and in the case of multiple selection, the `selected-items-changed` signal will give the user the full picture of the current items selected by the user, by being emitted every time the current selection changes, and passing an updated list of selected list items to potential callback functions.

Item headers

Item headers are widgets used to separate items into logical groups (for example, when showing tracks of an artist, they could be grouped in albums with the album name as the item header).

Due to the requirement for lazy initialisation, the solution proposed by `GtkListBox` cannot be adopted here, as it implies that all the list items need to be instantiated ahead of time.

Our approach here is similar to the solution[15] used with Android's `ListAdapter`: as the adapter is decoupled from the data model, and returns the actors that should be placed at a given position in the list, it may also account for such headers, which should be returned as unselectable `ListItem`s at specific positions in the adapter.

We make no assumptions as to how implementations may choose to associate a selected list item with the data model: in the simple case, the index of a list item may be directly usable to access the backing object it represents, if the backing data is stored in an array, and no item header is inserted in the adapter.

In other cases, where for example the backing data is stored in a database, or item headers are inserted and offset the indices of the following items, implementations may choose to store a reference to the backing object using `g_object_set_qdata` or an external mechanism such as a `GHashTable`.

An example of item headers is shown in [the following section][Header items].

Sticky item headers

As required for Lazy list model, when the list widget is scrolled to a random point, items surrounding the viewport may not be created yet.

It is proposed that a simple API be exposed to let application developers specify the sticky item at any point in the scrolling process, named `list_set_sticky_func`.

The implementation will, upon scrolling the list widget, pass this function the index of the top-most visible item, and expect it to return the `ListItem` that should be stickied (or `NULL`).

[15] http://stackoverflow.com/questions/18302494/how-to-add-section-separators-dividers-to-a-listview

673 ### Blur effect

674 Given the `MxKineticScrollView` container does the actual scrolling, it is the best
675 place to implement the desired blur effect (seeblur effect). Additionally, im-
676 plementing it in the container means it can be implemented once instead of in
677 every widget that needs to have a blur effect.

678 ### On-demand item resource loading

679 By default, list items should assume they are not in view and should not perform
680 expensive operations until they have been signalled by the list widget that they
681 are in view (see On-demand item resource loading). For example, a music
682 application might have a long list of albums and each item has the album cover
683 showing. Instead of loading every single album cover when creating the list,
684 each list item should use a default dummy picture in its place. When the user
685 scrolls the list, revealing previously hidden items, the album cover should be
686 loaded and the default dummy picture replaced with the newly loaded picture.

687 The list widget should have a way of determining the item from given co-
688 ordinates so that it can signal to said item when it comes into view after a
689 scroll event. The list item object should only perform expensive operations
690 when it has come into view, by reading and monitoring a property on itself.
691 Once visible an item will not return to the not visible state.

692 ### Scroll bubbles

693 The bubble displayed when scrolling to indicate in which category the scroll is
694 showing (seescroll bubbles) should be added to `MxScrollBar` as that is the widget
695 that controls changing the scroll position.

696 ### Roller subclass

697 The roller widget should be implemented as a subclass of the list widget.

698 The roller widget will implement the `MxScrollable` interface, setting appropriate
699 increment values on its adjustments, in order to ensure the currently-focused
700 row will always be aligned with the middle after scrolling.

701 As the roller subclass will implement rollover, the elastic effect when reaching
702 the bottom of the list will not be used.

703 In addition, it will also, in its `init` method, use a `ClutterEffect` in order to
704 render itself as a cylinder (or ideally, as a hexagonal prism[16]).

[16] http://static.kidspot.com.au/cm_assets/32906/hexagonal-prism__346x210-jpg-20151022203100.jpg~q75,dx330y198u1r1gg,c--.jpg

Column layout

By default, the list widget will display as many items as fit per row, given the list's width and the configured item width. Properties will be provided for:

- A `row-spacing` property, setting the blank space between adjacent rows.
- A `column-spacing` property, setting the blank space between adjacent columns.
- An `item-width` property, setting the width of all columns.
- An `item-height` property, setting the height of all rows.

Note that `GtkFlowBox` supports reflowing children of different sizes; in this design, we only consider children of equal sizes, which simplifies the API. It is equivalent to considering a `GtkFlowBox` with its `homogeneous` property set to true.

