Spring Data Key Value - Reference Documentation

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Chapter 1. Working with Spring Data Repositories

The goal of Spring Data repository abstraction is to significantly reduce the amount of boilerplate code required to implement data access layers for various persistence stores.

IMPORTANT

Spring Data repository documentation and your module

This chapter explains the core concepts and interfaces of Spring Data repositories. The information in this chapter is pulled from the Spring Data Commons module. It uses the configuration and code samples for the Java Persistence API (JPA) module. Adapt the XML namespace declaration and the types to be extended to the equivalents of the particular module that you are using. Namespace reference covers XML configuration which is supported across all Spring Data modules supporting the repository API, Repository query keywords covers the query method keywords supported by the repository abstraction in general. For detailed information on the specific features of your module, consult the chapter on that module of this document.

1.1. Core concepts

The central interface in Spring Data repository abstraction is `Repository` (probably not that much of a surprise). It takes the domain class to manage as well as the id type of the domain class as type arguments. This interface acts primarily as a marker interface to capture the types to work with and to help you to discover interfaces that extend this one. The `CrudRepository` provides sophisticated CRUD functionality for the entity class that is being managed.

Example 1. CrudRepository interface

```
public interface CrudRepository<T, ID extends Serializable>
  extends Repository<T, ID> {

  <S extends T> S save(S entity);      ①

  Optional<T> findById(ID primaryKey); ②

  Iterable<T> findAll();               ③

  long count();                        ④

  void delete(T entity);               ⑤

  boolean existsById(ID primaryKey);   ⑥

  // … more functionality omitted.
}
```

① Saves the given entity.

② Returns the entity identified by the given id.

③ Returns all entities.

④ Returns the number of entities.

⑤ Deletes the given entity.

⑥ Indicates whether an entity with the given id exists.

NOTE We also provide persistence technology-specific abstractions like e.g. `JpaRepository` or `MongoRepository`. Those interfaces extend `CrudRepository` and expose the capabilities of the underlying persistence technology in addition to the rather generic persistence technology-agnostic interfaces like e.g. CrudRepository.

On top of the `CrudRepository` there is a `PagingAndSortingRepository` abstraction that adds additional methods to ease paginated access to entities:

Example 2. PagingAndSortingRepository

```
public interface PagingAndSortingRepository<T, ID extends Serializable>
  extends CrudRepository<T, ID> {

  Iterable<T> findAll(Sort sort);

  Page<T> findAll(Pageable pageable);
}
```

Accessing the second page of `User` by a page size of 20 you could simply do something like this:

```
PagingAndSortingRepository<User, Long> repository = // … get access to a bean
Page<User> users = repository.findAll(new PageRequest(1, 20));
```

In addition to query methods, query derivation for both count and delete queries, is available.

Example 3. Derived Count Query

```
interface UserRepository extends CrudRepository<User, Long> {

  long countByLastname(String lastname);
}
```

Example 4. Derived Delete Query

```
interface UserRepository extends CrudRepository<User, Long> {

  long deleteByLastname(String lastname);

  List<User> removeByLastname(String lastname);
}
```

1.2. Query methods

Standard CRUD functionality repositories usually have queries on the underlying datastore. With Spring Data, declaring those queries becomes a four-step process:

1. Declare an interface extending Repository or one of its subinterfaces and type it to the domain class and ID type that it will handle.

```
interface PersonRepository extends Repository<Person, Long> { … }
```

2. Declare query methods on the interface.

```
interface PersonRepository extends Repository<Person, Long> {
  List<Person> findByLastname(String lastname);
}
```

3. Set up Spring to create proxy instances for those interfaces. Either via JavaConfig:

```
import org.springframework.data.jpa.repository.config.EnableJpaRepositories;

@EnableJpaRepositories
class Config {}
```

or via XML configuration:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:jpa="http://www.springframework.org/schema/data/jpa"
   xsi:schemaLocation="http://www.springframework.org/schema/beans
     http://www.springframework.org/schema/beans/spring-beans.xsd
     http://www.springframework.org/schema/data/jpa
     http://www.springframework.org/schema/data/jpa/spring-jpa.xsd">

   <jpa:repositories base-package="com.acme.repositories"/>

</beans>
```

The JPA namespace is used in this example. If you are using the repository abstraction for any other store, you need to change this to the appropriate namespace declaration of your store module which should be exchanging `jpa` in favor of, for example, `mongodb`.

Also, note that the JavaConfig variant doesn't configure a package explictly as the package of the annotated class is used by default. To customize the package to scan use one of the `basePackage…` attribute of the data-store specific repository `@Enable…`-annotation.

4. Get the repository instance injected and use it.

```
class SomeClient {

  private final PersonRepository repository;

  SomeClient(PersonRepository repository) {
    this.repository = repository;
  }

  void doSomething() {
    List<Person> persons = repository.findByLastname("Matthews");
  }
}
```

The sections that follow explain each step in detail.

1.3. Defining repository interfaces

As a first step you define a domain class-specific repository interface. The interface must extend Repository and be typed to the domain class and an ID type. If you want to expose CRUD methods for that domain type, extend `CrudRepository` instead of `Repository`.

1.3.1. Fine-tuning repository definition

Typically, your repository interface will extend `Repository`, `CrudRepository` or `PagingAndSortingRepository`. Alternatively, if you do not want to extend Spring Data interfaces, you can also annotate your repository interface with `@RepositoryDefinition`. Extending `CrudRepository` exposes a complete set of methods to manipulate your entities. If you prefer to be selective about the methods being exposed, simply copy the ones you want to expose from `CrudRepository` into your domain repository.

NOTE This allows you to define your own abstractions on top of the provided Spring Data Repositories functionality.

Example 5. Selectively exposing CRUD methods

```
@NoRepositoryBean
interface MyBaseRepository<T, ID extends Serializable> extends Repository<T, ID> {

  Optional<T> findById(ID id);

  <S extends T> S save(S entity);
}

interface UserRepository extends MyBaseRepository<User, Long> {
  User findByEmailAddress(EmailAddress emailAddress);
}
```

In this first step you defined a common base interface for all your domain repositories and exposed `findById(…)` as well as `save(…)`.These methods will be routed into the base repository implementation of the store of your choice provided by Spring Data ,e.g. in the case if JPA `SimpleJpaRepository`, because they are matching the method signatures in `CrudRepository`. So the `UserRepository` will now be able to save users, and find single ones by id, as well as triggering a query to find `Users` by their email address.

NOTE Note, that the intermediate repository interface is annotated with `@NoRepositoryBean`. Make sure you add that annotation to all repository interfaces that Spring Data should not create instances for at runtime.

1.3.2. Null handling of repository methods

As of Spring Data 2.0, repository CRUD methods that return an individual aggregate instance use

Java 8's `Optional` to indicate the potential absence of a value. Besides that, Spring Data supports to return other wrapper types on query methods:

- `com.google.common.base.Optional`
- `scala.Option`
- `io.vavr.control.Option`
- `javaslang.control.Option` (deprecated as Javaslang is deprecated)

Alternatively query methods can choose not to use a wrapper type at all. The absence of a query result will then be indicated by returning `null`. Repository methods returning collections, collection alternatives, wrappers, and streams are guaranteed never to return `null` but rather the corresponding empty representation. See [repository-query-return-types] for details.

Nullability annotations

You can express nullability constraints for repository methods using Spring Framework's nullability annotations. They provide a tooling-friendly approach and opt-in `null` checks during runtime:

- `@NonNullApi` – to be used on the package level to declare that the default behavior for parameters and return values is to not accept or produce `null` values.
- `@NonNull` – to be used on a parameter or return value that must not be `null` (not needed on parameter and return value where `@NonNullApi` applies).
- `@Nullable` – to be used on a parameter or return value that can be `null`.

Spring annotations are meta-annotated with JSR 305 annotations (a dormant but widely spread JSR). JSR 305 meta-annotations allow tooling vendors like IDEA, Eclipse, or Kotlin to provide null-safety support in a generic way, without having to hard-code support for Spring annotations. To enable runtime checking of nullability constraints for query methods, you need to activate non-nullability on package level using Spring's `@NonNullApi` in `package-info.java`:

Example 6. Declaring non-nullability in `package-info.java`

