

Beyond the Basics

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Chapter 1. Beyond the Basics

This guide provides [more advanced](#) guidance on writing maintainable larger applications.

Later chapters discuss how to [deploy](#) your app, and discuss other ways in which you can [extend](#) or adapt the framework itself to your particular needs.

1.1. Other Guides

Apache Isis documentation is broken out into a number of user, reference and "supporting procedures" guides.

The user guides available are:

- [Fundamentals](#)
- [Wicket viewer](#)
- [Restful Objects viewer](#)
- [DataNucleus object store](#)
- [Security](#)
- [Testing](#)
- [Beyond the Basics](#) (this guide)

The reference guides are:

- [Annotations](#)
- [Domain Services](#)
- [Configuration Properties](#)
- [Classes, Methods and Schema](#)
- [Apache Isis Maven plugin](#)
- [Framework Internal Services](#)

The remaining guides are:

- [Developers' Guide](#) (how to set up a development environment for Apache Isis and contribute back to the project)
- [Committers' Guide](#) (release procedures and related practices)

Chapter 2. i18n

Apache Isis' support for internationalization (i18n) allows every element of the domain model (the class names, property names, action names, parameter names and so forth) to be translated.

It also supports translations of messages raised imperatively, by which we mean as the result of a call to `title()` to obtain an object's title, or messages resulting from any business rule violations (eg `disable...`() or `validate...`()), and so on.

The [Wicket viewer](#) (that is, its labels and messages) is also internationalized using the same mechanism. If no translations are available, then the Wicket viewer falls back to using Wicket resource bundles.

Isis does not translate the values of your domain objects, though. So, if you have a domain concept such as `Country` whose name is intended to be localized according to the current user, you will need to model this yourself.

2.1. Implementation Approach

Most Java frameworks tackle i18n by using Java's own `ResourceBundle` API. However, there are some serious drawbacks in this approach, including:

- if a string appears more than once (eg "name" or "description") then it must be translated everywhere it appears in every resource bundle file
- there is no support for plural forms (see this [SO answer](#))
- there is no tooling support for translators

Apache Isis therefore takes a different approach, drawing inspiration from GNU's [gettext](#) API and specifically its `.pot` and `.po` files. These are intended to be used as follows:

- the `.pot` (portable object template) file holds the message text to be translated
- this file is translated into multiple `.po` (portable object) files, one per supported locale
- these `.po` files are renamed according to their locale, and placed into the 'appropriate' location to be picked up by the runtime. The name of each `.po` resolved in a very similar way to resource bundles.

The format of the `.pot` and `.po` files is identical; the only difference is that the `.po` file has translations for each of the message strings. These message strings can also have singular and plural forms.



Although Apache Isis' implementation is modelled after GNU's API, it does *not* use any GNU software. This is for two reasons: (a) to simplify the toolchain/developer experience, and (b) because GNU software is usually GPL, which would be incompatible with the Apache license.

This design tackles all the issues of `ResourceBundles`:

- the `.po` message format is such that any given message text to translate need only be translated once, even if it appears in multiple places in the application (eg "Name")
- the `.po` message format includes translations for (optional) plural form as well as singular form
- there are lots of freely available editors [to be found](#), many summarized on this [Drupal.org](#) webpage.

In fact, there are also online communities/platforms of translators to assist with translating files. One such is [crowdin](#) (nb: this link does not imply endorsement).

In Apache Isis' implementation, if the translation is missing from the `.po` file then the original message text from the `.pot` file will be returned. In fact, it isn't even necessary for there to be any `.po` files; `.po` translations can be added piecemeal as the need arises.

2.2. TranslationService

The cornerstone of Apache Isis' support for i18n is the `TranslationService` service. This is defined in the `applib` with the following API:

```
public interface TranslationService {
    public String translate(      ❶
        final String context,
        final String text);
    public String translate(      ❷
        final String context,
        final String singularText,
        final String pluralText,
        final int num);
    public enum Mode {
        READ,
        WRITE;
    }
    Mode getMode();              ❸
}
```

❶ is to translate the singular form of the text

❷ is to translate the plural form of the text

❸ indicates whether the translation service is in read or write mode.

The `translate(...)` methods are closely modelled on GNU's `gettext` API. The first version is used when no translation is required, the second is when both a singular and plural form will be required, with the `num` parameter being used to select which is returned. In both cases the `context` parameter provides some contextual information for the translator; this generally corresponds to the class member.

The mode meanwhile determines the behaviour of the service. More on this below.

2.2.1. TranslationServicePo

Isis provides a default implementation of `TranslationService`, namely `TranslationServicePo`.

If the service is running in the normal read mode, then it simply provides translations for the locale of the current user. This means it locates the appropriate `.po` file (based on the requesting user's locale), finds the translation and returns it.

If however the service is configured to run in write mode, then it instead records the fact that the message was requested to be translated (a little like a spy/mock in unit testing mock), and returns the original message. The service can then be queried to discover which messages need to be translated. All requested translations are written into the `.pot` file.

To make the service as convenient as possible to use, the service configures itself as follows:

- if running in prototype mode `deployment type` or during integration tests, then the service runs in **write** mode, in which case it records all translations into the `.pot` file. The `.pot` file is written out when the system is shutdown.
- if running in server (production) mode `deployment type`, then the service runs in **read** mode. It is also possible to set a configuration setting in `isis.properties` to force read mode even if running in prototype mode (useful to manually test/demo the translations).

When running in write mode the original text is returned to the caller untranslated. If in read mode, then the translated `.po` files are read and translations provided as required.

2.3. Imperative messages

The `TranslationService` is used internally by Apache Isis when building up the metamodel; the name and description of every class, property, collection, action and action parameter is automatically translated. Thus the simple act of bootstrapping Apache Isis will cause most of the messages requiring translation (that is: those for the Apache Isis metamodel) to be captured by the `TranslationService`.

However, for an application to be fully internationalized, any validation messages (from either `disableXxx()` or `validateXxx()` supporting methods) and also possibly an object's title (from the `title()` method) will also require translation. Moreover, these messages must be captured in the `.pot` file such that they can be translated.

2.3.1. TranslatableString

The first part of the puzzle is tackled by an extension to Apache Isis' programming model. Whereas previously the `disableXxx()` / `validateXxx()` / `title()` methods could only return a `java.lang.String`, they may now optionally return a `TranslatableString` (defined in Isis applib) instead.

Here's a (silly) example from the `SimpleApp` archetype:

```
public TranslatableString validateUpdateName(final String name) {
    return name.contains("!")? TranslatableString.tr("Exclamation mark is not allowed
"): null;
}
```

This corresponds to the following entry in the `.pot` file:

```
#: dom.simple.SimpleObject#updateName()
msgid "Exclamation mark is not allowed"
msgstr ""
```

The full API of `TranslatableString` is modelled on the design of GNU gettext (in particular the [gettext-commons](#) library):

```
public final class TranslatableString {
    public static TranslatableString tr(           ❶
        final String pattern,
        final Object... paramArgs) { ... }
    public static TranslatableString trn(         ❷
        final String singularPattern,
        final String pluralPattern,
        final int number,
        final Object... paramArgs) { ... }
    public String translate(                       ❸
        final TranslationService translationService,
        final String context) { ... }
}
```

- ❶ returns a translatable string with a single pattern for both singular and plural forms.
- ❷ returns a translatable string with different patterns for singular and plural forms; the one to use is determined by the 'number' argument
- ❸ translates the string using the provided `TranslationService`, using the appropriate singular/regular or plural form, and interpolating any arguments.

The interpolation uses the format `{xxx}`, where the placeholder can occur multiple times.

For example:

```
final TranslatableString ts = TranslatableString.tr(
    "My name is {lastName}, {firstName} {lastName}.",
    "lastName", "Bond", "firstName", "James");
```

would interpolate (for the English locale) as "My name is Bond, James Bond".

For a German user, on the other hand, if the translation in the corresponding `.po` file was:


```
#: xxx.yyy.Whatever#context()
msgid "My name is {lastName}, {firstName} {lastName}."
msgstr "Ich heisse {firstName} {lastName}."
```

then the translation would be: "Ich heisse James Bond".

The same class is used in `DomainObjectContainer` so that you can raise translatable info, warning and error messages; each of the relevant methods are overloaded.

For example:

```
public interface DomainObjectContainer {
    void informUser(String message);
    void informUser(
        TranslatableMessage message,
        final Class<?> contextClass, final String contextMethod); ①
    ...
}
```

① are concatenated together to form the context for the `.pot` file.

2.3.2. TranslatableException

Another mechanism by which messages can be rendered to the user are as the result of exception messages thrown and recognized by an `ExceptionRecognizer`.

In this case, if the exception implements `TranslatableException`, then the message will automatically be translated before being rendered. The `TranslatableException` itself takes the form:

```
public interface TranslatableException {
    TranslatableString getTranslatableMessage(); ①
    String getTranslationContext();              ②
}
```

① the message to translate. If returns `null`, then the `Exception#getMessage()` is used as a fallback

② the context to use when translating the message

2.4. Wicket Viewer

The `Wicket viewer` (its labels and messages) is also internationalized using the `TranslationService`. This is done through an Isis-specific implementation of the Wicket framework's `org.apache.wicket.Localizer` class, namely `LocalizerForIsis`.

The Wicket `Localizer` defines the following API:

```

public String getString(
    final String key,           ①
    final Component component,  ②
    final IModel<?> model,
    final Locale locale,
    final String style,
    final String defaultValue)
    throws MissingResourceException { ... }

```

- ① The key to obtain the resource for
- ② The component to get the resource for (if any)

For example, `key` might be a value such as "okLabel", while `component` an internal class of the Wicket viewer, such as `EntityPropertiesForm`.

The `LocalizerForIsis` implementation uses the `key` as the `msgId`, while the fully qualified class name of the `component` is used as a context. There is one exception to this: if the component is the third-party select2 component (used for drop-downs), then that class name is used directly.

In the main, using Isis' i18n support means simply adding the appropriate translations to the `translation.po` file, for each locale that you require. If the translations are missing then the original translations from the Wicket resource bundles will be used instead.

2.4.1. Commonly used

Most of the translation requirements can be covered by adding in the following `msgIds`:

```

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "CollectionContentsAsAjaxTablePanelFactory.Table"
msgstr "Table"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "CollectionContentsAsUnresolvedPanel.Hide"
msgstr "Hide"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "aboutLabel"
msgstr "About"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "cancelLabel"
msgstr "Cancel"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "datatable.no-records-found"
msgstr "No Records Found"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "editLabel"

```

```

msgstr "Edit"

#: org.wicketstuff.select2.Select2Choice
msgid "inputTooShortPlural"
msgstr "Please enter {number} more characters"

#: org.wicketstuff.select2.Select2Choice
msgid "inputTooShortSingular"
msgstr "Please enter 1 more character"

#: org.wicketstuff.select2.Select2Choice
msgid "loadMore"
msgstr "Load more"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "logoutLabel"
msgstr "Logout"

#: org.wicketstuff.select2.Select2Choice
msgid "noMatches"
msgstr "No matches"

#: org.apache.isis.viewer.wicket.ui.pages.entity.EntityPage
msgid "okLabel"
msgstr "OK"

#: org.wicketstuff.select2.Select2Choice
msgid "searching"
msgstr "Searching..."

#: org.wicketstuff.select2.Select2Choice
msgid "selectionTooBigPlural"
msgstr "You can only select {limit} items"

#: org.wicketstuff.select2.Select2Choice
msgid "selectionTooBigSingular"
msgstr "You can only select 1 item"

```

2.4.2. Login/self-sign-up

In addition, there are a reasonably large number of messages that are used for both login and the [user registration](#) (self sign-up) and password reset features.

