Speech for MSG-133 Paper 1

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Good morning Ladies and Gentlemen,

This paper explores the enhancements possible to traditional war gaming through the use of cognitive computing and time manipulation.

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How NATO has modelled the opposing force (or OPFOR as it is known) has changed over time. In the Cold War period, the opposing force was well known and their predictable behaviours could be used in training scenarios.

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NATO faces new adversaries as Squadron Leader McPherson puts it "Threats have become less structured, more complex and unpredictable whilst global terrorist organisations such as ISIS in Iraq and Syria, Al Qaeda, the Shabab in Somalia, and Boko Haram in Nigeria, have all emerged to dominate the headlines. Operations in Iraq and Afghanistan reinforced the need for a comprehensive and multi-dimensional solution to future NATO missions. Moreover, the emerging considerations of possible operations within NATO Member countries and the associated sensitivities this creates have only added to the dilemmas and challenges for commanders."

So there is an increasing diversity in potential adversaries that raises the question; "How can this complex array of opposing forces be realistically modelled"?

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In the last hundred years, we have witnessed three distinct evolutions in warfare.

- In World War I, some battle fields were industrialised with light railways to bring in men and materiel, with little actual territory changing hands but many thousands of casualties. This stalemate was broken by innovation, the tank being an example.
- In World War II, the war ending technology of the atomic bomb did not exist in an operational form at the beginning of the conflict. However the pace of the conflict was slow enough that technology continued to develop over the six years of that war. In that sense, WWII demonstrated the feedback loop of innovation, as the research and manufacturing necessary to operationalise the new atomic technology was integrated into national war planning.
- In today's world, the length of modern supply chains and the shortening timeframe of modern warfare means that complex weapons platforms must be available in the necessary quantities before conflict arises against a peer adversary. It is unlikely that there will be sufficient time within the reduced conflict period for innovation to occur.

So now more than ever it is critical that we train for the right opposing force as the tactics, techniques and procedures are different depending on the actual adversary. Not much point in being proficient in jungle warfare if the next conflict is desert warfare.

We need to objectively assess the opposing force, getting into the mindset of the adversary commanders. The challenge now is one of scale and realism. An amorphous opposing force will no longer suffice and this challenge is one that cognitive computing can assist with.

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Here are the main components in modelling an OPFOR;

- the military platforms to be used
- the organisational structure of the armed forces and C2
- the commanders who will exercise force through the organisational structures available to them

To this we can now add a fourth point; the dogma or doctrine driving the decision making processes. This is particularly relevant with terrorist organisations that are driven by radical ideologies.

All professional military organisations are guided by a recognised and defined military doctrine, or "way of doing things". That military doctrine is guided by the political background of the nation state and cultural influences that provide definite guiding viewpoints on such issues as minimisation or tolerance for civilian casualties. Non-state actors are more typically guided by dogma that may be religious in nature. It becomes much more difficult to find a published source of behaviours that non-state actors would consistently conform to. Cognitive computing is able to broadly mine a large corpus of open source intelligence, social media, blogs and newsfeeds for sentiment analysis to form an aggregate picture of likely behaviours. Non-state actor's Tactics, Techniques and Procedures are perhaps best understood by mapping recent social media activity rather than measurement of their equipment's technical capability.

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So how are these facts, rules and behaviours extracted about each potential OPFOR?

Cognitive computing is a way of mining a body or corpus of knowledge to derive behaviours. We don't want to be guessing at how an adversary commander would behave, we want to understand their military doctrine, their culture, their personality, in an organised fashion. To get into their mindset as a psychological, social and cultural being. This approach allows us to model the OPFOR on various real world scenarios. What is needed is a body of evidence such as:

- History of that nation and the various military conflicts over time
- Their military doctrine as they define it and as we understand it
- After action and military intelligence reports that give factual evidence on how their military has behaved
- Specific information about their commanders, personality, bias for action and other factors that influence their military decision making

- General cultural proclivities of that nation and how that might bias certain decision making processes

Traditional information gathering techniques to accurately model an OPFOR are usually based on human led research that builds up a particular level of expertise in the analyst team, whether that relates to military platforms, organisational structure or commander biographies.

