GOVERNMENT OF INDIA
MINISTRY OF HOUSING AND URBAN AFFAIRS

Artificial Intelligence and the Urban Transport

The ***Arguments*** for Precision, Sustainability, and Environment

Sheikh Muzamil Hussain
CEPT Ahmedabad

UP METRO

12th Urban Mobility India Conference & Expo 2019

Arguments

What role is AI going to play in the fourth age and what impact does it have on systems, transport including

Human vs Artificial intelligence

Conventional technology and Machine learning technology

The debate of precision, sustainability, and environment in relation to AI incursion into urban transport.

Why AI?

What is AI

- Everything is interconnected (Deleuze and Guattari, 2009). Concept of Urban Planning as **'rhizome'**
- World Economic Forum (WEF) defines AI by its ability to "do things traditionally done by people",
- Brain of smart cities.

AI can help us better understand our cities and delivers an informed urban planning, and together with citizens' input, it helps us better determine the needs of the public, what means making more sustainable decisions.

Network

Improve data quality

Data Volume

Frequency

Global Footprint

11%

of the surveyed organisations are AI adopters

62%

of the surveyed public transport organisations are involved in AI technologies projects and solutions

AI FOOTPRINT IN GLOBAL COUNTRIES

SOURCE: UITP

Why Artificial Intelligence

- Real time operations management
- Customer Analytics
- Predictive manner
- Network planning and road design

"connectivity and cartography are bridges to the unconsciousness and transparent connections between urban fabrics and movement"

Why AI?

SUSTAINABILITY AND ENVIRONMENT

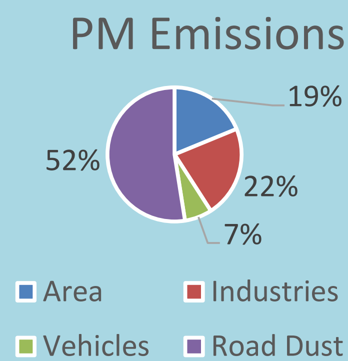
AI applications in transport is connected and autonomous vehicles, which aims to enhance productivity by reducing the number of accidents on highways.

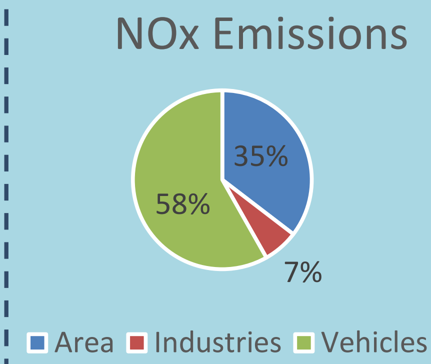
Sustainability is arbitrary term

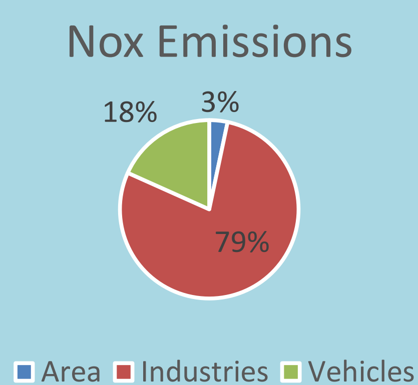
Less the utilization of resources, more the sustainable

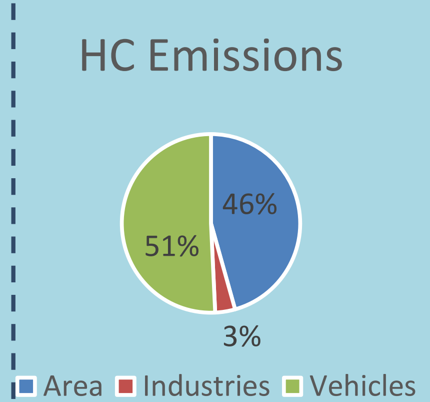
It is estimated that around **30-40%** of the emissions come from transport related services. In some studies that figure is more than **50%** which means transportation services around the world are dealing major blow to the idea of a sustainable future.

According to the Department of Energy (DoE), automated vehicles could reduce energy consumption in transportation by as much as **90%.** This stark contrast matters, considering that more than a quarter of greenhouse gas emissions come from the transport sector, as per the Environmental Protection Agency (EPA).