So, for example, to display items in a single column (one item per row), set the `item-width` to equal the list's width. To implement a grid layout where some items may be missing and gaps should be left for them, implement a custom row widget which displays its own children in a grid; and display one such row widget per row of the list.

We suggest the default value for `item-width` is to track the list's width, so that the list uses a single column unless otherwise specified.

Focus animation

A `use-animations` property will be exposed on the list items. Upon activation, an item with this property set to `True` will be animated to cover the whole width and height allocated to the list widget.

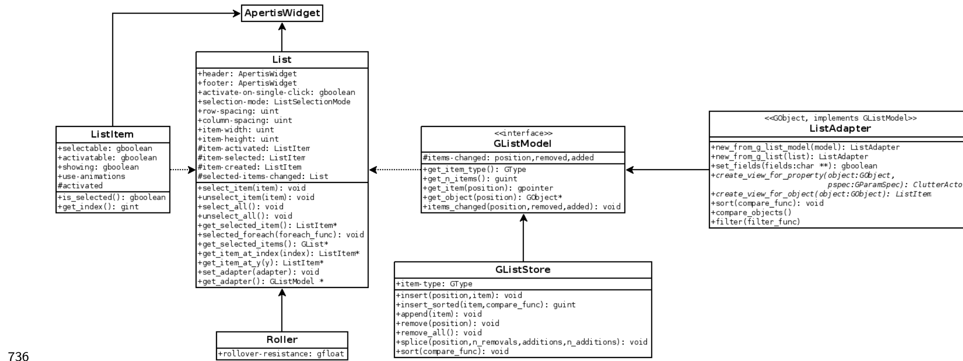
Application developers may connect to the `item-activated` signal in order to update the contents of the item, as shown in Item activation.

Once the set of possible and valuable animations has become clearer, API may be exposed to give more control to system integrators and application developers.

Item launching

In the roller subclass, the `item-activated` signal should only be emitted for actors in the currently focused row. This will ensure that only items that were scrolled to can be activated.

API diagram



Signals are shown with a hash beforehand (for example, `#item-activated`), with arguments listed afterwards. Properties are shown with a plus sign beforehand and without getters or setters (`get_model()`, `set_model()`) for brevity.

Example API usage

Basic usage

The following example creates a model, creates item actors for each artist available on the system, and adds them to the model. The exact API is purely an example but the approach to the API is to note.

As a simple example, this avoids creating a separate adapter and model, and instead creates a model which contains the list row widgets. In more complex examples, where data from the model is being used by multiple list widgets, the model and adapter are separate, and the entries in the model are not necessarily widget objects. See [Generic adapter] for such an example.

{{ ../examples/sample-list-api-usage-basic.c }}

The object created by `create_sample_artist_item` is an instance of `ClutterActor` (or an instance of a subclass) which defines how the item will display in the list. In that case, it is as simple as packing in a `ClutterText` to display the name of the artist as a string. More likely it would use a `ClutterBoxLayout` layout manager to pack different `ClutterActor`s into a horizontal line showing properties of the artist.

Item activation

The following example creates a list widget using the function defined in the previous section and connects to the `item-activated` signal to change the list item actor.

{{ ../examples/sample-list-api-usage-item-activated.c }}

762 **Filtering**

763 The following example shows how to filter the list store bound to the list widget
764 created using the function implemented in Basic usage to only display items
765 with a specific property.

766 {{ ../examples/sample-list-api-usage-filtering.c }}

767 **Multiple selection**

768 The following example sets the selection mode to allow multiple items to be
769 simultaneously selected.

770 {{ ../examples/sample-list-api-usage-selection.c }}

771 **Non-selectable items**

772 The following example makes half the items in a list impossible to select.

773 {{ ../examples/sample-list-api-usage-non-selectable-items.c }}

774 **Header items**

775 The following example adds alphabetical header items to the list.

776 {{ ../examples/sample-list-api-usage-header-items.c }}

777 **On-demand item resource loading**

778 The following example shows how on-demand item resource loading could be
779 implemented, using the model created in the first listing:

780 {{ ../examples/sample-list-api-usage-resource-loading.c }}

781 **Generic adapter**

782 The following example shows how developers may take advantage of the pro-
783 posed generic adapter.

784 {{ ../examples/sample-list-adapter-api-usage.c }}

785 **Alternative list adapter**

786 Authors of applications do not necessarily need to use a `GListStore` as their
787 adapter class. Instead they can implement the `GListModel` interface, and pass it
788 as the adapter for the list widget.

