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Scenario Generation Using Double Scope Blending

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Abstract

Conceptual Blending through the process of Double Scope Blending provides an account for human creativity. We show how computational creativity can be modeled after Double Scope Blending for machine generation of scenarios, stories, hypotheses, etc. This paper describes an application of this process to the generation of novel and creative scenarios in the maritime security domain.

Introduction

Conceptual Blending Theory (CBT) was developed by Fauconnier and Turner (2002) to explain how humans make sense of the world around them, through a process of imaginatively blending existing concepts to arrive at new understanding. CBT has since been applied to understanding formal expressions in linguistics (Fauconnier & Turner, 2008a), explaining metaphorical reasoning (Fauconnier & Turner, 2008b), understanding counterfactual reasoning (Lee & Barnden, 2001), analyzing mathematical evolution (Alexander, 2008), and developing human computer interfaces (Manuel and Benyon, 2007). Other applications of CBT can be found on Mark Turner's Blending and Conceptual Integration web portal (http://markturner.org).

Computational creativity, in particular, involves a specific from of conceptual blending known as double scope blending, and has been applied to machine poetry generation (Goguen & Harrell, 2007) and the generation of animation characters (Pereira, 2007). This paper describes a further application of double scope blending to generate novel and creative scenarios for sensemaking in a maritime security domain.

Conceptual Blending

CBT describes how humans process and rationalize information through blending existing mental spaces to produce new mental spaces with emergent properties. Blending operates under a set of *constitutive principles* and a set of *governing principles*. The constitutive principles for the blending process involve vital relations identification, generic space generation, blended space composition, completion, elaboration and back projection. The governing principles then provide for the compression and evaluation of the blended space. A key component of blends is the *organizing frame* which provides the structure for the blend. Depending on how the organizing frame is formed, four types of blending networks – simple, mirror, single and double scope – can be distinguished corresponding to different aspects of cognition. A simple network is one in which, one input space provides the frame while the other input space provides the values. A mirror network is one in which, both input spaces share the same frame. A single scope network is one in which, both input spaces have different frames but one of which is used to organize the blend. A double scope network is one in which both input spaces have different frames and a combination of both frames becomes the organizing frame for the blend. The double scope network is the one in CBT that accounts for human creativity.

Mental Spaces and Frames

In our current work, we represent mental spaces as *concept maps* implemented as graphs. Each concept map can be considered a *micro-theory* describing an integrated concept. For illustration, we begin with two maritime event frames – **Neutral Shipping** and **Maritime Suicide Bombing** – as our *input spaces*.

The Neutral Shipping frame is illustrated in Figure 1. It describes the neutral behavior displayed by ships such as innocent passage. For example, neutral ships can be expected to conform to traffic separation schemes, maintain proper separation distances from other ships, observe harbor and anchorage procedures, maintain proper radio communications, signal their intentions as appropriate, and transmit Automatic Identification System (AIS) information as required by port regulations. In this frame, a ship can further be classified by its type, such as fishing trawler, tanker ship, container ship or passenger ship.

