ISO/IEC JTC 1 SC 42 Artificial Intelligence – Working Group 4

Use Case Submission Form

The quality of use case submissions will be evaluated for inclusion in the Working Group's Technical Report based the application area, relevant AI technologies, credible reference sources (see References section), and the following characteristics:

— Data Focus & Learning: Use cases for AI system which utilizes Machine Learning, and those that use a fixed *a priori* knowledge base.

— Level of Autonomy: Use cases demonstrating several degrees (dependent, autonomous, human/critic in the loop, etc.) of AI system autonomy.

— Verifiability & Transparency: Use cases demonstrating several types and levels of verifiability and transparency, including approaches for explainable AI, accountability, etc.

— Impact: Use cases demonstrating the impact of AI systems to society, environment, etc.

— Architecture: Use cases demonstrating several architectural paradigms for AI systems (e.g., cloud, distributed AI, crowdsourcing, swarm intelligence, etc.)

1. General

ID	(leave blank, for internal use)	
Use case name	AI solution for traffic signal Optimization based on multi-source data fusion	
Application domain	Transportation	
Deployment model	Cloud services	
Status	In operation	
Scope[1]	Generate traffic signal timing plans by analyzing traffic flow status and patterns based on fusing internet data, induction coils data and video data, and control the traffic signal with the generated timing plans in a real-time, self-adaptive and cooperative way	
Objective(s)[2]	To find an effective and efficient solution to improve the road utilization efficiency by increasing traffic flow speed and reducing traffic flow waiting time.	
Narrative	Short description (not more than 150 words)	An AI solution was developed that could recognize real-time traffic flow status and abstract traffic flow patterns by fusing internet data, induction coils data and video data, and could generate optimized traffic signal timing plan by self-adaptively responding to real-time traffic flow

[1] The scope defines the intended area of applicability, limits, and audience.
[2] The intention of the system; what is to be accomplished?; who/what will benefit?.

		fluctuation and with regards to traffic flow coordination among multiple intersections within a given region.
	Complete description	By far, traffic administrator produces traffic signal timing plans by observing traffic flow situation on-site at intersections or through videos, and relies on her/his personal experience. Then, the timing plans are input into and executed by the traffic signal control system. The disadvantages of this manual traffic signal timing plan generation approach are as follows: 1. Low computing efficiency, it consumes very long time for traffic administrator to observe and analyze traffic patterns. 2. Low computing precision, traffic administrator only cares about the macro traffic flow tendency at intersections without computing detailed traffic parameters such as speed, queue length in each lane, etc. 3. Slow response to traffic flow fluctuation, it is hard for traffic administrator to produce adaptive timing plan in time with respect to real-time traffic flow fluctuation, due to her/his limited computing ability, not mention to coordinate traffic flows among multiple intersections by controlling the traffic signal in real-time. 4. Experienced traffic administrators are severely in short for cities with the scale of thousands intersections. For solving the above problems, the AI provider applies a multi-source data fusion approach to recognize the traffic flow status and generalize the traffic flow pattern by analyzing the internet data (i.e., vehicle driving trajectory data provided by internet service supplier), detector data collected by induction coils, and structured data recognized from videos. Furthermore, the AI provider develops an optimization method to figure out optimized traffic signal timing plan by self-adaptively responding to real-time traffic flow fluctuation and with regards to traffic flow coordination among multiple intersections. The developed methods have been applied in practice within a given region from a large city. It generates traffic signal timing plans for all the intersections in the region according to their real-time traffic flow fluctuation with an updating frequency of 5 minutes per time. Compared with the manual traffic signal timing plans form the traffic administrators, the plans generated by the new method have increased the average vehicle driving speed by 9%, and reduced the average vehicle waiting time by 15%.

Stakeholders[3]	DOT DOP			
Stakeholders' assets, values[4]	Safety,stability,trustworthiness			
System's threats & vulnerabilities[5]	new privacy threats,new security threats			
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
	1	Average vehicle driving speed	Average vehicle driving speed on all the road sections in a given region	Improve the road utilization efficiency
	2	Average vehicle waiting time	Average vehicle waiting time at all the intersections in a given region	Improve the road utilization efficiency
AI features	Task(s)	Optimization		
	Method(s)[6]	Deep learning, Bayesian network, Time series analysis, Operational research optimization method (i.e., Mixed integer linear programming, etc.)		
	Hardware[7]	ECS		
	Topology[8]	Cloud Service		
	Terms and concepts used[9]	Traffic signal self-adaptive and coordinative control for a large number of intersections. Issues: 1. Not all intersections are equipped with detectors such as induction coil or video. 2. The detectors may output abnormal values which need data clean processings.		
Standardization opportunities/ requirements				

[3] Stakeholder are those that can affect or be affected by the AI system in the scenario; e.g., organizations, customers, 3rd parties, end users, community, environment, negative influencers, bad actors, etc.