```
@org.springframework.lang.NonNullApi
package com.acme;
```

Once non-null defaulting is in place, repository query method invocations will get validated at runtime for nullability constraints. Exceptions will be thrown in case a query execution result violates the defined constraint, i.e. the method would return `null` for some reason but is declared as non-nullable (the default with the annotation defined on the package the repository resides in). If you want to opt-in to nullable results again, selectively use `@Nullable` that a method. Using the aforementioned result wrapper types will continue to work as expected, i.e. an empty result will be translated into the value representing absence.

Example 7. Using different nullability constraints

```
package com.acme;                                                          ①

import org.springframework.lang.Nullable;

interface UserRepository extends Repository<User, Long> {

  User getByEmailAddress(EmailAddress emailAddress);                       ②

  @Nullable
  User findByEmailAddress(@Nullable EmailAddress emailAdress);             ③

  Optional<User> findOptionalByEmailAddress(EmailAddress emailAddress); ④
}
```

① The repository resides in a package (or sub-package) for which we've defined non-null behavior (see above).

② Will throw an `EmptyResultDataAccessException` in case the query executed does not produce a result. Will throw an `IllegalArgumentException` in case the `emailAddress` handed to the method is `null`.

③ Will return `null` in case the query executed does not produce a result. Also accepts `null` as value for `emailAddress`.

④ Will return `Optional.empty()` in case the query executed does not produce a result. Will throw an `IllegalArgumentException` in case the `emailAddress` handed to the method is `null`.

Nullability in Kotlin-based repositories

Kotlin has the definition of nullability constraints baked into the language. Kotlin code compiles to bytecode which does not express nullability constraints using method signatures but rather compiled-in metadata. Make sure to include the `kotlin-reflect` JAR in your project to enable introspection of Kotlin's nullability constraints. Spring Data repositories use the language mechanism to define those constraints to apply the same runtime checks:

Example 8. Using nullability constraints on Kotlin repositories

```
interface UserRepository : Repository<User, String> {

  fun findByUsername(username: String): User     ①

  fun findByFirstname(firstname: String?): User? ②
}
```

① The method defines both, the parameter as non-nullable (the Kotlin default) as well as the result. The Kotlin compiler will already reject method invocations trying to hand `null` into the method. In case the query execution yields an empty result, an `EmptyResultDataAccessException` will be thrown.

② This method accepts `null` as parameter for `firstname` and returns `null` in case the query execution does not produce a result.

1.3.3. Using Repositories with multiple Spring Data modules

Using a unique Spring Data module in your application makes things simple hence, all repository interfaces in the defined scope are bound to the Spring Data module. Sometimes applications require using more than one Spring Data module. In such case, it's required for a repository definition to distinguish between persistence technologies. Spring Data enters strict repository configuration mode because it detects multiple repository factories on the class path. Strict configuration requires details on the repository or the domain class to decide about Spring Data module binding for a repository definition:

1. If the repository definition extends the module-specific repository, then it's a valid candidate for the particular Spring Data module.
2. If the domain class is annotated with the module-specific type annotation, then it's a valid candidate for the particular Spring Data module. Spring Data modules accept either 3rd party annotations (such as JPA's `@Entity`) or provide own annotations such as `@Document` for Spring Data MongoDB/Spring Data Elasticsearch.

Example 9. Repository definitions using Module-specific Interfaces

```
interface MyRepository extends JpaRepository<User, Long> { }

@NoRepositoryBean
interface MyBaseRepository<T, ID extends Serializable> extends JpaRepository<T,
ID> {
  …
}

interface UserRepository extends MyBaseRepository<User, Long> {
  …
}
```

`MyRepository` and `UserRepository` extend `JpaRepository` in their type hierarchy. They are valid candidates for the Spring Data JPA module.

Example 10. Repository definitions using generic Interfaces

```
interface AmbiguousRepository extends Repository<User, Long> {
 …
}

@NoRepositoryBean
interface MyBaseRepository<T, ID extends Serializable> extends CrudRepository<T,
ID> {
  …
}

interface AmbiguousUserRepository extends MyBaseRepository<User, Long> {
  …
}
```

`AmbiguousRepository` and `AmbiguousUserRepository` extend only `Repository` and `CrudRepository` in their type hierarchy. While this is perfectly fine using a unique Spring Data module, multiple modules cannot distinguish to which particular Spring Data these repositories should be bound.

Example 11. Repository definitions using Domain Classes with Annotations

```
interface PersonRepository extends Repository<Person, Long> {
 …
}

@Entity
class Person {
  …
}

interface UserRepository extends Repository<User, Long> {
 …
}

@Document
class User {
  …
}
```

`PersonRepository` references `Person` which is annotated with the JPA annotation `@Entity` so this repository clearly belongs to Spring Data JPA. `UserRepository` uses `User` annotated with Spring Data MongoDB's `@Document` annotation.

Example 12. Repository definitions using Domain Classes with mixed Annotations

```
interface JpaPersonRepository extends Repository<Person, Long> {
 …
}

interface MongoDBPersonRepository extends Repository<Person, Long> {
 …
}

@Entity
@Document
class Person {
  …
}
```

This example shows a domain class using both JPA and Spring Data MongoDB annotations. It defines two repositories, `JpaPersonRepository` and `MongoDBPersonRepository`. One is intended for JPA and the other for MongoDB usage. Spring Data is no longer able to tell the repositories apart which leads to undefined behavior.

Repository type details and identifying domain class annotations are used for strict repository configuration identify repository candidates for a particular Spring Data module. Using multiple persistence technology-specific annotations on the same domain type is possible to reuse domain types across multiple persistence technologies, but then Spring Data is no longer able to determine a unique module to bind the repository.

The last way to distinguish repositories is scoping repository base packages. Base packages define the starting points for scanning for repository interface definitions which implies to have repository definitions located in the appropriate packages. By default, annotation-driven configuration uses the package of the configuration class. The base package in XML-based configuration is mandatory.

Example 13. Annotation-driven configuration of base packages

