

Multi-Agent Planning Ontology

Metadata

IRI

<https://purl.org/ai4s/ontology/planning/multi-agent>

Title

Multi-Agent Planning Ontology

Creator

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Contributor

This ontology extends the base Planning Ontology available at <https://ai4society.github.io/planning-ontology#>

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Version Iri

<https://purl.org/ai4s/ontology/planning/multi-agent/v1.0.0>

Preferred Namespace Uri

[ma:](#)

Description

An ontology for representing knowledge in Multi-Agent Path Finding (MAPF) problems. This ontology defines concepts such as agents, plans, conflicts, and replanning strategies to support explainable AI in MAPF.

Classes

Agent ^c	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#Agent

Sub Class Of

[plan:ProblemObject](#)
[sosa:Platform](#)

In Domain Of

[ma:hasAgentID](#)^{dp}
[ma:hasCapability](#)^{op}
[ma:hasInitialLocation](#)^{op}
[ma:hasGoalLocation](#)^{op}
[ma:executesAction](#)^{op}

In Range Of

[ma:belongsToAgent](#)^{op}
[ma:hasAgentSet](#)^{op}
[ma:involvesAgents](#)^{op}
[ma:involvesAgentsEvent](#)^{op}
[ma:targetAgent](#)^{op}
[ma:belongsToAgentSegment](#)^{op}

Agent State^c

IRI

<https://purl.org/ai4s/ontology/planning/multi-agent#AgentState>

Sub Class Of

[plan:State](#)

In Domain Of

[ma:occursAtTime](#)^{op}
[ma:agentAt](#)^{op}

In Range Of

[ma:hasInitialStates](#)^{op}
[ma:hasGoalStates](#)^{op}

Agent Sub Plan^c

IRI

<https://purl.org/ai4s/ontology/planning/multi-agent#AgentSubPlan>

<u>Sub Class Of</u>	plan:Plan
<u>In Domain Of</u>	ma:belongsToAgent^{op} ma:hasPlanCost^{dp} ma:planData^{op}
<u>In Range Of</u>	ma:composedOfSubPlans^{op}
<u>Super Class Of</u>	ma:OriginalSubPlan^c ma:ResolvedSubPlan^c

Original Sub Plan^c

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#OriginalSubPlan
<u>Sub Class Of</u>	ma:AgentSubPlan^c
<u>In Range Of</u>	ma:derivesFrom^{op}

Resolved Sub Plan^c

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#ResolvedSubPlan
<u>Sub Class Of</u>	ma:AgentSubPlan^c
<u>In Domain Of</u>	ma:derivesFrom^{op} ma:generatedBy^{op} ma:resolvesConflict^{op}

Joint Plan^c

IRI	https://purl.org/ai4s/ontology/planning/multi-
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agent#JointPlan

Sub Class Of [plan:Plan](#)

In Domain Of

- [ma:planData](#)^{op}
- [ma:composedOfSubPlans](#)^{op}
- [ma:hasGlobalMakespan](#)^{dp}
- [ma:usedAlertSet](#)^{op}
- [ma:conflictResolutionProtocol](#)^{dp}

Conflict Constraint^c

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#ConflictConstraint>

Sub Class Of [plan:DomainRequirement](#)

In Domain Of

- [ma:involvesAgents](#)^{op}
- [ma:conflictType](#)^{dp}
- [ma:forbiddenRegion](#)^{op}

In Range Of [ma:hasConflictConstraint](#)^{op}

Agent Path Segment^c

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#AgentPathSegment>

In Domain Of

- [ma:belongsToAgentSegment](#)^{op}
- [ma:hasValidTime](#)^{op}
- [ma:hasPathSequence](#)^{op}

In Range Of

- [ma:planData](#)^{op}
- [ma:observedForbiddenSegment](#)^{op}

Grid Location^C

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#GridLocation>

Description

A structured representation of a grid cell with x and y coordinates.

