HOW NATURAL LANGUAGE PROCESSING IS DRIVING GOVERNMENT INNOVATION

The human ability to process language is at once profoundly intuitive and extraordinarily complex. You're doing it now, automatically ascribing meaning to this string of seemingly random symbols. If the words were uproariously funny, wrenchingly sad or deathly dull (sorry!) you'd know it without even having to extend much effort.

The technologies surrounding natural language processing, or NLP, offer the possibility of computers reading text or interpreting the spoken word with the same ease and fluidity, despite the inherent complexity. Driven by artificial intelligence, NLP promises to make government processes simultaneously leaner and more responsive. It could free workers from tedious and repetitive jobs, streamlining service requests and empowering them to devote their energies to higher-value tasks.

Here we'll offer a brief overview of NLP technologies, consider possible federal use cases, and chart a potential path forward for government.

TECHNOLOGY REVIEW

As a sub-field of AI, natural language processing seeks to enable computers to understand human language. The machines can't pick up every nuance, at least not yet, but they can learn a language well enough to translate text and summarize content. It works with the written word and can also be used to interpret and respond to spoken requests.

NLP's journey to the modern era has been fascinating. In the 1970s, scientists pursued a symbolic or rules-based approach which meant a machine had to learn everything about a language's grammar, dictionary and the specific context in order to understand and generate natural language.

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In the modern era, machines learn via a statistical approach, training on billions of examples of natural language available in digital form. This approach has yielded far more accurate results with much less effort. Today, we are applying the exciting advances in deep learning to significantly improve NLP's accuracy, further expanding its applicability across multiple domains and delivering a range of valuable services including transcription, translation, entity extraction, and semantic and conceptual analysis.

Under the hood, NLP relies on two basic concepts: Natural Language Understanding or NLU, and Natural Language Generation, NLG. In their most common usage, these are the engines powering chatbots and intelligent virtual assistants.

NLU depends on algorithms to break down human speech into computable properties or characteristics called feature vectors, with AI helping to refine the recognition of things like intent, timing and sentiment. In this way, NLU is able to understand input via text or speech.

Ideally, NLU looks beyond words to ferret out meaning, getting to the core of communication even in the face of mispronunciations and spelling errors. Such systems rely on a predefined lexicon and a set of grammar rules. Sophisticated systems leverage machine learning and statistical models to determine the most likely meaning.

Natural Language Generation refers to the computer's ability to generate text, whether by translating speech to written text, converting data to written language, or converting text to audible speech. Text-to-speech and speech-to-text engines rely on NLG to deliver coherent messages, once again backed by a predefined lexicon and a set of grammar rules.

Many of the biggest names in technology have introduced NLP applications, including Microsoft, Amazon and Google, as well as IBM, which offers NLP applications within its Watson AI platform. The big phone makers all have woven NLP into their virtual assistants, including Siri, Bixby and Alexa. Pure plays like Nuance, Nice Systems and IPSoft can also be sources of innovation. On the academic side, Stanford University has been a leader in developing new NLP iterations.

AI is the new UI

The Accenture Technology Vision 2017 declared that "AI is the New UI" as individuals began to interact with technology more naturally using senses like voice and hearing. Accenture's FJORD consultancy has developed Six Principles for Designing for Voice UI to guide development of new systems that build upon these capabilities to deliver intuitive, fulfilling experiences meeting user expectations.

EMERGING USES

First thing to know: This isn't futuristic stuff. Natural language processing is happening right under your nose. Sports broadcasters do it all the time, using machines to generate narrative based on scores and statistics. Many universities routinely turn to NLP to screen for plagiarism in student work.

The healthcare industry is eager to leverage this emerging capability, with NLP playing a prominent role in the "10 Promising AI Applications in Health Care" recently identified by Accenture. For example, virtual nurse assistants could save $20 billion annually by taking on some of the first line responsibilities for interviewing and assessing patients.

Furthermore, a 2016 poll by analytics firm HealthMine found that while 60 percent of patients could access their electronic medical data, 15 percent had trouble understanding it and just 22 percent used it to make medical decisions. Some see NLP as a means to bridge the language gap between doctors and patients.

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Researchers from Yale University, the University of Massachusetts, and Bedford VA Medical Center have addressed this point. In a recent study they applied an NLP algorithm to clinical documents, tracking medical terms to their lay-language equivalents and making it easier for patients to understand their doctors' instructions.

