“Traffic Control System Using Artificial Intelligence”

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Outlines

- Motivation
- What is Ai
- Phases of Accessing Data
- Types of Attack in Air Gap Network
- Countermeasures
- Conclusion

Motivation

- For finding the solution of traffic problems.
- Increasing of Pollution.
- Wastage of manpower precious time waiting for signals.
- Health issues of traffic men personnel.
- Increasing population.

A huge Traffic congestion the road

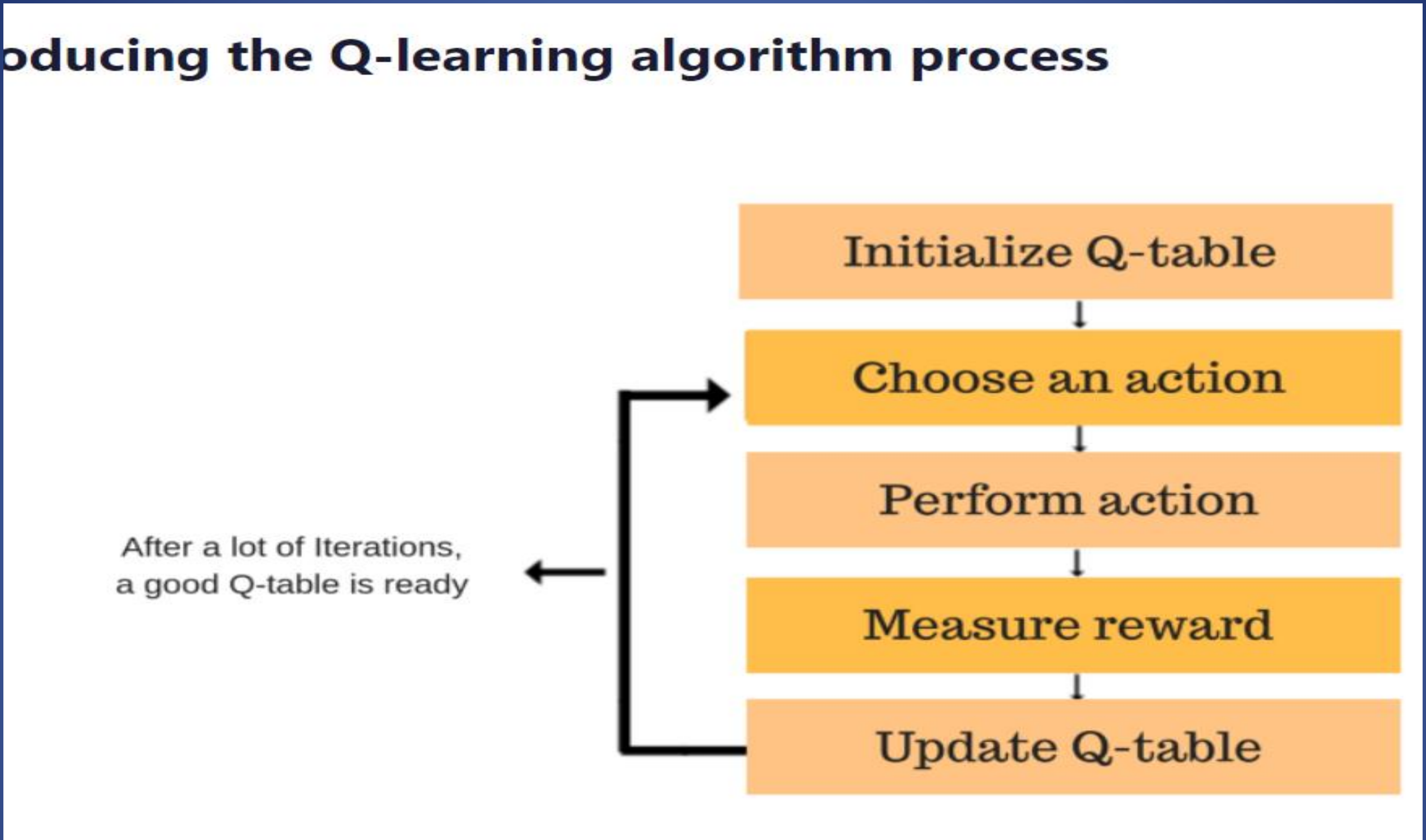
Effect on health of Traffic Personnel

Technology Used

- Q-Learning.
- Convolutional Neural Network(CNN).
- Dedicated Short Range Communication(DSRC).