SOURCE: Delhi Air Pollution Modelling Using Remote Sensing Technique
Handbook of Environmental Materials Management, Shivangi Saxena, Springer

EFFICIENT AND SUSTAINABLE

AUTONOMOUS VEHICLES

Autonomous Driving

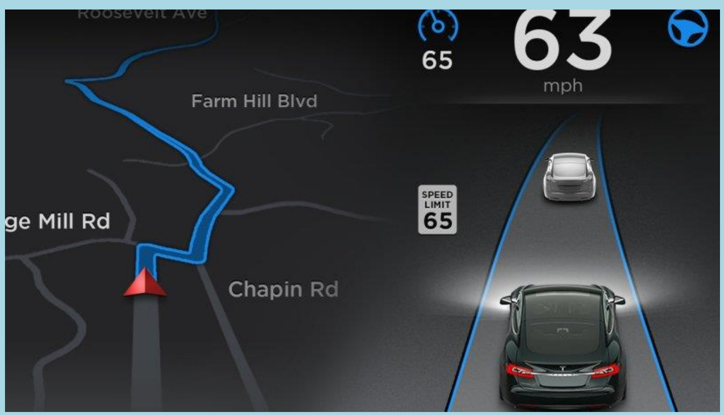
1961 — Stanfort car was inspired from lunar rover developed in US in the preceding decade and could navigate using a solid white line on the ground.

1977 — the Japanese Tsukuba Mechanical Engineering produced an autonomous vehicle that could recognize street signs and markings.

2009 — The Google car uses Light Detection and Ranging, abbreviated as LIDAR to measure the distance between the objects, which in case of road traffic are visualizing the vehicles.

2016 — Autopilot 8.0, which processes radar signals to create a coarse point cloud similar to LIDAR to help navigate in low visibility, and even to 'see' in front of the car ahead.

2018 — Uber Advanced technologies group (ATG) in support from Volvo has produced their own self driving vehicle which are capable of roaming the cities without manual assistance.



TESLA AUTOPILOT INTERFACE SOURCE: TESLA

Pros

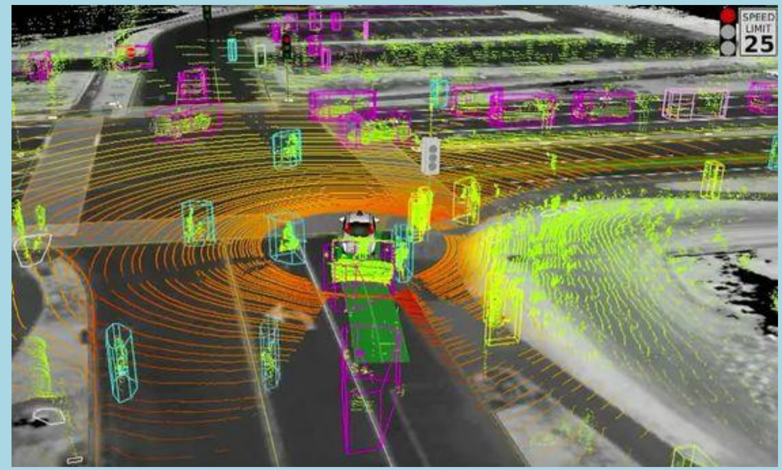
GPS Synchronization
Real time monitoring
Holistic Navigation

Challenges

Congestion
Recognition capability

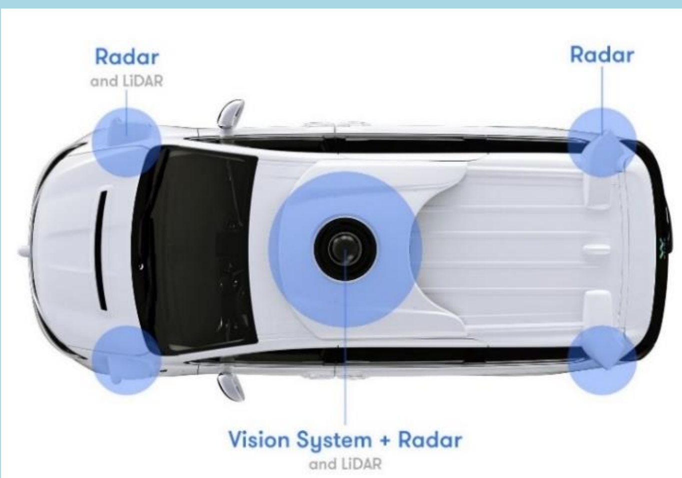
LIDAR Technology

- The Google Waymo uses **Light Detection and Ranging**, abbreviated as **LIDAR** to measure the distance between the objects, which in case of road traffic are visualizing the vehicles. The LIDAR is equipped with a camera atop the vehicle that uses array of 32 or 64 laser lights to measure span of distance within the moving objects.
- Google's Waymo is equipped with eight sensors.
- Additionally, the car has surface mounted cameras to receive **geographic information from satellites**. The GPS enables the car to be more precise and more importantly generates a real-time flow of activities.