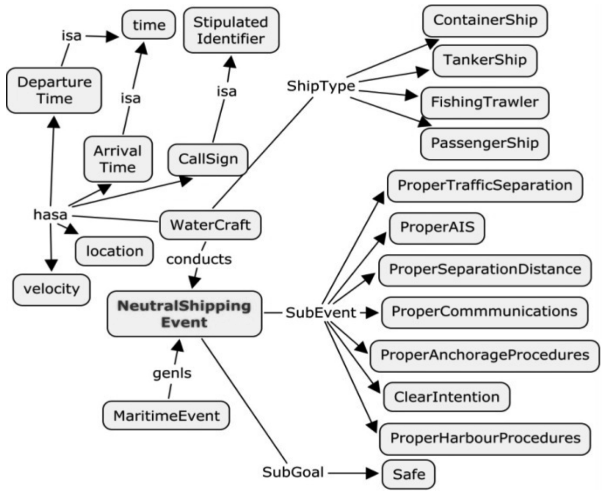

Figure 1: Neutral Shipping Frame

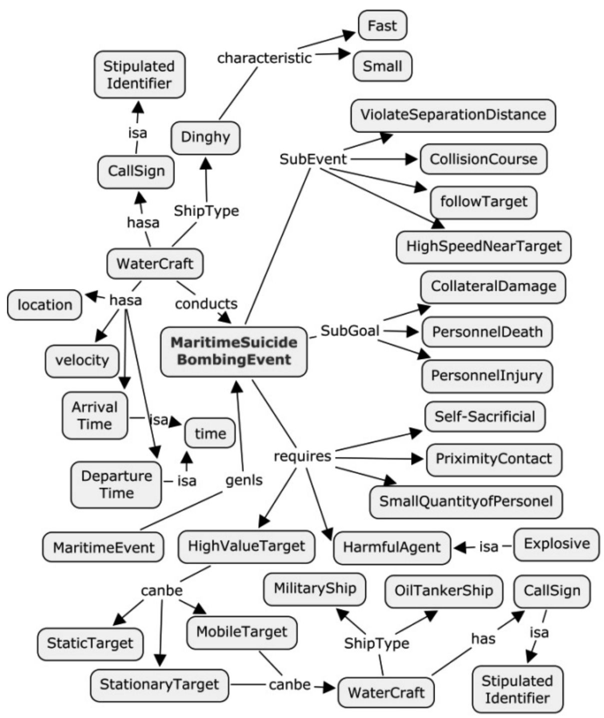

Figure 2: The Maritime Suicide Bombing Organizing Frame

We derived the Maritime Suicide Bombing Frame in Figure 2 by abstracting common elements and relationships from the two historical maritime suicide bombing events: the suicide bombings of the USS Cole and the Limburg. Our maritime suicide bombing frame involves a high value target, such as military shipping target or an oil tanker. It also involves the use of some harmful agents, such as explosives. The explosives require contact with the target in order to achieve its destructive effect. The perpetrators' intentions include causing terror through death, damage, or injury. Their boat might appear heavy, depending on the weight of the explosives. As depicted here, the suicide bombing event might involve self-sacrifice of one or more perpetrators. The bombing event would effectively require the terrorists' craft to be on a collision course with its target, and to violate proper separation distance and speed while in close proximity to other nearby ships.

During blending, *vital relation* (VR) mappings allow nodes across different micro-theories in the input spaces to be related for generating new nodes and links. Additional frames can be recruited to elaborate on properties of the resultant frame mappings. The product of blending is a blended space (new micro-theory) comprising a subset of nodes and links from the original input spaces, possibly supplemented by recruited frames.

Generating Blends for Maritime Security

In previous work, Tan and Hiles (2008) identified seven maritime security scenarios, two of which are the maritime suicide bombing and neutral shipping scenarios already introduced above. The others are:

i. Tanker Ship conducting Suicide Attack with onboard explosive cargo
ii. Container Ship conducting Suicide Attack with huge inertial energy
iii. Small Craft conducting Suicide Attack with Rocket Propelled Grenade
iv. Container ship conducting missile attack
v. Small Craft conducting Boarding Attack with small arms

We show here that it is possible for CBT to generate the remaining five scenarios from the initial two.

Blend 1 – Tanker Ship conducting Suicide Attack with onboard explosive cargo

Beginning with our input frames, `MaritimeSuicideBombingEvent` can be mapped to `NeutralShippingEvent` through the *Analogy* and *Disanalogy* VRs. The node `WaterCraft` in both frames can likewise be mapped. This blend is illustrated in Figure 3. Guided by the *Topology Principle*, the entire topologies from the two input spaces are projected into the blend. Applying the *Compression Principle*, the two original `WaterCraft` instances can be compressed into *Uniqueness*. To satisfy the *Integration Principle*, only one `ShipType` is projected, in this case `TankerShip`. Because the *Disanalogy* linking `MaritimeSuicideBombingEvent` to `NeutralShippingEvent`, violates the integration principle, it is necessary to compress the *Analogy* between `MaritimeSuicideBombingEvent` and `NeutralShippingEvent` using the *Change* VR so that `MaritimeSuicideBombingEvent` and

