WHITE PAPER

A DESIGN FRAMEWORK FOR ARCHITECTING NLP SOLUTIONS FOR ENTERPRISES

Abstract

In face of recent near-catastrophic events, such as, pandemic, war, etc. businesses have become extremely adept in innovative uses of IT. This includes a large demand for diverse NLP-based solutions and/or components. Given a problem, a solution needs to be architected in terms of a suitable composition of NLP tasks and subtasks, which in turn, need to be implemented using available technology. In recent years the field of NLP has experienced rapid progress for many tasks across many domains. Today's NLP technology space is experiencing an abundance of tools, libraries, services, frameworks, etc. available from various parties, including open-source communities, large tech companies, niche players, etc. While selecting the technologies for a solution we need to make the best possible choices those serve the business requirements as well as comply with various constraints. In this paper, we illustrate a novel (Digitize Recognize Organize) DRO framework which provides a comprehensive consideration for available alternatives. DRO decouples the NLP design process by breaking down NLP problems into small abstract interfaces (tasks and subtasks) thereby allowing great flexibility in choice of implementation and facilitate reusability. These individual components accomplish specific NLP task/subtask, along with well-defined modalities of interaction, boundaries of scope, purpose, and clear set of responsibilities. Our framework can be metaphorically thought as "Lego Box" consisting of blocks of different color, shapes, and sizes along with compatibility.

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A problem of riches

Facilitating technology choice in transparent and optimal manner and using them to build the solution can be a very complex task. To meet these demands, we face a unique challenge, deceptively, a problem of riches where we have a wide variety of NLP frameworks and APIs to solve sub tasks, but they usually do not solve the business problems end to end. As solution provider, we need to make the best possible technology choice that serves the client's requirements as well as various constraints making sure the business problem is solved end to end.

NLP in the modern world is at the forefront of Computational Linguistics and has made modest progress across domains, industries, language types and geographies. With over 7000+ languages in the world, it is expected that the market for NLP would grow at a CAGR of 20.3% (from 11.6 billion in 2020 to USD 35.1 billion by 2026) [1]. The diversity of applications, constraints, toolkit options and linguistic complexities makes architecting NLP solutions a difficult task.

Architecting NLP solution using DRO framework

Based on our knowledge and experience working with multiple customers on a variety of use cases in the filed of computational linguistics, we have identified a list of NLP tasks and subtasks which often comprise parts of enterprise use case design and implementations. The list of NLP tasks and subtasks helps in abstract architecture design, which can later be realized by a variety of options based on client needs. In order to facilitate and enable better design of NLP driven use cases we have clustered these tasks into three clusters, namely Digitize, Recognize and Organize.

The component abstractions within "Digitize cluster" are purposed for modality conversion. The diversity of modern NLP business problems may include linguistic information in multiple forms, which needs to be administered with special considerations. Analyzing them needs methodologies of different order. These components help in consuming data (containing linguistic information) in various forms and apply transformations to enable text conversion.

The components within "Recognize cluster" are more focused on information extraction, generation, and insight generation. These components are abstracted keeping in mind the range of linguistic features including semantics, pragmatics, syntax, morphology, or phonology. The design of component within this cluster is abstracted for a specific responsibility within the range of linguistic feature it enacts on.

The components within "Organize cluster" helps in storage, safekeeping and retrieval of information and insights. This helps to fulfil the flow of insight generation which can be used by business for taking informed decisions.