These are:

```

#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage
msgid "AutoLabel.CSS.required"
msgstr "Required"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage

```

```

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "confirmPasswordLabel"
msgstr "Confirm password"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
msgid "emailIsNotAvailable"
msgstr "The given email is already in use"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "emailPlaceholder"
msgstr "Enter your email"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
msgid "emailPlaceholder"
msgstr "Enter an email for the new account"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "emailLabel"
msgstr "Email"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "emailSentMessage"
msgstr "An email has been sent to '${email}' for verification."

#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage
msgid "forgotPasswordLinkLabel"
msgstr "Forgot your password?"

#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage
msgid "loginHeader"
msgstr "Login"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "noSuchUserByEmail"
msgstr "There is no account with this email"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "noUserForAnEmailValidToken"
msgstr "The account seems to be either already deleted or has changed its email address. Please try again."

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "passwordChangeSuccessful"
msgstr "The password has been changed successfully. You can <a class=\"alert-success\"

```

```
style="\text-decoration:underline;" href="\${signInUrl}">login</a> now."
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage  
msgid "passwordChangeUnsuccessful"  
msgstr "There was a problem while updating the password. Please try again."
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage  
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage  
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage  
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage  
msgid "passwordLabel"  
msgstr "Password"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage  
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage  
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage  
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage  
msgid "passwordPlaceholder"  
msgstr "Enter password"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage  
msgid "passwordResetExpiredOrInvalidToken"  
msgstr "You are trying to reset the password for an expired or invalid token"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage  
msgid "passwordResetHeader"  
msgstr "Forgot password"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage  
msgid "passwordResetSubmitLabel"  
msgstr "Submit"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage  
msgid "registerButtonLabel"  
msgstr "Register"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage  
msgid "registerHeader"  
msgstr "Register"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage  
msgid "rememberMeLabel"  
msgstr "Remember Me"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage  
msgid "resetButtonLabel"  
msgstr "Reset"
```

```
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage  
msgid "signInButtonLabel"  
msgstr "Sign in"
```

```

#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage
msgid "signUpButtonLabel"
msgstr "Don't have an account? Sign up now."

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "signUpButtonLabel"
msgstr "Verify email"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
msgid "signUpHeader"
msgstr "Sign Up"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "usernameIsNotAvailable"
msgstr "The provided username is already in use"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "usernameLabel"
msgstr "Username"

#: org.apache.isis.viewer.wicket.ui.pages.accmngt.signup.RegistrationFormPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.register.RegisterPage
#: org.apache.isis.viewer.wicket.ui.pages.login.WicketSignInPage
#: org.apache.isis.viewer.wicket.ui.pages.accmngt.password_reset.PasswordResetPage
msgid "usernamePlaceholder"
msgstr "Username"

```

2.5. Integration Testing

So much for the API; but as noted, it is also necessary to ensure that the required translations are recorded (by the [TranslationService](#)) into the `.pot` file.

For this, we recommend that you ensure that all such methods are tested through an [integration test](#) (not unit test).

For example, here's the corresponding integration test for the "Exclamation mark" example from the simpleapp (above):

```

@Rule
public ExpectedException expectedException = ExpectedException.none();

@Inject
FixtureScripts fixtureScripts;

@Test
public void failsValidation() throws Exception {
    // given
    RecreateSimpleObjects fs = new RecreateSimpleObjects().setNumber(1);
    fixtureScripts.runFixtureScript(fs, null);
    SimpleObject simpleObjectWrapped = wrap(fs.getSimpleObjects().get(0));

    // expect
    expectedExceptions.expect(InvalidException.class);
    expectedExceptions.expectMessage("Exclamation mark is not allowed");

    // when
    simpleObjectWrapped.updateName("new name!");
}

```

Running this test will result in the framework calling the `validateUpdateName(...)` method, and thus to record that a translation is required in the `.pot` file.

When the integration tests are complete (that is, when Apache Isis is shutdown), the `TranslationServicePo` will write out all captured translations to its log (more on this below). This will include all the translations captured from the Apache Isis metamodel, along with all translations as exercised by the integration tests.

To ensure your app is fully internationalized app, you must therefore:

- use `TranslatableString` rather than `String` for all validation/disable and title methods.
- ensure that (at a minimum) all validation messages and title methods are integration tested.



We make no apologies for this requirement: one of the reasons that we decided to implement Apache Isis' i18n support in this way is because it encourages/requires the app to be properly tested.

Behind the scenes Apache Isis uses a JUnit rule (`ExceptionRecognizerTranslate`) to intercept any exceptions that are thrown. These are simply passed through to the registered `ExceptionRecognizers` so that any messages are recorded as requiring translation.

2.6. Escaped strings

Translated messages can be escaped if required, eg to include embedded markup.

```
#: com.mycompany.myapp.OrderItem#quantity
msgid "<i>Quantity</i>"
msgstr "<i>Quantité</i>"
```

For this to work, the `namedEscaped()` attribute must be specified using either the [layout file](#), or using an annotation such as `@PropertyLayout` or `@ParameterLayout`.

For example:

```
@ParameterLayout(
    named="<i>Quantity</i>",      ❶
    namedEscaped=false
)
public Integer getQuantity() { ... }
```

❶ required (even though it won't be used when a translation is read; otherwise the escaped flag is ignored)

2.7. Configuration

There are several different aspects of the translation service that can be configured.

2.7.1. Logging

To configure the `TranslationServicePo` to write to out the `translations.pot` file, add the following to the `integtests logging.properties` file:

```
log4j.appender.translations-po=org.apache.log4j.FileAppender
log4j.appender.translations-po.File=./translations.pot
log4j.appender.translations-po.Append=false
log4j.appender.translations-po.layout=org.apache.log4j.PatternLayout
log4j.appender.translations-po.layout.ConversionPattern=%m%n

log4j.logger.org.apache.isis.core.runtime.services.i18n.po.PoWriter=INFO,translations-po
log4j.additivity.org.apache.isis.core.runtime.services.i18n.po.PotWriter=false
```

Just to repeat, this is *not* the `WEB-INF/logging.properties` file, it should instead be added to the `integtests/logging.properties` file.

2.7.2. Location of the `.po` files

The default location of the translated `.po` files is in the `WEB-INF` directory. These are named and searched for similarly to regular Java resource bundles.

For example, assuming these translations:


```
/WEB-INF/translations-en-US.po
  /translations-en.po
  /translations-fr-FR.po
  /translations.po
```

then:

- a user with **en-US** locale will use **translations-en-US.po**
- a user with **en-GB** locale will use **translations-en.po**
- a user with **fr-FR** locale will use **translations-fr-FR.po**
- a user with **fr-CA** locale will use **translations.po**

The basename for translation files is always **translations**; this cannot be altered.

2.7.3. Externalized translation files

Normally Apache Isis configuration files are read from the **WEB-INF** file. However, Apache Isis can be configured to read config files from an **external directory**; this is also supported for translations.

Thus, if in **web.xml** the external configuration directory has been set:

```
<context-param>
  <param-name>isis.config.dir</param-name>
  <param-value>location of external config directory</param-value>
</context-param>
```

Then this directory will be used as the base for searching for translations (rather than the default 'WEB-INF/' directory).

2.7.4. Force read mode

As noted above, if running in prototype mode then **TranslationServicePo** will be in write mode, if in production mode then will be in read mode. To force read mode (ie use translations) even if in prototype mode, add the following configuration property to **isis.properties**:

```
isis.services.translation.po.mode=read
```

2.8. Supporting services

The **TranslationServicePo** has a number of supporting/related services.

2.8.1. LocaleProvider

The **LocaleProvider** API is used by the **TranslationServicePo** implementation to obtain the locale of the "current user".

A default implementation is provided by the Wicket viewer.



Note that this default implementation does not support requests made through the Restful Objects viewer (there is no Wicket 'application' object available); the upshot is that requests through Restful Objects are never translated. Registering a different implementation of `LocaleProvider` that taps into appropriate REST (RestEasy?) APIs would be the way to address this.

2.8.2. `TranslationsResolver`

The `TranslationsResolver` is used by the `TranslationService` implementation to lookup translations for a specified locale. It is this service that reads from the `WEB-INF/` (or externalized directory).

2.8.3. `TranslationServicePoMenu`

The `TranslationServicePoMenu` provides a couple of menu actions in the UI (prototype mode only) that interacts with the underlying `TranslationServicePo`:

- the `downloadTranslationsFile()` action - available only in write mode - allows the current `.pot` file to be downloaded.



While this will contain all the translations from the metamodel, it will not necessarily contain all translations for all imperative methods returning `TranslatableString` instances; which are present and which are missing will depend on which imperative methods have been called (recorded by the service) prior to downloading.

- the `clearTranslationsCache()` action - available only in read mode - will clear the cache so that new translations can be loaded.

This allows a translator to edit the appropriate `translations-xx-XX.po` file and check the translation is correct without having to restart the app.

Chapter 3. Headless access

This section tackles the topic of enabling access to an Isis application directly, or at least, not through either the [Wicket](#) or [Restful](#) viewers.

There are several main use-cases:

- enabling background execution, eg of a thread managed by Quartz scheduler and running within the webapp
- integration from other systems, eg for a subscriber on a pub/sub mechanism such as Camel, pushing changes through an Apache Isis domain model.
- leveraging an Isis application within a batch process

Note that the calling thread runs in the same process space as the Apache Isis domain object model (must be physically linked to the JAR files containing the domain classes). For use cases where the calling thread runs in some other process space (eg migrating data from a legacy system), then the [Restful Objects viewer](#) is usually the way to go.

The API described in this chapter is reasonably low-level, allowing code to interact very directly with the Apache Isis metamodel and runtime. Such callers should be considered trusted: they do not (by default) honour any business rules eg implicit in the Isis annotations or hide/disable/validate methods. However the [WrapperFactory](#) service could be used to enforce such business rules if required.

3.1. AbstractIsisSessionTemplate

The [AbstractIsisSessionTemplate](#) class (whose name is inspired by the Spring framework's naming convention for similar classes that query [JDBC](#), [JMS](#), [JPA](#) etc.) provides the mechanism to open up a 'session' within the Apache Isis framework, in order to resolve and interact with entities.