In Domain Of

[ma:xCoordinate](#)^{dp}

[ma:yCoordinate](#)^{dp}

In Range Of

[ma:hasInitialLocation](#)^{op}

[ma:hasGoalLocation](#)^{op}

[ma:atLocation](#)^{op}

[ma:conflictLocation](#)^{op}

[ma:agentAt](#)^{op}

Agent Policy^C

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#AgentPolicy>

In Domain Of

[ma:policyName](#)^{dp}

[ma:trainedOnEnvironment](#)^{dp}

[ma:observationChannels](#)^{dp}

[ma:actionSpace](#)^{dp}

Observation Mask Spec^C

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#ObservationMaskSpec>

In Domain Of

[ma:hasChannel](#)^{dp}

[ma:maskDimension](#)^{dp}

Collision Event^c

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#CollisionEvent>

In Domain Of

[ma:conflictID](#)^{dp}
[ma:occursAtTime](#)^{op}
[ma:conflictTypeEvent](#)^{dp}
[ma:involvesAgentsEvent](#)^{op}
[ma:conflictLocation](#)^{op}

In Range Of

[ma:resolvesConflict](#)^{op}
[ma:alertsConflict](#)^{op}

Conflict Alert^c

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#ConflictAlert>

In Domain Of

[ma:selectionRationale](#)^{dp}
[ma:alertID](#)^{dp}
[ma:alertsConflict](#)^{op}
[ma:targetAgent](#)^{op}
[ma:rewindWindow](#)^{dp}
[ma:alertType](#)^{dp}
[ma:staticForbiddenCells](#)^{dp}
[ma:dynamicForbiddenPath](#)^{dp}

In Range Of

[ma:usedAlertSet](#)^{op}
[ma:triggeredBy](#)^{op}

Replanning Strategy^C

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#ReplanningStrategy>

In Domain Of

[ma:triggeredBy](#)^{op}
[ma:strategyID](#)^{dp}
[ma:usedStaticReplanning](#)^{dp}
[ma:usedDynamicReplanning](#)^{dp}
[ma:observedForbiddenCells](#)^{op}
[ma:observedForbiddenSegment](#)^{op}

Planner Procedure^C

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#PlannerProcedure>

In Domain Of

[ma:procedureID](#)^{dp}
[ma:implementsStage](#)^{dp}
[ma:agentSelectionPolicy](#)^{dp}
[ma:rewindWindowDefault](#)^{dp}
[ma:hasRationale](#)^{dp}

In Range Of [ma:implementsProcedure](#)^{op}

Multi Agent Planner^C

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#MultiAgentPlanner>

Sub Class Of [plan:Planner](#)

In Domain Of

[ma:ofPlannerType](#)^{dp}
[ma:implementsProcedure](#)^{op}
[ma:generatesPlan](#)^{op}
[ma:supportsConflictDetection](#)^{dp}

[ma:communicationOverhead](#)^{dp}
[ma:hasPerformanceTradeoff](#)^{dp}

Object Properties

has capability^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasCapability
<u>Domain</u>	ma:Agent ^c
<u>Range</u>	cora:Capability

has initial location^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasInitialLocation
<u>Domain</u>	ma:Agent ^c
<u>Range</u>	ma:GridLocation ^c

has goal location^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasGoalLocation
<u>Domain</u>	ma:Agent ^c
<u>Range</u>	ma:GridLocation ^c

executes action^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#executesAction
<u>Domain</u>	ma:Agent ^c
<u>Range</u>	plan:Action

at location ^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#atLocation
<u>Domain</u>	Thing ^c
<u>Range</u>	ma:GridLocation ^c

belongs to agent ^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#belongsToAgent
<u>Domain</u>	ma:AgentSubPlan ^c
<u>Range</u>	ma:Agent ^c

plan data ^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#planData
<u>Domain</u>	<ul style="list-style-type: none"> • ma:AgentSubPlan^c • ma:JointPlan^c
<u>Range</u>	ma:AgentPathSegment ^c

composed of sub plans ^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#composedOfSubPlans
<u>Domain</u>	ma:JointPlan ^C
<u>Range</u>	ma:AgentSubPlan ^C

used alert set ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#usedAlertSet
<u>Domain</u>	ma:JointPlan ^C
<u>Range</u>	ma:ConflictAlert ^C

has agent set ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasAgentSet
<u>Domain</u>	plan:PlanningProblem
<u>Range</u>	ma:Agent ^C

has initial states ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasInitialStates
<u>Domain</u>	plan:PlanningProblem
<u>Range</u>	ma:AgentState ^C

has goal states ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasGoalStates

agent#hasGoalStates

Domain [plan:PlanningProblem](#)

Range [ma:AgentState](#)^C

has conflict constraint^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#hasConflictConstraint>

Domain [plan:PlanningProblem](#)

Range [ma:ConflictConstraint](#)^C

involves agents^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#involvesAgents>

Domain [ma:ConflictConstraint](#)^C

Range [ma:Agent](#)^C

forbidden region^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#forbiddenRegion>

