Unveiling the Power of Image to Text Conversion: Advancements, Challenges, and Applications

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Abstract: The potential of converting visual information from images into text data spans various domains, from accessibility services to content indexing and search. This research paper examines Image-to-Text conversion, exploring its advancements, challenges, and applications. We delve into cutting-edge techniques, such as computer vision, deep learning, and natural language processing, which are pivotal in this field. Our study offers a comprehensive overview of existing image-to-text technologies, revealing their mechanisms and limitations. We analyze real-world cases where image-to-text conversion has been transformative. Furthermore, we address ethical concerns and potential biases linked to this technology. Additionally, we spotlight future research prospects in image-to-text conversion, focusing on accuracy, scalability, and multilingual support. We emphasize the importance of crafting inclusive and accessible solutions that cater to diverse user needs. In conclusion, this paper serves as a valuable resource for researchers, practitioners, and technologists interested in unlocking the potential of image-to-text conversion, fostering innovation, and enhancing accessibility in our increasingly visual digital landscape.

Keywords: image to text conversion.

1. Introduction

A. What is an image?

An image is a visual representation of an object or concept, taking on diverse forms, including two-dimensional or three-dimensional depictions that communicate information through the visual system. It can manifest as an artificially created piece, such as a photograph or a 2D illustration, closely resembling its subject. In signal processing, an image symbolizes the distributed amplitude of colors.

In optics, the term "image" may specifically denote a two-dimensional visual depiction.

An image need not necessarily encompass the entire visual spectrum to qualify as a visual representation. An illustrative example is a grayscale image, which relies on the visual system's sensitivity to brightness across all wavelengths while disregarding various colors. Even a monochromatic visual portrayal of something still qualifies as an image, notwithstanding its limited use of the visual system's capabilities.

B. Characteristics of an image

Images come in various forms, either two or three-dimensional like photos, screens, statues, or holograms. They can be captured by optical devices or occur naturally, like the human eye.

The term 'image' also extends to 2D figures like maps, graphs, paintings, or banners. These images can be created manually through drawing or artistic techniques, generated automatically via printing or computer graphics, or a combination of methods.

Images can be fleeting, like reflections or projections, or permanent as hard copies recorded on materials like paper through photography or digital processes.

Mental images reside in an individual's mind, representing memories or imaginative constructs. They can depict real or abstract concepts. Some scholars, including Slavoj Žižek and Jan Berger, have explored how mental images can be manipulated for ideological purposes in psychoanalysis and social sciences.

C. In culture

Images in public education, the media, and popular culture have a considerable impact on the creation of several mental constructs.

Their power stems from their capacity to circumvent conscious mental processes and instead engage the subconscious and emotions directly, avoiding critical scrutiny through contemplation. These fundamental images shape our desires (exemplified by the idyllic scene of honey-flavored cereals and fresh orange juice in a suburban home) and our rejections (as seen in the depiction of communism, which is characterized by lifeless throngs of people and machinery marching towards certain doom, accompanied by Soviet Russian tunes). What makes these pictures so fearsome is that their faithfulness to several levels of reality is secondary to the formation and durability of such illusions.

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D.　Vector vs. Raster

An image can also be described in terms of vector graphics or raster graphics. An image stored in raster form is sometimes called a bitmap. An image map is a file containing information that associates different locations on a specified image with hypertext links.

Fig. 1.　Vector and raster file features

1)　JPEG

JPEG (pronounced JAY-peg) is a graphic image file produced according to the Joint Photographic Experts Group standard. This group of experts develop and maintain standards for a suite of compression algorithms for computer image files. JPEGs usually have a .jpg file extension.

2)　GIF

GIF (pronounced JIF by many, including its designer, and pronounced GIF with a hard G by others) stands for Graphics Interchange Format. GIFs use a two-dimensional (2D) raster data type and are binarily encoded. GIF files usually have the .gif extension.

GIF89a is an animated GIF image format. The primary benefit of this format is the ability to create and play an animated image on a webpage. A twirling icon, a banner with a hand that waves or letters that magically get larger are examples of animated GIFs. GIF89a can also be specified for interlaced GIF presentations.

3)　PNG

PNG (pronounced ping) is the Portable Network Graphics file format for image compression. It provides several improvements over the GIF format. Like a GIF, a PNG file is compressed in a lossless manner, meaning that all image information can be restored when decompressing the file for viewing. PNG files typically have a .png extension.

