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Sampling signal processing To digitally analyze and manipulate an analog signal, it must be digitized with an analog-to-digital converter ADC. Sampling is usually carried out in two stages, discretization and quantization. Discretization means that the signal is divided into equal intervals of time, and each interval is represented by a single measurement of amplitude. Quantization means each amplitude measurement is approximated by a value from a finite set. Rounding real numbers to integers is an example. The Nyquistâ€”Shannon sampling theorem states that a signal can be exactly reconstructed from its samples if the sampling frequency is greater than twice the highest frequency component in the signal. In practice, the sampling frequency is often significantly higher than twice the Nyquist frequency. Theoretical DSP analyses and derivations are typically performed on discrete-time signal models with no amplitude inaccuracies quantization error , "created" by the abstract process of sampling. Numerical methods require a quantized signal, such as those produced by an ADC. The processed result might be a frequency spectrum or a set of statistics. But often it is another quantized signal that is converted back to analog form by a digital-to-analog converter DAC. Domains[edit] In DSP, engineers usually study digital signals in one of the following domains: They choose the domain in which to process a signal by making an informed assumption or by trying different possibilities as to which domain best represents the essential characteristics of the signal and the processing to be applied to it. A sequence of samples from a measuring device produces a temporal or spatial domain representation, whereas a discrete Fourier transform produces the frequency domain representation. Time and space domains[edit] Main article: Time domain The most common processing approach in the time or space domain is enhancement of the input signal through a method called filtering. Digital filtering generally consists of some linear transformation of a number of surrounding samples around the current sample of the input or output signal. There are various ways to characterize filters; for example: A linear filter is a linear transformation of input samples; other filters are nonlinear. Linear filters satisfy the superposition principle , i. A causal filter uses only previous samples of the input or output signals; while a non-causal filter uses future input samples. A non-causal filter can usually be changed into a causal filter by adding a delay to it. A time-invariant filter has constant properties over time; other filters such as adaptive filters change in time. A stable filter produces an output that converges to a constant value with time, or remains bounded within a finite interval. An unstable filter can produce an output that grows without bounds, with bounded or even zero input. A finite impulse response FIR filter uses only the input signals, while an infinite impulse response IIR filter uses both the input signal and previous samples of the output signal. A filter can be represented by a block diagram , which can then be used to derive a sample processing algorithm to implement the filter with hardware instructions. A filter may also be described as a difference equation , a collection of zeros and poles or an impulse response or step response. The output of a linear digital filter to any given input may be calculated by convolving the input signal with the impulse response. Frequency domain Signals are converted from time or space domain to the frequency domain usually through use of the Fourier transform. The Fourier transform converts the time or space information to a magnitude and phase component of each frequency. With some applications, how the phase varies with frequency can be a significant consideration. Where phase is unimportant, often the Fourier transform is converted to the power spectrum, which is the magnitude of each frequency component squared. The most common purpose for analysis of signals in the frequency domain is analysis of signal properties. The engineer can study the spectrum to determine which frequencies are present in the input signal and which are missing. Frequency domain analysis is also called spectrum- or spectral analysis. Filtering, particularly in non-realtime work can also be achieved in the frequency domain, applying the filter and then converting back to the time domain. This can be an efficient implementation and can give essentially any filter response including excellent approximations to brickwall filters. There are some commonly-used frequency domain transformations. For example, the cepstrum converts a signal to the frequency domain through Fourier transform, takes the logarithm, then applies another Fourier transform. This emphasizes the harmonic structure of the original spectrum. FIR filters have many advantages, but are computationally more demanding. The Z-transform provides a tool for analyzing stability issues of digital IIR filters. It is analogous to the Laplace transform , which is used to design and analyze analog IIR filters. The original image is high-pass filtered, yielding the three large images, each describing local changes in brightness details in the original image. It is then low-pass filtered and downscaled, yielding an approximation image; this image is high-pass filtered to produce the three smaller detail images, and low-pass filtered to produce the final approximation image in the upper-left. In numerical analysis and functional analysis , a discrete wavelet transform DWT is any wavelet transform for which the wavelets are discretely sampled. As with other wavelet transforms, a key advantage it has over Fourier transforms is temporal resolution: The accuracy of the joint time-frequency resolution is limited by the uncertainty principle of time-frequency.