```
@EnableJpaRepositories(basePackages = "com.acme.repositories.jpa")
@EnableMongoRepositories(basePackages = "com.acme.repositories.mongo")
interface Configuration { }
```

1.4. Defining query methods

The repository proxy has two ways to derive a store-specific query from the method name. It can derive the query from the method name directly, or by using a manually defined query. Available options depend on the actual store. However, there's got to be a strategy that decides what actual query is created. Let's have a look at the available options.

1.4.1. Query lookup strategies

The following strategies are available for the repository infrastructure to resolve the query. You can configure the strategy at the namespace through the `query-lookup-strategy` attribute in case of XML configuration or via the `queryLookupStrategy` attribute of the Enable${store}Repositories annotation in case of Java config. Some strategies may not be supported for particular datastores.

- `CREATE` attempts to construct a store-specific query from the query method name. The general approach is to remove a given set of well-known prefixes from the method name and parse the rest of the method. Read more about query construction in Query creation.
- `USE_DECLARED_QUERY` tries to find a declared query and will throw an exception in case it can't find one. The query can be defined by an annotation somewhere or declared by other means. Consult the documentation of the specific store to find available options for that store. If the repository infrastructure does not find a declared query for the method at bootstrap time, it fails.
- `CREATE_IF_NOT_FOUND` (default) combines `CREATE` and `USE_DECLARED_QUERY`. It looks up a declared query first, and if no declared query is found, it creates a custom method name-based query. This is the default lookup strategy and thus will be used if you do not configure anything explicitly. It allows quick query definition by method names but also custom-tuning of these queries by introducing declared queries as needed.

1.4.2. Query creation

The query builder mechanism built into Spring Data repository infrastructure is useful for building constraining queries over entities of the repository. The mechanism strips the prefixes `find…By`, `read…By`, `query…By`, `count…By`, and `get…By` from the method and starts parsing the rest of it. The introducing clause can contain further expressions such as a `Distinct` to set a distinct flag on the query to be created. However, the first `By` acts as delimiter to indicate the start of the actual criteria. At a very basic level you can define conditions on entity properties and concatenate them with `And` and `Or`.

Example 14. Query creation from method names

```
interface PersonRepository extends Repository<User, Long> {

  List<Person> findByEmailAddressAndLastname(EmailAddress emailAddress, String
lastname);

  // Enables the distinct flag for the query
  List<Person> findDistinctPeopleByLastnameOrFirstname(String lastname, String
firstname);
  List<Person> findPeopleDistinctByLastnameOrFirstname(String lastname, String
firstname);

  // Enabling ignoring case for an individual property
  List<Person> findByLastnameIgnoreCase(String lastname);
  // Enabling ignoring case for all suitable properties
  List<Person> findByLastnameAndFirstnameAllIgnoreCase(String lastname, String
firstname);

  // Enabling static ORDER BY for a query
  List<Person> findByLastnameOrderByFirstnameAsc(String lastname);
  List<Person> findByLastnameOrderByFirstnameDesc(String lastname);
}
```

The actual result of parsing the method depends on the persistence store for which you create the query. However, there are some general things to notice.

- The expressions are usually property traversals combined with operators that can be concatenated. You can combine property expressions with `AND` and `OR`. You also get support for operators such as `Between`, `LessThan`, `GreaterThan`, `Like` for the property expressions. The supported operators can vary by datastore, so consult the appropriate part of your reference documentation.
- The method parser supports setting an `IgnoreCase` flag for individual properties (for example, `findByLastnameIgnoreCase(…)`) or for all properties of a type that support ignoring case (usually `String` instances, for example, `findByLastnameAndFirstnameAllIgnoreCase(…)`). Whether ignoring cases is supported may vary by store, so consult the relevant sections in the reference documentation for the store-specific query method.

- You can apply static ordering by appending an `OrderBy` clause to the query method that references a property and by providing a sorting direction (`Asc` or `Desc`). To create a query method that supports dynamic sorting, see Special parameter handling.

1.4.3. Property expressions

Property expressions can refer only to a direct property of the managed entity, as shown in the preceding example. At query creation time you already make sure that the parsed property is a property of the managed domain class. However, you can also define constraints by traversing nested properties. Assume a `Person` has an `Address` with a `ZipCode`. In that case a method name of

```
List<Person> findByAddressZipCode(ZipCode zipCode);
```

creates the property traversal `x.address.zipCode`. The resolution algorithm starts with interpreting the entire part (`AddressZipCode`) as the property and checks the domain class for a property with that name (uncapitalized). If the algorithm succeeds it uses that property. If not, the algorithm splits up the source at the camel case parts from the right side into a head and a tail and tries to find the corresponding property, in our example, `AddressZip` and `Code`. If the algorithm finds a property with that head it takes the tail and continue building the tree down from there, splitting the tail up in the way just described. If the first split does not match, the algorithm move the split point to the left (`Address`, `ZipCode`) and continues.

Although this should work for most cases, it is possible for the algorithm to select the wrong property. Suppose the `Person` class has an `addressZip` property as well. The algorithm would match in the first split round already and essentially choose the wrong property and finally fail (as the type of `addressZip` probably has no `code` property).

To resolve this ambiguity you can use `\_` inside your method name to manually define traversal points. So our method name would end up like so:

```
List<Person> findByAddress_ZipCode(ZipCode zipCode);
```

As we treat underscore as a reserved character we strongly advise to follow standard Java naming conventions (i.e. **not** using underscores in property names but camel case instead).

1.4.4. Special parameter handling

To handle parameters in your query you simply define method parameters as already seen in the examples above. Besides that the infrastructure will recognize certain specific types like `Pageable` and `Sort` to apply pagination and sorting to your queries dynamically.

Example 15. Using Pageable, Slice and Sort in query methods

```
Page<User> findByLastname(String lastname, Pageable pageable);

Slice<User> findByLastname(String lastname, Pageable pageable);

List<User> findByLastname(String lastname, Sort sort);

List<User> findByLastname(String lastname, Pageable pageable);
```

The first method allows you to pass an `org.springframework.data.domain.Pageable` instance to the query method to dynamically add paging to your statically defined query. A `Page` knows about the total number of elements and pages available. It does so by the infrastructure triggering a count query to calculate the overall number. As this might be expensive depending on the store used, `Slice` can be used as return instead. A `Slice` only knows about whether there's a next `Slice` available which might be just sufficient when walking through a larger result set.

Sorting options are handled through the `Pageable` instance too. If you only need sorting, simply add an `org.springframework.data.domain.Sort` parameter to your method. As you also can see, simply returning a `List` is possible as well. In this case the additional metadata required to build the actual `Page` instance will not be created (which in turn means that the additional count query that would have been necessary not being issued) but rather simply restricts the query to look up only the given range of entities.

NOTE	To find out how many pages you get for a query entirely you have to trigger an additional count query. By default this query will be derived from the query you actually trigger.

1.4.5. Limiting query results

The results of query methods can be limited via the keywords `first` or `top`, which can be used interchangeably. An optional numeric value can be appended to top/first to specify the maximum result size to be returned. If the number is left out, a result size of 1 is assumed.

Example 16. Limiting the result size of a query with `Top` and `First`

```
User findFirstByOrderByLastnameAsc();

User findTopByOrderByAgeDesc();

Page<User> queryFirst10ByLastname(String lastname, Pageable pageable);

Slice<User> findTop3ByLastname(String lastname, Pageable pageable);

List<User> findFirst10ByLastname(String lastname, Sort sort);

List<User> findTop10ByLastname(String lastname, Pageable pageable);
```

The limiting expressions also support the `Distinct` keyword. Also, for the queries limiting the result set to one instance, wrapping the result into an `Optional` is supported.

If pagination or slicing is applied to a limiting query pagination (and the calculation of the number of pages available) then it is applied within the limited result.

NOTE Note that limiting the results in combination with dynamic sorting via a `Sort` parameter allows to express query methods for the 'K' smallest as well as for the 'K' biggest elements.

1.4.6. Streaming query results

The results of query methods can be processed incrementally by using a Java 8 `Stream<T>` as return type. Instead of simply wrapping the query results in a `Stream` data store specific methods are used to perform the streaming.

Example 17. Stream the result of a query with Java 8 `Stream<T>`

```
@Query("select u from User u")
Stream<User> findAllByCustomQueryAndStream();

Stream<User> readAllByFirstnameNotNull();

@Query("select u from User u")
Stream<User> streamAllPaged(Pageable pageable);
```

NOTE A `Stream` potentially wraps underlying data store specific resources and must therefore be closed after usage. You can either manually close the `Stream` using the `close()` method or by using a Java 7 try-with-resources block.

Example 18. Working with a `Stream<T>` result in a try-with-resources block

```
try (Stream<User> stream = repository.findAllByCustomQueryAndStream()) {
  stream.forEach(…);
}
```

NOTE Not all Spring Data modules currently support `Stream<T>` as a return type.

1.4.7. Async query results

Repository queries can be executed asynchronously using Spring's asynchronous method execution capability. This means the method will return immediately upon invocation and the actual query execution will occur in a task that has been submitted to a Spring TaskExecutor.