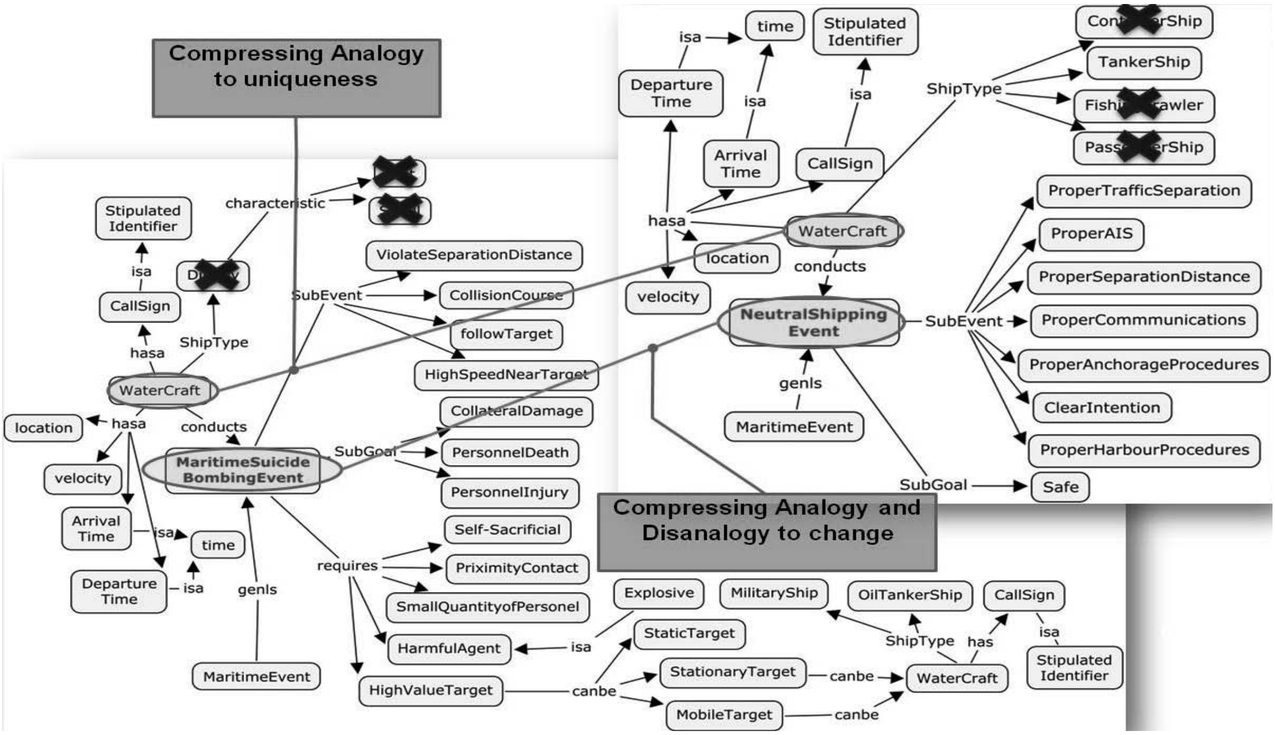

Figure 3: Neutral tanker ship behaving normal initially but turns towards target at a later time

NeutralShippingEvent are separated in time. The blend eventually consists of one WaterCraft that is of ShipType TankerShip. TankerShip is initially involved as a NeutralShippingEvent with its associated SubEvents and SubGoals. At some time later, the TankerShip morphs into a MaritimeSuicideBombingEvent and adopts its associated SubEvents and SubGoals, and eventually maneuvers itself to collide with either static, stationary or moving targets, depending on which of the targets is projected.

Blend 2 - Container Ship conducting Suicide Attack

Following the process in Blend 1, if ShipType Containership is projected instead of TankerShip, we get Blend 2 involving a container ship conducting a suicide attack. In addition, if FishingTrawler or PassengerShip are projected, we get other scenarios for maritime suicide attacks. This provides a first hint of the creative potential of conceptual blending for generating novel scenarios not previously encountered.