4)　SVG

SVG (Scalable Vector Graphics) is a vector file used to display 2D graphics, charts and illustrations online. SVG files do not depend on unique pixels to create images so they can scale up or down without losing resolution. This means that the file can be viewed on a computer display of any size and resolution, such as the small screen of a smartphone or a large widescreen display on a PC.

SVG files are also searchable and indexable since they use an Extensible Markup Language (XML) format. Any program, such as a browser, that recognizes XML can display the image using the information provided in the SVG file. SVG files usually have an .svg extension.

5)　TIFF

TIFF (Tag Image File Format) is a standard format for exchanging raster graphic (bitmap) images between application programs, including those used for scanner images. TIFF files have a .tiff or .tif file name suffix

2. Literature Review

A.　What is a pdf?

PDF, or Portable Document Format, established as ISO 32000, is a file format created by Adobe in 1992. It's designed to display documents, including text, images, and formatting, independently of software, hardware, or operating systems. Each PDF file contains a complete description of a fixed-layout document, encompassing text, fonts, vector graphics, raster images, and more. It originated from Adobe co-founder John Warnock's "The Camelot Project" in 1991.

PDF became an ISO standard (ISO 32000) in 2008, with the latest edition being ISO 32000-2:2020, released in December 2020.

PDFs can include various content types beyond text and graphics, like structural elements, interactive features (annotations, forms), layers, rich media (videos), 3D objects (U3D or PRC), and other data formats. The PDF specification also covers encryption, digital signatures, file attachments, and metadata for specialized workflows.

B.　History

In 1993, Adobe Systems made the PDF specification freely available. Initially, PDF was widely used in desktop publishing but faced competition from formats like DjVu, Envoy, and others, including Adobe's own PostScript.

PDF was initially Adobe's proprietary format but became an open standard in 2008 (ISO 32000-1:2008), overseen by an ISO Committee. Adobe granted royalty-free rights for their patents related to PDF. PDF 1.7 (ISO 32000-1) included Adobe-specific technologies like XFA and JavaScript extensions.

In December 2020, PDF 2.0 (ISO 32000-2:2020) was released without proprietary technologies as normative references.

C.　Technical Details

A PDF file is often a combination of vector graphics, text, and bitmap graphics. The basic types of content in a PDF are, typeset text stored as content streams (i.e., not encoded in plain text); Vector graphics for illustrations and designs that consist of shapes and lines; Raster graphics for photographs and other types of images, Multimedia objects in the document. In later PDF revisions, a PDF document can also support links (inside document or web page), forms, JavaScript (initially available as a plugin for Acrobat 3.0), or any other types of embedded contents that can be handled using plug-ins.

PDF combines three technologies: An equivalent subset of the PostScript page description programming language but in

declarative form, for generating the layout and graphics.

A font-embedding /replacement system to allow fonts to travel with the documents. A structured storage system to bundle these elements and any associated content into a single file, with data compression where appropriate

D. File Format

PDF files use ASCII characters, except for certain binary elements. They begin with a header containing a magic number and version (e.g., %PDF-1.7) and are based on the COS ("Carousel" Object Structure) format. PDFs mainly consist of nine object types:

1. Boolean values (true or false)
2. Real numbers
3. Integers
4. Strings (in parentheses or hexadecimal)
5. Names (start with /)
6. Arrays (ordered collections in square brackets)
7. Dictionaries (collections indexed by names in double angle brackets)
8. Streams (contain binary data with dictionaries)
9. Null objects

Comments, introduced with "%," may also appear. Objects can be direct or indirect, with indirect objects having object and generation numbers. PDFs utilize an index table near the end, allowing efficient access and incremental updates.

In older PDFs, the table was ASCII-based, marked with "xref." In version 1.5 and later, cross-reference streams may replace it, offering binary format and width specification. The footer includes "startxref" and "%%EOF."

Within pages, content streams describe text, vectors, and images. PDFs come in two layouts: non-linearized, which can be smaller but slower, and linearized, which loads quickly for web browsing. Optimization tools like Adobe Acrobat or QPDF can be used to optimize PDF files.

E. Imaging Model

The basic design of how graphics are represented in PDF is very similar to that of PostScript, except for the use of transparency, which was added in PDF 1.4.PDF graphics use a device-independent Cartesian coordinate system to describe the surface of a page. A PDF page description can use a matrix to scale, rotate, or skew graphical elements. A key concept in PDF is that of the graphics state, which is a collection of graphical parameters that may be changed, saved, and restored by a page description. PDF has (as of version 2.0) 25 graphics state properties, of which some of the most important are:

The current transformation matrix (CTM), which determines the coordinate system.