```
@Async
Future<User> findByFirstname(String firstname);               ①

@Async
CompletableFuture<User> findOneByFirstname(String firstname); ②

@Async
ListenableFuture<User> findOneByLastname(String lastname);    ③
```

① Use `java.util.concurrent.Future` as return type.

② Use a Java 8 `java.util.concurrent.CompletableFuture` as return type.

③ Use a `org.springframework.util.concurrent.ListenableFuture` as return type.

1.5. Creating repository instances

In this section you create instances and bean definitions for the repository interfaces defined. One way to do so is using the Spring namespace that is shipped with each Spring Data module that supports the repository mechanism although we generally recommend to use the Java-Config style configuration.

1.5.1. XML configuration

Each Spring Data module includes a repositories element that allows you to simply define a base package that Spring scans for you.

Example 19. Enabling Spring Data repositories via XML

```
<?xml version="1.0" encoding="UTF-8"?>
<beans:beans xmlns:beans="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://www.springframework.org/schema/data/jpa"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/data/jpa
    http://www.springframework.org/schema/data/jpa/spring-jpa.xsd">

  <repositories base-package="com.acme.repositories" />

</beans:beans>
```

In the preceding example, Spring is instructed to scan `com.acme.repositories` and all its sub-packages for interfaces extending `Repository` or one of its sub-interfaces. For each interface found, the infrastructure registers the persistence technology-specific `FactoryBean` to create the appropriate proxies that handle invocations of the query methods. Each bean is registered under a bean name that is derived from the interface name, so an interface of `UserRepository` would be registered under `userRepository`. The `base-package` attribute allows wildcards, so that you can define a pattern of scanned packages.

Using filters

By default the infrastructure picks up every interface extending the persistence technology-specific `Repository` sub-interface located under the configured base package and creates a bean instance for it. However, you might want more fine-grained control over which interfaces bean instances get created for. To do this you use `<include-filter />` and `<exclude-filter />` elements inside `<repositories />`. The semantics are exactly equivalent to the elements in Spring's context namespace. For details, see Spring reference documentation on these elements.

For example, to exclude certain interfaces from instantiation as repository, you could use the following configuration:

Example 20. Using exclude-filter element

```
<repositories base-package="com.acme.repositories">
  <context:exclude-filter type="regex" expression=".*SomeRepository" />
</repositories>
```

This example excludes all interfaces ending in `SomeRepository` from being instantiated.

1.5.2. JavaConfig

The repository infrastructure can also be triggered using a store-specific

`@Enable${store}Repositories` annotation on a JavaConfig class. For an introduction into Java-based configuration of the Spring container, see the reference documentation. [1: JavaConfig in the Spring reference documentation]

A sample configuration to enable Spring Data repositories looks something like this.

Example 21. Sample annotation based repository configuration

```
@Configuration
@EnableJpaRepositories("com.acme.repositories")
class ApplicationConfiguration {

  @Bean
  EntityManagerFactory entityManagerFactory() {
    // …
  }
}
```

NOTE The sample uses the JPA-specific annotation, which you would change according to the store module you actually use. The same applies to the definition of the `EntityManagerFactory` bean. Consult the sections covering the store-specific configuration.

1.5.3. Standalone usage

You can also use the repository infrastructure outside of a Spring container, e.g. in CDI environments. You still need some Spring libraries in your classpath, but generally you can set up repositories programmatically as well. The Spring Data modules that provide repository support ship a persistence technology-specific RepositoryFactory that you can use as follows.

Example 22. Standalone usage of repository factory

```
RepositoryFactorySupport factory = … // Instantiate factory here
UserRepository repository = factory.getRepository(UserRepository.class);
```

1.6. Custom implementations for Spring Data repositories

In this section you will learn about repository customization and how fragments form a composite repository.

When query method require a different behavior or can't be implemented by query derivation than it's necessary to provide a custom implementation. Spring Data repositories easily allow you to provide custom repository code and integrate it with generic CRUD abstraction and query method functionality.

1.6.1. Customizing individual repositories

To enrich a repository with custom functionality, you first define a fragment interface and an implementation for the custom functionality. Then let your repository interface additionally extend from the fragment interface.

Example 23. Interface for custom repository functionality

```
interface CustomizedUserRepository {
  void someCustomMethod(User user);
}
```

Example 24. Implementation of custom repository functionality

```
class CustomizedUserRepositoryImpl implements CustomizedUserRepository {

  public void someCustomMethod(User user) {
    // Your custom implementation
  }
}
```

NOTE The most important bit for the class to be found is the `Impl` postfix of the name on it compared to the fragment interface.

The implementation itself does not depend on Spring Data and can be a regular Spring bean. So you can use standard dependency injection behavior to inject references to other beans like a `JdbcTemplate`, take part in aspects, and so on.

Example 25. Changes to your repository interface

```
interface UserRepository extends CrudRepository<User, Long>,
CustomizedUserRepository {

  // Declare query methods here
}
```

Let your repository interface extend the fragment one. Doing so combines the CRUD and custom functionality and makes it available to clients.

Spring Data repositories are implemented by using fragments that form a repository composition. Fragments are the base repository, functional aspects such as QueryDsl and custom interfaces along with their implementation. Each time you add an interface to your repository interface, you enhance the composition by adding a fragment. The base repository and repository aspect implementations are provided by each Spring Data module.

Example 26. Fragments with their implementations

```
interface HumanRepository {
  void someHumanMethod(User user);
}

class HumanRepositoryImpl implements HumanRepository {

  public void someHumanMethod(User user) {
    // Your custom implementation
  }
}

interface EmployeeRepository {

  void someEmployeeMethod(User user);

  User anotherEmployeeMethod(User user);
}

class ContactRepositoryImpl implements ContactRepository {

  public void someContactMethod(User user) {
    // Your custom implementation
  }

  public User anotherContactMethod(User user) {
    // Your custom implementation
  }
}
```

Example 27. Changes to your repository interface

```
interface UserRepository extends CrudRepository<User, Long>, HumanRepository,
ContactRepository {

  // Declare query methods here
}
```

Repositories may be composed of multiple custom implementations that are imported in the order of their declaration. Custom implementations have a higher priority than the base implementation and repository aspects. This ordering allows you to override base repository and aspect methods and resolves ambiguity if two fragments contribute the same method signature. Repository fragments are not limited to be used in a single repository interface. Multiple repositories may use a fragment interface to reuse customizations across different repositories.

Example 28. Fragments overriding `save(…)`

```
interface CustomizedSave<T> {
  <S extends T> S save(S entity);
}

class CustomizedSaveImpl<T> implements CustomizedSave<T> {

  public <S extends T> S save(S entity) {
    // Your custom implementation
  }
}
```

Example 29. Customized repository interfaces