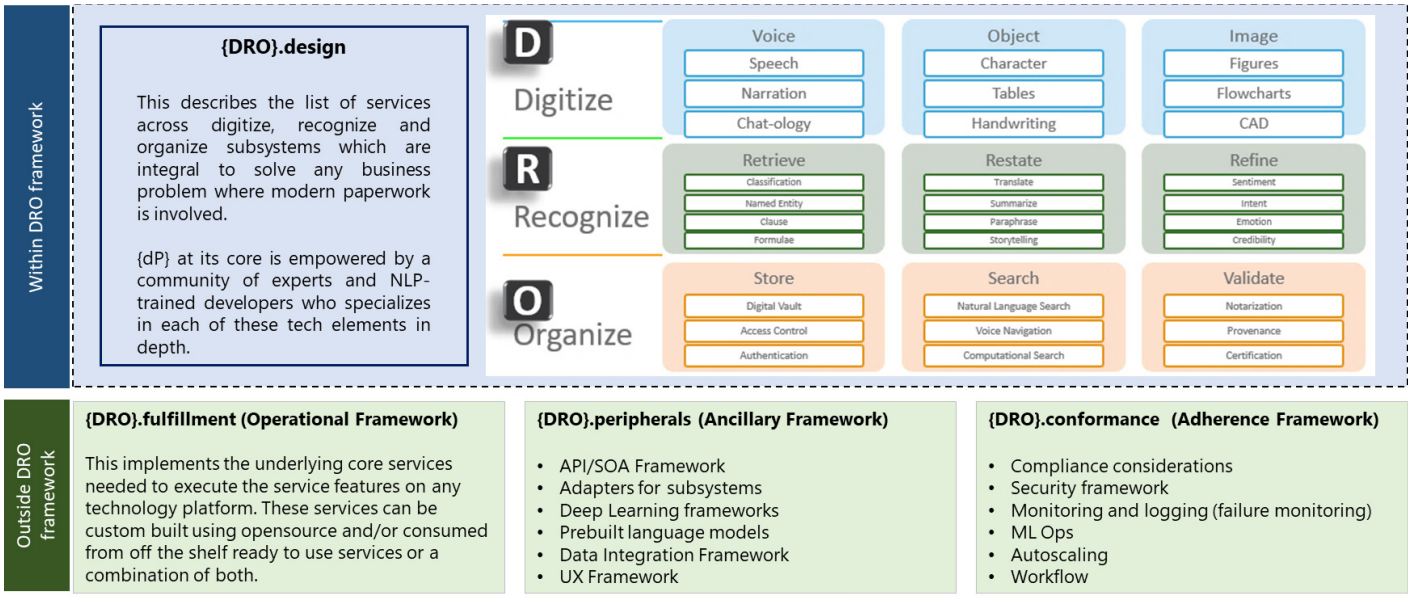


Figure 1. DRO Blueprint

For each element within DRO clusters we

- Frame boundaries to entail abstract architecture design, making each element independent of other which can be purposed for a variety of use cases
- Build a catalogue of tech. options which can be used for implementing these abstractions. We have observed that NLP has seen dramatic changes in some of these tasks like translation, paraphrasing etc. Language translation initially started with RBMT (Rule Based Machine Translation), then moved to SMT (Statistical Machine Translation) and then NMT (Neural Machine Translation). Within NMT also there are transformers of multiple kinds. With more than 7000 languages in the world, each language based on the richness of digital resources may have a design choice which is different from other languages.
- We constantly revise the catalogue to enable us to make an informed choice for our customers based on their constraints, preferences, quality considerations and available staff.
- We also enrich this catalogue by creating partnerships with niche players leveraging their expertise to have options to build the realizations of these abstract components outside of cloud.

"DRO" helps in getting most ingredients needed to design NLP solution under one umbrella, helping businesses achieve modern paperwork automation with optimized resources and considerations. The core of DRO framework deals with getting NLP tasks together to solve a business problem.

We have observed that enterprise environments shall need to provide additional elements to overall solution so as to make the overall architecture complete. These additional components are outside of DRO core framework; however, we work with relevant SMEs on these groups to make sure the entire ecosystem is integrated. (Refer to Figure 1 for details)

The Lego Way

Lego blocks vary in color, shape, size, and structure and can combine with various possibilities. This makes them re-useable, multipurpose, personalized, and universal. Our framework is based on similar principles, and architects NLP solution according to client convenience, budget, problem domain, affinity, and other constraints.

The shape and structure of Lego blocks

Each element within DRO warrants clear responsibilities, analogous to the variety in shape and structure of Lego blocks, allowing loose coupling enabling isolation. Each component is implantable across tech platforms and encapsulates the math behind NLP. Having loose coupling on behavioral, knowledge, schema and implementation facilitates performance, scalability, and flexibility. This makes sure the component can be deployed independently regardless of other components and build a functional pipeline solving a variety of business problems.

