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JSR-335 Update for JCP EC Meeting, January 2012

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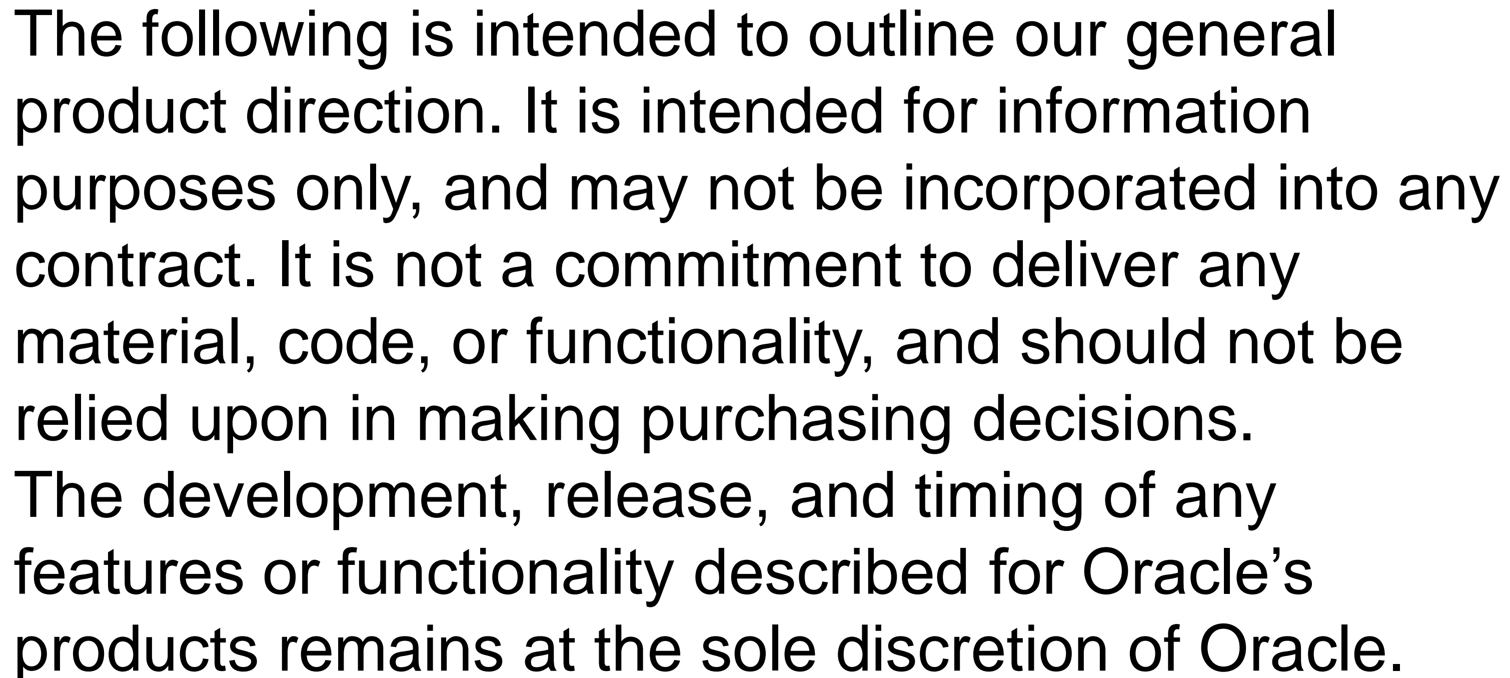

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Why closures for Java?

- Help Java programmers easily harness the power of today's multicore processors
- In Java SE 7, the serial code and the parallel code for a given computation look completely dissimilar – a barrier to parallelism
- The idiom of *internal iteration* is key to reducing this barrier
- Closures enable the development of rich, parallel-friendly libraries by supporting internal iteration
- This is not controversial – all other mainstream languages have already embraced closures (C#, VB, JavaScript, Ruby, Obj-C…)

Example: A simple query

"In a music library, get the set of 'favorite' albums where at least one track is highly rated"

```
class Album {
  String      title;
  List<Track> tracks;
}

class Track {
  String title;
  String artist;
  int    rating;
}
```

```
class Library {
  Set<Album> albums;

  Set<Album> favoriteAlbums() {
    // TODO
  }
}
```

Identifying a favorite album

```
// Set hasFavorite to true if some track in album a is rated >= 4

boolean hasFavorite = false;
for (Track t : a.tracks) {
  if (t.rating >= 4) {
    hasFavorite = true;
    break;
  }
}
```