Domain [ma:ConflictConstraint](#)^C

Range [plan:Region](#)

derives from^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#derivesFrom>

<u>Sub Property Of</u>	<u>was derived from</u> ^{op}
<u>Domain</u>	<u>ma:ResolvedSubPlan</u> ^c
<u>Range</u>	<u>ma:OriginalSubPlan</u> ^c

generated by^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#generatedBy
<u>Sub Property Of</u>	<u>was generated by</u> ^{op}
<u>Domain</u>	<u>ma:ResolvedSubPlan</u> ^c
<u>Range</u>	<u>Activity</u> ^c

resolves conflict^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#resolvesConflict
<u>Description</u>	Connects a revised plan to the conflict it solves.
<u>Domain</u>	<u>ma:ResolvedSubPlan</u> ^c
<u>Range</u>	<u>ma:CollisionEvent</u> ^c

triggered by^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#triggeredBy
<u>Description</u>	Shows which alert initiated a replanning action.
<u>Domain</u>	<u>ma:ReplanningStrategy</u> ^c

Range [ma:ConflictAlert](#)^C

occurs at time^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#occursAtTime>

Domain

- [ma:CollisionEvent](#)^C
- [ma:AgentState](#)^C

Range [time:Instant](#)

involves agents event^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#involvesAgentsEvent>

Domain [ma:CollisionEvent](#)^C

Range [ma:Agent](#)^C

conflict location^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#conflictLocation>

Domain [ma:CollisionEvent](#)^C

Range [ma:GridLocation](#)^C

alerts conflict^{op}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#alertsConflict>

<u>Domain</u>	ma:ConflictAlert ^C
<u>Range</u>	ma:CollisionEvent ^C

target agent^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#targetAgent
<u>Domain</u>	ma:ConflictAlert ^C
<u>Range</u>	ma:Agent ^C

belongs to agent segment^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#belongsToAgentSegment
<u>Domain</u>	ma:AgentPathSegment ^C
<u>Range</u>	ma:Agent ^C

has valid time^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasValidTime
<u>Domain</u>	ma:AgentPathSegment ^C
<u>Range</u>	time:Interval

has path sequence^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasPathSequence
<u>Domain</u>	ma:AgentPathSegment ^C

<u>Range</u>	<u>List</u>
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observed forbidden cells ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#observedForbiddenCells
<u>Domain</u>	ma:ReplanningStrategy ^C
<u>Range</u>	plan:Cell

observed forbidden segment ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#observedForbiddenSegment
<u>Domain</u>	ma:ReplanningStrategy ^C
<u>Range</u>	ma:AgentPathSegment ^C

implements procedure ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#implementsProcedure
<u>Domain</u>	ma:MultiAgentPlanner ^C
<u>Range</u>	ma:PlannerProcedure ^C

generates plan ^{op}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#generatesPlan
<u>Domain</u>	ma:MultiAgentPlanner ^C
<u>Range</u>	plan:Plan

agent at^{op}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#agentAt
<u>Domain</u>	ma:AgentState ^c
<u>Range</u>	ma:GridLocation ^c

Datatype Properties

has agent id^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasAgentID
<u>Domain</u>	ma:Agent ^c
<u>Range</u>	xsd:string

x coordinate^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#xCoordinate
<u>Domain</u>	ma:GridLocation ^c
<u>Range</u>	xsd:integer

y coordinate^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#yCoordinate
<u>Domain</u>	ma:GridLocation ^c

<u>Range</u>	<u>xsd:integer</u>
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has plan cost ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasPlanCost
<u>Domain</u>	<u>ma:AgentSubPlan</u> ^c
<u>Range</u>	<u>xsd:decimal</u>

has global makespan ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasGlobalMakespan
<u>Domain</u>	<u>ma:JointPlan</u> ^c
<u>Range</u>	<u>xsd:decimal</u>

conflict resolution protocol ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#conflictResolutionProtocol
<u>Domain</u>	<u>ma:JointPlan</u> ^c
<u>Range</u>	<u>xsd:string</u>

conflict type ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#conflictType
<u>Domain</u>	<u>ma:ConflictConstraint</u> ^c
<u>Range</u>	<u>xsd:string</u>

selection rationale^{dp}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#selectionRationale>

Description Explains why a specific agent was chosen for a conflict alert.