Cognitive computing can go a long way towards automating that process. The sheer ability to absorb a large corpus of documentation including biographies, intelligence reports, after action reports and engineering specifications distinguishes cognitive computing from the manual efforts of human researchers

Cognitive computing is an alternative approach to manually researching the answers to various questions about the OPFOR characteristics. The cognitive computing system searches the corpus of information to formulate answers to questions posed. The best answers are confirmed by a Subject Matter Expert. This is one of its great advantages; the best answers are found again and again when later researchers ask the same or similar questions. This can preserve the corporate knowledge that analysts gain on their subject over many years.

This is not asking the machine to do our thinking for us. It assists the human researcher to focus on the relevant information.

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A feedback loop where the system is trained by experts in their field improves the correctness of the answering process. Context is a key part of that training process; for example a reference to 'Atlas' would need disambiguation by context to either a member of the Atlas rocket family; a collection of geographic maps ; or a mountain range which stretches across north-western Africa extending about 2,500 km (1,600 mi) through Algeria, Morocco and Tunisia. A key advantage provided by that expert training is making the results available to all subsequent queries. Future users interacting with the system will benefit from that expert training, which the system will 'remember' and apply to future questions.

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The term cognitive computing is describing a computing platform that is able to form concepts, understand and reason, and learn with the capacity to recognise patterns and use natural language to communicate.

That is not to suggest that computers have developed to the point of having human like intelligence characterised by perception, consciousness, self-awareness, and volition.

We need computers to interact and reason over natural-language content in the same way that humans do.

Essentially there is no one computer program that is able to reproduce the subtleties of the human mind and the way it understands language interactions. There are multiple analytical paths, each of which contributes part of the solution.

The challenge in computerising these multiple analytic paths was addressed by an architecture framework for integrating diverse collections of text, speech and image analytics called Unstructured Information Management Architecture (UIMA) developed by IBM and later contributed to the Apache foundation and is in use by industry and academia today.

Building on the UIMA architecture, a set of parallel processing pipelines is used to analyse the question and independently pursue possible candidate answers by searching many different resources. Evidence is then gathered for each alternative answer until a final weighting gives a confidence score for presentation of the preferred answer.

To be practical, we need the performance of cognitive computing to be reasonable. An interesting example is when IBM built a computer system called Watson to compete on the U.S. game show Jeopardy!, the first computer attempts took two hours to answer each single question. Although correctly answered, it was hardly a champion performance level. The solution as part of the UIMA architecture was to introduce massive parallelism in the computations. Ultimately 2,880 processors working in parallel on a single question brought the response time down under 3 seconds allowing the Watson computer to challenge and finally win Jeopardy! in 2011 against the two highest ranked human players.

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In a modelling sense, even a generic OPFOR will have general characteristics. Military platforms move and fire weapons, commanders receive information and make decisions according to their organisational structure and support.

Cognitive computing can query and derive fact based answers about the characteristics of military platforms from the literature corpus and can infer a hypothesis about a commander’s likely behaviour and personality characteristics.

All cognitive computing platforms require training, and as a high level concept, this can be viewed as the system providing a ranked set of hypothetical answers. The 'ground truth' is determined by a subject matter expert and the answer sets are so marked. Next time the same question is asked, the system will rank the 'correct' answer higher and come closer to the way that an expert would answer the question. In the field of military intelligence, this cognitive learning ability provides a way of capturing the expertise of personnel that have spent many years analysing various subjects. By marking their version of the 'ground truth', they contribute their years of experience to the corporate knowledge on OPFOR matters.

Published or classified documents on the life and battles of historical commanders provide a depth of insight into their behaviours, which can be built into a realistic model. A country specific model may have a general set of cultural characteristics, over which is layered the specific personality attributes of each individual commander (noting also the rise of non-state actors as potential military adversaries). In an ideal world, the simulation scenario would be able to select an OPFOR modelled on a specific country (or non-state military organisation) with contemporary commanders for the most realism.

Envision a future where the military exercise planners can select a hypothetical but realistic opposing force that uses current commanders with the current organisational structures and available military platforms, based on real world scenarios.