- The clipping path
- The color space
- The alpha constant, which is a key component of transparency
- Black point compensation control (introduced in PDF 2.0)

F. Vector Graphics

As in PostScript, vector graphics in PDF are constructed with paths. Paths are usually composed of lines and cubic Bézier curves, but can also be constructed from the outlines of text. Unlike PostScript, PDF does not allow a single path to mix text outlines with lines and curves. Paths can be stroked, filled, fill then stroked, or used for clipping. Strokes and fills can use any color set in the graphics state, including patterns. PDF supports several types of patterns. The simplest is the tiling pattern in which a piece of artwork is specified to be drawn repeatedly. This may be a colored tiling pattern, with the colors specified in the pattern object, or an uncolored tiling pattern, which defers color specification to the time the pattern is drawn. Beginning with PDF 1.3 there is also a shading pattern, which draws continuously varying colors. There are seven types of shading patterns of which the simplest are the axial shading (Type 2) and radial shading (Type 3).

G. Raster Images

In PDF documents, raster images (referred to as Image XObjects) are represented by dictionaries paired with associated streams. These dictionaries describe image properties, while the streams contain the actual image data. Occasionally, smaller raster images may be directly embedded within a page description as inline images. Typically, images undergo filtering to achieve compression. PDF supports various general-purpose filters for this purpose:

1. ASCII85 Decode: This filter encodes the stream into 7-bit ASCII format.
2. ASCII Hex Decode: Similar to ASCII85Decode but less compact.
3. Flate Decode: A widely used filter based on the deflate algorithm (as defined in RFC 1951). Introduced in PDF 1.2, it can utilize one of two sets of predictor functions for more efficient zlib/deflate compression: Predictor 2 from the TIFF 6.0 specification or predictors from the PNG specification (RFC 2083).
4. LZW Decode: This filter relies on LZW Compression and can also employ one of two groups of predictor functions for more efficient LZW compression: Predictor 2 from the TIFF 6.0 specification or predictors from the PNG specification.
5. Run Length Decode: It's a straightforward compression method for streams with repetitive data, using the run-length encoding algorithm and image-specific filters.
6. DCT Decode: This filter is lossy and based on the JPEG standard.

These filters are employed to optimize the storage and transmission of raster images within PDF documents.

1) Logical structure and accessibility

Tagged PDF (detailed in ISO 32000-1 clause 14.8) enhances text extraction and accessibility by providing document structure and semantic information. It's a stylized use of PDF, expanding on the logical structure introduced in PDF 1.3. Tagged PDF defines standard structures and attributes for text, graphics, and images, allowing content to be extracted and

repurposed.

Notably, Tagged PDF is optional, mainly needed for non-print purposes. Its adoption varies among devices and assistive technology (AT) as the rules in ISO 32000-1 were somewhat vague. ISO 32000-2 offers improved guidance on tagged PDF, potentially promoting wider use.

For accessibility, an ISO-standardized PDF subset called PDF/UA was introduced in 2012.

2) Optional content group layers

With the introduction of PDF version, 1.5 (2003) came the concept of Layers. Layers, or as they are more formally known Optional Content Groups (OCGs), refer to sections of content in a PDF document that can be selectively viewed or hidden by document authors or viewers. This capability is useful in CAD drawings, layered artwork, maps, multi-language documents, etc.

Basically, it consists of an Optional Content Properties Dictionary added to the document root. This dictionary contains an array of Optional Content Groups (OCGs), each describing a set of information and each of which may be individually displayed or suppressed, plus a set of Optional Content Configuration Dictionaries, which give the status (Displayed or Suppressed) of the given OCGs.

3) Encryption and signatures

PDF files can be encrypted for security, requiring passwords for access. PDF 2.0 standardizes 256-bit AES encryption. Third parties can define their encryption systems for PDF.

PDFs can also have digital signatures for authentication, detailed in ISO 32000-2.

Embedded DRM restrictions in PDFs limit copying, editing, or printing, but rely on reader software compliance, making them less secure.

PDF security includes user and owner passwords. The user password encrypts the file, while the owner password sets restrictions like editing or copying. However, these restrictions aren't foolproof and can be bypassed.

Usage rights signatures in PDF 1.5 and later enable additional interactive features, validated by a granting authority.

Adobe Reader uses public-key cryptography to grant permissions. Manipulation by the sender is possible under certain conditions, especially on non-patched systems.