The class itself is intended to be subclassed:

```
public abstract class AbstractIsisSessionTemplate {  
  
    public void execute(final AuthenticationSession authSession, final Object context)  
    { ... } ①  
    protected abstract void doExecute(Object context); ②  
  
    protected ObjectAdapter adapterFor(final Object targetObject) { ... }  
    protected ObjectAdapter adapterFor(final RootOid rootOid) { ... }  
  
    protected PersistenceSession getPersistenceSession() { ... }  
    protected IsisTransactionManager getTransactionManager() { ... }  
    protected AdapterManager getAdapterManager() { ... }  
}
```

① `execute(...)` sets up the [IsisSession](#) and delegates to ...

② `doExecute(...)`, the mandatory hook method for subclasses to implement. The passed object represents a context from the caller (eg the scheduler, cron job, JMS etc) that instantiated and executed the class.

The `protected` methods expose key internal APIs within Apache Isis, for the subclass to use as necessary.



One notable feature of `AbstractIsisSessionTemplate` is that it will automatically inject any domain services into itself. Thus, it is relatively easy for the subclass to "reach into" the domain, through injected repository services.

3.2. BackgroundCommandExecution

The `BackgroundCommandExecution` class (a subclass of `AbstractIsisSessionTemplate`) is intended to simplify the execution of background `Commands` persisted by way of the `CommandService` and the `BackgroundCommandService`.

Its signature is:

```
public abstract class BackgroundCommandExecution extends AbstractIsisSessionTemplate {
    protected void doExecute(Object context) { ... }
    protected abstract List<? extends Command> findBackgroundCommandsToExecute(); ①
}
```

① `findBackgroundCommandsToExecute()` is a mandatory hook method for subclasses to implement.

This allows for different implementations of the `CommandService` and `BackgroundCommandService` to persist to wherever.

The diagram below (yuml.me/363b335f) shows the dependencies between these various classes:



Figure 1. Inheritance Hierarchy for `BackgroundCommandExecution`

3.2.1. Background Execution

The `BackgroundCommandExecutionFromBackgroundCommandServiceJdo` is a concrete subclass of `BackgroundCommandExecution` (see the `BackgroundCommandService`), the intended use being for the class to be instantiated regularly (eg every 10 seconds) by a scheduler such as `Quartz` to poll for `Commands` to be executed, and then execute them.

This implementation queries for `Commands` persisted by the `Isis addons Command Module's` implementations of `CommandService` and `BackgroundCommandService` using the `BackgroundCommandServiceJdoRepository`.

The diagram below (yuml.me/25343da1) shows the inheritance hierarchy for this class:

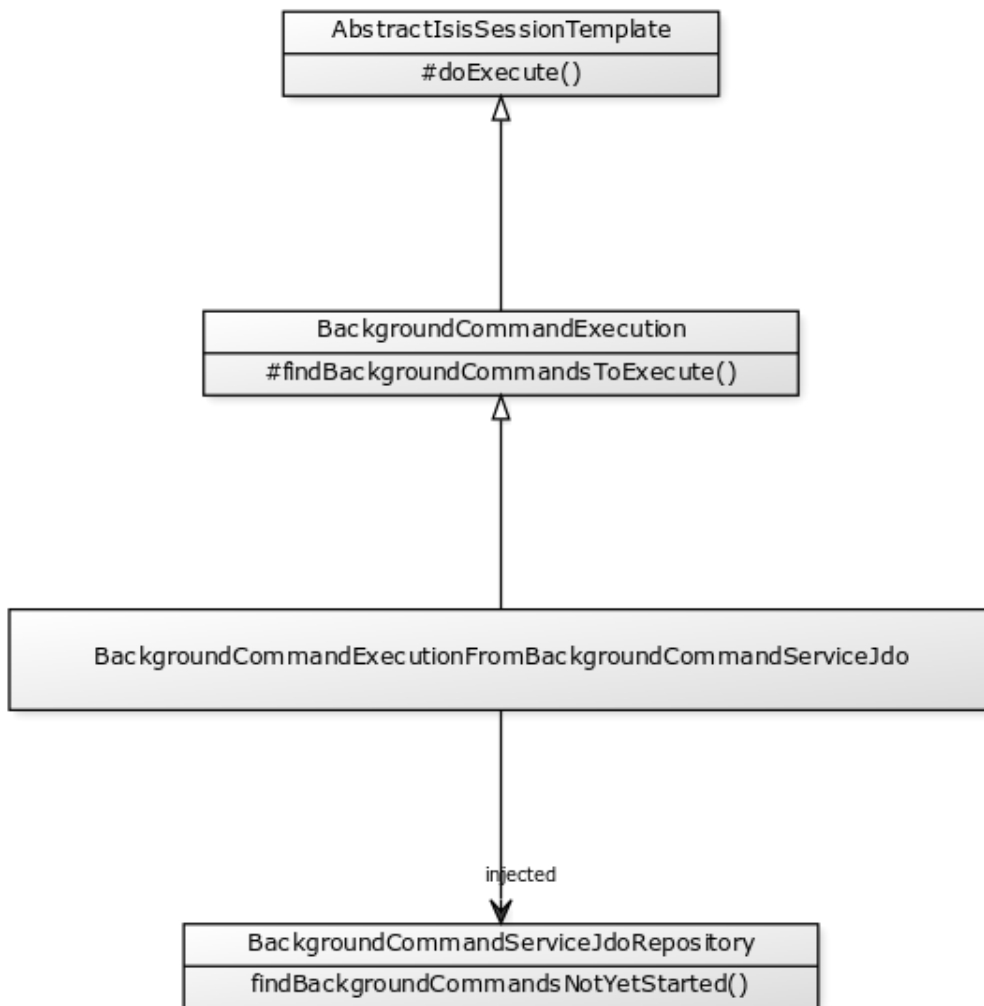


Figure 2. Inheritance Hierarchy for `BackgroundCommandExecutionFromBackgroundCommandServiceJdo`

Chapter 4. Hints and Tips

This chapter provides some solutions for problems we've encountered ourselves or have been raised on the Apache Isis mailing lists.

See also hints-n-tips chapters in the:

- the [Developers'](#) guide
- the [Wicket viewer](#) guide
- the [Restful Objects viewer](#) guide
- the [Datanucleus ObjectStore](#) guide
- the [Security](#) guide
- the [Beyond the Basics](#) guide (this chapter).

4.1. 'Are you sure?' idiom

Sometimes an action might perform irreversible changes. In such a case it's probably a good idea for the UI to require that the end-user explicitly confirms that they intended to invoke the action.

4.1.1. Using action semantics

One way to meet this requirement is using the framework's built-in `@Action#semantics()` attribute:

```
@Action(  
    semantics = SemanticsOf.IDEMPOTENT_ARE_YOU_SURE  
)  
public SimpleObject updateName(  
    @Parameter(maxLength = NAME_LENGTH)  
    @ParameterLayout(named = "New name")  
    final String name) {  
    setName(name);  
    return this;  
}
```

This will render as:



4.1.2. Using a checkbox

An alternative approach (for all versions of the framework) is to require the end-user to check a dummy checkbox parameter (and prevent the action from being invoked if the user hasn't checked that parameter).

For example:



Note that these screenshots shows an earlier version of the [Wicket viewer](#) UI (specifically, pre 1.8.0).

If the user checks the box:



Buy bread due by 2014-10-14

Delete

ARE YOU SURE? *



OK

CANCEL

then the action will complete.

However, if the user fails to check the box, then a validation message is shown:



Buy milk due by 2014-10-14

Delete

ARE YOU SURE? *



Please confirm you are sure

OK

CANCEL

The code for this is pretty simple:

```
public List<ToDoItem> delete(@Named("Are you sure?") boolean areYouSure) {
    container.removeIfNotAlready(this);
    container.informUser("Deleted " + container.titleOf(this));
    return toDoItems.notYetComplete(); ①
}
public String validateDelete(boolean areYouSure) {
    return areYouSure? null: "Please confirm you are sure";
}
```

① invalid to return `this` (cannot render a deleted object)

Note that the action itself does not use the boolean parameter, it is only used by the supporting `validate...` method.

4.2. Overriding Default Service Implns

The framework provides default implementations for many of the [domain services](#). This is convenient, but sometimes you will want to replace the default implementation with your own service implementation.

For example, suppose you wanted to provide your own implementation of `LocaleProvider`. The trick is to use the `@DomainService#menuOrder()` attribute, specifying a low number (typically "1").

Here's how:

```
@DomainService(  
    nature = NatureOfService.DOMAIN,  
    menuOrder = "1" ①  
)  
public class MyLocaleProvider implements LocaleProvider {  
    @Override  
    public Locale getLocale() {  
        return ...  
    }  
}
```

① takes precedence over the default implementation.

The framework uses the value of the `menuOrder` attribute to determine priority; lowest number wins.

Thus, if a single instance is to be injected, eg:

```
@javax.inject.Inject  
LocaleProvider localeProvider;
```

then the custom implementation will be used in preference to the framework's default implementation.

If multiple instances are injected, eg:

```
@javax.inject.Inject  
List<LocaleProvider> localeProviders;
```

then all implementations will be present in the list, ordered by priority; your custom implementation will be first in the list.

As of **1.15.0-SNAPSHOT**, there is no need to specify the `menuOrder` attribute: its default value is now set to a lower value (specifically: `Integer.MAX_VALUE - 100`). Thus, the code simplifies to:

```

@DomainService(nature = NatureOfService.DOMAIN)
public class MyLocaleProvider implements LocaleProvider {
    @Override
    public Locale getLocale() {
        return ...
    }
}

```



It is also possible to use `@DomainServiceLayout#menuOrder()` attribute, rather than `@DomainService#menuOrder()`. The general convention is to use the former only for services that are rendered in the UI, the latter for programmatic services.

If both attributes are present, then the value of `@DomainServiceLayout#menuOrder()` is used.

4.2.1. Decorating existing implementations

It's also quite common to want to decorate the existing implementation (ie have your own implementation delegate to the default); this is also possible and quite easy:

```

@DomainService(
    nature = NatureOfService.DOMAIN
)
@DomainServiceLayout(
    menuOrder = "1"
①
)
public class MyLocaleProvider implements LocaleProvider {
    @Override
    public Locale getLocale() {
        return getDelegateLocaleProvider().getLocale();
    }
    Optional<LocaleProvider> delegateLocaleProvider;
    ③
    private LocaleProvider getDelegateLocaleProvider() {
        if(delegateLocaleProvider == null) {
            delegateLocaleProvider = Iterables.tryFind(localeProviders, input -> input
            != this); ④
        }
        return delegateLocaleProvider.orNull();
    }
    @Inject
    List<LocaleProvider> localeProviders;
    ⑤
}

```

① takes precedence over the default implementation when injected elsewhere.