```
interface UserRepository extends CrudRepository<User, Long>, CustomizedSave<User>
{
}

interface PersonRepository extends CrudRepository<Person, Long>, CustomizedSave
<Person> {
}
```

Configuration

If you use namespace configuration, the repository infrastructure tries to autodetect custom implementation fragments by scanning for classes below the package we found a repository in. These classes need to follow the naming convention of appending the namespace element's attribute `repository-impl-postfix` to the found fragment interface name. This postfix defaults to `Impl`.

Example 30. Configuration example

```
<repositories base-package="com.acme.repository" />

<repositories base-package="com.acme.repository" repository-impl-postfix="FooBar"
/>
```

The first configuration example will try to look up a class `com.acme.repository.CustomizedUserRepositoryImpl` to act as custom repository implementation, whereas the second example will try to lookup `com.acme.repository.CustomizedUserRepositoryFooBar`.

Resolution of ambiguity

If multiple implementations with matching class names get found in different packages, Spring Data uses the bean names to identify the correct one to use.

Given the following two custom implementations for the `CustomizedUserRepository` introduced above the first implementation will get picked. Its bean name is `customizedUserRepositoryImpl` matches that of the fragment interface (`CustomizedUserRepository`) plus the postfix `Impl`.

Example 31. Resolution of amibiguous implementations

```
package com.acme.impl.one;

class CustomizedUserRepositoryImpl implements CustomizedUserRepository {

  // Your custom implementation
}
```

```
package com.acme.impl.two;

@Component("specialCustomImpl")
class CustomizedUserRepositoryImpl implements CustomizedUserRepository {

  // Your custom implementation
}
```

If you annotate the `UserRepository` interface with `@Component("specialCustom")` the bean name plus `Impl` matches the one defined for the repository implementation in `com.acme.impl.two` and it will be picked instead of the first one.

Manual wiring

The approach just shown works well if your custom implementation uses annotation-based configuration and autowiring only, as it will be treated as any other Spring bean. If your implementation fragment bean needs special wiring, you simply declare the bean and name it after the conventions just described. The infrastructure will then refer to the manually defined bean definition by name instead of creating one itself.

Example 32. Manual wiring of custom implementations

```
<repositories base-package="com.acme.repository" />

<beans:bean id="userRepositoryImpl" class="…">
  <!-- further configuration -->
</beans:bean>
```

1.6.2. Customize the base repository

The preceding approach requires customization of all repository interfaces when you want to customize the base repository behavior, so all repositories are affected. To change behavior for all repositories, you need to create an implementation that extends the persistence technology-specific repository base class. This class will then act as a custom base class for the repository proxies.

Example 33. Custom repository base class

```
class MyRepositoryImpl<T, ID extends Serializable>
  extends SimpleJpaRepository<T, ID> {

  private final EntityManager entityManager;

  MyRepositoryImpl(JpaEntityInformation entityInformation,
                          EntityManager entityManager) {
    super(entityInformation, entityManager);

    // Keep the EntityManager around to used from the newly introduced methods.
    this.entityManager = entityManager;
  }

  @Transactional
  public <S extends T> S save(S entity) {
    // implementation goes here
  }
}
```

WARNING The class needs to have a constructor of the super class which the store-specific repository factory implementation is using. In case the repository base class has multiple constructors, override the one taking an `EntityInformation` plus a store specific infrastructure object (e.g. an `EntityManager` or a template class).

The final step is to make the Spring Data infrastructure aware of the customized repository base class. In JavaConfig this is achieved by using the `repositoryBaseClass` attribute of the `@Enable…Repositories` annotation:

Example 34. Configuring a custom repository base class using JavaConfig

```
@Configuration
@EnableJpaRepositories(repositoryBaseClass = MyRepositoryImpl.class)
class ApplicationConfiguration { … }
```

A corresponding attribute is available in the XML namespace.

Example 35. Configuring a custom repository base class using XML

```
<repositories base-package="com.acme.repository"
     base-class="….MyRepositoryImpl" />
```

1.7. Publishing events from aggregate roots

Entities managed by repositories are aggregate roots. In a Domain-Driven Design application, these aggregate roots usually publish domain events. Spring Data provides an annotation `@DomainEvents` you can use on a method of your aggregate root to make that publication as easy as possible.

Example 36. Exposing domain events from an aggregate root

```
class AnAggregateRoot {

    @DomainEvents ①
    Collection<Object> domainEvents() {
        // … return events you want to get published here
    }

    @AfterDomainEventPublication ②
    void callbackMethod() {
       // … potentially clean up domain events list
    }
}
```

① The method using `@DomainEvents` can either return a single event instance or a collection of events. It must not take any arguments.

② After all events have been published, a method annotated with `@AfterDomainEventPublication`. It e.g. can be used to potentially clean the list of events to be published.

The methods will be called every time one of a Spring Data repository's `save(…)` methods is called.

1.8. Spring Data extensions

This section documents a set of Spring Data extensions that enable Spring Data usage in a variety of contexts. Currently most of the integration is targeted towards Spring MVC.

1.8.1. Querydsl Extension

Querydsl is a framework which enables the construction of statically typed SQL-like queries via its fluent API.

Several Spring Data modules offer integration with Querydsl via `QueryDslPredicateExecutor`.

Example 37. QueryDslPredicateExecutor interface

```
public interface QueryDslPredicateExecutor<T> {

  Optional<T> findById(Predicate predicate);  ①

  Iterable<T> findAll(Predicate predicate);   ②

  long count(Predicate predicate);            ③

  boolean exists(Predicate predicate);        ④

  // … more functionality omitted.
}
```

① Finds and returns a single entity matching the `Predicate`.

② Finds and returns all entities matching the `Predicate`.

③ Returns the number of entities matching the `Predicate`.

④ Returns if an entity that matches the `Predicate` exists.

To make use of Querydsl support simply extend `QueryDslPredicateExecutor` on your repository interface.

Example 38. Querydsl integration on repositories

```
interface UserRepository extends CrudRepository<User, Long>,
QueryDslPredicateExecutor<User> {

}
```

The above enables to write typesafe queries using Querydsl `Predicate` s.

```
Predicate predicate = user.firstname.equalsIgnoreCase("dave")
    .and(user.lastname.startsWithIgnoreCase("mathews"));

userRepository.findAll(predicate);
```

1.8.2. Web support

NOTE This section contains the documentation for the Spring Data web support as it is implemented as of Spring Data Commons in the 1.6 range. As it the newly introduced support changes quite a lot of things we kept the documentation of the former behavior in Legacy web support.

Spring Data modules ships with a variety of web support if the module supports the repository programming model. The web related stuff requires Spring MVC JARs on the classpath, some of them even provide integration with Spring HATEOAS [2: Spring HATEOAS - https://github.com/SpringSource/spring-hateoas]. In general, the integration support is enabled by using the `@EnableSpringDataWebSupport` annotation in your JavaConfig configuration class.

Example 39. Enabling Spring Data web support

```
@Configuration
@EnableWebMvc
@EnableSpringDataWebSupport
class WebConfiguration {}
```

The `@EnableSpringDataWebSupport` annotation registers a few components we will discuss in a bit. It will also detect Spring HATEOAS on the classpath and register integration components for it as well if present.

Alternatively, if you are using XML configuration, register either `SpringDataWebSupport` or `HateoasAwareSpringDataWebSupport` as Spring beans:

Example 40. Enabling Spring Data web support in XML

```
<bean class="org.springframework.data.web.config.SpringDataWebConfiguration" />