PAdES (PDF Advanced Electronic Signatures) extends PDF for advanced electronic signatures and is published as TS 102 778 by ETSI.

PDF files may have attachments accessible by processors for opening or saving locally.

4) Metadata

PDF files include two types of metadata:

1. *Document Information Dictionary:* This consists of key/value fields like author, title, subject, creation/update dates. It's optional and is referenced from the Info key in the trailer. PDF 2.0 deprecates this method.
2. *Metadata Streams (introduced in PDF 1.4):* These use the Extensible Metadata Platform (XMP) to add XML-based metadata, similar to other file formats. In PDF

2.0, metadata can be attached to any object in the document, including illustrations, fonts, images, or the entire document itself, using an extensible schema.

PDFs may also contain display settings, affecting page layout and zoom levels. Adobe Reader uses these settings, which cannot be removed in the free version.

5) Accessibility

PDFs can be made accessible for people with disabilities by including tags, text equivalents, captions, and audio descriptions. Some software can create tagged PDFs automatically, but it may not always be the default setting. Leading screen readers like JAWS, Window-Eyes, Hal, and Kurzweil 1000 and 3000 can read tagged PDFs. These PDFs can also be adjusted for visually impaired readers by re-flowing and magnifying text. However, adding tags to older or scanned PDFs can be challenging.

One significant challenge in PDF accessibility is that there are three different views: the physical view (what most people see), the tags view (used by screen readers), and the content view (based on object order). These views can be inconsistent. PDF/UA, an international standard based on ISO 32000-1, was introduced in 2012 to establish accessible PDF technology norms.

6) Multimedia

Rich Media PDF is a PDF file including interactive content that can be embedded or linked within the file. It can contain images, audio, video content or buttons. For example, if the interactive PDF is a digital catalog for an E-commerce business, products can be listed on the PDF pages, can be added images, links to the website and buttons to order directly from there.

7) Forms

PDF supports two methods for adding forms:

1. AcroForms (Acrobat forms): Introduced in PDF 1.2 and included in all later PDF specs. These forms allow objects like text boxes and radio buttons, along with some code like JavaScript. AcroForms support actions like submitting, resetting, and importing data. The "submit" action sends field names and values to a specific URL in various formats.
2. XML Forms Architecture (XFA) forms: Introduced in PDF 1.5 but deprecated in PDF 2.0. Not compatible with Acro Forms.

3. Software Design

A. Form Data Format (FDF)

Based on PDF, uses the same syntax and has essentially the same file structure, but is much simpler than PDF since the body of an FDF document consists of only one required object. Forms Data Format is defined in the PDF specification (since PDF 1.2). The Forms Data Format can be used when submitting form data to a server, receiving the response, and incorporating it into the interactive form. It can also be used to export form data to stand-alone files that can be imported back into the corresponding PDF interactive form. FDF was originally defined in 1996 as part of ISO 32000-2:2017.

B. XML Form Data Format (XFDF)

XFDF is an XML version of Forms Data Format, but it covers only a subset of FDF, focusing on forms and annotations. Some FDF entries like Status, Encoding, JavaScript, and others don't have XFDF equivalents. XFDF also lacks the ability to add new pages based on data, unlike FDF. The XFDF specification is referred to in PDF 1.5 but described separately in the XML Forms Data Format Specification. In PDF 1.4, form submissions in XML were allowed but later replaced by XFDF in PDF 1.5. XFDF adheres to XML standards and can be used for form data submission, modifications, and exporting to standalone files that can be reimported into PDF forms. As of August 2019, XFDF 3.0 is an ISO/IEC standard (ISO 19444-1:2019) under ISO 32000-2.

C. PDF

In PDF 1.4, the entire document can be submitted, not just individual fields and values.

AcroForms can store form field values in separate files using formats like Forms Data Format (FDF) and XML Forms Data Format (XFDF). Usage rights (UR) signatures define rights for importing and exporting form data in various formats.

In PDF 1.5, Adobe introduced a proprietary format called Adobe XML Forms Architecture (XFA) for forms. XFA is not compatible with ISO 32000's AcroForms and is not widely supported by PDF processors. XFA is referenced in ISO 32000-1/PDF 1.7 as an external proprietary specification but was deprecated entirely in PDF 2.0 (ISO 32000-2).

