16 March 2020

## **Decision Logic (DL) Rules for Mission Execution Ontology (MEO)**

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Original 2014, updated 2018-2020

| **Rules** | **Description Logic Equations** | **Plain-language description** |
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| M = Mission Rules | | |
| M1 | Mission ⊑ ∀startsWith.Goal ⊓ =1startsWith.Goal | A Mission can only start with a Goal and must start with exactly one Goal |
| M2 | Mission ⊑ ∀includes.Goal ⊓ ≥1includes.Goal | A Mission can only include Goals and must include one or more Goals |
| M3 | Mission ⊑ ∀hasConstraint.Constraint | A Mission can only be constrained by Constraints |
| M4 | startsWith ⊑ includes | A Mission must include the Goal that it starts with |
| M5 | Mission ⊑ ∀performableBy.Vehicle | A Mission can only be performed by a Vehicle |
| M6 | Cannot be expressed in DL | A Mission cannot be performable by a Vehicle unless that Vehicle has the ability to identify all Constraints associated with that mission |
| M7 | Cannot be expressed in DL | A Mission cannot be performable by a Vehicle unless that Vehicle has the capability to accomplish all Goals included in that Mission |
| V = Vehicle Rules | | |
| V1 | Vehicle ⊑ ∀hasFeature.VehicleFeature | The only allowable features of a Vehicle are VehicleFeatures |
| V2 | canPerform ≡ performableBy¯ | performableBy and canPerform are inversely equivalent |
| V3 | hasFeature ∘ canFulfill ⊑ meetsRequirement | A Vehicle meets a GoalRequirement if it has a VehicleFeature that can fullfill that GoalRequirement |
| V4 | hasFeature ∘ canTest ⊑ canIdentify | If a Vehicle has a VehicleFeature that can test a Constraint, then that Vehicle can identify that constraint |
| V5 | Cannot be expressed in DL | If a Vehicle meets all GoalRequirements for a specific Goal, then that vehicle has the capability for that Goal |
| F = Feature Rules | | |
| F1 | VehicleFeature ⊑ ∀canFulfill.GoalRequirement | A VehicleFeature can only fulfill GoalRequirements |
| F2 | VehicleFeature ⊑  ∀canTest.Constraint | A VehicleFeature can only test Constraints |

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| C = Constraint Rules | | |
| C1 | Constraint ⊑ ∀appliesTo.(Mission ⊔ Goal) | A Constraint can apply to a Mission or a Goal (and nothing else) |
| C2 | Constraint ⊑ ≥1appliesTo.Goal | A Constraint must apply to at least one Goal |
| C3 | appliesTo ∘ includes ⊑ appliesTo | A Constraint that applies to a Mission must also apply to all of the Goals that Mission includes |
| EC = End Condition Rules | | |
| EC1 | EndCondition ≡ Succeed ⊔ Fail ⊔ Violate | Possible types of ending conditions are “Succeed", "Fail", and "Violate" (i.e., imminent Constraint violation) |
| G = Goal Rules | | |
| G1 | Goal ⊑  ∀requires.GoalRequirement | A Goal can only require a GoalRequirement G2 |
| G2 | Goal ⊑ ∀hasEndCondition.EndCondition ⊓ ≤1hasEndCondition.EndCondition | A Goal's ending state must be an EndCondition, and a Goal can end with at most one EndCondition |
| G3 | Goal ⊑ ∀hasNext.Goal | A Goal can only have other Goals next |
| G4 | Cannot be expressed in DL | A Goal can only have an immediate successor based on the existence of an ending state for that Goal |
| G5 | Goal ⊑  ( ≤1hasNextOnSuccess ⊓ ∀hasEndCondition.Succeed) ⊔ (≤1hasNextOnFail ⊓ ∀hasEndCondition.Fail) ⊔ (≤1hasNextOnViolate ⊓ ∀hasEndCondition.Violate) | A Goal can have no more than one immediate successor in the event of a specific ending state |
| G6 | Goal ⊑ ∀isFollowedBy.Goal | A Goal can only be followed by another Goal |
| G7 | Goal(G) ⊑ ¬∃isFollowedBy.Self | A Goal cannot follow itself (no loops) |
| G8 | hasNext ⊑ isFollowedBy | A Goal follows another goal if it is the next Goal |
| G9 | isFollowedBy ∘ isFollowedBy ⊑ isFollowedBy | isFollowedBy is transitive (if isFollowedBy (A,B) and isFollowedBy (B,C), then isFollowedBy (A,C)) |
| G10 | startsWith ∘ isFollowedBy ⊑ includes | All Goals that follow the starting Goal for a Mission are included in the Mission |

Available at

* <https://savage.nps.edu/EthicalControl/ontologies/DescriptionLogicRulesMissionExecutionOntology.pdf>
* <https://gitlab.nps.edu/Savage/EthicalControl/DescriptionLogicRulesMissionExecutionOntology.pdf>

**TODO**

1. Define description logic(s) of interest
2. Update version to match latest MEO