<!-- If you're using Spring HATEOAS as well register this one *instead* of the
former -->
<bean class=
"org.springframework.data.web.config.HateoasAwareSpringDataWebConfiguration" />
```

Basic web support

The configuration setup shown above will register a few basic components:

- A `DomainClassConverter` to enable Spring MVC to resolve instances of repository managed domain classes from request parameters or path variables.
- `HandlerMethodArgumentResolver` implementations to let Spring MVC resolve `Pageable` and `Sort` instances from request parameters.

DomainClassConverter

The `DomainClassConverter` allows you to use domain types in your Spring MVC controller method signatures directly, so that you don't have to manually lookup the instances via the repository:

Example 41. A Spring MVC controller using domain types in method signatures

```
@Controller
@RequestMapping("/users")
class UserController {

  @RequestMapping("/{id}")
  String showUserForm(@PathVariable("id") User user, Model model) {

    model.addAttribute("user", user);
    return "userForm";
  }
}
```

As you can see the method receives a User instance directly and no further lookup is necessary. The instance can be resolved by letting Spring MVC convert the path variable into the id type of the domain class first and eventually access the instance through calling `findById(…)` on the repository instance registered for the domain type.

NOTE Currently the repository has to implement `CrudRepository` to be eligible to be discovered for conversion.

HandlerMethodArgumentResolvers for Pageable and Sort

The configuration snippet above also registers a `PageableHandlerMethodArgumentResolver` as well as an instance of `SortHandlerMethodArgumentResolver`. The registration enables `Pageable` and `Sort` being valid controller method arguments

Example 42. Using Pageable as controller method argument

```
@Controller
@RequestMapping("/users")
class UserController {

  private final UserRepository repository;

  UserController(UserRepository repository) {
    this.repository = repository;
  }

  @RequestMapping
  String showUsers(Model model, Pageable pageable) {

    model.addAttribute("users", repository.findAll(pageable));
    return "users";
  }
}
```

This method signature will cause Spring MVC try to derive a Pageable instance from the request parameters using the following default configuration:

Table 1. Request parameters evaluated for Pageable instances

`page`	Page you want to retrieve, 0 indexed and defaults to 0.
`size`	Size of the page you want to retrieve, defaults to 20.
`sort`	Properties that should be sorted by in the format `property,property(,ASC|DESC)`. Default sort direction is ascending. Use multiple `sort` parameters if you want to switch directions, e.g. `?sort=firstname&sort=lastname,asc`.

To customize this behavior register a bean implementing the interface `PageableHandlerMethodArgumentResolverCustomizer` or `SortHandlerMethodArgumentResolverCustomizer` respectively. It's `customize()` method will get called allowing you to change settings. Like in the following example.

```
@Bean SortHandlerMethodArgumentResolverCustomizer sortCustomizer() {
    return s -> s.setPropertyDelimiter("<-->");
}
```

If setting the properties of an existing `MethodArgumentResolver` isn't sufficient for your purpose extend either `SpringDataWebConfiguration` or the HATEOAS-enabled equivalent and override the `pageableResolver()` or `sortResolver()` methods and import your customized configuration file instead of using the `@Enable`-annotation.

In case you need multiple `Pageable` or `Sort` instances to be resolved from the request (for multiple tables, for example) you can use Spring's `@Qualifier` annotation to distinguish one from another.

The request parameters then have to be prefixed with `${qualifier}_`. So for a method signature like this:

```
String showUsers(Model model,
      @Qualifier("foo") Pageable first,
      @Qualifier("bar") Pageable second) { … }
```

you have to populate `foo_page` and `bar_page` etc.

The default `Pageable` handed into the method is equivalent to a `new PageRequest(0, 20)` but can be customized using the `@PageableDefault` annotation on the `Pageable` parameter.

Hypermedia support for Pageables

Spring HATEOAS ships with a representation model class `PagedResources` that allows enriching the content of a `Page` instance with the necessary `Page` metadata as well as links to let the clients easily navigate the pages. The conversion of a Page to a `PagedResources` is done by an implementation of the Spring HATEOAS `ResourceAssembler` interface, the `PagedResourcesAssembler`.

Example 43. Using a PagedResourcesAssembler as controller method argument

```
@Controller
class PersonController {

  @Autowired PersonRepository repository;

  @RequestMapping(value = "/persons", method = RequestMethod.GET)
  HttpEntity<PagedResources<Person>> persons(Pageable pageable,
    PagedResourcesAssembler assembler) {

    Page<Person> persons = repository.findAll(pageable);
    return new ResponseEntity<>(assembler.toResources(persons), HttpStatus.OK);
  }
}
```

Enabling the configuration as shown above allows the `PagedResourcesAssembler` to be used as controller method argument. Calling `toResources(…)` on it will cause the following:

- The content of the `Page` will become the content of the `PagedResources` instance.
- The `PagedResources` will get a `PageMetadata` instance attached populated with information form the `Page` and the underlying `PageRequest`.
- The `PagedResources` gets `prev` and `next` links attached depending on the page's state. The links will point to the URI the method invoked is mapped to. The pagination parameters added to the method will match the setup of the `PageableHandlerMethodArgumentResolver` to make sure the links can be resolved later on.

Assume we have 30 Person instances in the database. You can now trigger a request `GET http://localhost:8080/persons` and you'll see something similar to this:

```
{ "links" : [ { "rel" : "next",
                "href" : "http://localhost:8080/persons?page=1&size=20 }
  ],
  "content" : [
     … // 20 Person instances rendered here
  ],
  "pageMetadata" : {
    "size" : 20,
    "totalElements" : 30,
    "totalPages" : 2,
    "number" : 0
  }
}
```

You see that the assembler produced the correct URI and also picks up the default configuration present to resolve the parameters into a `Pageable` for an upcoming request. This means, if you change that configuration, the links will automatically adhere to the change. By default the assembler points to the controller method it was invoked in but that can be customized by handing in a custom `Link` to be used as base to build the pagination links to overloads of the `PagedResourcesAssembler.toResource(…)` method.

Web databinding support

Spring Data projections – generally described in [projections] – can be used to bind incoming request payloads by either using JSONPath expressions (requires Jayway JasonPath or XPath expressions (requires XmlBeam).

Example 44. HTTP payload binding using JSONPath or XPath expressions

```
@ProjectedPayload
public interface UserPayload {

  @XBRead("//firstname")
  @JsonPath("$..firstname")
  String getFirstname();

  @XBRead("/lastname")
  @JsonPath({ "$.lastname", "$.user.lastname" })
  String getLastname();
}
```

The type above can be used as Spring MVC handler method argument or via `ParameterizedTypeReference` on one of `RestTemplate`'s methods. The method declarations above would try to find `firstname` anywhere in the given document. The `lastname` XML looup is performed on the top-level of the incoming document. The JSON variant of that tries a top-level `lastname` first but also tries `lastname` nested in a `user` sub-document in case the former doesn't return a value. That way changes if the structure of the source document can be mitigated easily without having to touch clients calling the exposed methods (usually a drawback of class-based payload binding).

Nested projections are supported as described in [projections]. If the method returns a complex, non-interface type, a Jackson `ObjectMapper` is used to map the final value.

For Spring MVC, the necessary converters are registered automatically, as soon as `@EnableSpringDataWebSupport` is active and the required dependencies are available on the classpath. For usage with `RestTemplate` register a `ProjectingJackson2HttpMessageConverter` (JSON) or `XmlBeamHttpMessageConverter` manually.

For more information, see the web projection example in the canonical Spring Data Examples repository.

Querydsl web support

For those stores having QueryDSL integration it is possible to derive queries from the attributes contained in a `Request` query string.

This means that given the `User` object from previous samples a query string

```
?firstname=Dave&lastname=Matthews
```

can be resolved to

```
QUser.user.firstname.eq("Dave").and(QUser.user.lastname.eq("Matthews"))
```

using the `QuerydslPredicateArgumentResolver`.

NOTE The feature will be automatically enabled along `@EnableSpringDataWebSupport` when Querydsl is found on the classpath.

Adding a `@QuerydslPredicate` to the method signature will provide a ready to use `Predicate` which can be executed via the `QueryDslPredicateExecutor`.

TIP Type information is typically resolved from the methods return type. Since those information does not necessarily match the domain type it might be a good idea to use the `root` attribute of `QuerydslPredicate`.