D. Licensing

Anyone may create applications that can read and write PDF files without having to pay royalties to Adobe Systems; Adobe holds patents to PDF, but licenses them for royalty-free use in developing software complying with its PDF specification. \

E. Security

In November 2019, researchers found vulnerabilities in digitally signed PDFs, allowing changes to visible content without invalidating the signature in most PDF viewers and online validation services. They also demonstrated how to extract encrypted content in PDFs. In 2021, they revealed "shadow attacks" exploiting PDF specification features. Security concerns in PDFs include denial of service, information disclosure, data manipulation, and code execution attacks. PDFs have been used to carry viruses since 2001. Vulnerabilities are periodically discovered in Adobe Reader and other PDF readers, often triggered by embedded PDFs on web pages. Disabling JavaScript in PDF readers can mitigate some exploits. Converting files to another format before viewing can also reduce PDF-related risks. In 2010, an exploit was reported in Adobe Reader and Foxit Reader, executing malicious code if allowed by the user

F. Software

For a more comprehensive list, see List of PDF software.

1) Viewers and editors

PDF viewers are typically free and widely available from various sources. Many software options can create PDFs, including built-in features in macOS, iOS, Linux distributions, LibreOffice, Microsoft Office (from 2007 SP2 onward), WordPerfect 9, Scribus, PDF print drivers for Windows, pdfTeX, DocBook PDF tools, Ghostscript-based applications, Adobe Acrobat, InDesign, FrameMaker, Illustrator, and Photoshop. Google Docs also allows uploading and saving to PDF, while some web apps offer free PDF editing and annotation tools.

Previously, the Free Software Foundation aimed to develop a free, high-quality PDF library following ISO 32000 standards. However, the GNU PDF project was removed from high-priority status in 2011 due to the popularity of the Poppler library, used in applications like Evince within the GNOME desktop environment. Poppler is based on the Xpdf code base. Commercial development libraries are also available.

The Apache PDFBox project, part of the Apache Software Foundation, offers an open-source Java library for working with PDF documents, licensed under the Apache License.

2) Printing

Raster Image Processors (RIPs) are crucial for converting PDFs into a suitable raster format for printing on paper and digital production presses in a process called rasterization. Notable RIPs that process PDFs directly include Adobe PDF Print Engine, Jaws, and the Harlequin RIP.

In 1993, Global Graphics' Jaws became the first prepress RIP to interpret PDFs natively, without conversion to another format. They later upgraded their Harlequin RIP with the same capability in 1997. Agfa-Gevaert introduced Apogee in 1997, the first prepress workflow system based on PDF.

Many commercial offset printers now accept press-ready PDF files, especially the PDF/X-1a subset, as a replacement for receiving native working files. In 2006, PDF gained widespread acceptance as the standard print job format, supported by various desktop applications and printing systems, including direct PDF printing by some desktop printers.

3) Native display model

In Mac OS X, PDF replaced the PICT format as the "native" metafile format. This change aligns with the Quartz graphics layer, which uses a model similar to Display PostScript and PDF, earning it the nickname Display PDF. The Preview app and Safari 2.0 and later can display PDF files. Mac OS X supports PDF at a system level, enabling applications to create PDFs automatically if they adhere to the OS-standard printing system. These files are exported in PDF 1.3 format. In earlier Mac OS X versions (10.0 to 10.3), screenshots were captured as PDFs, but later versions use PNG files by default, with an option to switch back to PDF.

4) Annotation

Adobe Acrobat is a proprietary software that enables users to annotate, highlight, and add notes to existing PDF files. For UNIX users, there's a free software option called PDFedit, available under the GNU General Public License. Foxit Reader, a freeware application for Microsoft Windows, macOS, and Linux, allows document annotations. Tracker Software's PDF-XChange Viewer provides unrestricted annotations and markups in its free version. Apple's macOS includes the Preview PDF viewer, which supports annotations. Open-source

software like Skim also allows annotations and integrates with LaTeX, SyncTeX, PDFSync, and BibDesk reference management software.

4. Technologies Used

A. Frontend

HTML, CSS, JAVASCRIPT and BOOTSTRAP

1) HTML

- HTML stands for Hyper Text Markup Language
- HTML is the standard markup language for creating Web pages
- HTML describes the structure of a Web page
- HTML consists of a series of elements
- HTML elements tell the browser how to display the content
- HTML elements label pieces of content such as "this is a heading", "this is a paragraph", "this is a link", etc.