- ② this implementation merely delegates to the default implementation
- ③ lazily populated
- ④ delegate to the first implementation that isn't *this* implementation (else infinite loop!)
- ⑤ Injects all implementations, including this implementation

4.3. Vetoing Visibility



FIXME - a write-up of the "vetoing subscriber" design pattern, eg as described in the [BookmarkService](#)

eg if included an addon such as auditing or security.

solution is to write a domain event subscriber that vetoes the visibility

All the addons actions inherit from common base classes so this can be as broad-brush or fine-grained as required

4.4. Transactions and Errors

In Apache Isis, every interaction (action invocation or property edit) is automatically wrapped in a transaction, and any repository query automatically does a flush before hand.

What that means is that there's no need to explicitly start or commit transactions in Apache Isis; this will be done for you. Indeed, if you do try to manage transactions (eg by reaching into the JDO [PersistenceManager](#) exposed by the [IsisJdoSupport](#) domain service, then you are likely to confuse the framework and get a stack trace for your trouble.

However, you can complete a given transaction and start a new one. This is sometimes useful if writing a fixture script which is going to perform some sort of bulk migration of data from an old system. For this use case, use the [TransactionService](#).

For example:

```
public class SomeLongRunningFixtureScript extends FixtureScript

    protected void execute(final ExecutionContext executionContext) {
        // do some work
        transactionService.nextTransaction();
        // do some work
        transactionService.nextTransaction();
        // do yet more work
    }

    @javax.inject.Inject
    TransactionService transactionService;
}
```

You get the idea.

4.4.1. Raise message in the UI

The framework provides the `MessageService` as a means to return an out-of-band message to the end-user. In the `Wicket viewer` these are shown as "toast" pop-ups; the `Restful Objects viewer` returns an HTTP header.

The `UserService` provides three APIs, for different:

- `informUser()` - an informational message. In the Wicket viewer these are short-lived pop-ups that disappear after a short time.
- `warnUser()` - a warning. In the Wicket viewer these do not auto-close; they must be acknowledged.
- `raiseError()` - an error. In the Wicket viewer these do not auto-close; they must be acknowledged.

Each pop-up has a different background colour indicating its severity.

None of these messages/errors has any influence on the transaction; any changes to objects will be committed.

4.4.2. Aborting transactions

If you want to abort Apache Isis' transaction, this can be done by throwing an exception. The exception message is displayed to the user on the error page (if `Wicket viewer`) or a 500 status error code (if the `Restful Objects viewer`).

If the exception thrown is because of an unexpected error (eg a `NullPointerException` in the domain app itself), then the error page will include a stack trace. If however you want to indicate that the exception is in some sense "expected", then throw a `RecoverableException` (or any subclass, eg `ApplicationException`); the stack trace will then be suppressed from the error page.

Another way in which exceptions might be considered "expected" could be as the result of attempting to persist an object which then violates some type of database constraint. Even if the domain application checks beforehand, it could be that another user operating on the object at the same moment of time might result in the conflict.

To handle this the `ExceptionRecognizer` SPI can be used. The framework provides a number of implementations out-of-the-box; whenever an exception is thrown it is passed to each known recognizer implementation to see if it recognizes the exception and can return a user-meaningful error message. For example, `ExceptionRecognizerForSQLIntegrityConstraintViolationUniqueOrIndexException` checks if the exception inherits from `java.sql.SQLIntegrityConstraintViolationException`, and if so, constructs a suitable message.

4.5. Persisted Title

Normally the title of an object is not persisted to the database, rather it is recomputed automatically from underlying properties. On occasion though you might want the title to also be persisted; either to make things easier for the DBA, or for an integration scenario, or some other purpose.

We can implement this feature by leveraging the [JDO lifecycle](#). In the design we discuss here we make it a responsibility of the entities to persist the title as a property, by implementing a `ObjectWithPersistedTitle` interface:

```
public interface ObjectWithPersistedTitle {
    @PropertyLayout(hidden = Where.EVERYWHERE) ①
    String getTitle();
    void setTitle(final String title);
}
```

① we don't want to expose this in the UI because the title is already prominently displayed.

We can then define a subscribing domain service that leverage this.

```
@DomainService(nature = NatureOfService.DOMAIN)
public class TitlingService extends AbstractSubscriber {
    @Subscribe
    public void on(final ObjectPersistingEvent ev) {
        handle(ev.getSource());
    }
    @Subscribe
    public void on(final ObjectUpdatingEvent ev) {
        handle(ev.getSource());
    }
    private void handle(final Object persistentInstance) {
        if(persistentInstance instanceof ObjectWithPersistedTitle) {
            final ObjectWithPersistedTitle objectWithPersistedTitle =
                (ObjectWithPersistedTitle) persistentInstance;
            objectWithPersistedTitle.setTitle(container.titleOf
(objectWithPersistedTitle));
        }
    }
    @Inject
    private DomainObjectContainer container;
}
```

Prior to 1.10.0 (when lifecycle events were introduced), this could also be done by accessing the JDO API directly:

```

@RequestScoped
@DomainService(nature = NatureOfService.DOMAIN)
public class TitlingService {
    @PostConstruct
    public void init() {
        isisJdoSupport.getJdoPersistenceManager().addInstanceLifecycleListener(
            new StoreLifecycleListener() {
                @Override
                public void preStore(final InstanceLifecycleEvent event) {
                    final Object persistentInstance = event.getPersistentInstance();
                    if(persistentInstance instanceof ObjectWithPersistedTitle) {
                        final ObjectWithPersistedTitle objectWithPersistedTitle =
                            (ObjectWithPersistedTitle) persistentInstance;
                        objectWithPersistedTitle.setTitle(container.titleOf
(objectWithPersistedTitle));
                    }
                }
                @Override
                public void postStore(final InstanceLifecycleEvent event) {
                }
            }, null);
    }
    @Inject
    private IsisJdoSupport isisJdoSupport;
    @Inject
    private DomainObjectContainer container;
}

```

The above is probably the easiest and most straightforward design. One could imagine other designs where the persisted title is stored elsewhere. It could even be stored off into an [Apache Lucene](#) (or similar) database to allow for free-text searches.

4.6. Collections of values

Although in Apache Isis you can have properties of either values (string, number, date etc) or of (references to other) entities, with collections the framework (currently) only supports collections of (references to) entities. That is, collections of values (a bag of numbers, say) are not supported.

However, it is possible to simulate a bag of numbers using view models.

4.6.1. View Model



FIXME

4.6.2. Persistence Concerns



FIXME - easiest to simply store using DataNucleus' support for collections, marked as `@Programmatic` so that it is ignored by Apache Isis. Alternatively can store as json/xml in a `varchar(4000)` or clob and manually unpack.

4.7. How to handle void/null results

From this [thread](#) on the Apache Isis users mailing list:

- *When using a `void` action, let's say a remove action, the user is redirected to a page "no results". When clicking the back button in the browser the user sees "Object not found" (since you've just deleted this object).*
- *You can return a list for example to prevent the user from being redirect to a "No results" page, but I think it's not the responsibility of the controllers in the domain model.*
- *A solution could be that wicket viewer goes back one page when encountering a deleted object. And refresh the current page when receiving a null response or invoking a void action. But how to implement this?*

One way to implement this idea is to provide a custom implementation of the `RoutingService` SPI domain service. The default implementation will either return the current object (if not null), else the home page (as defined by `@HomePage`) if one exists.

The following custom implementation refines this to use the breadcrumbs (available in the Wicket viewer) to return the first non-deleted domain object found in the list of breadcrumbs:


```

@DomainService(nature = NatureOfService.DOMAIN)
@DomainServiceLayout(menuOrder = "1") ①
public class RoutingServiceUsingBreadcrumbs extends RoutingServiceDefault {
    @Override
    public Object route(final Object original) {
        if(original != null) { ②
            return original;
        }
        container.flush(); ③

        final BreadcrumbModelProvider wicketSession = ④
            (BreadcrumbModelProvider) AuthenticatedWebSession.get();
        final BreadcrumbModel breadcrumbModel =
            wicketSession.getBreadcrumbModel();
        final List<EntityModel> breadcrumbs = breadcrumbModel.getList();

        final Optional<Object> firstViewModelOrNonDeletedPojoIfAny =
            breadcrumbs.stream() ⑤
                .filter(entityModel -> entityModel != null) ⑥
                .map(EntityModel::getObject) ⑦
                .filter(objectAdapter -> objectAdapter != null) ⑧
                .map(ObjectAdapter::getObject) ⑨
                .filter(pojo -> !(pojo instanceof Persistable) ||
                    !((Persistable)pojo).dnIsDeleted())
                .findFirst();

        return firstViewModelOrNonDeletedPojoIfAny.orElse(homePage());
    }
    private Object homePage() {
        return homePageProviderService.homePage();
    }
    @Inject
    HomePageProviderService homePageProviderService;
    @Inject
    DomainObjectContainer container;
}

```

- ① override the default implementation
- ② if a non-null object was returned, then return this
- ③ ensure that any persisted objects have been deleted.
- ④ reach inside the Wicket viewer's internals to obtain the list of breadcrumbs.
- ⑤ loop over all breadcrumbs
- ⑥ unwrap the Wicket viewer's serializable representation of each domain object (**EntityModel**) to the Isis runtime's representation (**ObjectAdapter**)
- ⑦ unwrap the Isis runtime's representation of each domain object (**ObjectAdapter**) to the domain object pojo itself
- ⑧

if object is persistable (not a view model) then make sure it is not deleted

⑨ return the first object if any, otherwise the home page object (if any).

Note that the above implementation uses Java 8, so if you are using Java 7 then you'll need to backport accordingly.

4.8. Multi-tenancy

Of the various Isis Addons, the [security module](#) has the most features. One significant feature is the ability to associate users and objects with a "tenancy".

For more details, see the [security module](#) README.

4.9. Subclass properties in tables

Suppose you have a hierarchy of classes where a property is derived and abstract in the superclass, concrete implementations in the subclasses. For example:

```
public abstract class LeaseTerm {
    public abstract BigDecimal getEffectiveValue();
    ...
}

public class LeaseTermForIndexableTerm extends LeaseTerm {
    public BigDecimal getEffectiveValue() { ... }
    ...
}
```

Currently the Wicket viewer will not render the property in tables (though the property is correctly rendered in views).



For more background on this workaround, see [ISIS-582](#).

The work-around is simple enough; make the method concrete in the superclass and return a dummy implementation, eg:

```
public abstract class LeaseTerm {
    public BigDecimal getEffectiveValue() {
        return null; // workaround for ISIS-582
    }
    ...
}
```

Alternatively the implementation could throw a `RuntimeException`, eg

```
throw new RuntimeException("never called; workaround for ISIS-582");
```

4.10. Pushing Changes (deprecated)



This technique is much less powerful than using `../ugfun/ugfun.adoc#_ugfun_building-blocks_events_domain-events`[the event bus] or an SPI service. We present it mostly for completeness.

4.10.1. When a property is changed

If you want to invoke functionality whenever a property is changed by the user, then you can create a supporting `modifyXxx()` method and include the functionality within that. The syntax is:

```
public void modifyPropertyName(PropertyType param) { ... }
```

Why not just put this functionality in the setter? Well, the setter is used by the object store to recreate the state of an already persisted object. Putting additional behaviour in the setter would cause it to be triggered incorrectly.