```
@Controller
class UserController {

  @Autowired UserRepository repository;

  @RequestMapping(value = "/", method = RequestMethod.GET)
  String index(Model model, @QuerydslPredicate(root = User.class) Predicate
predicate,    ①
          Pageable pageable, @RequestParam MultiValueMap<String, String>
parameters) {

    model.addAttribute("users", repository.findAll(predicate, pageable));

    return "index";
  }
}
```

① Resolve query string arguments to matching `Predicate` for `User`.

The default binding is as follows:

- `Object` on simple properties as `eq`.
- `Object` on collection like properties as `contains`.
- `Collection` on simple properties as `in`.

Those bindings can be customized via the `bindings` attribute of `@QuerydslPredicate` or by making use of Java 8 `default methods` adding the `QuerydslBinderCustomizer` to the repository interface.

```
interface UserRepository extends CrudRepository<User, String>,
                                 QueryDslPredicateExecutor<User>,
①
                                 QuerydslBinderCustomizer<QUser> {
②

  @Override
  default void customize(QuerydslBindings bindings, QUser user) {

    bindings.bind(user.username).first((path, value) -> path.contains(value))
③
    bindings.bind(String.class)
      .first((StringPath path, String value) -> path.containsIgnoreCase(value));
④
    bindings.excluding(user.password);
⑤
  }
}
```

① `QueryDslPredicateExecutor` provides access to specific finder methods for `Predicate`.

② `QuerydslBinderCustomizer` defined on the repository interface will be automatically picked up and shortcuts `@QuerydslPredicate(bindings=…)`.

③ Define the binding for the `username` property to be a simple contains binding.

④ Define the default binding for `String` properties to be a case insensitive contains match.

⑤ Exclude the *password* property from `Predicate` resolution.

1.8.3. Repository populators

If you work with the Spring JDBC module, you probably are familiar with the support to populate a `DataSource` using SQL scripts. A similar abstraction is available on the repositories level, although it does not use SQL as the data definition language because it must be store-independent. Thus the populators support XML (through Spring's OXM abstraction) and JSON (through Jackson) to define data with which to populate the repositories.

Assume you have a file `data.json` with the following content:

Example 45. Data defined in JSON

```
[ { "_class" : "com.acme.Person",
 "firstname" : "Dave",
  "lastname" : "Matthews" },
  { "_class" : "com.acme.Person",
 "firstname" : "Carter",
  "lastname" : "Beauford" } ]
```

You can easily populate your repositories by using the populator elements of the repository namespace provided in Spring Data Commons. To populate the preceding data to your PersonRepository , do the following:

Example 46. Declaring a Jackson repository populator

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:repository="http://www.springframework.org/schema/data/repository"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/data/repository
    http://www.springframework.org/schema/data/repository/spring-repository.xsd">

  <repository:jackson2-populator locations="classpath:data.json" />

</beans>
```

This declaration causes the `data.json` file to be read and deserialized via a Jackson `ObjectMapper`.

The type to which the JSON object will be unmarshalled to will be determined by inspecting the `\_class` attribute of the JSON document. The infrastructure will eventually select the appropriate repository to handle the object just deserialized.

To rather use XML to define the data the repositories shall be populated with, you can use the `unmarshaller-populator` element. You configure it to use one of the XML marshaller options Spring OXM provides you with. See the Spring reference documentation for details.

Example 47. Declaring an unmarshalling repository populator (using JAXB)

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:repository="http://www.springframework.org/schema/data/repository"
  xmlns:oxm="http://www.springframework.org/schema/oxm"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/data/repository
    http://www.springframework.org/schema/data/repository/spring-repository.xsd
    http://www.springframework.org/schema/oxm
    http://www.springframework.org/schema/oxm/spring-oxm.xsd">

  <repository:unmarshaller-populator locations="classpath:data.json"
    unmarshaller-ref="unmarshaller" />

  <oxm:jaxb2-marshaller contextPath="com.acme" />

</beans>
```

1.8.4. Legacy web support

Domain class web binding for Spring MVC

Given you are developing a Spring MVC web application you typically have to resolve domain class ids from URLs. By default your task is to transform that request parameter or URL part into the domain class to hand it to layers below then or execute business logic on the entities directly. This would look something like this:

```java
@Controller
@RequestMapping("/users")
class UserController {

  private final UserRepository userRepository;

  UserController(UserRepository userRepository) {
    Assert.notNull(repository, "Repository must not be null!");
    this.userRepository = userRepository;
  }

  @RequestMapping("/{id}")
  String showUserForm(@PathVariable("id") Long id, Model model) {

    // Do null check for id
    User user = userRepository.findById(id);
    // Do null check for user

    model.addAttribute("user", user);
    return "user";
  }
}
```

First you declare a repository dependency for each controller to look up the entity managed by the controller or repository respectively. Looking up the entity is boilerplate as well, as it's always a `findById(…)` call. Fortunately Spring provides means to register custom components that allow conversion between a `String` value to an arbitrary type.

PropertyEditors

For Spring versions before 3.0 simple Java `PropertyEditors` had to be used. To integrate with that, Spring Data offers a `DomainClassPropertyEditorRegistrar`, which looks up all Spring Data repositories registered in the `ApplicationContext` and registers a custom `PropertyEditor` for the managed domain class.

```xml
<bean class="….web.servlet.mvc.annotation.AnnotationMethodHandlerAdapter">
  <property name="webBindingInitializer">
    <bean class="….web.bind.support.ConfigurableWebBindingInitializer">
      <property name="propertyEditorRegistrars">
        <bean class=
"org.springframework.data.repository.support.DomainClassPropertyEditorRegistrar" />
      </property>
    </bean>
  </property>
</bean>
```

If you have configured Spring MVC as in the preceding example, you can configure your controller as follows, which reduces a lot of the clutter and boilerplate.

```java
@Controller
@RequestMapping("/users")
class UserController {

  @RequestMapping("/{id}")
  String showUserForm(@PathVariable("id") User user, Model model) {

    model.addAttribute("user", user);
    return "userForm";
  }
}
```

Reference Documentation

Chapter 2. Key Value Repositories

This chapter explains concepts and usage patterns when working with the key value abstraction and the `java.util.Map` based implementation provided by Spring Data Commons.

2.1. Core Concepts

The Key/Value abstraction within Spring Data Commons requires an `Adapter` shielding the native store implementation freeing up `KeyValueTemplate` to work on top of any key/value pair like structure. Keys are distributed across Keyspaces. Unless otherwise specified the class name is used as the default keyspace for an entity.