LIDAR NAVIGATION SYSTEM

SOURCE: DANIELA MOYA



LIDAR COMPONENTS ON WAYMO

SOURCE: 9TO10GOOGLE.COM

LIDAR SENSOR MODULE

SOURCE: MONSH GMBH

COMPONENTS

- COMPUTING
- SENSORS
- DRIVE SYSTEM
- POWER SUPPLY
- COMMUNICATION

Cost Benefit

- Vehicle operation cost savings (VOC savings)
- Fuel savings
- Environmental pollution maintenance cost
- Passenger time savings
- Speed optimization
- Acceleration and Deacceleration
- Whole system sync with real time data

20 – 30%

Automation has a more effective grip over acceleration and deacceleration which significantly increases the efficiency of transportation systems.

ICT ENABLED TRANSIT SYSTEM EXAMPLE

The maintenance and operation cost are around **20%** less than conventional bus transport network given the fact the BRTS uses real time data from GIS and additionally uses Intelligent system (ITS).

Ahmedabad BRTS

Ahmedabad has 89 km network of BRTS and the capital cost was Rs. 1200 Crores, averaging at around cost of 13 Crores per Km.
Trips = 130000 per day
Bus fleet = 254
Maintenance cost = 20.2 Cr.
Operation cost = 110.22 Cr.
Other costs = 20 Cr.
All cost figures are for year 2018

SOURCE: M. Chaudhary, Shodhganga.inflibnet.ac.in

Technology

REAL TIME DATA COLLECTION

Advances in Traffic Data Assessment

Data Assessment- Practices, Challenges and Possibilities

Traffic Data is fundamental to all Transportation Infrastructure planning and improvements. Inaccurate Traffic data can affect the entire Infrastructure project very badly. Inaccurate Data can be either an undercount or an Over count. Both have terrible impacts on the entire project

- Route number
- Trip number
- Number of passengers
- Origin (Stage or stop)
- Destination (Stage or stop)
- Time stamp of ticket sold

Transportation studies are backed by number of surveys to access the ground situation. In most of the developing countries the data is manually collected and sampled in proportion of the population. Many field surveys, for instance trip data collection which is a mutual discussion between the surveyor and the respondent may lack the rigorous stats by which the modelling is performed to generate desire lines or the busiest corridors of the city in terms of traffic flow.

GPS BASED DATA ASSESSMENT

PICK UP POINT + CLUSTER GROUPS = PoI/ DESTINATION

PICK UP POINT + TRAJECTORY = ROUTE

AUTOMATIC FARE COLLECTION SYSTEM (AFC)

- DATA GENERATION ON TRANSIT SYSTEMS
- DIGITAL COLLECTION OF DATA
- REAL TIME ANALYSIS

ELECTRONIC TICKETING MACHINES (ETM)

- PORTABLE FOR BUSES
- RECORDS VITAL DETAILS LIKE TIME OF TRAVEL, ORIGIN AND DESTINATION

Advances in Traffic Data Assessment

NEURAL NETWORK RECOGNITION TECHNOLOGY

Omni directional single camera

Control Apparatus (196 core processor GPU)

SOURCE: VION Technologies

The algorithms digitised using Convolutional Neural Network (CNN) by the control apparatus using the hi-res camera can detect-

- Vehicle recognition
- Logo recognition
- License recognition
- Face capture
- Adherence to traffic rule
- Pedestrian yield
- Seat belt compliance

The pixel quality of the camera is high-resolution and thus can detect minutest of detail. The standard pixels are-

- 6.08 million Pixels (2752x2208)
- 6.8 million pixels (3382x2008)
- 8.30 million pixels (3840x2160)

GOOGLE STREET VIEW CAR WITH MOUNTED CAMERAS

SOURCE: GOOGLE AUSTRALIA

Advances in Traffic Data Assessment

NEURAL NETWORK RECOGNITION TECHNOLOGY

SOURCE: IntelligentTransport.com

Demand Analysis

- Flow of traffic
- Waiting time, length of Queue
- Average travel speed
- Modal statistics for analysis
- Security and safety

