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NIO

Java NIO or `new-io`, is basically the new improved implementation of the standard `java.io`, this new implementation which was greatly improved in 1.7 allows one to work with IO streams in a non blocking way, which can greatly alleviate the load on particular systems, such as web servers. For example in a regular scenario where each new request to a web server creates a new thread, or uses free thread from a pool, instead of blocking the entire thread waiting for an `java.io` operation, using the old implementation, with the new approach one can use `java.nio` to open a channel to a file in a non blocking way, and when ready to read from the file or device.

Reading

The two examples show the usage of the new API, compared to the old one, in both cases the implementation is blocking however, the new NIO API is much cleaner, does most of the work internally, is wrapped in nice short methods which deliver the data easily, however it has less control over how the data stream is read.

```
public class OldIOReadExample {
    public static void main(String[] args) {
        try (BufferedReader reader = new BufferedReader(new
            FileReader("example.txt"))) {
            String line;
            while ((line = reader.readLine()) != null) {
                System.out.println(line);
            }
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

```
public class NIOReadExample {
    public static void main(String[] args) {
        try {
            List<String> lines =
                Files.readAllLines(Paths.get("example.txt"),
                    StandardCharsets.UTF_8);
            for (String line : lines) {
                System.out.println(line);
            }
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

```
}  
}
```

Writing

The two examples show the usage of the new API, compared to the old one, in both cases the implementation is blocking however, the new NIO API is much cleaner, does most of the work internally, is wrapped in nice short methods which deliver the data easily, however it has less control over how the data stream is write.

```
public class OldIOWriteExample {  
    public static void main(String[] args) {  
        try (BufferedWriter writer = new BufferedWriter(new  
            FileWriter("example.txt"))) {  
            writer.write("Hello, World!");  
            writer.newLine();  
            writer.write("This is a sample text.");  
        } catch (IOException e) {  
            e.printStackTrace();  
        }  
    }  
}
```

```
public class NIOWriteExample {  
    public static void main(String[] args) {  
        List<String> lines = Arrays.asList("Hello, World!", "This is a  
            sample text.");  
        try {  
            Files.write(Paths.get("example.txt"), lines,  
                StandardCharsets.UTF_8);  
        } catch (IOException e) {  
            e.printStackTrace();  
        }  
    }  
}
```

Memory-mapping

The implementation below deals with memory mapped files, which is a feature of the NIO library, allows one to map a given file resource to virtual memory, the OS can serve the file contents as if from the main memory which should make reading `mmaped` files more effective. This is a well known feature used in other languages such as C or C++.

```
public class NIOMemoryMappedReadExample {  
    public static void main(String[] args) {  
        try (FileChannel fileChannel =  
            FileChannel.open(Paths.get("example.txt"),  
                StandardOpenOption.READ)) {  
            MappedByteBuffer buffer =  
                fileChannel.map(FileChannel.MapMode.READ_ONLY, 0,  
                    fileChannel.size());  
  
            for (int i = 0; i < buffer.limit(); i++) {
```

```

        System.out.print((char) buffer.get());
    }
} catch (IOException e) {
    e.printStackTrace();
}
}
}

```

Async

In the example below one can see how the channels API might be used to read from a file, in an **async** manner, while the future is not finished, other work can be done, one can poll on the future over a specific period of time to check if it is ready, but the reading itself happens without blocking the current thread.

The code below demonstrates how to read and write from a file using the **async** approach in **nio**, notice how both the calls to read and write are non blocking, the thread is not stopped waiting for response from the calls, instead

```

public class AsyncFileReadExample {
    public static void main(String[] args) {
        try (AsynchronousFileChannel fileChannel =
            AsynchronousFileChannel.open(Paths.get("example.txt"),
            StandardOpenOption.READ)) {
            ByteBuffer buffer = ByteBuffer.allocate(1024);
            Future<Integer> result = fileChannel.read(buffer, 0);

            while (!result.isDone()) {
                System.out.println("Doing something else while file is
                    being read...");
                // Do something else in the meantime (e.g., a longer
                    computation)
            }

            int bytesRead = result.get(); // Blocks future here if not
                yet done
            System.out.println("Bytes read: " + bytesRead);

            // rewind the buffer, reset the buffer pointer back so it can
                be read
            buffer.rewind();

            // read the contents of the buffer, that can be done in many
                ways, here
            // one just copies back to a regular byte array,
            byte[] data = new byte[buffer.remaining()];
            buffer.get(data);
            System.out.println("File content: " + new String(data));
        } catch (IOException | InterruptedException |
            java.util.concurrent.ExecutionException e) {
            e.printStackTrace();
        }
    }
}

```

```

}

public class AsyncFileWriteExample {
    public static void main(String args[]) {
        try (AsynchronousFileChannel fileChannel =
            AsynchronousFileChannel.open(Paths.get("example.txt"),
            StandardOpenOption.WRITE, StandardOpenOption.CREATE))
        {
            // Create a buffer.
            ByteBuffer mBuf = ByteBuffer.allocate(26);
            // Write some bytes to the buffer.
            for(int i=0; i<26; i++)
                mBuf.put((byte)('A' + i));
            // Reset the buffer so that it can be written.
            mBuf.rewind();
            // Write the buffer from start to the output file.
            fChan.write(mBuf);
        } catch (InvalidPathException e) {
            System.out.println("Path Error " + e);
        } catch (IOException e) {
            System.out.println("I/O Error: " + e);
            System.exit(1);
        }
    }
}