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As a business tool, some say NLP could help drive better decision making by applying computer intelligence to insights harvested from news, social media, financial influencers and blogs. NLP could identify hot topics of discussion, chart consumer interest and potentially aid in business decision-making. For example, marketers are increasingly using sentiment analysis to mine social media for consumer insights regarding brand favorability and preference.

Others see in NLP the ability to streamline business processes. JPMorgan Chase for instance has developed a proprietary algorithm called COiN to analyze legal documents. The bank says this could save countless hours of manual labor and significantly reduce errors in loan servicing.

On the federal side, NLP offers a range potential benefits across diverse use cases.

GOVERNMENT USE CASES

In a recent [study](#), researchers from Duke Law, University of Southern California, and Stanford Law School pitted an AI contract review platform against a team of lawyers.

The computers achieved an average 94 percent accuracy rate at surfacing risks in Non-Disclosure Agreements (NDAs), one of the most common legal agreements used in business, versus an average of 85 percent for experienced lawyers.

Better still: It took the machines an average of 26 seconds to complete the task, compared to an average of 92 minutes for the lawyers. This shows that AI can holds its own in performing human tasks and suggests that the pairing of AI and humans together could deliver even more powerful results.

This has big implications for government at a time when agency headcount continues to decline, while the sheer volume of data increases exponentially. Citizens deserve an AI-empowered government, one that can process requests in a timely way and [can cut down on the backlog](#) that plagues so many citizen-facing agencies. NLP can do this by handily summarizing and prioritizing information.

HHS has [piloted](#) the use of NLP to process public comments on new regulations, which can require over 1,000 hours just to categorize for a single proposed rule. The tool was able to meet quality requirements and improve staff satisfaction, allowing one agency to demonstrate millions in cost savings.

The low-hanging fruit here may well lie with the agency help desk, where AI can be trained on the FAQs. NLP could route calls effectively, easing the burden on help desk staff, and could even help to resolve queries that are purely informational. In mature contact centers, Accenture has found that [costs can be reduced](#) by 30% with higher customer satisfaction through expanded use of more intelligent virtual assistants.

Some agencies already are moving in this direction. U.S. Citizenship and Immigration Services (USCIS) for instance has introduced [Emma](#), a voice-powered personal assistant that can understand and speak both Spanish and English. Other agencies are looking to Emma as a model for what may be possible on the citizen-service side, with natural language enabling organic conversations and helping to fulfill routine requests with little to no human intervention.

As our population continues to age, finding new ways to enable the elderly to lead productive, independent lives will grow in importance. An [Accenture pilot](#) in the UK used Amazon Echo devices to empower caregivers to provide more virtual care and support. And working with the UK's National Theatre, Accenture developed a device using NLP for [real-time audio captioning](#) for those with loss of hearing.

While these use cases focus on the spoken word, government also may have much to gain from the ability to both analyze and generate text.

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For example, Accenture is working with government agencies responsible for processing benefits claims for citizens. A key challenge is the inordinate volume of documentation requiring manual review to ensure information is correct and consistent. NLP can do that, "reading" documents at computer speed to ensure citizens are eligible for services or benefits. The machines won't make the final call – no one likes to think of AI rejecting a claim – but they can flag suspicious entries, inconsistencies or apparent discrepancies. Rather than wade through 100 pages of detail, a human reviewer can skip to the two pages where things look sticky, or the computer can automatically confirm that claims are supported by the text.

NLP is also a core technology for link analysis, which allows analysts and researchers to make network correlations across data, whether it be medical research, search engine optimization or criminal investigations. In this context, NLP technologies like latent semantic indexing can play an important role in concept matching, eDiscovery and disambiguation, allowing conceptual relationships to be identified even when not readily apparent.

In the near future, some expect NLP will become adept not just at reading government documents, but at writing them, too. Many agencies are tasked with generating reports, typically based on tables of data. What if the machines could read the data and formulate human-sounding sentences and paragraphs?

Another scenario that's easy to envision centers upon document retention. Various agencies are charged with keeping documents for certain lengths of time, in response to Freedom of Information Act requirements and other regulations. Typically, documents are marked for retention by a manual process: That's time consuming, tedious and error prone. A better idea would be to have the machine read and classify documents, automatically filing them according to authorized release dates.

In each case, the sweet spot for NLP lies somewhere at the intersection of simplicity and repeatability. AI shines brightest when it helps to automate routine tasks, where the level of complexity is fairly low and where the high frequency gives the AI the opportunity to learn from many repeated instances.

How exactly could government put NLP to work, and who would be in charge of that? It's worth a deeper dive.