2) Features of html

1. It is a very easy and simple language. It can be easily understood and modified.
2. It is very easy to make an effective presentation with HTML because it has a lot of formatting tags.
3. It is a markup language, so it provides a flexible way to design web pages along with the text.
4. It facilitates programmers to add a link on the web pages (by html anchor tag), so it enhances the interest of browsing of the user.
5. It is platform-independent because it can be displayed on any platform like Windows, Linux, and Macintosh, etc.
6. It facilitates the programmer to add Graphics, Videos, and Sound to the web pages which makes it more attractive and interactive.
7. HTML is a case-insensitive language, which means we can use tags either in lower-case or upper-case.

3) CSS

- CSS stands for Cascading Style Sheet.
- CSS is used to design HTML tags.
- CSS is a widely used language on the web.
- HTML, CSS and JavaScript are used for web designing. It helps the web designers to apply style on HTML tags

4) JavaScript

JavaScript, a versatile scripting language, plays a vital role in enhancing web pages. Unlike static content, JavaScript adds interactivity, dynamic updates, animations, and more to web applications. It complements HTML and CSS, which structure content and apply styles, respectively. JavaScript is dynamic and finds use in web development, gaming, and various applications. Browsers utilize JavaScript for dynamic web elements like dropdown menus, added content, and color changes, providing enhanced user experiences.

B. What is a bootstrap

A widely-used framework for responsive web development, comprising HTML, CSS, and JavaScript components. It's freely available, enhances web development speed, and provides templates for various design elements like typography, forms, buttons, and more. Bootstrap supports JavaScript plugins and simplifies the creation of responsive designs.

1) Why use bootstrap?

Following are the main advantage of Bootstrap:

- It is very easy to use. Anybody having basic knowledge of HTML and CSS can use Bootstrap.
- It facilitates users to develop a responsive website.
- It is compatible with most of the browsers like Chrome, Firefox, Internet Explorer, Safari Opera etc.

2) What is a responsive website?

A website is called a responsive website which can automatically adjust itself to look good on all devices, from smartphones to desktops, etc.

3) What bootstrap package contains?

- Scaffolding: Bootstrap provides a basic structure with a Grid System, link styles, and background.
- CSS: Bootstrap comes with the feature of global CSS settings, fundamental HTML elements style and an advanced grid system.
- Components: Bootstrap contains a lot of reusable components built to provide iconography, dropdowns, navigation, alerts, pop-overs, and much more.
- JavaScript Plugins: Bootstrap also contains a lot of custom jQuery plugins. You can easily include them all, or one by one.

4) Bootstrap 3 vs Bootstrap 4

Bootstrap 4 has some new components, a faster stylesheet, more buttons, and effects and more responsiveness.

Bootstrap 4 supports some of the latest, stable releases of all major browsers and platforms.

Bootstrap is more than efficient for creating a responsive and mobile-first website but it is not the best in the industry. There is an alternative of Bootstrap named W3.CSS which is smaller, faster, and easier to use.

5. Database Connection

A. SQL

- SQL: Stands for Structured Query Language
- SQL: Enables database access and manipulation
- SQL: Became an ANSI standard in 1986 and an ISO standard in 1987

1) Using SQL in your website

To build a web site that shows data from a database, you will need:

- An RDBMS database program (i.e., MS Access, SQL Server, MySQL)
- To use a server-side scripting language, like PHP or ASP
- To use SQL to get the data you want
- To use HTML / CSS to style the page

2) SQL process

When you are executing an SQL command for any RDBMS, the system determines the best way to carry out your request and SQL engine figures out how to interpret the task.

There are various components included in this process.

These components are,

Query Dispatcher, Optimization Engines, Classic Query Engine, SQL Query Engine, etc.

PostgreSQL, an open-source object-relational database system, extends SQL with advanced features for secure and scalable data handling. Originating in the 1986 POSTGRES project at the University of California, Berkeley, it boasts over 35 years of active development. Renowned for its architecture, reliability, data integrity, rich feature set, and community support, PostgreSQL runs on major OSes, adheres to ACID principles since 2001, and offers powerful add-ons like PostGIS. It's the top choice for open-source relational databases. Starting with PostgreSQL is now easier than ever; choose your project, and let it safely and efficiently

B. PostgreSQL

1) Why use PostgreSQL?

PostgreSQL offers developers extensive features for application development and provides administrators with tools to ensure data integrity and build fault-tolerant systems. It excels in managing data, regardless of its size, and is not only open source but also highly adaptable. Users can define custom data types, create bespoke functions, and code in various programming languages without the need for recompilation.