[4] Stakeholders' assets and values that are at stake with potential risk of being compromised by the AI system deployment – e.g., competitiveness, reputation, trustworthiness, fair treatment, safety, privacy, stability, etc.

[5] Threats and vulnerabilities can compromise the assets and values above - e.g., different sources of bias, incorrect AI system use, new security threats, challenges to accountability, new privacy threats (hidden patterns), etc.

[6] AI method(s)/framework(s) used in development.

[7] Hardware system used in development and deployment.

[8] Topology of the deployment network architecture.

[9] Terms and concepts used here should be consistent with those defined by Working Group 1 (AWI 22989 and AWI 23053) or to be recommended for inclusion.

Challenges and issues	Challenges:Traffic signal self-adaptive and coordinated control for a large number of intersections. Issues: 1. Not all intersections are equipped with detectors such as induction coil or video. 2. The detectors may output abnormal values which need data clean processing.	
Societal Concerns[10]	Description	Relieve urban road congestion
	SDGs[11] to be achieved	Sustainable cities and communities

[10] To be inserted.

[11] The Sustainable Development Goals (SDGs), also known as the Global Goals, are a collection of 17 global goals set by the United Nations General Assembly. SDGs are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.
URL: http://www.undp.org/content/undp/en/home/sustainable-development-goals.html

Data (optional)

Data characteristics	
Description	Internet data, Induction coil data, Video data
Source[12]	Internet, Detector, Detector
Type[13]	Structured text and number, Structured text and number, Unstructured video
Volume (size)	
Velocity[14]	Internet data updated daily, Induction coil data updated every 5 minutes, Video data updated in real-time
Variety[15]	From multiple domains
Variability (rate of change)[16]	Dynamic
Quality[17]	Exists missing values or abnormal values

[12] Origin of data, which could be from customers, instruments, IoT, web, surveys, commercial activity, simulations, etc.
[13] Structured/unstructured text, images, voices, gene sequences, numbers, composite: time-series, graph-structures, etc.
[14] The rate of flow at which the data is created, stored, analysed, or visualized. Could be in real time.
[15] Domains and types of data employed including formats, logical models, timescales, and semantics. Could be from multiple databases.
[16] Changes in data rate, format/structure, semantics, and/or quality.
[17] Completeness and accuracy of the data with respect to semantic content as well as syntax of the data (such as presence of missing fields or incorrect values).

Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition[18]	Post-condition[19]
1	Training	Train multiple models (deep learning, Bayesian network, Time series analysis) for recognizing traffic flow volume and abnormal values in the input data	Dataset is ready		
2	Optimization	Based on the data processed by the trained models, optimize the period length, split, and key phase offsets among multiple intersections for traffic signal timing plans	Completion of training/retraining	Completion of missing values or abnormal values processings	

[18] Describes which condition(s) should have been met before this scenario happens.

[19] Describes which condition(s) should prevail after this scenario happens. The post-condition may also define "success" or "failure" conditions

3	Evaluation	Pre-evaluate the execution effects of the optimized traffic signal timing plans, which include the period lengths, splits, and key phase offsets among multiple intersections	Completion of optimization	Input prediction of traffic flow situation in the next period	The pre-evaluated execution effects of the optimized traffic signal timing plan is superior to the current one
4	Execution	Execute the optimized traffic signal timing plan	Completion of evaluation	The pre-evaluated execution effects of the optimized traffic signal timing plan is superior to the current one	

Training (optional)

Scenario name	Training				
Step No.	Event[20]	Name of process/Activity[21]	Primary actor	Description of process/activity	Requirement
1	Dataset is ready	Transform video data into structured data	AI provider	Transform video data into structured data by deep learning	
2	Completion of Step 1	Data clustering	AI provider	Recognize abnormal value patterns and label them in internet data, induction coil data, and structures video data by data clustering	
3	Completion of Step 2	Processing of missing value and abnormal value	AI provider	Recognize abnormal value and process them, and fill missing values by data clustering, time series analysis and Bayesian network	
4	Completion of Step 3	Data fusion	AI provider	Compute traffic status parameters such as traffic volume, vehicle driving speed, etc. by fusing internet data, induction coil data and structured video data	

[20] The event that triggers the step. This might be completion of the previous event.
[21] Action verbs should be used when naming activity.

Specification of training data	

Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event[22]	Name of process/Activity[23]	Primary actor	Description of process/activity	Requirement
1	Completion of optimization	Construct the evaluation model of the traffic signal timing plan	AI provider	Construct the evaluation model of the traffic signal timing plan based on traffic engineering theory	
2	Completion of Step 1	Evaluate the effect of the computed traffic signal timing plan	Traffic administrator	Pre-evaluate the effect of the computed traffic signal timing plan with the evaluation model	

Input of evaluation	
Output of evaluation	

[22] The event that triggers the step. This might be completion of the previous event.
[23] Action verbs should be used when naming activity.