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FIRST STEPS

When it comes to implementation, government IT leaders and business line champions will need to tread thoughtfully as they embark on the road to NLP.

On the up side, all the major cloud vendors and many third-party providers offer NLP services, with APIs to make these offerings readily interoperable with existing systems (see for example here, here and here). This means that once a government agency is ready to make the leap, there should be ample infrastructure support available to enable an NLP application.

On the other hand, human language is extremely complex; verbal and written communication is incredibly nuanced. That means that while it is possible to buy the general tools that empower NLP, business leaders within government will likely need to refine those tools for their specific purposes. The more technical and specific the subject matter, the more fine-tuning you'll need to do.

Suppose you're a citizen-facing agency providing a government benefit. There are a finite number of forms in play and the ontology is fairly constrained. Now look at something more esoteric. Say you're a law enforcement agency and you have a court order to read the cell phone texts of potential bad actors. There are emojis, slang, perhaps a foreign language thrown in. See how it gets tricky?

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For planning purposes, this suggests that the NLP effort will have to extend beyond the agency IT shop, to embrace the business line owners and subject matter experts with the specificity of experience needed to round out the knowledge base. The technologists still will have a critical role to play: They know where the data lives and how it moves; and they are attuned to the regulatory and compliance nuances to which government is bound.

But it's the subject matter experts who will have to help write the playbook. They will do that first by defining the problem: Do we spend too much time on these forms? Do citizens wait on hold for too long? Then they will break down the business processes, looking for places where simplicity and repetition open a potential window for AI.

When it's time to take that initial plunge, it may pay to train the AI to search for winners rather than losers. Say you're using NLP to review claims forms. Instead of seeking the typos, the mismatches and the incomplete fields, you can ask NLP to flag those forms that look perfect, where everything matches and all you need is a human to sign off. Take the easy wins first, to pave the way for further, more complex iterations.

THE ROAD AHEAD

Looking ahead, it's clear that private-sector market momentum is building behind NLP.

Markets and Markets analysts put the natural language processing market at $16.07 billion by 2021, while analysts at Mordor Intelligence project the market will reach $12.88 billion by 2023, a 22.5 percent annual growth rate.

The recent introduction of Apple's Siri-enabled watch sounded either a starting gun or a warning shot for government agencies. By ratcheting up citizen expectation, such implementations put new pressure on government agencies: If consumers can speak natural-language questions into their wrists and get immediate intelligible answers, that creates a whole new service expectation.

It's quickly getting to be second nature for people to interact via voice when in search of basic information. According to the 2018 Accenture Digital Consumer Survey, 37% of Americans were expected to have an Alexa-style smart speaker by the end of the year. The survey also found that usage and satisfaction with standalone intelligent virtual assistants surpassed mobile devices, with two-thirds of virtual assistant owners using their smartphone less as a result. As these tools continue to gain traction in the commercial sector, government will find itself pressed to offer its services on at least as sophisticated a footing.

Given that the technology is still evolving, the more forward-thinking agencies will begin an internal self-scrutiny now. The vendors will come up with the mechanical supports, but the business process details that form the core of the NLP value proposition – those have to come from within. Internal subject matter experts can be getting the ducks in a row now, highlighting the places where automation can yield the greatest benefit. Business line owners can start to think about small experiments, looking for the easy wins that will be help to break down cultural barriers and position agencies for future gains.

Where AI meets language processing

Accenture sees strong potential at the intersection of artificial intelligence and human language processing. In collaboration with leading universities such as Stanford, MIT, and Carnegie Mellon as well as our clients, we are currently focused on a number of opportunities, including:

INQUISITIVE VIRTUAL AGENTS

As chatbots take customer service to new levels, critical business needs emerge. How can the bots keep up with the thousands of products and services in constant flux? What to do with queries that can't be answered with existing documentation? New techniques in machine learning will help chatbots and other virtual agents meet escalating citizen expectation.

INTELLIGENT RISK MONITORING

Identifying, assessing and mitigating risks is critical to success. By developing models of different project categories and their associated risks, we can leverage NLP to analyze a combination of structured and unstructured data sources to provide business owners with risk alerts.

COLLABORATIVE CONTENT SYNTHESIS

Government professionals across a wide range of functions share a recurring need to examine vast quantities of content, identify relevant portions, and assemble them into a specific artifact: An insurance claim, for instance, or a vendor profile. NLP can replace today's largely manual approaches with something fast and scalable, freeing human expertise to confirm the relevance and tune the models.

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