Surveys

- Road Inventory survey
- Traffic volume counts (peak and non-peak)
- Origin and destination
- Pedestrian survey
- Cordon line survey
- Speed and delay analysis

Precision and Accuracy

Accuracy to detect the movement on roads and how the AI data can be synched for other operations like traffic management

95%
Recognition accuracy for vehicle license plate

95%
Recognition of running red lights

95%
Recognition of crossing forbidden lines

98%
Recognition of converse driving

98%
Recognition of occupying non-motor vehicle lanes

98%
Recognition of occupying dedicated bus lanes

95%
Recognition of spotting trucks on roads

80%
Recognition of non yielding to pedestrians

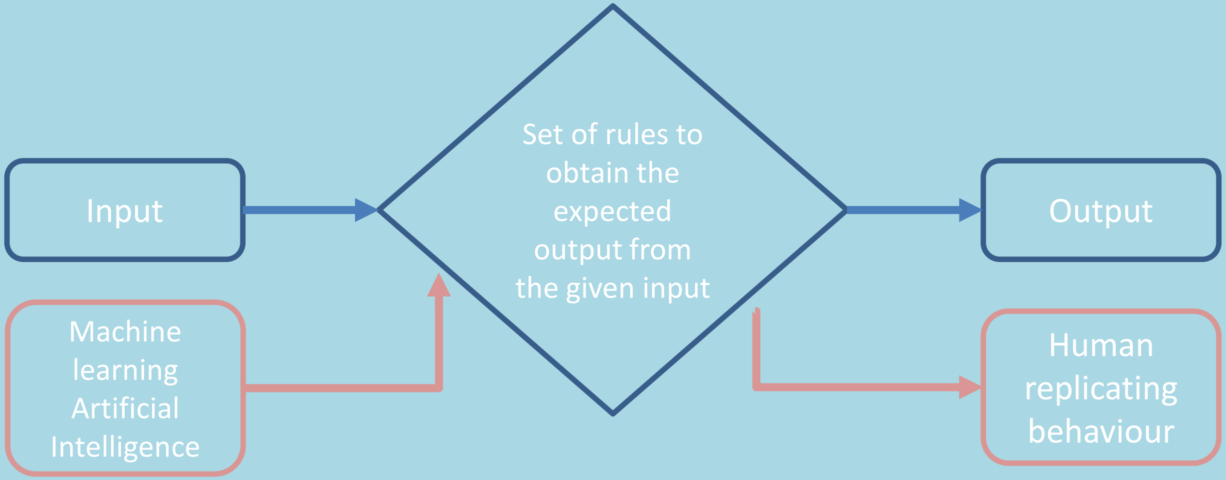
SOURCE: Hai Tao, AITPM Conference 2017, China

Ant Colony Optimization Algorithm

ALGORITHM IN TRANSPORTATION

Machine learning Algorithm

A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

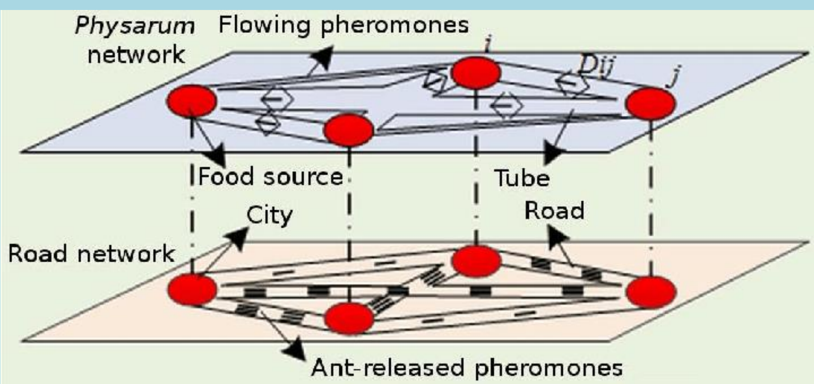


Ant Colony Optimization Algorithm

Travel time optimization using ACO

Ant Colony Optimisation algorithm (ACO) is a similar manifestation of natural phenomenon of ants which they use for searching food. Ants can't see but possess a highly developed sense to trail paths using a chemical they transpire- pheromone.