Q-Learning

- Q-learning is an off policy reinforcement learning algorithm.
- It seeks to find the best action to take given the current state.
- It learns from actions that are outside the current policy, like taking random actions.
- Q here is quality which represents how useful a given action is in gaining some future reward.



oducing the Q-learning algorithm process

Initialize Q-table

Choose an action

Perform action

Measure reward

Update Q-table

After a lot of Iterations, a good Q-table is ready

Q-Learning Algorithm Process

Creating the Q table

- When it is performed we create a *q-table* that follows the shape of [state , action].
- Initially all values are initialized to zero.
- We then update and store our *q-values* after an episode.
- It becomes a reference table for our agent to select the best action based on the q-value.

Updating the Q table

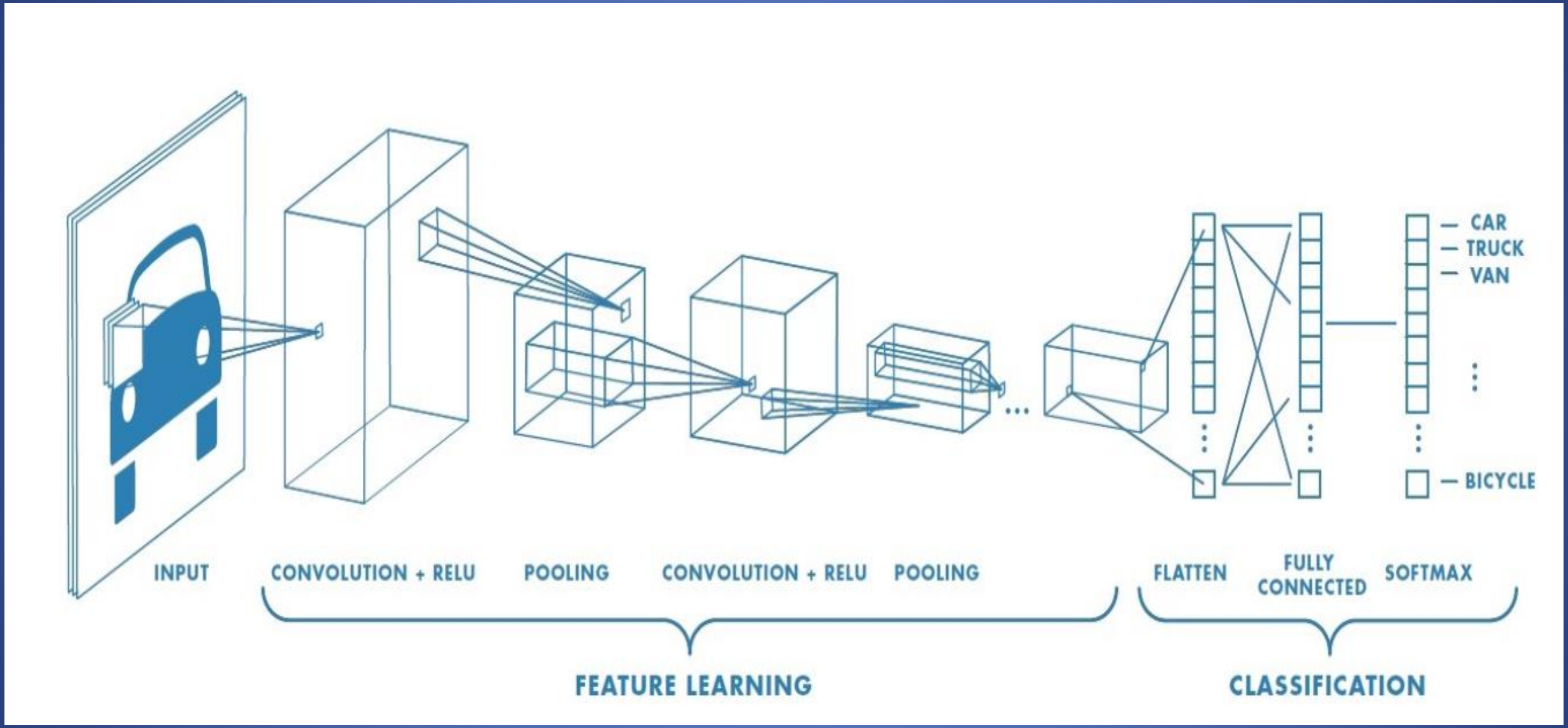
- It can be done in three basic steps:

1. Agent starts in a state (s1) takes an action (a1) and receives a reward (r1).
2. Agent selects action by referencing Q-table with highest value (max) **OR** by random.
3. Update q-values

Convolutional Neural Network(CNN)

- It is widely used to do images recognition, images classifications. Object detection, recognition faces etc.
- CNN image classifications takes an input image, process it and classify it under certain categories.
- input image will pass it through a series of convolution layers with filters (Kernals), Pooling, fully connected layers (FC) .
- apply Softmax function to classify an object with probabilistic values between 0 and 1.

Neural network with many convolutional layers



Convolution Layer

- It is the first layer to extract features from an input image.
- preserves the relationship between pixels by learning image features using small squares of input data.
- It is a mathematical operation that takes two inputs such as image matrix and a filter or kernel.
- Consider a 5 x 5 whose image pixel values are 0, 1 and filter matrix 3 x 3 as shown in below.

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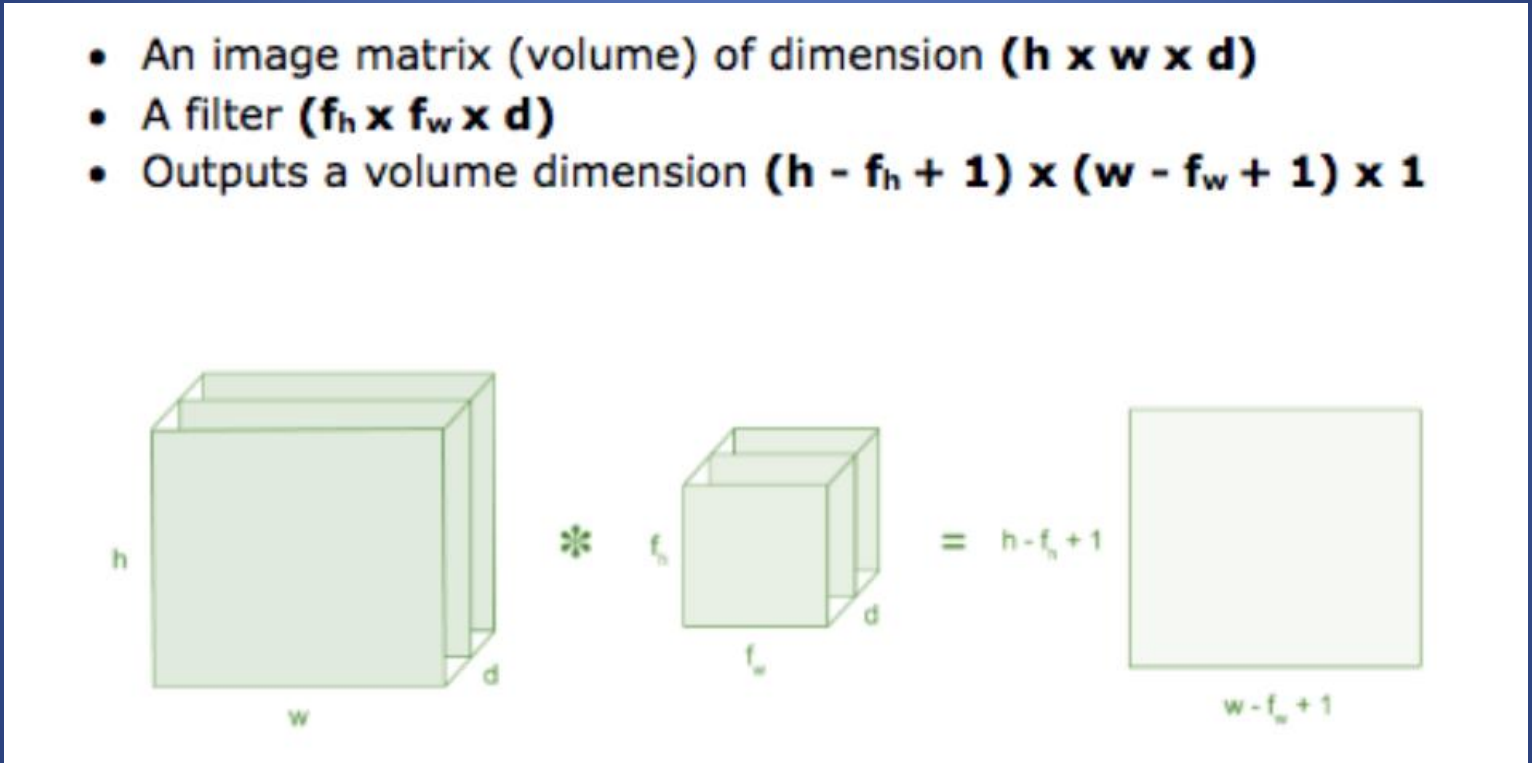
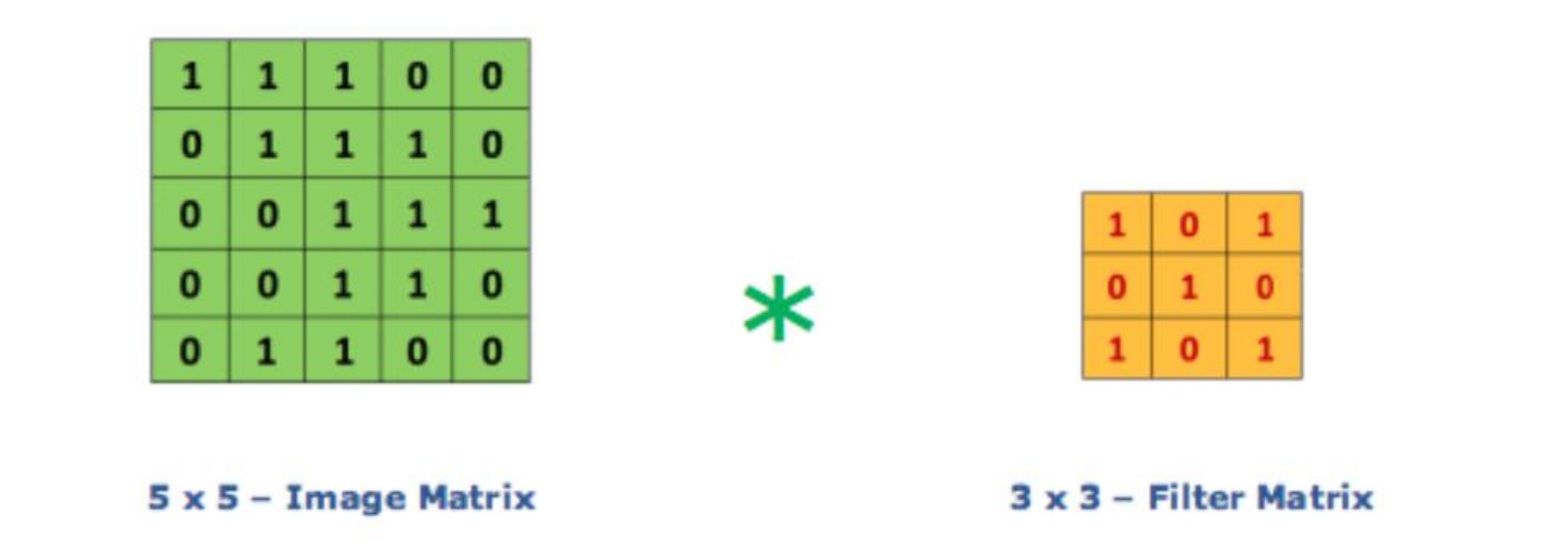
Image matrix multiplies kernel or filter matrix