PostgreSQL aims to adhere to SQL standards, prioritizing conformance while avoiding conflicts with established practices or suboptimal architectural choices. Although it supports many SQL standard features, there may be minor variations in syntax or function. Ongoing efforts are focused on improving conformance. As of October 2022 (version 15), PostgreSQL complies with a minimum of 170 out of 179 mandatory features in SQL:2016 Core conformance. Below is an overview of numerous PostgreSQL features, with continuous additions in each major release.

2) Data types

Structured: Date/Time, Array, Range / Multirange, UUID

- Document: JSON/JSONB, XML, Key-value (Hstore)
- Geometry: Point, Line, Circle, Polygon
- Customizations: Composite, Custom Types

3) Data integrity

- UNIQUE, NOT NULL
- Primary Keys
- Foreign Keys
- Exclusion Constraints
- Explicit Locks, Advisory Locks

4) Concurrency and performance

- Indexing: B-tree, Multicolumn, Expressions, Partial
- Advanced Indexing: GiST, SP-Gist, KNN Gist, GIN, BRIN, Covering indexes, Bloom filters
- Sophisticated query planner/optimizer, index-only scans, multicolumn statistics
- Transactions, Nested Transactions (via save points)
- Multi-Version concurrency Control (MVCC)
- Parallelization of read queries and building B-tree indexes

- Table partitioning
- All transaction isolation levels defined in the SQL standard, including Serializable
- Just-in-time (JIT) compilation of expressions

5) Reliability, Disaster recovery

- Write-ahead Logging (WAL)
- Replication: Asynchronous, Synchronous, Logical
- Point-in-time-recovery (PITR), active standbys
- Tablespaces

6) Security

Authentication: GSSAPI, SSPI, LDAP, SCRAM-SHA-256, Certificate, and more Robust access-control system

- Column and row-level security
- Multi-factor authentication with certificates and an additional method

7) Extensibility

- Stored functions and procedures
- Procedural Languages: PL/pgSQL, Perl, Python, and Tcl. There are other languages available through extensions, e.g., Java, JavaScript (V8), R, Lua, and Rust
- SQL/JSON path expressions
- Foreign data wrappers: connect to other databases or streams with a standard SQL interface
- Customizable storage interface for tables
- Many extensions that provide additional functionality, including PostGIS

8) Internalization, Text search

Support for international character sets, e.g., through ICU collations. Case-insensitive and accent-insensitive collations, Full-text search.

There are many more features that you can discover in the PostgreSQL documentation. Additionally, PostgreSQL is highly extensible: many features, such as indexes, have defined APIs so that you can build out with PostgreSQL to solve your challenges.

PostgreSQL has been proven to be highly scalable both in the sheer quantity of data it can manage.

6. Backend

A. Django

Django, a high-level Python web framework, promotes rapid development and clean, practical design. Developed by experienced professionals, it simplifies web development tasks, allowing you to concentrate on your app's creation without starting from scratch. It's both free and open source, incredibly fast, prioritizes security, and offers exceptional scalability.

B. What happens when someone request a web browser from your server?

When a web server receives a request, Django steps in to determine what action is needed. This task is handled by Django's URL resolver, which matches the URL in the request to predefined patterns. If a match is found, Django directs the request to the associated function known as a view.

Think of it like a mail carrier delivering letters. The carrier

checks each house number against the one on the letter and places it in the matching mailbox. This is similar to how the URL resolver operates.

Within the view function, the real work happens. It can access databases, process user requests, and generate responses. For instance, if a user wants to update their job description, the view checks permissions, makes the update, and sends a confirmation message. Finally, Django sends the response to the user's web browser.

C. Container

A container is a standardized software unit that bundles code and its dependencies, enabling consistent and efficient application execution across various computing environments. Docker container images, for example, are self-contained packages containing everything necessary for running an application, from code to runtime, system tools, libraries, and settings. These images transform into containers when executed on Docker Engine, ensuring consistent performance across Linux and Windows environments. Containers offer isolation, making software behave uniformly despite differences between development and staging environments. Docker containers are known for being:

- Standard: Docker established the industry standard for portability.
- Lightweight: They share the host OS kernel, reducing server resource usage and costs.
- Secure: Docker provides robust isolation capabilities, enhancing application security.

7. Deployment

A. Azure Web Apps

Azure Web Apps is a highly utilized Azure service that allows hosting various web applications, from user interactive apps to backend services like WCF and Web APIs. It offers the advantages of scalability, security, and accessibility while managing the underlying infrastructure automatically. Unlike traditional hosting, where you must handle server maintenance, OS updates, and IIS configuration, Azure Web Apps, backed by Azure Service Fabric, ensures your app has the necessary computing power and resources without such concerns. This platform supports building web apps in multiple languages, including ASP.NET, PHP, Node.js, and Python, without the need to deploy and manage Azure virtual machines manually

B. Features of Web Apps

1) Auto scale

Azure promises 99.95% availability in its SLA for web apps. In order to have a seamless experience for the users even in high demand, we can scale out or scale up the web apps instances to support the load. We can also configure auto-scale to web apps based on some metrics like CPU percentage, RAM Utilization, etc.