Execution (optional)

Scenario name	Execution				
Step No.	Event[24]	Name of process/Activity[25]	Primary actor	Description of process/activity	Requirement
1	Completion of evaluation	Execute the computed traffic signal timing plan	Traffic administrator	Input the computed traffic signal timing plan into the traffic signal control system and execute it	The pre-evaluated execution effects of the optimized traffic signal timing plan is superior to the current one

Input of Execution	
Output of Execution	

[24] The event that triggers the step. This might be completion of the previous event.
[25] Action verbs should be used when naming activity.

Retraining (optional)

Scenario name	Retraining				
Step No.	Event[26]	Name of process/Activity[27]	Primary actor	Description of process/activity	Requirement

Specification of retraining data	

[26] The event that triggers the step. This might be completion of the previous event.
[27] Action verbs should be used when naming activity.

References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link
	patent	ZHANG MAOLEI;WEI LIXIA;CHEN XIAOMING; LI JIN., ”Crossing traffic jam judging and control method and system based on sensing detectors ”. CN201310395431.2013			QINGDAO HISENSE TRANS TECH CO	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
	patent	ZHANG MAOLEI;WEI LIXIA;CHEN XIAOMING; LIU XIN;LIU HONGMEI; LI JIN. “Multi-strategy and multi-object self-adaptation traffic control method”. CN201310548921.2013			QINGDAO HISENSE TRANS TECH CO	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
	patent	WANGMENGJIA;MINWANLI.” Road traffic optimization method and device and electronic equipment			ALIBABA GROUP HOLDING LTD;	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml

		”. CN201710081075.2017				
	patent	HUA XIANSHENG” Assessment method and device of traffic condition ”. CN201610645412.2016			ALIBABA GROUP HOLDING LTD;	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
	patent	HUA XIANSHENG,REN PEIRAN,SHEN CHEN,CHU WENQING, LIU YAO.” Road intersection traffic flow control method and device”. CN201610644132.2016			ALIBABA GROUP HOLDING LTD;	http://www.pss-system.gov.cn/sipopublicsearch/patentsearch/showViewList-jumpToView.shtml
	paper	Liang Yu,Jingqiang Yu,Maolei Zhang, Xin Zhang, Yuehu Liu.”Large Scale Traffic Signal Network Optimization-a Paradigm Shift Driven by Big Data”. ICDE2019			Alibaba Cloud Computing Hangzhou, China	
		M. Papageorgiou, C. Diakaki, V.				

		Dinopoulou, A. Kotsialos, and Y.Wang, "Review of road traffic control strategies," Proceedings of the IEEE, vol. 91, no. 12, pp. 2043–2067, 2003.				
	paper	P. Lowrie, "Scats, sydney co-ordinated adaptive traffic system: A traffic responsive method of controlling urban traffic," 1990.				
	paper	F. Corman, A. D'Ariano, D. Pacciarelli, and M. Pranzo, "Evaluation of green wave policy in real-time railway traffic management," Transportation Research Part C: Emerging Technologies, vol. 17, no. 6, pp.				

		607–616, 2009.				
	paper	L. Singh, S. Tripathi, and H. Arora, "Time optimization for traffic signal control using genetic algorithm," International Journal of Recent Trends in Engineering , vol. 2, no. 2, p. 4, 2009.				

Acceptable Reference Sources of Use Cases

— Peer-reviewed scientific/technical publications on AI applications (e.g. [1]).
— Patent documents describing AI solutions (e.g. [2], [3]).
— Technical reports or presentations by renowned AI experts (e.g. [4])
— High quality company whitepapers and presentations
— Publicly accessible sources with sufficient detail

This list is not exhaustive. Other credible sources may be acceptable as well.

Examples of credible sources:

— [1] B. Du Boulay. "Artificial Intelligence as an Effective Classroom Assistant". IEEE Intelligent Systems, V 31, p.76–81. 2016.

- [2] S. Hong. "Artificial intelligence audio apparatus and operation method thereof". N US 9,948,764, Available at: https://patents.google.com/patent/US20150120618A1/en. 2018.
- [3] M.R. Sumner, B.J. Newendorp and R.M. Orr. "Structured dictation using intelligent automated assistants". N US 9,865,280, 2018.
- [4] J. Hendler, S. Ellis, K. McGuire, N. Negedley, A. Weinstock, M. Klawonn and D. Burns. "WATSON@RPI, Technical Project Review".
  URL: https://www.slideshare.net/jahendler/watson-summer-review82013final. 2013.