- An image matrix (volume) of dimension **(h x w x d)**
- A filter **(f_h x f_w x d)**
- Outputs a volume dimension **(h - f_h + 1) x (w - f_w + 1) x 1**

Image matrix multiplies kernel or filter matrix



1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

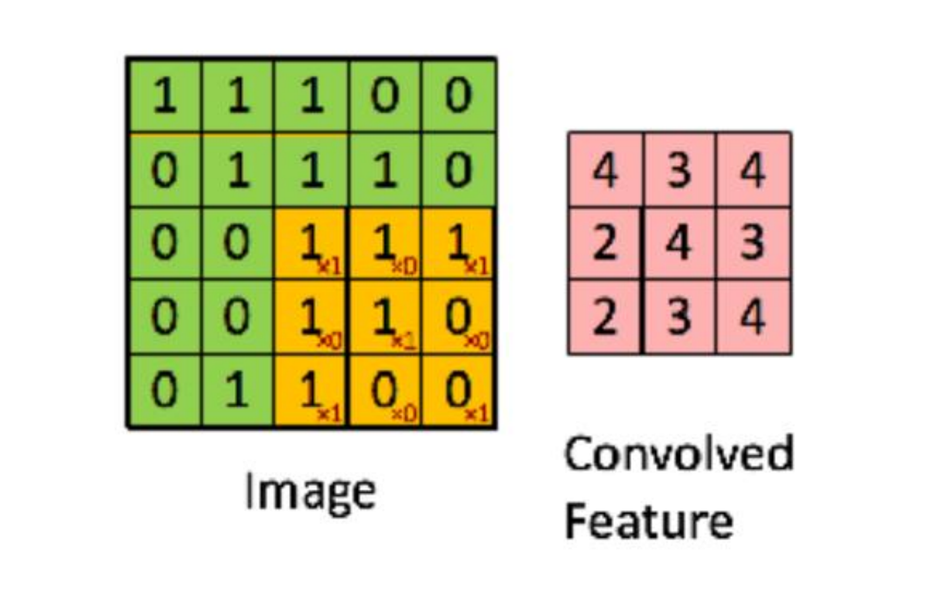
5 x 5 – Image Matrix

*

1	0	1
0	1	0
1	0	1

3 x 3 – Filter Matrix

3 x 3 Output matrix



1	1	1	0	0
0	1	1	1	0
0	0	$1_{\times 1}$	$1_{\times 0}$	$1_{\times 1}$
0	0	$1_{\times 0}$	$1_{\times 1}$	$0_{\times 0}$
0	1	$1_{\times 1}$	$0_{\times 0}$	$0_{\times 1}$