789 In the following example, we define and implement an adapter to optimise both
790 initialisation performance by creating `MyArtistItem`s only when required, and
791 memory usage by letting the `List` widget assume ownership of the created items.

792 {{ ../examples/alternative_list_model.c }}

Requirements

This design fulfils the following requirements:

-common api1 — the list widget and roller widget have the same API and any roller-specific roller API is in its own class.

-mvc separation1 — `GListModel` is used as an adapter to the backing data, which storage format is not imposed to the user. The list widget and item widgets are separate objects.

-data backend agnosticity1 — Applications provide list items through an adapter, no requirement is made as to the storage format.

-kinetic scrolling1 — use `MxKineticScrollView`.

- Elastic effect — use `MxKineticScrollView`.
- Item focus — list items can be selected (Selections).

-roller focus handling1 — this roller-specific selecting behaviour can be added to the roller's class.

-animations1 — use `MxKineticScrollView`.

-item launching1 — the item-activated signal on the list widget will signal when an item is activated.

-header and footer1 — `ApertisWidget`s can be set as header or footer header and footer2).

-roller rollover1 — this roller-specific rollover behaviour can be added to the roller's class.

-widget size1 — use `ClutterLayoutManager` and the `ClutterActor` properties widget size2).

-consistent focus1 — the API asserts a consistent focus and ensures the implementation behaves when the model changes.

-focus animation1 — items are `ClutterActor`s which can animate using regular Clutter API.

-mutable list1 — use `GListStore`.

-ui customisation1 — subclass `ApertisWidget` and use the `GtkStyleProvider`s.

-blur effect1 — add a `motion-blur` property to `MxKineticScrollView` and use that blur effect2).

-scrollbar1 — use the `scroll-visibility` property on the `MxScrollView` container.

-hardware scroll1 — use the adjustment on the list widget to scroll down a page, and use the appropriate function to move the selection on.

- On-demand item resource loading1 — ensure list widget can look up the item based on co-ordinates, and add a property to the list item object to denote whether it's in view, which the list widget updates.

-scroll bubbles1 — add support for overlay actors to `MxScrollBar`.

-item headers1 — Added as regular `ListItem`s in the adapter, a `list_set_sticky_func` API is exposed.

- Lazy list model — see Alternative list adapter, for an example of how application developers may implement their own model.
- Flow layout — The number of columns is calculated by dividing the list width by the specified item width. Padding between the resulting columns and rows may be specified using `row-spacing` and `column-spacing` properties.

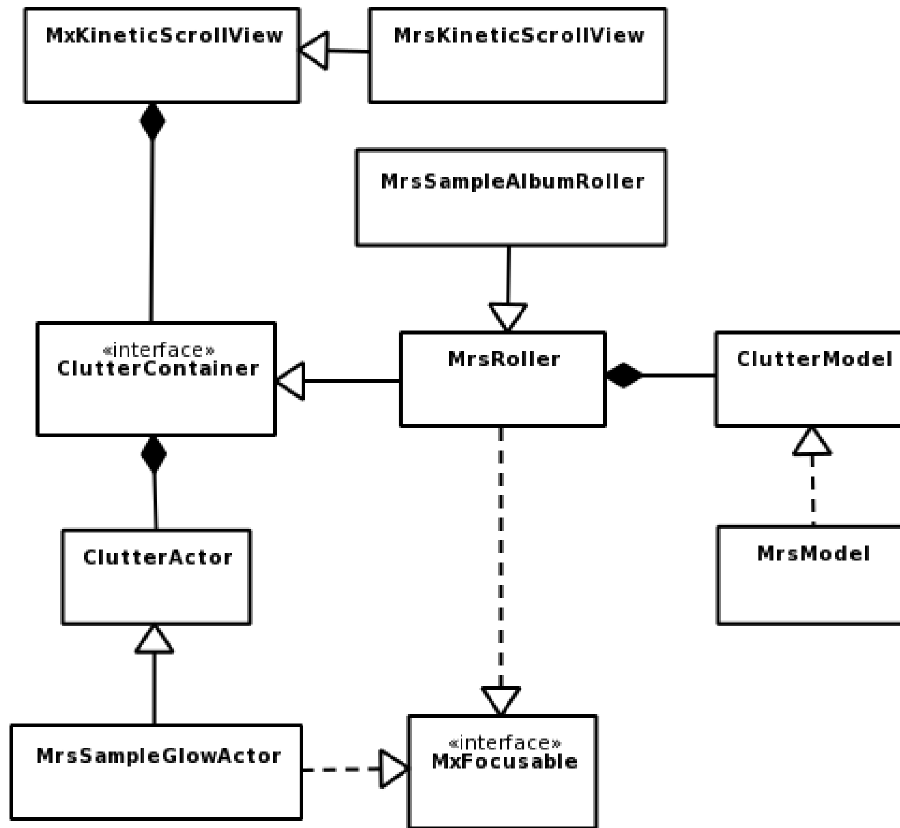
Summary of recommendations

As discussed in the above sections, we recommend:

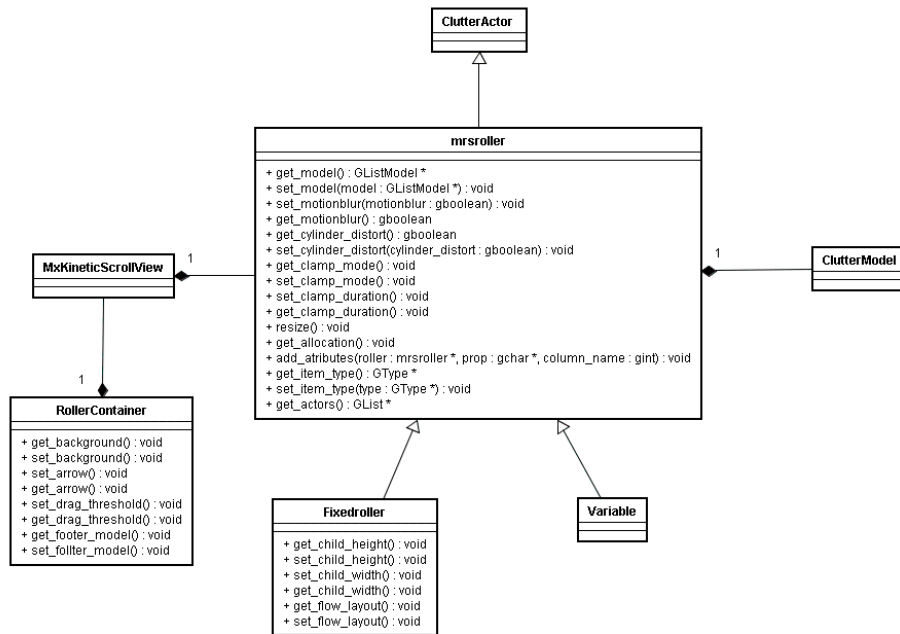
- Write a list widget partially based on `GtkListBox`, which subclasses `ApertisWidget`.
- Write a list item widget partially based on `GtkListBoxRow` which also subclasses ApertisWidget.
- Add a `motion-blur` property to `MxKineticScrollView`.
- Expose a sticky item callback registration method.
- Add support for overlay actors to `MxScrollBar`.
- Write a Roller widget as a list widget subclass.
- Ensure new widgets are easily customisable using CSS.
- Add demo programs for the new widgets.
- Define unit tests to run manually using the example programs to check the widgets work correctly.

852 # Appendix

853 ## Existing roller design



854


ClutterActor
mrsroller
+ get_model() : GListModel *
+ set_model(model : GListModel *) : void
+ set_motionblur(motionblur : gboolean) : void
+ get_motionblur() : gboolean
+ get_cylinder_distort() : gboolean
+ set_cylinder_distort(cylinder_distort : gboolean) : void
+ get_clamp_mode() : void
+ set_clamp_mode() : void
+ set_clamp_duration() : void
+ get_clamp_duration() : void
+ resize() : void
+ get_allocation() : void
+ add_atributes(roller : mrsroller *, prop : gchar *, column_name : gint) : void
+ get_item_type() : GType *
+ set_item_type(type : GType *) : void
+ get_actors() : GList *
MxKineticScrollView
1
ClutterModel
1
1
RollerContainer
+ get_background() : void
+ set_background() : void
+ set_arrow() : void
+ get_arrow() : void
+ set_drag_threshold() : void
+ get_drag_threshold() : void
+ get_footer_model() : void
+ set_follter_model() : void
Fixedroller
+ get_child_height() : void
+ set_child_height() : void
+ set_child_width() : void
+ get_child_width() : void
+ get_flow_layout() : void
+ set_flow_layout() : void
Variable
855