Blend 3 - Small Craft conducting Attack with Rocket Propelled Grenade (RPG)

Here, as in Blends 1 and 2, WaterCraft are linked by the *Analogy* VR and compressed into *Uniqueness*. However, in this case, as shown in Figure 4, the ShipType projected is Dinghy and the *Disanalogy* VR between MaritimeSuicideBombingEvent and NeutralShippingEvent is also compressed into *Uniqueness* (i.e. they are the same event). To minimize disintegration, the SubEvents of MaritimeSuicide BombingEvent and the SubGoals of NeutralShippingEvent are not projected, and as a result, the suicide aspects of the initial frames are not projected into the blend either. To fulfill the remaining Subgoals of causing death and damage, there is a need to recruit an external frame to provide the HarmfulAgent. To do this, we consulted a weapons knowledgebase derived from Cyc (Figure 5). And if we assume that the Dingy cannot get near its target, we need a weapon that can travel across the separation distance between itself and its target. Suppose that Rocket Propelled Grenade (RPG) is selected, the scenario of a small craft conducting an RPG attack would emerge.

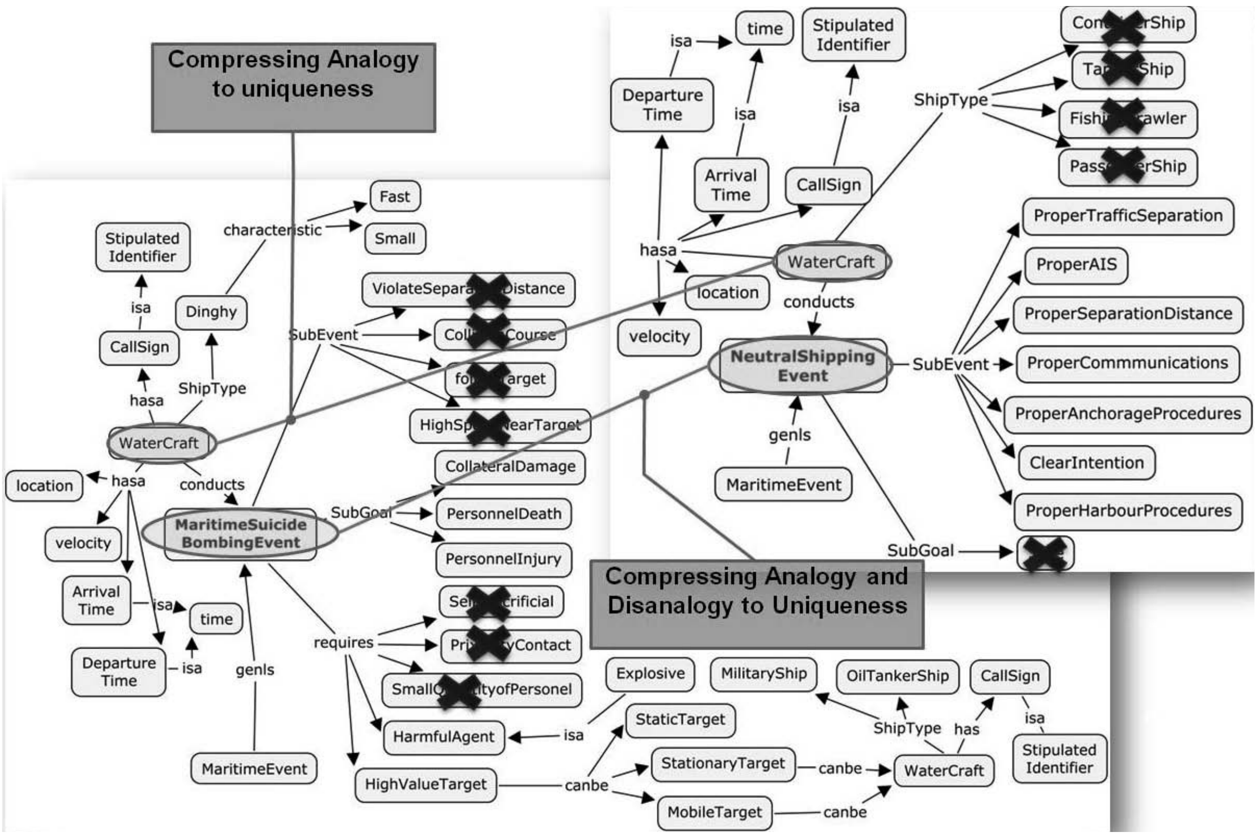

Figure 4: Small Craft conduct Suicide Attack with Rocket Propelled Grenade

Blend 4 - Container ship conducting missile attack

Suppose that in Blend 3, `Containership` is projected instead of `Dinghy` and that we select a Missile from the knowledgebase for the role of `HarmfulAgent`, this leads to a scenario of a container ship conducting a missile attack. As can be seen, with the recruitment of a weapon frame and selective projection, many other scenarios can be generated besides Blends 3 and 4, such as a container ship launching a RPG or tanker ship launching a biological weapon.