```
interface KeyValueOperations {

    <T> T insert(T objectToInsert);                                  ①

    void update(Object objectToUpdate);                              ②

    void delete(Class<?> type);                                      ③

    <T> T findById(Object id, Class<T> type);                        ④

    <T> Iterable<T> findAllOf(Class<T> type);                        ⑤

    <T> Iterable<T> find(KeyValueQuery<?> query, Class<T> type);     ⑥

    //... more functionality omitted.

}
```

① Inserts the given entity and assigns id if required.

② Updates the given entity.

③ Removes all entities of matching type.

④ Returns the entity of given type with matching id.

⑤ Returns all entities of matching type.

⑥ Returns a List of all entities of given type matching the criteria of the query.

2.2. Configuring The KeyValueTemplate

In its very basic shape the `KeyValueTemplate` uses a `MapAdapter` wrapping a `ConcurrentHashMap` using Spring Expression Language to perform queries and sorting.

NOTE	The used `KeyValueAdapter` does the heavy lifting when it comes to storing and retrieving data. The data structure used will influence performance and/or multi threading behavior.

One may choose to use a different type or preinitialize the adapter with some values, and can do so using various constructors on `MapKeyValueAdapter`.

```
@Bean
public KeyValueOperations keyValueTemplate() {
  return new KeyValueTemplate(keyValueAdapter());
}

@Bean
public KeyValueAdapter keyValueAdapter() {
  return new MapKeyValueAdapter(ConcurrentHashMap.class);
}
```

2.3. Keyspaces

Keyspaces define in which part of the data structure the entity should be kept. So this is a rather similar concept as collections in MongoDB and Elasticsearch, Cores in Solr, Tables in JPA. By default the keyspace of an entity is extracted form its type, but one can also choose to store entities of different types within one keyspace. In that case any find operation will type check results.

```
@KeySpace("persons")
class Person {

  @Id String id;
  String firstname;
  String lastname;
}

class User extends Person {
  String username;
}

template.findAllOf(Person.class); ①
template.findAllOf(User.class);   ②
```

① Returns all entities for keyspace "persons".

② Returns only elements of type `User` stored in keyspace "persons".

2.3.1. Custom KeySpace Annotation

It is possible to compose own `KeySpace` annotations for a more domain centric usage by annotating one of the attributes with `@AliasFor`.

NOTE The composed annotation needs to inherit `@Persistent`.

```java
@Keyspace
@Persistent
@Retention(RetentionPolicy.RUNTIME)
@Target({ ElementType.TYPE })
static @interface CacheCentricAnnotation {

  @AliasFor(annotation = KeySpace.class, attribute = "value")
  String cacheRegion() default "";
}

@CacheCentricAnnotation(cacheRegion = "customers")
class Customer {
  //...
}
```

2.4. Querying

Query execution is managed by the `QueryEngine`. As mentioned before it is possible to instruct the `KeyValueAdapter` to use an implementation specific `QueryEngine` that allows access to native functionality. When used without further customization queries are be executed using a `SpELQueryEngine`.

NOTE For performance reasons, we highly recommend to have at least Spring 4.1.2 or better to make use of compiled SpEL Expressions. Please use the `-Dspring.expression.compiler.mode=IMMEDIATE` switch to turn it on.

```java
KeyValueQuery<String> query = new KeyValueQuery<String>("lastname == 'targaryen'");
List<Person> targaryens = template.find(query, Person.class);
```

WARNING Please note that you need to have getters/setters present to query properties using SpEL.

2.5. Sorting

Depending on the store implementation provided by the adapter entities might already be stored in some sorted way but do not necessarily have to be. Again the underlying `QueryEngine` is capable of performing sort operations. When used without further customization sorting is done using a `SpelPropertyComparator` extracted from the `Sort` clause provided

```java
KeyValueQuery<String> query = new KeyValueQuery<String>("lastname == 'baratheon'");
query.setSort(Sort.by(DESC, "age"));
List<Person> targaryens = template.find(query, Person.class);
```

WARNING Please note that you need to have getters/setters present to sort using SpEL.

2.6. Map Repositories

Map repositories reside on top of the `KeyValueTemplate`. Using the default `SpelQueryCreator` allows deriving query and sort expressions from the given method name.

```
@Configuration
@EnableMapRepositories
class KeyValueConfig {

}

interface PersonRepository implements CrudRepository<Person, String> {
    List<Person> findByLastname(String lastname);
}
```

Appendix

Appendix A: Namespace reference

The <repositories /> element

The `<repositories />` element triggers the setup of the Spring Data repository infrastructure. The most important attribute is `base-package` which defines the package to scan for Spring Data repository interfaces. [3: see XML configuration]

Table 2. Attributes

Name	Description
`base-package`	Defines the package to be used to be scanned for repository interfaces extending *Repository (actual interface is determined by specific Spring Data module) in auto detection mode. All packages below the configured package will be scanned, too. Wildcards are allowed.
`repository-impl-postfix`	Defines the postfix to autodetect custom repository implementations. Classes whose names end with the configured postfix will be considered as candidates. Defaults to `Impl`.
`query-lookup-strategy`	Determines the strategy to be used to create finder queries. See Query lookup strategies for details. Defaults to `create-if-not-found`.
`named-queries-location`	Defines the location to look for a Properties file containing externally defined queries.
`consider-nested-repositories`	Controls whether nested repository interface definitions should be considered. Defaults to `false`.

Appendix B: Populators namespace reference

The <populator /> element

The `<populator />` element allows to populate the a data store via the Spring Data repository infrastructure. [4: see XML configuration]

Table 3. Attributes

Name	Description
`locations`	Where to find the files to read the objects from the repository shall be populated with.

Appendix C: Repository query keywords

Supported query keywords

The following table lists the keywords generally supported by the Spring Data repository query derivation mechanism. However, consult the store-specific documentation for the exact list of supported keywords, because some listed here might not be supported in a particular store.

Table 4. Query keywords

Logical keyword	Keyword expressions
`AND`	`And`
`OR`	`Or`
`AFTER`	`After`, `IsAfter`
`BEFORE`	`Before`, `IsBefore`
`CONTAINING`	`Containing`, `IsContaining`, `Contains`
`BETWEEN`	`Between`, `IsBetween`
`ENDING_WITH`	`EndingWith`, `IsEndingWith`, `EndsWith`
`EXISTS`	`Exists`
`FALSE`	`False`, `IsFalse`
`GREATER_THAN`	`GreaterThan`, `IsGreaterThan`
`GREATER_THAN_EQUALS`	`GreaterThanEqual`, `IsGreaterThanEqual`
`IN`	`In`, `IsIn`
`IS`	`Is`, `Equals`, (or no keyword)
`IS_EMPTY`	`IsEmpty`, `Empty`
`IS_NOT_EMPTY`	`IsNotEmpty`, `NotEmpty`
`IS_NOT_NULL`	`NotNull`, `IsNotNull`
`IS_NULL`	`Null`, `IsNull`
`LESS_THAN`	`LessThan`, `IsLessThan`
`LESS_THAN_EQUAL`	`LessThanEqual`, `IsLessThanEqual`
`LIKE`	`Like`, `IsLike`
`NEAR`	`Near`, `IsNear`
`NOT`	`Not`, `IsNot`
`NOT_IN`	`NotIn`, `IsNotIn`
`NOT_LIKE`	`NotLike`, `IsNotLike`
`REGEX`	`Regex`, `MatchesRegex`, `Matches`
`STARTING_WITH`	`StartingWith`, `IsStartingWith`, `StartsWith`
`TRUE`	`True`, `IsTrue`
`WITHIN`	`Within`, `IsWithin`