```

Path

Another key feature added to the NIO library which serves as a bridge between the native `java.lang` File class and the new NIO packages. Below are listed some of the methods which are present in the `Path` class which are mostly meant to work with system paths, and are the backbone of the `nio` package library

Method	Description
<code>compareTo(Path other)</code>	Compares this Path to another Path lexicographically.
<code>endsWith(Path other)</code>	Checks if this Path ends with the specified Path .
<code>endsWith(String other)</code>	Checks if this Path ends with the given string, treating it as a sequence of name elements.
<code>equals(Object other)</code>	Compares this Path with another object for equality.
<code>getFileName()</code>	Returns the file name or the last name element of the Path .
<code>getName(int index)</code>	Returns the name element at the specified index from the Path .
<code>getNameCount()</code>	Returns the number of name elements in the Path .
<code>getParent()</code>	Returns the parent path of this Path , or null if there is no parent.
<code>getRoot()</code>	Returns the root of the Path , if available.
<code>hashCode()</code>	Returns a hash code for the Path .
<code>isAbsolute()</code>	Returns true if the Path is absolute.
<code>iterator()</code>	Returns an iterator over the name elements of the Path .
<code>normalize()</code>	Returns a normalized version of the Path , removing redundant elements like <code>.</code> and <code>...</code>

Method	Description
<code>of(String first, String... more)</code>	Creates a Path from one or more strings.
<code>of(URI uri)</code>	Converts a URI to a Path .
<code>register(WatchService watcher, Kind<?>... events)</code>	Registers the Path with a WatchService to monitor file system events.
<code>register(WatchService watcher, Kind<?>[] events, Modifier... modifiers)</code>	Registers the Path with a WatchService with extra settings.
<code>relativize(Path other)</code>	Constructs a relative path from this path to the given Path .
<code>resolve(Path other)</code>	Appends the provided Path to this Path .
<code>resolve(Path first, Path... more)</code>	Appends one or more paths to this Path .
<code>resolve(String other)</code>	Appends the given string (path segment) to this Path .
<code>resolve(String first, String... more)</code>	Appends one or more strings to this Path .
<code>resolveSibling(Path other)</code>	Resolves the Path against the parent of this path.
<code>resolveSibling(String other)</code>	Resolves the Path against the parent with a sibling represented by a string.
<code>startsWith(Path other)</code>	Checks if this Path starts with the specified Path .
<code>startsWith(String other)</code>	Checks if this Path starts with the given string.
<code>subpath(int beginIndex, int endIndex)</code>	Returns a subpath of this Path from beginIndex to endIndex .
<code>toAbsolutePath()</code>	Converts this Path to an absolute path.
<code>toFile()</code>	Converts the Path to a File object.
<code>toRealPath(LinkOption... options)</code>	Returns the real path after resolving symbolic links and verifying the file's existence.
<code>toString()</code>	Returns the string representation of the Path .
<code>toUri()</code>	Converts the Path to a URI .

When updating legacy code bases it is possible to convert from the old **File** to the new **Path** and vice versa by calling the `toPath` or `toFile` methods which will do exactly that.

Files

The **Files** class mostly contains static methods, which are also meant to work with the **Path** class, already mentioned above, the **Files** class is similarly to the **Path** class one of the cornerstones of the NIO library in java. Some of the most notable methods from the **Files** class are listed below

Method	Description
<code>copy(InputStream, Path, CopyOption...)</code>	Copies data from an InputStream to the target Path .
<code>copy(Path, OutputStream)</code>	Copies the contents of a file (from a Path) to an OutputStream .
<code>copy(Path, Path, CopyOption...)</code>	Copies a file from one Path to another, with optional copy options.
<code>createAndCheckIsDirectory(Path, FileAttribute<?>...)</code>	Creates a directory and checks if it was successfully created.
<code>createBufferedReaderLinesStream(BufferedReader)</code>	Creates a Stream of lines from a BufferedReader .
<code>createDirectories(Path, FileAttribute<?>...)</code>	Creates a directory along with any necessary non-existent parent directories.
<code>createDirectory(Path, FileAttribute<?>...)</code>	Creates a new directory at the specified Path .