Blend 5 - Boarding Attack

Suppose that in Blend 1, `Dinghy` is projected instead of `TankerShip`. We have a dinghy that maneuvers neutrally at first but changes into evasive maneuver at a later time. In this case, however, we choose not to project the `SubGoal` values of `CollateralDamage`, and requirements `SelfSacrificial` and `SmallQuantityPersonnel` into the blend. This produces a scenario in which a small craft carrying many crew members with an intention of harming personnel but not the ship. Such a scenario of boarding attack by a small craft is depicted in Figure 6.

- (genls BiologicalWeapon Weapon)
- (genls MilitaryWeapon Weapon)
- (genls (WeaponizedFormFn (GaseousFn Cyanide)) Weapon)
- (genls (WeaponizedFormFn SodiumCyanide) Weapon) (genls (WeaponizedFormFn SulfuricAcid) Weapon)
- (genls HYP-Weapon-36350808 Weapon)
- **(genls RocketsInABox Weapon)**
- **(genls MissileSystem-Offensive Weapon)**
- (genls Submarine-Military Weapon)
- **(genls MissileSystem Weapon)**
- (genls AmphibiousAssaultShip Weapon)
- (genls Cruiser Weapon)
- (genls ArmoredFightingVehicle Weapon)
- (genls AircraftCarrier Weapon)
- (genls Destroyer Weapon)
- (genls AirDefenseSystem Weapon)
- (genls GunCruiser Weapon)
- (genls (WeaponizedFormFn (GaseousFn Cyanide)) Weapon)
- (genls (WeaponizedFormFn SodiumCyanide) Weapon)
- (genls (WeaponizedFormFn SulfuricAcid) Weapon)
- (genls Gun Weapon)

Figure 5: Knowledgebase returned from Cyc query for "Weapon"