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Historical commanders have a wealth of published information about them, so that we can potentially go into battle against the great commanders of history such as Montgomery, Napoleon, Patton, and Rommel. This also creates the intriguing possibility that we can make the commander more or less conservative; more or less willing to take risks etc.

It is one way of making the game play more engaging and repeatable in an interesting way; "today you will be taking on Rommel in desert warfare ..."

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Time is a key learning factor. Playing against these more realistic adversaries, how can we improve the efficiency of game play. Time saving without compromising the learning objectives. To extract more value out of the exercise period? To move beyond basic training into what-if scenarios that test out replacing OPFOR leaders or testing alternative attack paths to an objective.

Players in a multiplayer real-time strategy game can be afforded the ability to manipulate the fourth dimension of time. This allows players to optimise strategy collectively in ways that maximise resilience. Time manipulation allows users to explore doctrine and its implications within different scenarios and how those decisions cascade to other players.

Some game engines now allow for players to independently decide on where in the game timeline they want to play. So as a scenario develops, sensing imminent defeat, a player can independently move their time slider backwards to go back and marshal greater battle field resources. This is then propagated forward as a 'time wave' so the player reappears in the present with greater resources with which to deter an impending attack. While an interesting conceptual development, this sort of time manipulation is perhaps more of a recreational game playing option, than for serious war game development.

We normally think of time as something that cannot be altered in the past. Given a particular scenario, we can only affect the future as we make decisions in the present. This also typically applies to game playing; our moves are based on the game up to now and new moves affect the play based on where the combined play is up to. It would be useful to be able to stop a chess game when we recognise an imminent check-mate if we continued on the present path, and back up to a safe position and branch off in a new direction.

As an illustration, let's assume that all military activity takes place during daylight hours only. There would then be a safe rest point at midnight where the position of all game objects would be consistent and able to be restarted from that point in time. This would give the game controller the option of restarting the game at an earlier day in the developing battle. Naturally more fine-grained control than this is needed. Smaller time units can be set, or on alternative moves by each side and so on.

The strategic point is that players can recognise when they are on the point of losing and collaborate with other players/instructors to optimise strategy collectively in a way that maximises resilience. This multiplayer time manipulation can help players explore how adversaries can thwart plans, create distractions and exploit weaknesses. It also provides a balanced viewpoint that can be crucial to winning the battle, such as the observable truth that armour columns must be supplied with both fuel and ammunition to be effective, and not get too far ahead of their supply columns.

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Somewhat like the old Irish joke "Well I wouldn't be starting from here"; the issue is that when considering time manipulation in a game, we need to think of how practical is it to be somewhere else and when would that decision need to be made?

As a simplified example to illustrate the concept within a larger scenario, let's assume that materiel is being brought to a port to supply the force. The ship departs from Port A on day four of the exercise and has 1000nmi to travel to reach Port B where it will disembark the materiel. Other players on day six of the exercise call out for the ship as they now urgently need those supplies. Assuming a maximum speed of 250nmi per day, the ship has to be somewhere within the circle of maximum range.

Clearly the ship still has 500nmi or two days travel left. In simple terms, if the ship is out of position by 500nmi and can steam at 250nmi per day, then it is clear that the decision had to be made two days earlier than the ship actually left, to get the ship into position at Port B on time. The learning from this illustration is that the ship had to leave on day two of the exercise. By agreement with the game controllers, the time slider can be reset at day two and game play resumed with the ship being sent off on day two of the exercise to arrive in port on day six as required. There are of course other complex factors that all interact and would need to be thrashed out into the overall strategy. The ability to work this through as game theory can provide tangible feedback into doctrine, tactics, techniques and procedures. That new behaviour may also have other implications such as loading with cargo, assembling the crew, and so on, depending on the realism of the game play.

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This paper explored the enhancements possible to traditional war gaming through the use of cognitive computing and time manipulation.

Cognitive computing provides an organised way of extracting behavioural indications for the opposing force which can be structured as rules of OPFOR behaviour.

Time manipulation gives the opportunity to implement learning in a faster cycle by being able to restart the war game at various points according to the learned outcomes.

Considering the length of modern supply chains, when we do have to stand and fight against a peer adversary, cognitive computing and time manipulation may have enabled our war gaming to focus on the essential preparation of resources for the next major conflict.