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
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

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