Identifying a favorite album

```
// Set hasFavorite to true if some track in album a is rated >= 4

boolean hasFavorite = false;
for (Track t : a.tracks) {
  if (t.rating >= 4) {
    hasFavorite = true;
    break;
  }
}
```

External iteration

- Client controls iteration
- *Inherently serial:* iterate from beginning to end
- Lots of boilerplate
- Not thread-safe because business logic is stateful

Identifying a favorite album with lambdas

```
// Set hasFavorite to true if some track in album a is rated >= 4

boolean hasFavorite = false;
for (Track t : a.tracks) {
  if (t.rating >= 4) {
    hasFavorite = true;
    break;
  }
}

boolean hasFavorite = a.tracks.anyMatch(t -> t.rating >= 4);
```

Identifying a favorite album with lambdas

```
// Set hasFavorite to true if some track in album a is rated >= 4

boolean hasFavorite = false;
for (Track t : a.tracks) {
  if (t.rating >= 4) {
    hasFavorite = true;
    break;
  }
}
```

Internal iteration

- Iteration / filtering / accumulation controlled by the library
- Not inherently serial
- Thread-safe because business logic is stateless in the client

```
boolean hasFavorite = a.tracks.anyMatch(t -> t.rating >= 4);
```

Making a set of favorite albums

```
// Initialize favs as a set of favorite albums drawn from albums

Set<Album> favs = new HashSet<>();
for (Album a : albums) {
  if (a.tracks.anyMatch(t -> (t.rating >= 4)))
    favs.add(a);
}
```

Making a set of favorite albums

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// Initialize favs as a set of favorite albums drawn from albums

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for (Album a : albums) {
  if (a.tracks.anyMatch(t -> (t.rating >= 4)))
    favs.add(a);
}


Set<Album> favs =
  albums.filter(a -> a.tracks.anyMatch(t -> t.rating >= 4))
        .into(new HashSet<>());
```

Loops v. Lambdas

```
Set<Album> favs = new HashSet<>();
for (Album a : albums) {
  boolean hasFavorite = false;
  for (Track t : a.tracks) {
    if (t.rating >= 4) {
      hasFavorite = true;
      break;
    }
  }
  if (hasFavorite) favs.add(a);
}
```

```
Set<Album> favs =
  albums.filter(a -> a.tracks.anyMatch(t -> t.rating >= 4))
        .into(new HashSet<>());
```

Loops v. Lambdas

Explicit but unobstrusive parallelism

```
Set<Album> favs = new HashSet<>();
for (Album a : albums) {
  boolean hasFavorite = false;
  for (Track t : a.tracks) {
    if (t.rating >= 4) {
      hasFavorite = true;
      break;
    }
  }
  if (hasFavorite) favs.add(a);
}
```

```
Set<Album> favs =
  albums.parallel()
        .filter(a -> a.tracks.anyMatch(t -> (t.rating >= 4)))
        .into(new ConcurrentHashSet<>());
```

The real challenge: Library evolution

- If Java had closures in 1996, APIs would look very different
- Adding closures now, but not evolving core APIs to support them, would be foolish
  - The older APIs get, the more obvious the gaps
  - It is difficult to add entirely new core libraries because the old interfaces (e.g. List) permeate non-core libraries
- Historically, evolving interface-based APIs has been a problem
- Virtual extension methods provide a mechanism for *controlled* evolution of libraries over time
  - Puts burden of evolution on API designers/implementers, not users

JSR-335 features

- Language features
  - Lambda expressions (closures) with “SAM conversion”
  - Method references
  - Virtual extension methods
- Upgraded libraries to use new language features
  - Bulk data operations on Collections
    e.g. filter, map, reduce…
  - “Point lambdafication” of java.util / java.io / java.net
    e.g. “run this closure for every line of a file”
- Synergy with JSR-292 VM enhancements

JSR-335 status

- EDR #1 completed December 2011
  - Specification covers lambda expressions, SAM conversion, method references
  - Prototype of RI compiler available in OpenJDK Project Lambda
- EDR #2 targeted for April 2012
  - Adds type inference and virtual extension methods
- EDR #3 targeted for Summer 2012
  - Adds bulk data operations
  - Initial design is starting now in JSR 166 EG
  - API specification is ultimately expected to go through SE 8 Umbrella JSR