Method	Description
<code>createFile(Path, FileAttribute<?>...)</code>	Creates a new file at the given Path with optional file attributes.
<code>createFileChannelLinesStream(FileChannel, Charset)</code>	Creates a Stream \< String > of lines from a FileChannel , using the specified Charset .
<code>createLink(Path, Path)</code>	Creates a hard link between two paths (source and target).
<code>createTempDirectory(Path, String, FileAttribute<?>...)</code>	Creates a temporary directory in the given Path , with an optional prefix.
<code>createTempFile(Path, String, String, FileAttribute<?>...)</code>	Creates a temporary file in the given Path , with an optional prefix and suffix.
<code>delete(Path)</code>	Deletes the file or directory at the given Path .
<code>deleteIfExists(Path)</code>	Deletes the file or directory if it exists, otherwise does nothing.
<code>exists(Path, LinkOption...)</code>	Checks if the file or directory at the given Path exists.
<code>find(Path, int, BiPredicate<Path, BasicFileAttributes>, FileVisitOption...)</code>	Finds files in a directory tree based on a matching condition (BiPredicate).
<code>followLinks(LinkOption...)</code>	Configures whether symbolic links should be followed during file operations.
<code>getAttribute(Path, String, LinkOption...)</code>	Retrieves a specific file attribute of the file at the given Path .
<code>getFileStore(Path)</code>	Returns the FileStore (e.g., disk partition) where the file is located.
<code>getLastModifiedTime(Path, LinkOption...)</code>	Retrieves the last modified time of the file at the given Path .
<code>getOwner(Path, LinkOption...)</code>	Retrieves the owner of the file at the given Path .
<code>getPosixFilePermissions(Path, LinkOption...)</code>	Retrieves the POSIX file permissions of the file at the given Path .
<code>isAccessible(Path, AccessMode...)</code>	Checks if the file can be accessed with the given access modes (e.g., read, write).
<code>isDirectory(Path, LinkOption...)</code>	Checks if the given Path represents a directory.
<code>isExecutable(Path)</code>	Checks if the file at the given Path is executable.
<code>isHidden(Path)</code>	Checks if the file at the given Path is hidden.
<code>isReadable(Path)</code>	Checks if the file at the given Path is readable.
<code>isRegularFile(Path, LinkOption...)</code>	Checks if the given Path represents a regular file.
<code>isSameFile(Path, Path)</code>	Checks if two Path objects refer to the same file.
<code>isWritable(Path)</code>	Checks if the file at the given Path is writable.
<code>lines(Path)</code>	Returns a Stream \< String > of all lines in the file at the given Path .
<code>lines(Path, Charset)</code>	Returns a Stream \< String > of all lines in the file using the specified Charset .
<code>list(Path)</code>	Returns a Stream \< Path > of all entries in the directory at the given Path .
<code>move(Path, Path, CopyOption...)</code>	Moves a file from one Path to another, with optional move options.
<code>notExists(Path, LinkOption...)</code>	Checks if the file or directory at the given Path does not exist.
<code>read(InputStream, int)</code>	Reads up to n bytes from an InputStream .
<code>readAllBytes(Path)</code>	Reads all bytes from a file at the given Path .
<code>readAllLines(Path)</code>	Reads all lines from a file at the given Path .
<code>readAllLines(Path, Charset)</code>	Reads all lines from a file using the specified Charset .

Method	Description
<code>readAttributes(Path, Class<A>, LinkOption...)</code> <A extends <code>BasicFileAttributes</code> >	Reads the file attributes as an instance of the given class A .
<code>readAttributes(Path, String, LinkOption...)</code>	Reads a set of file attributes identified by a string.
<code>readString(Path)</code>	Reads the contents of a file into a String .
<code>readString(Path, Charset)</code>	Reads the contents of a file into a String using the specified Charset .
<code>setAttribute(Path, String, Object, LinkOption...)</code>	Sets a file attribute for the file at the given Path .
<code>setLastModifiedTime(Path, FileTime)</code>	Sets the last modified time of the file at the given Path .
<code>setOwner(Path, UserPrincipal)</code>	Sets the owner of the file at the given Path .
<code>setPosixFilePermissions(Path, Set<PosixFilePermission>)</code>	Sets the POSIX file permissions for the file at the given Path .
<code>size(Path)</code>	Returns the size of the file at the given Path .
<code>walk(Path, FileVisitOption...)</code>	Returns a Stream \< Path \> that walks through the directory tree starting at the given Path .
<code>walk(Path, int, FileVisitOption...)</code>	Returns a Stream \< Path \> that walks the directory tree to a specified depth.
<code>walkFileTree(Path, FileVisitor<? super Path>)</code>	Walks a file tree starting from the given Path , visiting each file using a FileVisitor .
<code>walkFileTree(Path, Set<FileVisitOption>, int, FileVisitor<? super Path>)</code>	Walks a file tree with additional options and a depth limit, visiting each file using a FileVisitor .
<code>write(Path, Iterable<? extends CharSequence>, Charset, OpenOption...)</code>	Writes an Iterable of character sequences to a file using the specified Charset .
<code>write(Path, Iterable<? extends CharSequence>, OpenOption...)</code>	Writes an Iterable of character sequences to a file.
<code>write(Path, byte[], OpenOption...)</code>	Writes a byte array to a file at the given Path .
<code>writeString(Path, CharSequence, Charset, OpenOption...)</code>	Writes a CharSequence to a file using the specified Charset .
<code>writeString(Path, CharSequence, OpenOption...)</code>	Writes a CharSequence to a file.