For example:

```
public class Order() {  
    public Integer getAmount() { ... }  
    public void setAmount(Integer amount) { ... }  
    public void modifyAmount(Integer amount) { ①  
        setAmount(amount); ③  
        addToTotal(amount); ②  
    }  
    ...  
}
```

① The `modifyAmount()` method calls ...

② ... the `addToTotal()` (not shown) to maintain some running total.

We don't want this `addToCall()` method to be called when pulling the object back from the object store, so we put it into the modify, not the setter.

You may optionally also specify a `clearXxx()` which works the same way as `modify Xxx()` but is called when the property is cleared by the user (i.e. the current value replaced by nothing). The syntax is:

```
public void clearPropertyName() { ... }
```

To extend the above example:

```

public class Order() {
    public Integer getAmount() { ... }
    public void setAmount(Integer amount) { ... }
    public void modifyAmount(Integer amount) { ... }
    public void clearAmount() {
        removeFromTotal(this.amount);
        setAmount(null);
    }
    ...
}

```

4.10.2. When a collection is modified

A collection may have a corresponding `addToXxx()` and/or `removeFromXxx()` method. If present, and direct manipulation of the contents of the connection has not been disabled (see ?), then they will be called (instead of adding/removing an object directly to the collection returned by the accessor).

The reason for this behaviour is to allow other behaviour to be triggered when the contents of the collection is altered. That is, it is directly equivalent to the supporting `modifyXxx()` and `clearXxx()` methods for properties (see ?).

The syntax is:

```

public void addTo<CollectionName>(EntityType param) { ... }

```

and

```

public void removeFromCollectionName(EntityType param) { ... }

```

where `EntityType` is the same type as the generic collection type.

For example:

```

public class Employee { ... }

public class Department {

    private int numMaleEmployees;           ①
    private int numFemaleEmployees;         ②

    private Set<Employee> employees = new TreeSet<Employee>();
    public Set<Employee> getEmployees() {
        return employees;
    }
    private void setEmployees(Set<Employee> employees) {
        this.employees = employees;
    }
    public void addToEmployees(Employee employee) {           ③
        numMaleEmployees += countOneMale(employee);
        numFemaleEmployees += countOneFemale(employee);
        employees.add(employee);
    }
    public void removeFromEmployees(Employee employee) {       ④
        numMaleEmployees -= countOneMale(employee);
        numFemaleEmployees -= countOneFemale(employee);
        employees.remove(employee);
    }
    private int countOneMale(Employee employee) { return employee.isMale()?1:0; }
    private int countOneFemale(Employee employee) { return employee.isFemale()?1:0; }

    ...
}

```

- ① maintain a count of the number of male ...
- ② ... and female employees (getters and setters omitted)
- ③ the `addTo...`() method increments the derived properties
- ④ the `removeFrom...`() method similarly decrements the derived properties

4.11. How to implement a spellchecker?

From this [thread](#) on the Apache Isis users mailing list:

- *What is the easiest way to add a spell checker to the text written in a field in a domain object, for instance to check English syntax?*

One way to implement is to use the [event bus](#):

- Set up a [domain event subscriber](#) that can veto the changes.
- if the change is made through an action, you can use `@Action#domainEvent()`.

if if the change is made through an edit, you can use `@Property#domainEvent()`.

You'll need some way to know which fields should be spell checked. Two ways spring to mind:

- either look at the domain event's identifier
- or subclass the domain event (recommended anyway) and have those subclass events implement some sort of marker interface, eg a `SpellCheckEvent`.

And you'll (obviously) also need some sort of spell checker implementation to call.

Chapter 5. Customizing the Prog Model

This chapter explains the main APIs to extend or alter the programming conventions that Apache Isis understands to build up its metamodel.

5.1. Custom validator

Apache Isis' programming model includes a validator component that detects and prevents (by failing fast) a number of situations where the domain model is logically inconsistent.

For example, the validator will detect any orphaned supporting methods (eg `hideXxx()`) if the corresponding property or action has been renamed or deleted but the supporting method was not also updated. Another example is that a class cannot have a title specified both using `title()` method and also using `@Title` annotation.



The support for [disallowing deprecated annotations](#) is also implemented using the metamodel validator.

You can also impose your own application-specific rules by installing your own metamodel validator. To give just one example, you could impose naming standards such as ensuring that a domain-specific abbreviation such as "ISBN" is always consistently capitalized wherever it appears in a class member.



Isis' [Maven plugin](#) will also validate the domain object model during build time.

5.1.1. API and Implementation

There are several ways to go about implementing a validator.

`MetaModelValidator`

Any custom validator must implement Apache Isis' internal `MetaModelValidator` interface, so the simplest option is just to implement `MetaModelValidator` directly:

```
public interface MetaModelValidator
    implements SpecificationLoaderSpiAware { ①
    public void validate(
        ValidationFailures validationFailures); ②
}
```

① the `SpecificationLoader` is the internal API providing access to the Apache Isis metamodel.

② add any metamodel violations to the `ValidationFailures` parameter (the [collecting parameter](#) pattern)

`Visitor`

More often than not, you'll want to visit every element in the metamodel, and so for this you can

instead subclass from `MetaModelValidatorVisiting.Visitor`:

```
public final class MetaModelValidatorVisiting ... {
    public static interface Visitor {
        public boolean visit(           ①
            ObjectSpecification objectSpec,  ②
            ValidationFailures validationFailures); ③
    }
    ...
}
```

① return `true` continue visiting specs.

② `ObjectSpecification` is the internal API representing a class

③ add any metamodel violations to the `ValidationFailures` parameter

You can then create your custom validator by subclassing `MetaModelValidatorComposite` and adding the visiting validator:

```
public class MyMetaModelValidator extends MetaModelValidatorComposite {
    public MyMetaModelValidator() {
        add(new MetaModelValidatorVisiting(new MyVisitor()));
    }
}
```

If you have more than one rule then each can live in its own visitor.

SummarizingVisitor

As a slight refinement, you can also subclass from `MetaModelValidatorVisiting.SummarizingVisitor`:

```
public final class MetaModelValidatorVisiting ... {
    public static interface SummarizingVisitor extends Visitor {
        public void summarize(ValidationFailures validationFailures);
    }
    ...
}
```

A `SummarizingVisitor` will be called once after every element in the metamodel has been visited. This is great for performing checks on the metamodel as a whole. For example, Apache Isis uses this to check that there is at least one `@Persistable` domain entity defined.

5.1.2. Configuration

Once you have implemented your validator, you must register it with the framework by defining the appropriate configuration property:


```
isis.reflector.validator=com.mycompany.myapp.MyMetaModelValidator
```

5.2. Finetuning

The core metamodel defines APIs and implementations for building the Apache Isis metamodel: a description of the set of entities, domain services and values that make up the domain model.

The description of each domain class consists of a number of elements:

ObjectSpecification

Analogous to `java.lang.Class`; holds information about the class itself and holds collections of each of the three types of class' members (below);

OneToOneAssociation

Represents a class member that is a single-valued property of the class. The property's type is either a reference to another entity, or is a value type.

OneToManyAssociation

Represents a class member that is a collection of references to other entities. Note that Apache Isis does not currently support collections of values.

ObjectAction

Represents a class member that is an operation that can be performed on the action. Returns either a single value, a collection of entities, or is `void`.

The metamodel is built up through the [ProgrammingModel](#), which defines an API for registering a set of [FacetFactory](#)s. Two special [FacetFactory](#) implementations - [PropertyAccessorFacetFactory](#) and [CollectionAccessorFacetFactory](#) - are used to identify the class members. Pretty much all the other [FacetFactory](#)s are responsible for installing [Facets](#) onto the metamodel elements.

There are many many such [Facets](#), and are used to do such things get values from properties or collections, modify properties or collections, invoke action, hide or disable class members, provide UI hints for class members, and so on. In short, the [FacetFactory](#)s registered defines the Apache Isis programming conventions.

5.2.1. Modifying the Prog. Model

The default implementation of [ProgrammingModel](#) is [ProgrammingModelFacetsJava5](#), which registers a large number of [FacetFactory](#)s.

By editing `isis.properties` you can modify the programming conventions either by (a) using the default programming model, but tweaking it to include new `FacetFactory`'s or exclude existing, or (b) by specifying a completely different programming model implementation.

Let's see how this is done.

Including or excluding facets

Suppose that you wanted to completely remove support for the (already deprecated) `@ActionOrder` annotation. This would be done using:

```
isis.reflector.facets.exclude=org.apache.isis.core.metamodel.facets.object.actionorder
.annotation.ActionOrderFacetAnnotationFactory
```

Or, suppose you wanted to use the example `"namefile"` `FacetFactory` as part of your programming conventions, use:

```
isis.reflector.facets.include=org.apache.isis.example.metamodel.namefile.facets.NameFileFacetFactory
```

To include/exclude more than one `FacetFactory`, specify as a comma-separated list.



This [thread](#) from the users mailing list (in Apr 2014) shows a typical customization (to enable per-instance security) (though note that [Multi-Tenancy](#) is now a better solution to that particular use-case).



Previously (prior to `1.13.0`) the framework also supported the "isis.reflector.facets" configuration property, to specify a completely new implementation of the (internal API) `ProgrammingModel`. This is no longer supported; use "isis.reflector.facets.include" and "isis.reflector.facet.exclude" to adjust the framework's default implementation (called `ProgrammingModelFacetsJava5`).

5.3. Layout Metadata Reader (deprecated)

The metadata for domain objects is obtained both [annotations](#) and [files](#). There is also deprecated support for reading layouts from `.layout.json` files. This service provides an SPI (and default implementation) for reading layouts defined in this fashion.

5.3.1. Default implementation

The default implementation for reading dynamic layout metadata is `org.apache.isis.core.metamodel.layoutmetadata.json.LayoutMetadataReaderFromJson`, which is responsible for reading from the `Xxx.layout.json` files on the classpath (for each domain entity `Xxx`).

You can also implement your own metadata readers and plug them into Apache Isis. These could read from a different file format, or they could, even, read data dynamically from a URL or database. (Indeed, one could imagine an implementation whereby users could share layouts, all stored in some central repository).

5.3.2. API and Implementation

Any reader must implement Apache Isis' internal `LayoutMetadataReader` interface:

```
public interface LayoutMetadataReader {  
    public Properties asProperties(Class<?> domainClass) throws ReaderException;  
}
```

The implementation "simply" returns a set of properties where the property key is a unique identifier to both the class member and also the facet of the class member to which the metadata relates.

See the implementation of the built-in `LayoutMetadataReaderFromJson` for more detail.

Returning either `null` or throwing an exception indicates that the reader was unable to load any metadata for the specified class.