A heuristic algorithm is one that is designed to solve a problem in a faster and more efficient fashion than traditional methods by sacrificing optimality, accuracy, precision, or completeness for speed



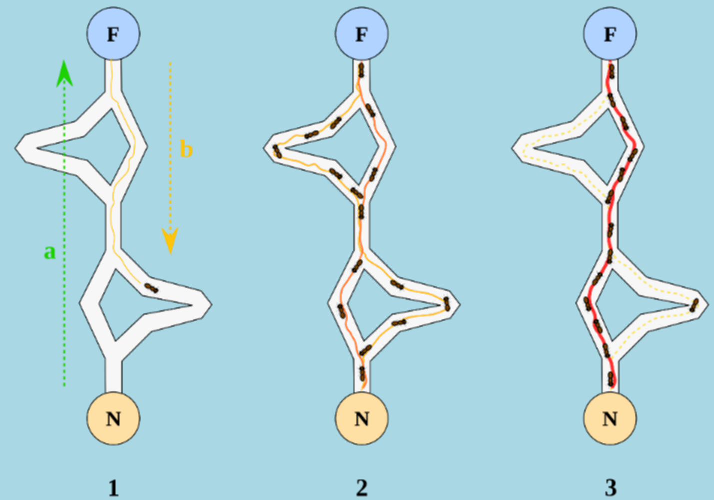
Combining ant colony optimisation (ACO) with the current reinforcement (CR) model

SOURCE: Chao Gao, Chen Liu

Optimization

Continuous Iterations

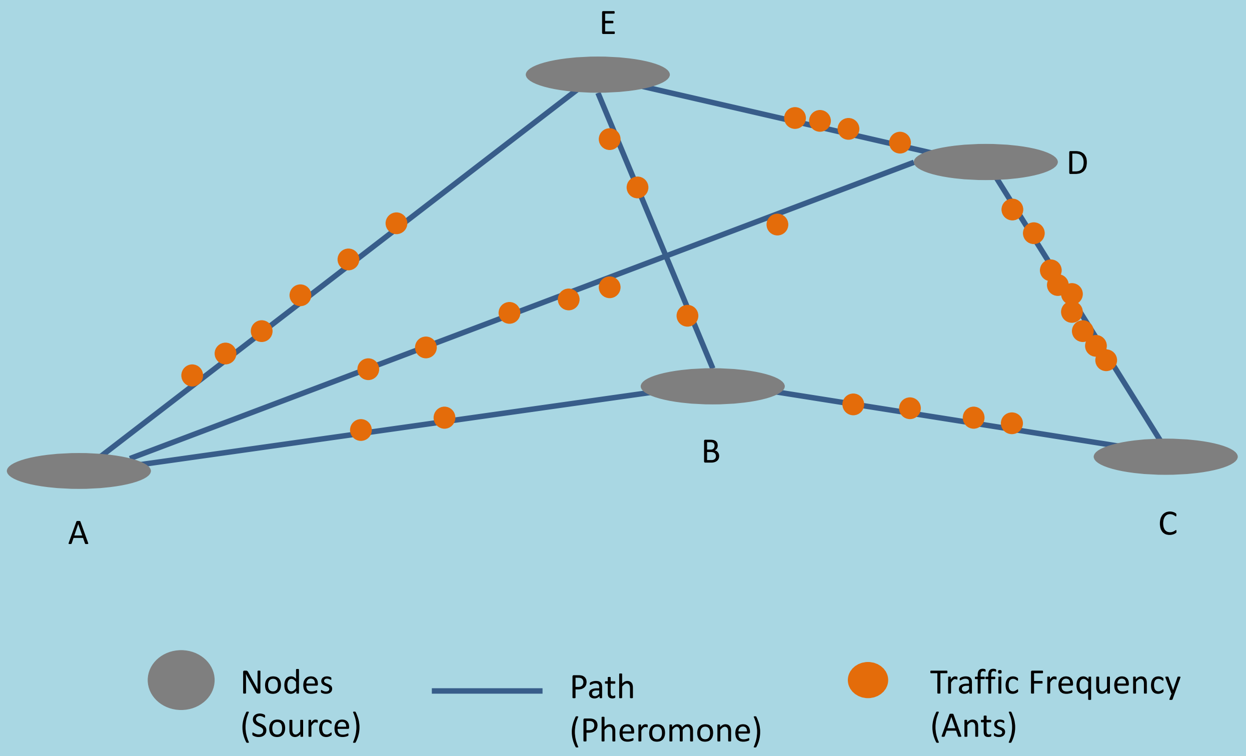
Dynamic Networks



SOURCE: Uloom Computers Isfahan

Ant Count	Vehicles
Pheromone	Demand
Iterations	Optimal Path

Ant Colony Optimization - Concept



$$p_{ij} = \frac{[\tau_{ij}]^{\alpha} [\eta_{ij}]^{\beta}}{\sum_{h \in \mathcal{E}} [\tau_{ih}]^{\alpha} [\eta_{ih}]^{\beta}}$$