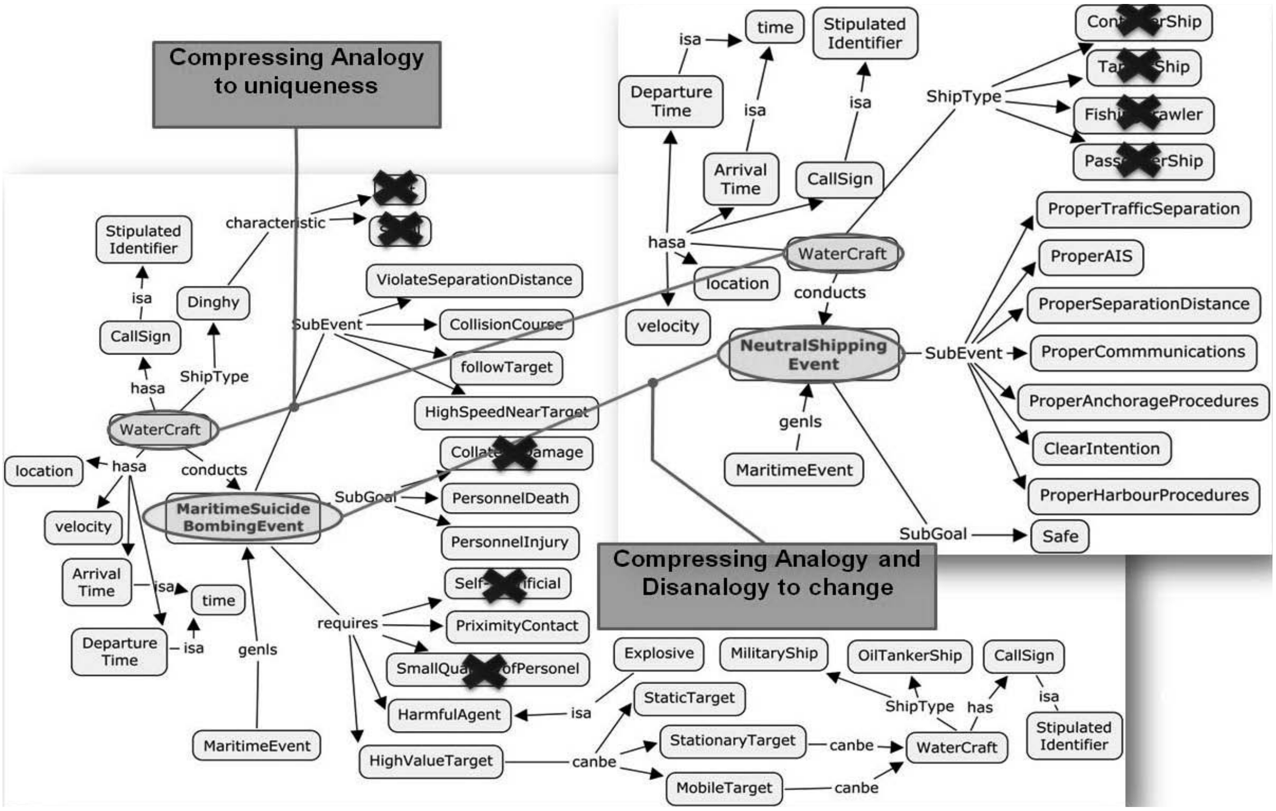

Figure 6: Boarding Attack

Blend 6 – Additional Novel Scenarios

The purpose of this final blend example is to demonstrate a simple and yet non-obvious blend that can be construct through conceptual blending. Suppose that the entire graph topologies from the two original input frames are projected without `ShipType` `TankerShip`, `FishingTrawler` or `PassengerShip` from `NeutralShippingEvent`. Instead `WaterCraft` in the `MaritimeSuicideBombingEvent` frame is linked to that in `NeutralShippingEvent` through a *partof* VR. The last outer space mapping suggests a scenario in which a container ship with ostensibly a neutral disposition, can covertly be carrying a small craft for mischief. This scenario is shown in Figure 7.

Discussion

The examples in this paper are but a small fraction of the set of possible scenarios that can arise from blending the two initial frames. At this point, the reader should be able to appreciate the potential of Conceptual Blending for generating novel and creative scenarios. This would be very useful for the Maritime Security agencies as scenario generation is an important task that will help them better prepare for threats before they emerge. In particular, these agencies are looking for machine augmentation in generating novel scenarios that transcend human mindsets.

Our presentation of Conceptual Blending is however vastly simplified due to space constraints which prevent us from detailing the blending process, such as the *Vital Relations* mentioned in our examples. For a full treatment of CBT, we would like to refer the reader to Fauconnier & Turner (2002). Our aim here is to allow reader to have a quick appreciation without getting lost into the details.