Extended API

Optionally the reader can implement the extended `LayoutMetadataReader2` API:

```
public interface LayoutMetadataReader2 extends LayoutMetadataReader {  
    public static class Support {  
        public static Support entitiesOnly() {  
            return new Support(false,false,false,false,false,false,false);  
        }  
        ...  
        public boolean interfaces() { ... } ①  
        public boolean anonymous() { ... } ②  
        public boolean synthetic() { ... } ③  
        public boolean array() { ... } ④  
        public boolean enums() { ... } ⑤  
        public boolean applibValueTypes() { ⑥  
        public boolean services() { ... } ⑦  
    }  
    Support support();  
}
```

- ① whether this implementation can provide metadata for interface types.
- ② whether this implementation can provide metadata for anonymous classes.
- ③ whether this implementation can provide metadata for synthetic types.
- ④ whether this implementation can provide metadata for arrays.
- ⑤ whether this implementation can provide metadata for enums.
- ⑥ whether this implementation can provide metadata for applib value types.
- ⑦ whether this implementation can provide metadata for domain services.

The `support()` method returns a struct class that describes the types of classes are supported by this implementation.

The `LayoutMetadataReaderFromJson` implements this extended API.

5.3.3. Configuration

Once you have implemented your validator, you must register it with the framework by defining the appropriate configuration property:

```
isis.reflector.layoutMetadataReaders=\
    com.mycompany.myapp.MyMetaModelValidator,\
    org.apache.isis.core.metamodel.layoutmetadata.json.LayoutMetadataReaderFromJson ①
```

① the property replaces any existing metadata readers; if you want to preserve the ability to read from `Xxx.layout.json` then also register Apache Isis' built-in implementation.

Chapter 6. Deployment

This chapter provides guidance on some common deployment scenarios.

6.1. Command Line (**WebServer**)

As well as deploying an Apache Isis application into a servlet container, it is also possible to invoke from the command line using the `org.apache.isis.WebServer` utility class. This is especially useful while developing and testing, but may also suit some deployment scenarios (eg running as a standalone EXE within a Docker container, for example). Internally the **WebServer** spins up a Jetty servlet container.

The class also supports a number of command line arguments:

Table 1. Command line args for `org.apache.isis.Webserver`

Flag	Long format	Values (default)	Description
-t	--type	server_prototype, server (server)	Deployment type
-m	--manifest	FQCN	Fully qualified class name of the AppManifest to use to bootstrap the system. This flag sets/overrides the <code>isis.appManifest</code> configuration property to the specified class name.
-f	--fixture	FQCN	Fully qualified class name of the fixture (extending FixtureScript) to be run to setup data. This flag sets/overrides the <code>isis.fixtures</code> configuration property to the specified class name, and also sets the <code>isis.persistor.datanucleus.install-fixtures</code> configuration property to <code>true</code> to instruct the JDO/DataNucleus objectstore to actually load in the fixtures. It is also possible to specify the fixture class name using either the <code>\$IsisFixture</code> or <code>\$IsisFixtures</code> environment variable (case insensitive).
-p	--port	(8080)	The port number to listen on. This flag sets/overrides the <code>isis.embedded-web-server.port</code> configuration property.
-c	--config	filename	configuration file containing additional configuration properties

Flag	Long format	Values (default)	Description
<code>-D</code>		<code>xxx=yyy</code>	Specify additional arbitrary configuration properties. This can be specified multiple times. Further discussion below.
<code>-v</code>	<code>--version</code>		Prints the version, then quits
<code>-h</code>	<code>--help</code>		Prints a usage message, then quits

Note that the `-D` argument is **not** a system property, it is parsed by `WebServer` itself. That said, it is *also* possible to specify system properties, and these will also be processed in the exact same way.

Said another way, properties can be specified either as application arguments:

```
java org.apache.isis.WebServer -Dxxx=yyy -Daaa=bbb
```

or as system properties:

```
java -Dxxx=yyy -Daaa=bbb org.apache.isis.WebServer
```



The Dummy class

The framework also provides the `org.apache.isis.Dummy` class, which consists of a single empty `main(String[])` method. It was introduced as a convenience for developers using Eclipse in combination with the DataNucleus plugin; if used as a launch target then it allow the entities to be enhanced without the running an app.

6.2. Deploying to Tomcat

Some pointers when deploying to Tomcat (or any other servlet container).

6.2.1. Externalized Configuration

See the guidance [below](#).

6.2.2. JVM Args

The `WrapperFactory` uses `Javassist` to create on-the-fly classes acting as a proxy. The cost of these proxies can be mitigated using:

```
-XX:+CMSCClassUnloadingEnabled -XX:+UseConcMarkSweepGC
```

6.2.3. Using a JNDI Datasource

See the guidance in the [configuring datanucleus](#) section.

6.3. Externalized Configuration

As described [here](#), by default Apache Isis itself bootstraps from the `isis.properties` configuration file. It will also read configuration from the (optional) component/implementation-specific configuration files (such as `persistor_datanucleus.properties` or `viewer_wicket.properties`), and also (optional) component-specific configuration files (such as `persistor.properties` or `viewer.properties`).

It's generally not good practice to have the same configuration property in more than one file, but if that does occur, then the subsequent configuration property will be ignored.



In addition the framework will also load the `overrides.properties` file. This is intended to support deployment through Docker, as discussed [next](#).

All of these files are read from the `WEB-INF` directory. Having this configuration "baked into" the application is okay in a development environment, but when the app needs to be deployed to a test or production environment, this configuration should be read from an external location.

There are in fact several frameworks involved here, all of which need to be pointed to this external location:

- Apache Isis itself, which (as already discussed) reads `isis.properties` and optional component-specific config files.
- [Apache Shiro](#), which reads the `shiro.ini` file (and may read other files referenced from that file)
- [Apache log4j 1.2](#), for logging, which reads `logging.properties` file
- although not used by Apache Isis, there's a good chance you may be using the Spring framework (eg if using [Apache Active MQ](#) or [Apache Camel](#)).

Each of these frameworks has its own way of externalizing its configuration.

6.3.1. Apache Isis' Config

To tell Apache Isis to load configuration from an external directory, specify the `isis.config.dir` context parameter.

If the external configuration directory is fixed for all environments (systest, UAT, prod etc), then you can specify within the `web.xml` itself:

```
<context-param>
  <param-name>isis.config.dir</param-name>
  <param-value>location of external config directory</param-value>
</context-param>
```

If however the configuration directory varies by environment, then the context parameter will be specified to each installation of your servlet container. Most (if not all) servlet containers will provide a means to define context parameters through proprietary config files.

For example, if using Tomcat 7.0, you would typically copy the empty `$TOMCAT_HOME/webapps/conf/context.xml` to a file specific to the webapp, for example `$TOMCAT_HOME/webapps/conf/todo.xml`. The context parameter would then be specified by adding the following:

```
<Parameter name="isis.config.dir"
  value="/usr/local/tomcat/myapp/conf/"
  override="false"/>
```



Note that the `override` key should be set to "false", not "true". It indicates whether the application's own `web.xml` can override the setting. In most cases, you probably want to disallow that.

For more detail, see the Tomcat documentation on [defining a context](#) and on [context parameters](#).



Note that running the app using Apache Isis' `org.apache.isis.WebServer` bootstrapper currently does not externalized Apache Isis configuration.

6.3.2. Shiro Config

If using Apache Isis' [Shiro integration](#) for authentication and/or authorization, note that it reads from the `shiro.ini` configuration file. By default this also resides in `WEB-INF`.

Similar to Apache Isis, Shiro lets this configuration directory be altered, by specifying the `shiroConfigLocations` context parameter.

You can therefore override the default location using the same technique as described above for Apache Isis' `isis.config.dir` context parameter. For example:

```
<Parameter name="shiroConfigLocations"
  value="file:/usr/local/myapp/conf/shiro.ini"
  override="false" />
```



Note that Shiro is more flexible than Apache Isis; it will read its configuration from any URL, not just a directory on the local filesystem.

6.3.3. Log4j Config

By default Apache Isis configures log4j to read the `logging.properties` file in the `WEB-INF` directory. This can be overridden by setting the `log4j.properties` system property to the URL of the log4j properties file.

For example, if deploying to Tomcat7, this amounts to adding the following to the `CATALINA_OPTS` flags:

```
export CATALINA_OPTS="-
Dlog4j.configuration=/usr/local/tomcat/myapp/conf/logging.properties"
```



`CATALINA_OPTS` was called `TOMCAT_OPTS` in earlier versions of Tomcat.

Further details can be found in the [log4j documentation](#).

6.3.4. Spring Config

Although Apache Isis does not use Spring, it's possible that your app may use other components that do use Spring. For example, the (non-ASF) [Isis addons'](#) `publishmq` module uses ActiveMQ and Camel to support publishing; both of these leverage Spring.

There are several ways to externalized Spring config, but the mechanism described here is similar in nature to those that we use for externalizing Apache Isis' and Shiro's configuration. In your `web.xml`, you will probably load the Spring application context using code such as:

```
<listener>
  <listener-class>org.springframework.web.context.ContextLoaderListener</listener-
class>
</listener>
<context-param>
  <param-name>contextConfigLocation</param-name>
  <param-value>
    classpath:my-application-context-config.xml
  </param-value>
</context-param>
```

Add a new application context `propertyPlaceholderConfigurer-config.xml` defining a `PropertyPlaceholderConfigurer` bean.

```

<beans
  xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans.xsd
http://activemq.apache.org/schema/core
http://activemq.apache.org/schema/core/activemq-core.xsd">
  <bean class=
"org.springframework.beans.factory.config.PropertyPlaceholderConfigurer">
    <property name="locations">
      <list>
        <value>${spring.config.file}</value>
      </list>
    </property>
  </bean>
</beans>

```

This reads the properties from a `spring.config.file`, defined as a context-param in the `web.xml`:

```

<context-param>
  <param-name>spring.config.file</param-name>
  <param-value>classpath:spring.properties</param-value>
</context-param>

```

Then update the bootstrapping in `web.xml` to use this new application context, eg:

```

<context-param>
  <param-name>contextConfigLocation</param-name>
  <param-value>
    classpath:my-application-context-config.xml,
    classpath:propertyPlaceholderConfigurer-config.xml
  </param-value>
</context-param>

```

To use some other externalized configuration, override the `spring.config.file` property, eg using Tomcat's config file:

```

<Parameter name="spring.config.dir"
  value="file:/usr/local/myapp/conf/spring.properties"
  override="false" />

```

An alternative approach

As mentioned, there are several other ways to externalize Spring's config; one approach is to use Spring's profile support.

For example, in the application context you could have:

```
<beans profile="default">
  <bean class=
"org.springframework.beans.factory.config.PropertyPlaceholderConfigurer">
    <property name="locations">
      <list>
        <value>classpath:dev.properties</value>
      </list>
    </property>
  </bean>
</beans>
<beans profile="externalized">
  <bean id="propertyPlaceholder" class=
"org.springframework.beans.factory.config.PropertyPlaceholderConfigurer">
    <property name="locations">
      <list>
        <value>classpath:prod.properties</value>
      </list>
    </property>
  </bean>
</beans>
```

The idea being that specifying the "prod" profile rather than the "default" profile would cause a different set of configuration properties to be read.