The interlocks (Orchestration) of Lego blocks

Elements within DRO can be used in a variety of combinations to solve different problems. This is equivalent to the locking mechanism of Lego blocks enables them to join with other blocks in a variety of combinations and form different shapes. One combination of these components can accomplish conversational analytics, consuming voice data and extracting multiple metrices related to call center intelligence. Another combination can solve customer onboarding, for enterprise customers where documentation spans across tax documents to compliance reports to financial statements. Consequently, the ability of the framework to take multiple avatars with orchestration of components helps enterprise solve multiple problems with same ingredients.

The colors of Lego blocks

Different customers have special affinity to service providers according to their existing tech landscape. This is synonymous to the colors of Lego blocks enabling them for end user personalization. The diversity and too many options in the modern NLP service provider world, makes it a very hard task to finalize on what works best.

Our catalogue of tech options for each component helps enterprises make informed choices for realization of components using cloud (AWS, Azure, GCP, IBM), or opensource, along with our own niche startups.

The Experience of Lego Blocks

Another significant design aspect of Logo blocks is the experience end users get while building up a particular shape. The Lego blocks gives an incremental result every time the components come together and hence can be modified on time if the interim results are not as per expectations.

Following the same analogy, all organizations may not be entirely convinced to invest on AI strategically for automation. Some of the small to medium enterprises may want to take baby steps and see some value on their investments before they make bigger investments. For such scenarios investing in large off the shelf platforms may not be the best thing to do. Our framework can start from some very basic document scan and extraction automation for back-office jobs, which can be built in a quick time and very less investment. Once the enterprise can establish the cost-benefit ratio, more complex scenarios can be incrementally built.

Case Study

The Client

The customer is a large retail and commercial bank in the United Kingdom. The bank operates a network of 290 branches across England, Scotland, and Wales. They have more than 5.0 million customers with over £35 billion of loans and customer deposits.

The bank was looking for an AI driven contact center solution for operational efficiency and regulatory needs. The intent was to elevate human experience (HX) which included customer experience (CX) along with agent's efficiency and experience (EX) to empower them for data driven decisions.