Furthermore, we are unable at this point to provide a full specification of the computational algorithms that we used to implement the constitutive and governing principles as this is still a work in progress. We have also identified several technical challenges that we need to address beyond simply turning Fauconnier and Turner's blending principles into algorithms. One of these is to manage the combinatorial explosion that results from the blending process. We think that some form of clustering would be necessary to deal with blends at an aggregate level. Another is to ensure that the blends generated are meaningful. This is a difficult problem as Fauconnier and Turner's governing principles do not impose semantic constraints in the evaluation of blends. It is also difficult for machines to evaluate blends for meaning given the

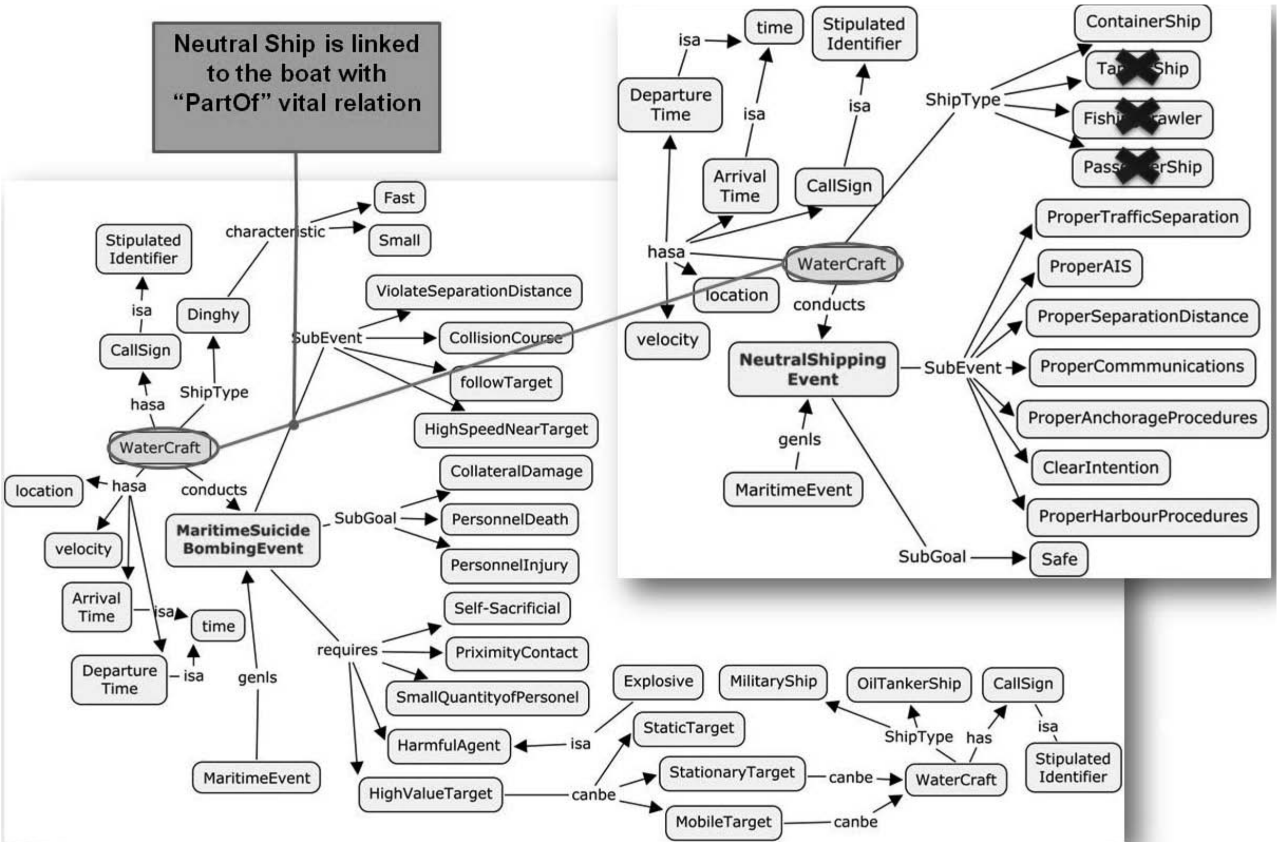

Figure 7: Containership Launches a Small Boat

current state of AI. An intermediate solution might require a human-in-the-loop to perform blend evaluation.

Conclusion

We described an application of double scope blending to scenario generation for sensemaking in the maritime security domain. The purpose is to allow reader to have a quick appreciation of the possible utility of conceptual blending for achieving computational creativity.

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