The active profile can be overridden with a system property, eg:

```
-Dspring.active.profiles=prod
```

take a look at [this SO answer](#) on using Spring profiles.

6.3.5. See also

See [JVM args](#) for other JVM args and system properties that you might want to consider setting.

6.4. Docker

When running the application within a Docker container, the problem that must be solved is to override the configuration properties baked into the war file, eg to point to the app to a different JDBC URL.

There are several options.



All the options here rely on starting the Docker container with a set of arguments, some of which would very likely be passwords for database connections etc. As such these techniques are only suitable where the security of the Docker host can be assured.

6.4.1. Using an `overrides.properties`

In addition to loading the regular configuration properties from `WEB-INF` directory (described [here](#)), Apache Isis will also load the `overrides.properties` file.

This file is treated slightly differently than the other configuration files; it is loaded last, and any configuration properties defined in it will *override* any configuration properties already read from other files (this includes any properties specified via the command line).

While the regular configuration files are "baked into" the application WAR file, the `overrides.properties` file is created dynamically as part of the Docker `ENTRYPOINT` script, eg as documented in the [Dockerfile best practices](#).

Thus, Docker can be supported as follows:

- use `mvn` (as currently) to create a WAR file; set up with the `pom.xml` with the JDBC drivers of all DB servers that you might want to connect to (hsqldb, sql server, postgresql etc)
- in the `Dockerfile`, specify a base image containing Tomcat 8 + Java 8 (say)
- also in the `Dockerfile`, arrange it such that the WAR file is "exploded" (there is no need to copy over the WAR file itself)
- write a script that:
 - explodes the WAR file, copying it into the Tomcat's `webapp` directory. There is no need to copy over the WAR file itself.
 - creates the `overrides.properties` file from any input arguments, placing it into the `WEB-INF` directory
 - sets all files to read-only
- use `ENTRYPOINT` (and probably also `CMD`) to invoke above script.

6.4.2. Using system properties

The servlet context initializer will search for any system properties called `isis.xxx` and if present will use them as overrides.

Thus, an alternative option for a Docker image is to bootstrap the servlet container (Tomcat, Jetty) with appropriate system properties set up. For example, with Tomcat this can be done by writing into the `conf/catalina.properties` file (see for example [this stackoverflow post](#)).

The Docker's `ENTRYPOINT` therefore just needs to parse the Docker container's own command line arguments and use to create this file.

6.4.3. Using `$ISIS_OPTS`

The servlet context initializer will search for an environment variable called `$ISIS_OPTS` and if present will parse the content as a set of key/value pairs. Each key/value pair is separated by `"|"`.

For example:

```
export
ISIS_OPTS="isis.appManifest=domainapp.app.DomainAppAppManifestWithFixtures||isis.objects.editing=false"
```

can be used to run with a different app manifest, and also to disable editing of properties.

To use a different separator, set the (optional) `$ISIS_OPTS_SEPARATOR` variable.

```
export ISIS_OPTS_SEPARATOR=";"
export
ISIS_OPTS="isis.appManifest=domainapp.app.DomainAppAppManifestWithFixtures;isis.objects.editing=false"
```

The Docker's `ENTRYPOINT` therefore just needs to parse the Docker container's own command line arguments and use to set this environment variable.

6.5. Deploying to Google App Engine

The [Google App Engine](#) (GAE) provides a JDO API, meaning that you can deploy Apache Isis onto GAE using the JDO objectstore.

However, GAE is not an RDBMS, and so there are some limitations that it imposes. This page gathers together various hints, tips and workarounds.

6.5.1. Primary Keys and Owned/Unowned Relationships

All entities must have a `@PrimaryKey`. Within GAE, the type of this key matters.

For an entity to be an aggregate root, (ie a root of an GAE entity group), its key must be a `Long`, eg:

Any collection that holds this entity type (eg `ToDoItem#dependencies` holding a collection of `ToDoItem`'s) should then be annotated with `@Unowned` (a GAE annotation).

If on the other hand you want the object to be owned (through a 1:m relationship somewhere) by some other root, then use a `String`:

Note: if you store a relationship with a `String` key it means that the parent object *owns* the child, any attempt to change the relationship raise an exception.

6.5.2. Custom Types

Currently Apache Isis' **Blob** and **Clob** types and the JODA types (**LocalDate** et al) are *not* supported in GAE.

Instead, GAE defines a **fixed set of value types**, including **BlobKey**. Members of the Apache Isis community have this working, though I haven't seen the code.

The above notwithstanding, Andy Jefferson at DataNucleus tells us:

<div class="extended-quote-first"><p>GAE JDO/JPA does support some type conversion, because looking at StoreFieldManager.java for any field that is Object-based and not a relation nor Serialized it will call TypeConversionUtils.java and that looks for a <code>TypeConverter</code> (specify <code>@Extension</code> with key of "type-converter-name" against a field and value as the <code>TypeConverter</code> class) and it should convert it. Similarly when getting the value from the datastore. </p></div>

On further investigation, it seems that the GAE implementation performs a type check on a **SUPPORTED_TYPES** Java set, in **com.google.appengine.api.datastore.DataTypeUtils**:

```
if (!supportedTypes.contains(value.getClass())) {
    throw new IllegalArgumentException(prefix + value.getClass().getName() + " is not
a supported property type.");
}
```

We still need to try out Andy's recipe, above.

6.6. Neo4J

As of 1.8.0 Apache Isis has experimental support for Neo4J, courtesy of DataNucleus' **Neo4J Datastore** implementation.

The **SimpleApp archetype** has been updated so that they can be optionally run under Neo4J.



In addition, the **Isis addons' neoapp** (non-ASF) is configured to run with an embedded Neo4J server running alongside the Apache Isis webapp.

The steps below describe the configuration steps required to update an existing app.

6.6.1. ConnectionURL

In **persistor.properties**, update the JDO **ConnectionURL** property, eg:

```
isis.persistor.datanucleus.impl.javax.jdo.option.ConnectionURL=neo4j:neo4j_DB
```

The other connection properties (`ConnectionDriverName`, `ConnectionUserName` and `ConnectionPassword`) should be commented out.

6.6.2. Update pom.xml

Add the following dependency to the `webapp` project's `pom.xml`:

```
<dependencies>
  ...
  <dependency>
    <groupId>org.datanucleus</groupId>
    <artifactId>datanucleus-neo4j</artifactId>
    <version>4.0.5</version> ①
  </dependency>
  ...
</dependencies>
```

① for Isis v1.9.0, use the value shown. for Isis v1.8.0, use 3.2.3.

In the `SimpleApp archetype` this is defined under the "neo4j" profile so can be activated using `-Pneo4j`.

6.6.3. Try it out!

If you want to quickly try out neo4j for yourself:

- run the `SimpleApp archetype` (v1.8.0)
- build the app:
- run the app:

If you visit the about page you should see the neo4j JAR files are linked in, and a `neo4j_DB` subdirectory within the `webapp` directory.

6.7. JVM Flags



FIXME

The default JVM configuration will most likely not be appropriate for running Isis as a webapp. The table below suggests some JVM args that you will probably want to modify:

Table 2. JVM args

Flag	Description
-server	Run the JVM in server mode, meaning that the JVM should spend more time on the optimization of the fragments of codes that are most often used (hotspots). This leads to better performance at the price of a higher overhead at startup.
-Xms128m Minimum heap size	-Xmx768m
Maximum heap size	-XX:PermSize=64m
Minimum perm size (for class definitions)	-XX:MaxPermSize=256m
Maximum perm size (for class definitions)	-XX:+DisableExplicitGC

There are also a whole bunch of GC-related flags, that you might want to explore; see this detailed [Hotspot JVM](#) documentation and also this [blog post](#).

6.7.1. Configuring in Tomcat

If using Tomcat, update the `CATALINA_OPTS` variable. (This variable is also updated if [configuring logging to run externally](#)).

Chapter 7. `web.xml`

Apache Isis provides two different viewers, the [Wicket viewer](#) and the [RestfulObjects viewer](#). You can deploy both of these concurrently, or deploy just the Wicket viewer, or deploy just the Restful Objects viewer. The configuration in `web.xml` varies accordingly, both in terms of the servlet context listeners, filters and servlets.

If you are using Apache Isis' integration with Apache Shiro (for security) then this also needs configuring in `web.xml`. See the [security chapter](#) for full details on this topic.

The servlets and filters are mapped to three main pipelines:

- `/wicket` - the Wicket viewer UI
- `/restful` - the Restful Objects resources (REST API)
- other paths, also static resources (such as `.png`, `.css`)

With the following key:

[\[key \]](#) | *images/runtime/web-xml/key.png*

the diagram below shows the components to be configured if deploying both the Wicket viewer and Restful Objects viewer:

[\[wicket and ro \]](#) | *images/runtime/web-xml/wicket-and-ro.png*

Here the Wicket viewer is responsible for the main bootstrapping of Apache Isis itself, in other words the shared (global) metadata; this is done by the `IsisWicketApplication` class (extending the `WicketApplication` Wicket API). This class is also responsible for Apache Isis' own session and transaction management.

The Restful Objects viewer - being a JAX-RS application implemented using the RestEasy framework - requires the `RestEasyBootstrapper` servlet context listener. It is this context listener that also sets up the `RestfulObjectsApplication`, which is then delegated to by the RestEasy `HttpServletDispatcher`. This pipeline uses the `IsisSessionFilter` and `IsisTransactionFilterForRestfulObjects` to perform the session and transaction management before it hits the RestEasy servlet.

If only the Wicket viewer is deployed, then the diagram is more or less the same: the RestEasy servlet, context listener and supporting filters are simply removed:

[\[wicket only \]](#) | *images/runtime/web-xml/wicket-only.png*

Finally, if only the Restful Objects viewer is deployed, then things change a little more subtly. Here, the Wicket filter is no longer needed. In its place, though the `IsisWebAppBootstrapper` context listener is required: this is responsible for setting up the shared (global) metadata.

[\[ro only \]](#) | *images/runtime/web-xml/ro-only.png*

The following sections detail these various listeners, filters and servlets in more detail.

7.1. Servlet Context Listeners

Servlet context listeners are used to perform initialization on application startup. Both Shiro (if configured as the security mechanism) and RestEasy (for the Restful Objects viewer) require their own context listener. In addition, if the Wicket viewer is *not* being used, then additional Apache Isis-specific listener is required for bootstrapping of the Apache Isis framework itself.

7.1.1. EnvironmentLoaderListener (Shiro)

Bootstrap listener to startup and shutdown the web application's Shiro `WebEnvironment` at startup and shutdown respectively.

Its definition is:

```
<listener>
  <listener-class>org.apache.shiro.web.env.EnvironmentLoaderListener</listener-
class>
</listener>
```

7.1.2. IsisWebAppBootstrapper

The `IsisWebAppBootstrapper` servlet context listener bootstraps the shared (global) metadata for the Apache Isis framework. This listener is not required (indeed must not be configured) if the Wicket viewer is in use.

