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    "\n",
    "* The advantages of Apache Spark over plain Hadoop\n",
```

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38     "* The high-level architecture of Spark\n",
39     "\n",
40     "* The Spark API\n"
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51     "\n",
52     "We invite you to further supplement this
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53     "\n",
54     "* Spark Homepage: https://spark.apache.org/\n",
55     "\n",
56     "\n",
57     "* Spark Documentation: https://spark.apache.org/
   docs/latest/\n",
58     "\n",
59     "\n",
60     "* Databricks Blog: _A Tale of Three Apache Spark
    APIs: RDDs vs DataFrames and Datasets. When to use
   them and why._ https://databricks.com/blog/2016/07/14
   /a-tale-of-three-apache-spark-apis-rdds-dataframes-
   and-datasets.html\n",
61     "\n",
62     "\n",
63     "* Databricks Cloud: https://goo.gl/X5cWGA\n",
64     "\n",
65     "\n",
66     "* Madhukar's Blog - History of Apache Spark:
   Journey from Academia to Industry http://blog.
   madhukaraphatak.com/history-of-spark/\n",
67     "\n",
68     "\n"
69    ]
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167    ]
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176     "Apache Spark is a **cluster computing**
    platform designed to be fast and general purpose.
    Spark extends Hadoop's MapReduce model to
    efficiently support more types of computations,
    including interactive queries and stream processing
    .\n",
177     "\n",
178     "If you need a reminder of the definitions of *
    cluster computing* and *MapReduce*, review the
    previous module or the Wikipedia entries here:\n",
179     "\n",
180     "- https://en.wikipedia.org/wiki/
    Computer_cluster\n",
181     "\n",
182     "\n",
183     "- https://en.wikipedia.org/wiki/MapReduce\n",
184     "\n",
185     "Spark can work with a cluster that has the
    Hadoop file system (recall HDFS from the last module
    ) installed but adds a processing engine that
    performs far better than simple MapReduce can.
    Spark has several advantages over plain Hadoop:\n",
186     "\n",
187     "- **Speed**: Speed is important in processing
    large datasets. Exploring data interactively
    requires short response times. Spark is much faster
    than Hadoop's built-in MapReduce for most
    calculations.  One of the main features Spark offers
     that makes it fast is its ability to run multi-step
     computations in memory rather than always needing
    to save data to disk between tasks like Hadoop does
    .\n",
188     "\n",
189     "\n",
190     "- **Variety of workloads**: Spark is designed
    to cover a wide range of distributed computational
```

```
190 workloads that previously required several
    specialized computers and software. The types of
    workloads include batch applications, iterative
    algorithms, interactive queries, and streaming. By
    supporting these all of these workload types with a
    single engine, Spark makes it easy and inexpensive
    to combine different processing types.  This is
    often necessary in production data analysis
    pipelines when we are running several data
    preprocessing, transformation and analyses in a
    sequence and/or in parallel. This reduces the
    management burden of knowing and maintaining many
    individual specialized tools.\n",
191     "\n",
192     "\n",
193     "- **Works with several programming languages
    **: Spark offers several simple APIs in Python, Java
    , Scala, R and SQL.\n",
194     "\n",
195     "\n",
196     "- **Rich libraries**: Spark provides a lot of
    rich built-in analytics capabilities through
    included libraries.\n",
197     "\n",
198     "\n",
199     "- **Integrates with other big data tools**: It
    also integrates closely with other popular Big Data
    tools."
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219     "Matei Zaharia, a Romanian-Canadian started the
    Spark project during his PhD at UC Berkeley (
    although the name Spark was given to it much later
    ). It started in 2009 as a research project in the
    UC Berkeley RAD Lab, later to become the AMPLab. The
     researchers in the lab had previously been working
    on Hadoop MapReduce, and observed that MapReduce was
     inefficient for iterative and interactive computing
     jobs.\n",
220     "\n",
221     "Thus, from the beginning, Spark was designed to
     overcome Hadoop's limitations: to be fast for
    interactive queries and iterative algorithms, but
    without sacrificing Hadoop's fault tolerance and
    large file processing capabilities.\n",
222     "Even in its early form it was already 10-20
    times faster than MapReduce for certain jobs.\n",
223     "\n",
224     "Spark was open sourced in early 2010. After
    being released, a broad developer community grew,
    and the project was moved to the Apache Software
    Foundation in 2013. \n",
225     "\n",
226     "Matei, with two other partners, Ali Ghodsi and
    Ion Stoica, went on to start a company called
    Databricks. Databricks aims to help clients with
    cloud-based big data processing \"as-a-service\"
    using Spark.  Databricks is the platform we will use
     to experiment with Spark in this course.  "
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236     "# Who uses Spark, and for what?\n",
237     "\n",
238     "Since Spark is a general-purpose framework for
    cluster computing, companies and governments use it
    for a diverse range of data-intensive applications,
    but first and foremost for data analytics.\n",
239     "\n",
240     "## Data Analytics\n",
241     "\n",
242     "Spark provides facilities that are familiar to
    data scientists, such as dataframes, SQL and
    statistical tools. It also supports the programming
    languages most commonly used by Data Scientists.