The future belongs to intelligent operations

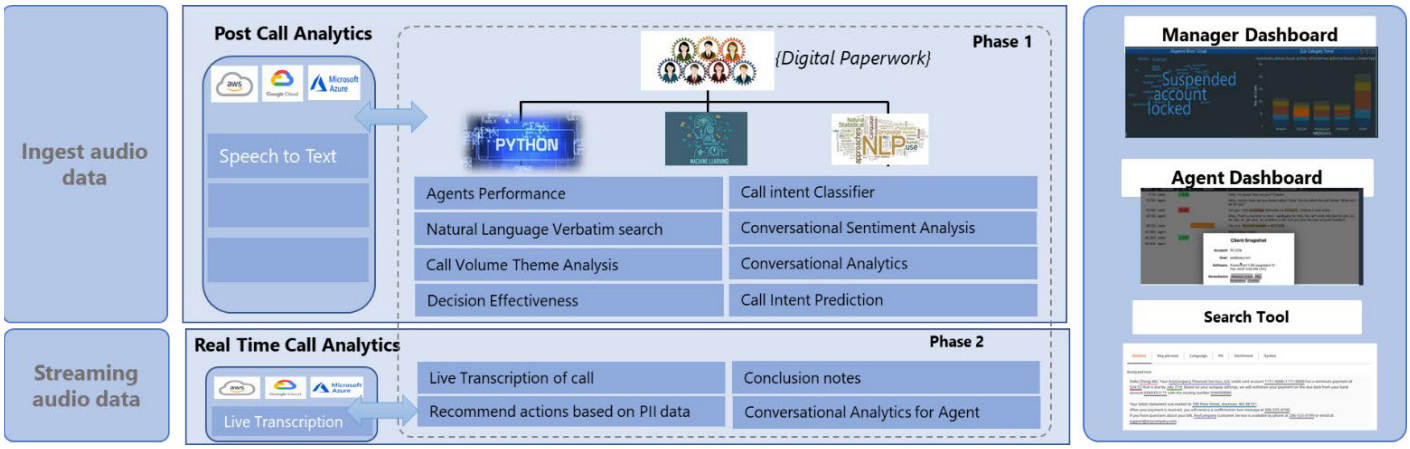


Figure 2. Architecture for our implementation

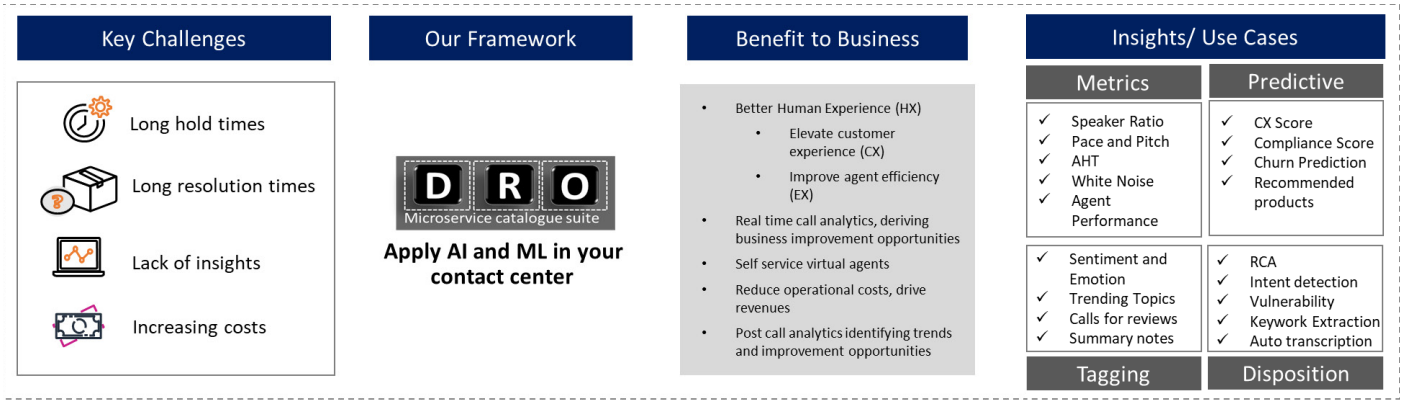
As illustrated in Figure 2, Infosys analyzed the business needs and designed contact center intelligence solution using DRO as backbone framework via AWS as fulfillment tech stack thereby providing customer insights, conversational analytics, root cause analysis (RCA), call intent prediction, self-help advisory, agent performance analysis along with sentiment and emotion detection. Our solution uncovers hidden insights, builds a graph-based knowledge map for customer behavior, and identifies potential customers for churn. It also identifies improvement areas for agents and recommends trainings for the same.

Measurable Output

The program has given three-way benefits to the customer, including (a) reduction in operational cost driving revenues, (b) Elevate customer experience leading to reduced churn and (c) Improve agent efficiency. In addition, the solution also helped the customer to respond more effectively to regulators.

Conclusion and the road ahead

We have designed a general framework which abstracts the NLP pipeline into sub problems, each of which can be implemented by a variety of toolkit. We have carefully considered all forms of information entities which may contain various forms of linguistic information. Our framework helps NLP practitioner and consumer in right choice and right combinations of technologies and architecture to solve problems end to end. Our solution is expandable, maintainable and cloud agnostic.



Source: Infosys Knowledge Institute

Figure 3. Call center intelligence solution

As illustrated in Figure 3, our call center intelligence solution is listed on AWS marketplace as a re-useable solution certified by AWS architects. This was also discussed in depth at AWS tech talks. We plan to build more such solutions powered by digital paper framework which are re-useable and run on a variety of tech. platforms. We also intend to create a repository of startups in NLP world who can be instrumental in solutioning each of DRO components, so that the appropriate and apt use can be recommended based on customer needs.

Testimonials from some of our clients where we discussed our framework

> After evaluating multiple products for Contact Center Intelligence, what this framework can achieve is a lot more personalization and answers every need. Balancing cost and getting industry leading solutions along with Bespoke modules is the main attraction.

Head of data exploitation at large UK bank.

> The framework is beautiful and the idea to orchestrate a finite service to engineer paperwork problems is theoretically simple and effective. We are looking forward to exploring this with simple business cases and expand further as we realize the value.

Head of data monetization at large US bank.

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