Pij = Travel from node i to node j
T = represents an n by n pheromone matrix
η = Attractive co-efficient
Σ = h is summation of all possible locations to reach by a particular ant

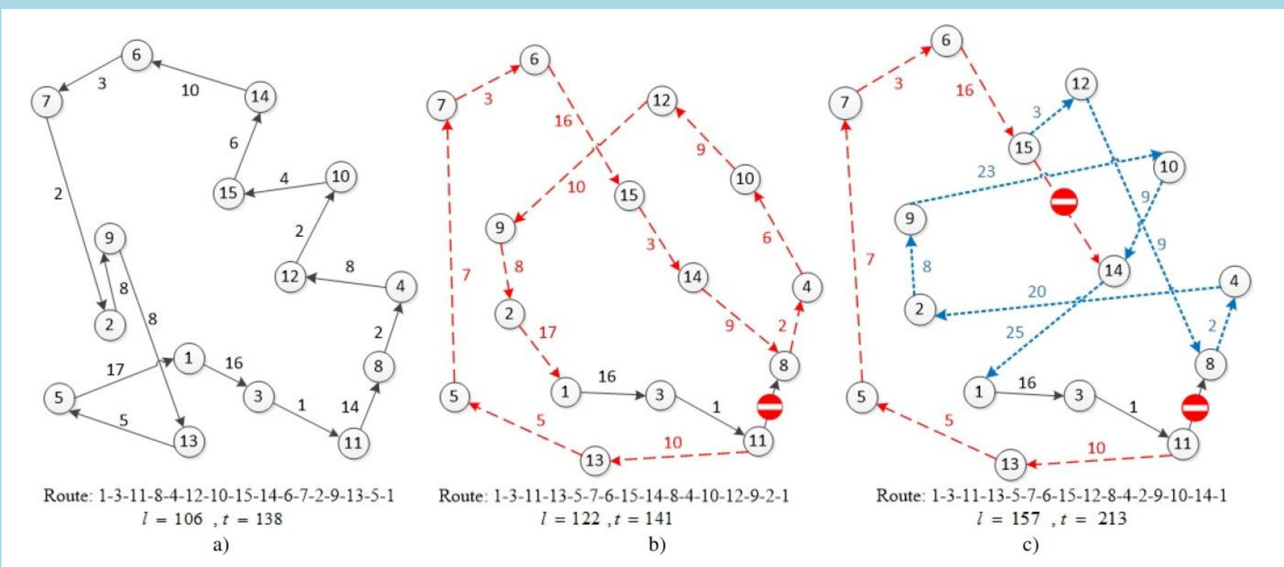
Probability is also subject to vaporization of pheromone (demand in our case).

ACO Principle in Urban Transport

Algorithm Design Principle

Time complexity is one of the main factors considered in this algorithm. Time complexity refers to the time function required for the program to run to the end of the solution. When the number of vehicles and road nodes is large enough, the time complexity of the lower power can be ignored.

1. Measuring the distance from the vehicle to the end point, and then we can judge whether the vehicle has reached the end point or not according to the measured distance. If it arrives, return the pheromone. If not, continue to execute the cycle.
2. Determine whether the information of the next node is different from the original plan. If there is a difference, continue to proceed according to the original plan.
3. According to the information concentration and the heuristic function, the next function is measured.
4. Select the road that the vehicle will travel to determine whether it has reached the end point.



The principle and flow of ACO used by the Isaack Kamanga in his study of city public transport design in Tanzania.

Source – Viktor Danchuk et al, (Danchuk, Bakulich, & Svatko, 2007)

Conclusion

AI imitates human thinking and behaviour and thus makes for an viable alternative

Intrusion of AI into Urban Transport system is inevitable

Significant reduction in operation costs

AI makes Urban Transport more sustainable, alike for governments, policy makers and environment

Thank You