    Whereas in the early days of Big Data, analysts
    needed to know about the details of Hadoop to do
    their jobs, now Spark provides a way of interacting
    with a computing cluster that is much higher-level,
    more intuitive and hides most of the details of how
    the underlying cluster operates.\n",
243     "\n",
244     "## Other Big Data Processing Applications\n",
245     "\n",
246     "Spark is also used by Big Data Engineers to
    support more general data processing of large
    quantities of data.  Rather than having deal with
    the details of concurrent programming or using
    Hadoop, Spark makes their life easier by looking
    after all the messy details of managing the cluster
    , handling faults automatically and making sure
    parallel processes don't interfere with each other."
247    ]
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253     "# Spark Terminology\n",
254     "\n",
```

```
255     "Spark, like Hadoop, has its own terminology for its components and abstractions.  Here is a handy glossary to refer back to as you read the following sections.\n",
256     "\n",
257     "| ***Term*** | ***Definition*** |\n",
258     "| :---: | :--- |\n",
259     "| **API** | Application Program Interface. Spark supports a few different programming models (**RDD**'s, **DataFrames** and **DataSets**) each with their own set of methods. |\n",
260     "| **Application** | When Spark documentation refers to the **application**, it means a program you've written in any of the languages it supports (Java, R, Python, Scala) that calls on Spark to do work |\n",
261     "| **Application JAR** | If you're using Java or Scala, this is essentially the compiled executable of your application |\n",
262     "| **Cluster** | A set of similar servers that are networked tightly together so they can be used for parallel computing |\n",
263     "| **Cluster Manager** | The operating system-like program that manages resources (CPU, disk, memory) on a cluster.  This is something that is set up when the cluster is first created.  For Hadoop, this is called **YARN**. Spark comes with its own cluster manager that can be used rather than YARN, or it can use YARN, or some other alternatives. |\n",
264     "| **DataFrame** | Similar to a Pandas DataFrame, Spark provides a table-like structure with methods for doing operations on the table's contents.  The difference here is that Spark DataFrames can be larger than what can be stored in the memory of a single computer whereas Pandas DataFrames cannot. |\n",
265     "| **DataSet** | A Spark DataSet is similar to a Spark **DataFrame**, but strongly typed.  (This means for example that the contents of a column of the table it represents to be of a single type, like
```

```
265  a relational table.  DataSets may be less
    convenient for exploratory data analysis but are
    more robust for business applications).\n",
266     "| **Driver Program** | The part of your
    application that creates the **SparkContext**. In
    Java terms, the driver program is the `main()`
    method in your program. |\n",
267     "| **Executor** | One of many processes launched
     by Spark on **worker nodes** to run the tasks
    needed by your application to do its work on the
    cluster |\n",
268     "| **Job** | A parallel computation consisting
    of multiple tasks that gets created as the result of
     a **Spark action** |\n",
269     "| **Mesos** | A **cluster manager** that
    enables an entire data centre to be managed as if it
    's a **cluster**.  The nodes in a cluster are
    typically all very similar, but Mesos allows a more
    diverse mix of nodes to be treated as a single pool
    of resources.  Mesos is an Apache project. |\n",
270     "| **Resilient Distributed Dataset (RDD)** | An
    older, lower-level API which DataFrames and DataSets
     is built upon.  Early Spark applications
    manipulated RDD's directly but DataFrames or
    DataSets are now used instead unless there is a need
     to do special optimization of a program by using
    lower-level features. |\n",
271     "| **SparkContext** | An object that you create
    in your program before you can run a Spark **job**,
    that tells Spark how to run your application on the
    cluster |\n",
272     "| **Stage** | Each **job** gets divided into a
    smaller sets of tasks, called **stages** (similar to
     the *map* and *reduce* stages in Hadoop) |\n",
273     "| **Task** | A unit of work that will be sent
    to one executor |\n",
274     "| **Worker Node** | Any node that can run **
    application** code in the cluster |\n",
275     "| **YARN** | Hadoop's standard **cluster
    manager** |"
276    ]
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