Chapter 2 : Digital Fundamentals, 11th Edition

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Hadoop managed by the Apache Foundation is a powerful open-source platform written in Java that is capable of processing large amounts of heterogeneous data-sets at scale in a distributive fashion on a cluster of computers using simple programming models. I will be discussing all the important components of the Hadoop Ecosystem in this post and also cover their application areas. This discussion is aimed at bringing the different capabilities of Hadoop and helping the developer community form a clear disposition on Hadoop Ecosystem. Hadoop and Hadoop Ecosystem What is Hadoop? Hadoop is an open source distributed processing framework that manages data processing and storage for Big Data applications running in clustered systems. It lies at the center of a growing ecosystem of big data technologies that are required for supporting advanced analytics initiatives, including predictive analytics, data mining and machine learning applications. Hadoop is capable of handling various forms of structured and unstructured data, giving users more flexibility for collecting, processing and analyzing data than relational databases and data warehouses provide. Hadoop Ecosystem To understand the core concepts of Hadoop Ecosystem, you need to delve into the components and Hadoop Ecosystem architecture. The Hadoop platform consists of two key services: Here, we will discuss some of the most widely used Hadoop components: It helps us in storing our data across various nodes and maintaining the log file about the stored data metadata. HDFS has two core components: It contains metadata, just like a log file or you can say as a table of content. Therefore, it requires less storage and high computational resources. All your data is stored on the DataNodes. So, it requires more storage resources. These DataNodes are commodity hardware like your laptops and desktops in the distributed environment. You always communicate to the NameNode while writing the data. Then, it internally sends a request to the client to store and replicate data on various DataNodes. MapReduce, the most widely-used, general-purpose computing model and runtime system for distributed data analytics, provides a flexible and scalable foundation for analytics, from traditional reporting to leading-edge machine learning algorithms. These tasks are then distributed around the cluster to parallelize and balance the load as much as possible. The MapReduce runtime infrastructure coordinates the tasks, re-running any that fail or appear to hang. MapReduce users do not need to implement parallelism or reliability features themselves. Instead, they can focus on the data problem. The combination of HDFS and MapReduce provides a sturdy software framework for processing vast amounts of data in parallel on large clusters of commodity hardware in a reliable, fault-tolerant manner. Hadoop is a generic processing framework designed to execute queries and other batch read operations against massive datasets that can scale from tens of terabytes to petabytes in size. The popularity of Hadoop has grown in the last few years because it meets the needs of many organizations for flexible data analysis capabilities with an unmatched price-performance curve. The flexible data analysis features apply to data in a variety of formats, from unstructured data, such as raw text, to semi-structured data, such as logs, to structured data with a fixed schema. Mahout provides an environment for creating machine learning applications which are scalable. Machine learning algorithms allow us to build self-learning machines that evolve by itself without being explicitly programmed. Based on user behavior, data patterns and past experiences it makes important future decisions. You can call it a descendant of Artificial Intelligence AI. It performs collaborative filtering, clustering, and classification. We will examine them in details. Mahout mines user behaviors, their patterns, and their characteristics and based on that it predicts and make recommendations to the users. The typical use case is an E-commerce website. It organizes a similar group of data together like articles can contain blogs, news, research papers etc. It means classifying and categorizing data into various sub-departments like articles can be categorized into blogs, news, essay, research papers, and other categories. Here Mahout checks, which objects are likely to be appearing together and make suggestions, if they are missing. For example, cell phone and cover are brought together in general. So, if you search for a cell phone, it will also recommend you the cover and cases. Mahout provides a command line to invoke various algorithms. It has a predefined set of the library which already contains different inbuilt algorithms for different use cases. Hive is a SQL dialect and Pig is a data flow language. Another tool, Zookeeper is used for federating services and Oozie is a scheduling system. Avro, Thrift, and Protobuf are platform-portable data serialization and description formats. Pig is a platform for constructing data flows for extract, transform, and load ETL processing and analysis of large datasets. Pig Latin, the programming language for Pig provides common data manipulation operations, such as grouping, joining, and filtering. Pig generates Hadoop MapReduce jobs to perform the data flows. This high-level language for ad hoc analysis allows developers to inspect HDFS stored data without having to learn the complexities of the MapReduce framework. Hive is a SQL-based data warehouse system for Hadoop that facilitates data summarization, ad hoc queries, and the analysis of large datasets stored in Hadoop-compatible file systems e. Hive is not a relational database, but a query engine that supports the parts of SQL specific to querying data, with some additional support for writing new tables or files, but not updating individual records. That is, Hive jobs are optimized for scalability, i. Table schema can be defined that reflect the data in the underlying files or data stores and SQL queries can be written against that data. Queries are translated to MapReduce jobs to exploit the scalability of MapReduce. Hive also support custom extensions written in Java, including user-defined functions UDFs and serializer-deserializers for reading and optionally writing custom formats, e. Hence, analysts have tremendous flexibility in working with data from many sources and in many different formats, with minimal need for complex ETL processes to transform data into more restrictive formats. Contrast with Shark and Impala. You may read linear algebra for machine learning books or download linear algebra for machine learning pdf files. A deeper understanding of linear algebra for machine learning mit is essential for a thorough analysis of the Hadoop Ecosystem. Read my earlier post on Linear Algebra for Machine Learning. Hadoop and Linear Algebra, both are inextricably linked with Data Science , a subfield of machine learning. These two new disciplines of learning are also closely related to Data Analytics, which is now a goldmine of opportunities for data analysts and data science professionals. So, if you are a programmer looking forward to a career change, a Data Analytics course is the right choice for you. Look for more lucrative career options in Hadoop. Another survey by McKinsey predicts that by there will be a shortage of 1. This goes without saying that one must be abreast of the latest trends and developments in Hadoop Ecosystem, for a rewarding career. You may go read up more by learning about linear algebra for machine learning mit or even go for a data analytics course, for more insights. Digital Vidya offers advanced courses in Data Science. Industry-relevant curriculum, pragmatic market-ready approach, hands-on Capstone Project are some of the best reasons for choosing Digital Vidya. Bonani Bose A self-starter technical communicator, capable of working in an entrepreneurial environment producing all kinds of technical content including system manuals, product release notes, product user guides, tutorials, software installation guides, technical proposals, and white papers. Plus, an avid blogger and Social Media Marketing Enthusiast.

Chapter 3 : Understanding Hadoop Ecosystem: Concept and Applications

Digital concepts and applications by Amin R. Ismail, , Saunders College Pub. edition, in English.

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