2) Easy deployment

With Web apps, we can make use of the DevOps feature and we can deploy our applications directly from source code repositories like Visual Studio Team Services, Git Hub Bitbucket, etc.

3) Language choice

Web apps support applications built on many languages and frameworks like ASP.Net, .Net Core, Java, PHP, Python, and Node.js.

The Azure web apps support multiple programming languages and frameworks, and some of the widely used languages are ASP.NET, Java, ASP.NET Core, Ruby on Rails, Nodejs, PHP, and Python. The PowerShell and other certain scripts or executables can also be used as background services.

4) Security

We can integrate user identity provider services and enhance the capability of web applications. For example, we can use Azure AD to maintain a user database, authenticated login, and authorization.

The Azure app service complies with the security standards such as ISO, SOC, and PCI thus the level of security is extremely high. Apart from that the end-user or customer can log in to their account by using Azure Active Directory, Facebook, Twitter, or the Microsoft accounts.

5) Diagnostics

Azure App Services provides diagnostics logs for both application level and server level. It supports Application logging - This is basically the logs written using the code or even uncaught exceptions. Web server logging -It contains the logs of HTTP requests which hit the web app. Detailed error messages - Detailed error messages contain detailed information about each failed request with an HTTP status code.

8. Business Analysis

A. Translator Tool

Unlike other PDF tools, we provide our JDF tool to convert into any language you desire.

B. Dashboard Service

Your previous conversions are safely available in our dashboard when you login which is not available in most of PDF's tools available in the internet.
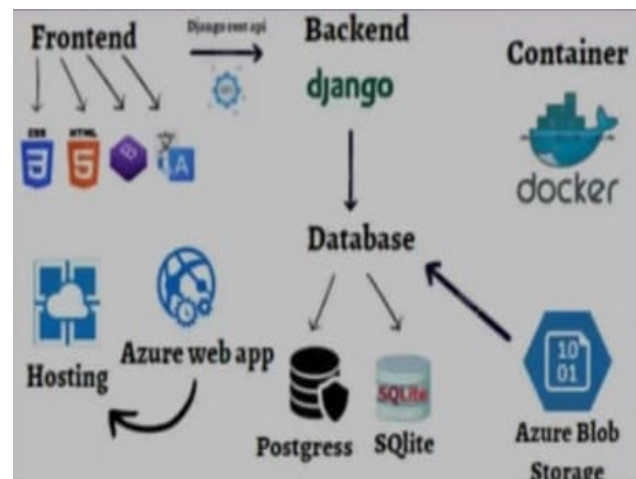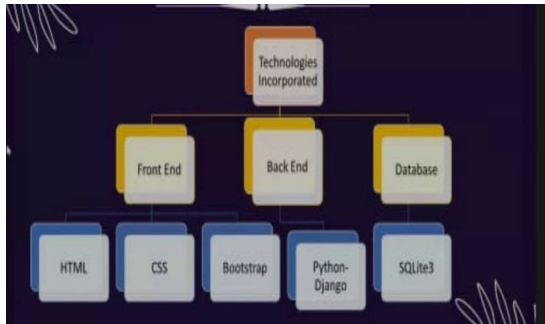

Fig. 2. System architecture
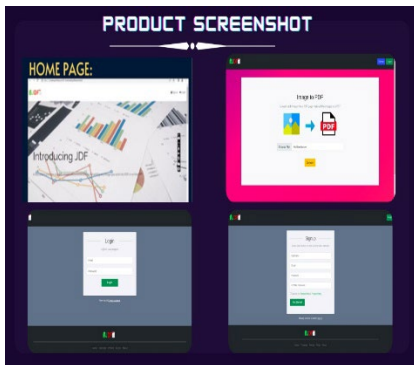
Fig. 3. Technology stack

Fig. 4. Product screenshot

9. Conclusion

No matter how many images are present, JDF is the tool you want to seek for efficient Image to PDF conversion.

The tool provides the maximum convenience for you to gain maximum productivity in,

- Graphic integrity
- Multidimensionality
- Convenience and compactness

References

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