Its definition is:

```
<listener>
  <listener-class>org.apache.isis.core.webapp.IsisWebAppBootstrapper</listener-
class>
</listener>
```

Its context parameters are:

```
<context-param>
  <param-name>deploymentType</param-name>
  <param-value>SERVER_PROTOTYPE</param-value>
</context-param>
<context-param>
  <param-name>isis.viewers</param-name>
  <param-value>restfulobjects</param-value>
</context-param>
```

7.1.3. ResteasyBootstrap (RestEasy)

The `ResteasyBootstrap` servlet context listener initializes the RestEasy runtime, specifying that

classes (namely, those specified in Isis' `RestfulObjectsApplication`) to be exposed as REST resources. It is required if the Restful Objects viewer is to be deployed.

Its definition is:

```
<listener>
  <listener-class>
org.jboss.resteasy.plugins.server.servlet.ResteasyBootstrap</listener-class>
</listener>
```

There are two relevant context parameters:

```
<context-param>
  <param-name>javax.ws.rs.Application</param-name> ①
  <param-
value>org.apache.isis.viewer.restfulobjects.server.RestfulObjectsApplication</param-
value>
</context-param>
<context-param>
  <param-name>resteasy.servlet.mapping.prefix</param-name>
  <param-value>/restful/</param-value> ②
</context-param>
```

① used by RestEasy to determine the JAX-RS resources and other related configuration

② should correspond to the filter mapping of the `HttpServletDispatcher` servlet

7.2. Servlets

Servlets process HTTP requests and return corresponding responses.

7.2.1. `HttpServletDispatcher` (RestEasy)

This servlet is provided by the RestEasy framework, and does the dispatching to the resources defined by Apache Isis' `RestfulObjectsApplication` (see above).

Its definition is:

```
<servlet>
  <servlet-name>RestfulObjectsRestEasyDispatcher</servlet-name>
  <servlet-class>
org.jboss.resteasy.plugins.server.servlet.HttpServletDispatcher</servlet-class>
</servlet>
```

Its mapping is:

```
<servlet-mapping>
  <servlet-name>RestfulObjectsRestEasyDispatcher</servlet-name>
  <url-pattern>/restful/*</url-pattern>
</servlet-mapping>
```

7.2.2. ResourceServlet

The `ResourceServlet` loads and services static content either from the filesystem or from the classpath, each with an appropriate mime type.

Static content here means request paths ending in `.js`, `.css`, `.html`, `.png`, `.jpg`, `.jpeg` and `gif`.

Its definition is:

```
<servlet>
  <servlet-name>Resource</servlet-name>
  <servlet-class>org.apache.isis.core.webapp.content.ResourceServlet</servlet-class>
</servlet>
```

Its mapping is:

```

<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.css</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.png</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.jpg</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.jpeg</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.gif</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.svg</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.js</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.html</url-pattern>
</servlet-mapping>
<servlet-mapping>
  <servlet-name>Resource</servlet-name>
  <url-pattern>*.swf</url-pattern>
</servlet-mapping>

```

7.3. Filters

The order in which filters appear in `web.xml` matters: first to last they define a pipeline. This is shown in the above diagrams, and the subsections also list the in the same order that they should appear in your `web.xml`.

7.3.1. ShiroFilter (Shiro)

Shiro filter that sets up a Shiro security manager for the request, obtained from the Shiro `WebEnvironment` set up by the Shiro `EnvironmentLoaderListener` (discussed above).

Its definition is:

```
<filter>
  <filter-name>ShiroFilter</filter-name>
  <filter-class>org.apache.shiro.web.servlet.ShiroFilter</filter-class>
</filter>
```

Its mapping is:

```
<filter-mapping>
  <filter-name>ShiroFilter</filter-name>
  <url-pattern>/*</url-pattern>
</filter-mapping>
```

7.3.2. IsisLogOnExceptionHandler

The `IsisLogOnExceptionHandler` filter simply logs the URL of any request that causes an exception to be thrown, then re-propagates the exception. The use case is simply to ensure that all exceptions are logged (against the `IsisLogOnExceptionHandler` slf4j appender).

Its definition is:

```
<filter>
  <filter-name>IsisLogOnExceptionHandler</filter-name>
  <filter-class>
org.apache.isis.core.webapp.diagnostics.IsisLogOnExceptionHandler</filter-class>
</filter>
```

Its mapping is:

```
<filter-mapping>
  <filter-name>IsisLogOnExceptionHandler</filter-name>
  <url-pattern>/wicket/*</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>IsisLogOnExceptionHandler</filter-name>
  <url-pattern>/restful/*</url-pattern>
</filter-mapping>
```

7.3.3. ResourceCachingFilter

The `ResourceCachingFilter` adds HTTP cache headers to specified resources, based on their pattern.

Its definition is:

```
<filter>
  <filter-name>ResourceCachingFilter</filter-name>
  <filter-class>org.apache.isis.core.webapp.content.ResourceCachingFilter</filter-
class>
  <init-param>
    <param-name>CacheTime</param-name>      ①
    <param-value>86400</param-value>
  </init-param>
</filter>
```

① cache time, in seconds

Its mapping is:

```

<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.css</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.png</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.jpg</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.jpeg</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.gif</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.svg</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.html</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.js</url-pattern>
</filter-mapping>
<filter-mapping>
  <filter-name>ResourceCachingFilter</filter-name>
  <url-pattern>*.swf</url-pattern>
</filter-mapping>

```

7.3.4. WicketFilter

The **WicketFilter** is responsible for initiating the handling of Wicket requests.

Its definition is:


```

<filter>
  <filter-name>WicketFilter</filter-name>
  <filter-class>org.apache.wicket.protocol.http.WicketFilter</filter-class>
  <init-param>
    <param-name>applicationClassName</param-name> ①
    <param-value>domainapp.webapp.SimpleApplication</param-value>
  </init-param>
</filter>

```

① specify the application (subclass of `IsisWicketApplication`) to use

Its mapping is:

```

<filter-mapping>
  <filter-name>WicketFilter</filter-name>
  <url-pattern>/wicket/*</url-pattern>
</filter-mapping>

```

This filter reads one context parameter:

```

<context-param>
  <param-name>configuration</param-name>
  <param-value>deployment</param-value> ①
</context-param>

```

① alternatively set to "development"; see [deployment types](#) for further discussion.

7.3.5. `IsisSessionFilter`

The `IsisSessionFilter` is responsible for the (persistence) session management; in effect a wrapper around DataNucleus' `PersistenceManager` object. It is only required for the Restful Objects viewer.

```

<filter>
  <filter-name>IsisSessionFilterForRestfulObjects</filter-name>
  <filter-class>org.apache.isis.core.webapp.IsisSessionFilter</filter-class>
  <init-param>
    <param-name>authenticationSessionStrategy</param-name> ①
    <param-value>

```

```

org.apache.isis.viewer.restfulobjects.server.authentication.AuthenticationSessionStrat
egyBasicAuth

```

```

    </param-value>
  </init-param>
  <init-param>
    <param-name>whenNoSession</param-name> ②
    <param-value>basicAuthChallenge</param-value>
  </init-param>
  <init-param>
    <param-name>passThru</param-name> ③
    <param-value>/restful/swagger</param-value>
  </init-param>
  <!--
  <init-param>
    <param-name>restricted</param-name> ④
    <param-value>...</param-value>
  </init-param>
  <init-param>
    <param-name>redirectToOnException</param-name> ⑤
    <param-value>...</param-value>
  </init-param>
  -->
</filter>

```

- ① pluggable strategy for determining what the authentication session (credentials) are of the request
- ② what the servlet should do if no existing session was found. Usual values are either `unauthorized`, `basicAuthChallenge` or `auto`. Discussed in more detail below.
- ③ specify which URIs to ignore and simply passthru. Originally introduced to allow the `SwaggerSpec` resource (which does not require a session) to be invoked.
- ④ List of paths that are allowed through even if not authenticated. The servlets mapped to these paths are expected to be able to deal with there being no session. Typically they will be login pages. See below for further details.
- ⑤ where to redirect to if an exception occurs.

The `whenNoSession` parameter determines what the behaviour should be if no existing session can be found. There are a number of predetermined values available:

- `unauthorized` will generates a 401 response
- `basicAuthChallenge` will also generate a 401 response, and also issues a Basic Auth challenge

using `WWW-Authenticate` response header

- `auto` combines the `unauthorized` and `basicAuthChallenge` strategies: it will generate a 401 response, but only issues a Basic Auth challenge if it detects that the request originates from a web browser (ie that the HTTP `Accept` header is set to `text/html`). This means that custom Javascript apps can perform their authentication correctly, while the REST API can still be explored using the web browser (relying upon the web browser's in-built support for HTTP Basic Auth).
- `continue`, in which case the request is allowed to continue but the destination expected to know that there will be no open session
- `restricted`, which allows access to a restricted list of URLs, otherwise will redirect to the first of that list of URLs

If accessing the REST API through a web browser, then normally `basicAuthChallenge` is appropriate; the browser will automatically display a simple prompt. If accessing the REST API through a custom Javascript app, then `unauthorized` is usually the one to use.

This filter should be mapped to the `servlet-name` for the RestEasy `HttpServletDispatcher`; for example:

```
<filter-mapping>
  <filter-name>IsisSessionFilterForRestfulObjects</filter-name>
  <servlet-name>RestfulObjectsRestEasyDispatcher</servlet-name>
</filter-mapping>
```

7.3.6. `IsisTransactionFilterForRestfulObjects`

The `IsisTransactionFilterForRestfulObjects` filter simply ensures that a transaction is in progress for all calls routed to the [RestfulObjects viewer](#).

Its definition is:

```
<filter>
  <filter-name>IsisTransactionFilterForRestfulObjects</filter-name>
  <filter-
class>org.apache.isis.viewer.restfulobjects.server.webapp.IsisTransactionFilterForRest
fulObjects</filter-class>
</filter>
```

This filter should be mapped to the `servlet-name` for the RestEasy `HttpServletDispatcher`; for example:

```
<filter-mapping>
  <filter-name>IsisTransactionFilterForRestfulObjects</filter-name>
  <servlet-name>RestfulObjectsRestEasyDispatcher</servlet-name>
</filter-mapping>
```

7.4. Configuration Files

However Apache Isis is bootstrapped (using the `IsisWicketApplication` or using `IsisWebAppBootstrapper`), it will read a number of configuration files, such as `isis.properties`.

By default these are read from `WEB-INF` directory. This can be overridden using the `isis.config.dir` context parameter:

```
<context-param>
  <param-name>isis.config.dir</param-name>
  <param-value>location of your config directory if fixed</param-value>
</context-param>
```

Another context parameter, `isis.viewres` specifies which additional configuration files to search for (over and above the default ones of `isis.properties` et al):

```
<context-param>
  <param-name>isis.viewers</param-name>
  <param-value>wicket,restfulobjects</param-value>
</context-param>
```

For example, this will cause `viewer_wicket.properties` and `viewer_restfulobjects.properties` to also be loaded.