Domain [ma:ConflictAlert](#)^c

Range [xsd:string](#)

policy name^{dp}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#policyName>

Domain [ma:AgentPolicy](#)^c

Range [xsd:string](#)

trained on environment^{dp}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#trainedOnEnvironment>

Domain [ma:AgentPolicy](#)^c

Range [xsd:string](#)

observation channels^{dp}

IRI <https://purl.org/ai4s/ontology/planning/multi-agent#observationChannels>

Domain [ma:AgentPolicy](#)^c

<u>Range</u>	<u>xsd:string</u>
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action space ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#actionSpace
<u>Domain</u>	<u>ma:AgentPolicy</u> ^C
<u>Range</u>	<u>xsd:string</u>

has channel ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasChannel
<u>Domain</u>	<u>ma:ObservationMaskSpec</u> ^C
<u>Range</u>	<u>xsd:string</u>

mask dimension ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#maskDimension
<u>Domain</u>	<u>ma:ObservationMaskSpec</u> ^C
<u>Range</u>	<u>xsd:string</u>

conflict id ^{dp}	
IRI	https://purl.org/ai4s/ontology/planning/multi-agent#conflictID
<u>Domain</u>	<u>ma:CollisionEvent</u> ^C
<u>Range</u>	<u>xsd:string</u>

conflict type event^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#conflictTypeEvent
<u>Domain</u>	ma:CollisionEvent ^c
<u>Range</u>	xsd:string

alert id^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#alertID
<u>Domain</u>	ma:ConflictAlert ^c
<u>Range</u>	xsd:string

rewind window^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#rewindWindow
<u>Domain</u>	ma:ConflictAlert ^c
<u>Range</u>	xsd:integer

alert type^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#alertType
<u>Domain</u>	ma:ConflictAlert ^c
<u>Range</u>	xsd:string

static forbidden cells^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#staticForbiddenCells
<u>Domain</u>	ma:ConflictAlert ^c
<u>Range</u>	xsd:string

dynamic forbidden path^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#dynamicForbiddenPath
<u>Domain</u>	ma:ConflictAlert ^c
<u>Range</u>	xsd:string

strategy id^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#strategyID
<u>Domain</u>	ma:ReplanningStrategy ^c
<u>Range</u>	xsd:string

used static replanning^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#usedStaticReplanning
<u>Domain</u>	ma:ReplanningStrategy ^c
<u>Range</u>	xsd:boolean

used dynamic replanning^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#usedDynamicReplanning
<u>Domain</u>	ma:ReplanningStrategy ^c
<u>Range</u>	xsd:boolean

procedure id^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#procedureID
<u>Domain</u>	ma:PlannerProcedure ^c
<u>Range</u>	xsd:string

implements stage^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#implementsStage
<u>Domain</u>	ma:PlannerProcedure ^c
<u>Range</u>	xsd:string

agent selection policy^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#agentSelectionPolicy
<u>Domain</u>	ma:PlannerProcedure ^c
<u>Range</u>	xsd:string

rewind window default^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#rewindWindowDefault
<u>Domain</u>	ma:PlannerProcedure ^c
<u>Range</u>	xsd:integer

has rationale^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasRationale
<u>Domain</u>	ma:PlannerProcedure ^c
<u>Range</u>	xsd:string

of planner type^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#ofPlannerType
<u>Domain</u>	ma:MultiAgentPlanner ^c
<u>Range</u>	xsd:string

supports conflict detection^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#supportsConflictDetection
<u>Domain</u>	ma:MultiAgentPlanner ^c
<u>Range</u>	xsd:boolean

communication overhead^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#communication0verhead
<u>Domain</u>	ma:MultiAgentPlanner^c
<u>Range</u>	xsd:string

has performance tradeoff^{dp}

IRI	https://purl.org/ai4s/ontology/planning/multi-agent#hasPerformanceTradeoff
<u>Domain</u>	ma:MultiAgentPlanner^c
<u>Range</u>	xsd:string

Namespaces

cora

<http://www.IEEE1872-2015/cora#>

dct

<http://purl.org/dc/terms/>

ma

<https://purl.org/ai4s/ontology/planning/multi-agent#>

owl

<http://www.w3.org/2002/07/owl#>

plan

<https://ai4society.github.io/planning-ontology#>

prov

<http://www.w3.org/ns/prov#>

rdf

<http://www.w3.org/1999/02/22-rdf-syntax-ns#>

rdfs

<http://www.w3.org/2000/01/rdf-schema#>

sosa

<http://www.w3.org/ns/sosa/>

time

<http://www.w3.org/2006/time#>

vann

<http://purl.org/vocab/vann/>

xsd

<http://www.w3.org/2001/XMLSchema#>

Legend

c	Classes
op	Object Properties
dp	Datatype Properties