Image

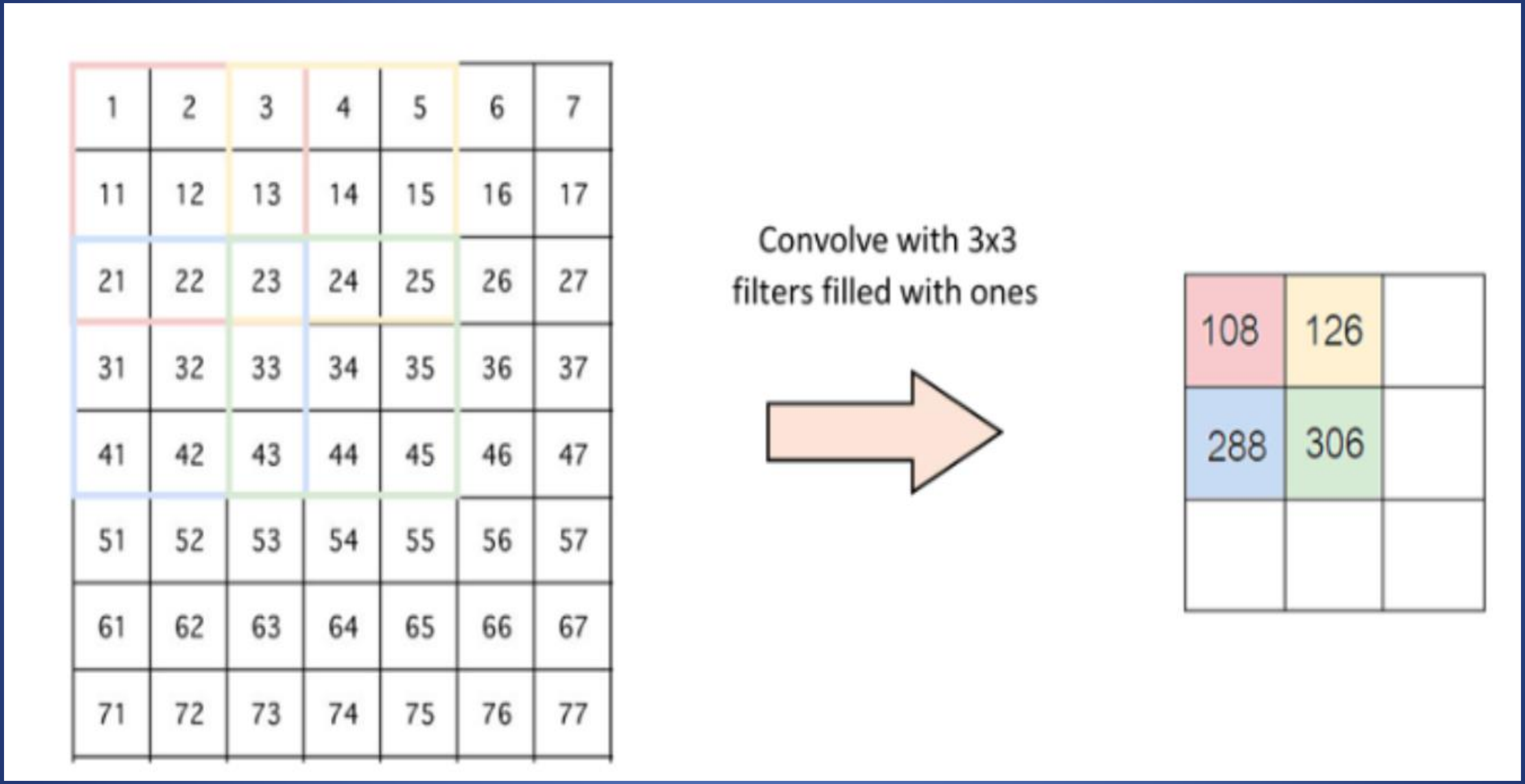
4	3	4
2	4	3
2	3	4

Convolved Feature

Strides

- Stride is the number of pixels shifts over the input matrix.
- When the stride is 1 then we move the filters to 1 pixel at a time and so on.
- The below figure shows convolution would work with a stride of 2.

Stride of 2 pixels



1	2	3	4	5	6	7
11	12	13	14	15	16	17
21	22	23	24	25	26	27
31	32	33	34	35	36	37
41	42	43	44	45	46	47
51	52	53	54	55	56	57
61	62	63	64	65	66	67
71	72	73	74	75	76	77

Convolve with 3x3 filters filled with ones

108	126	
288	306	

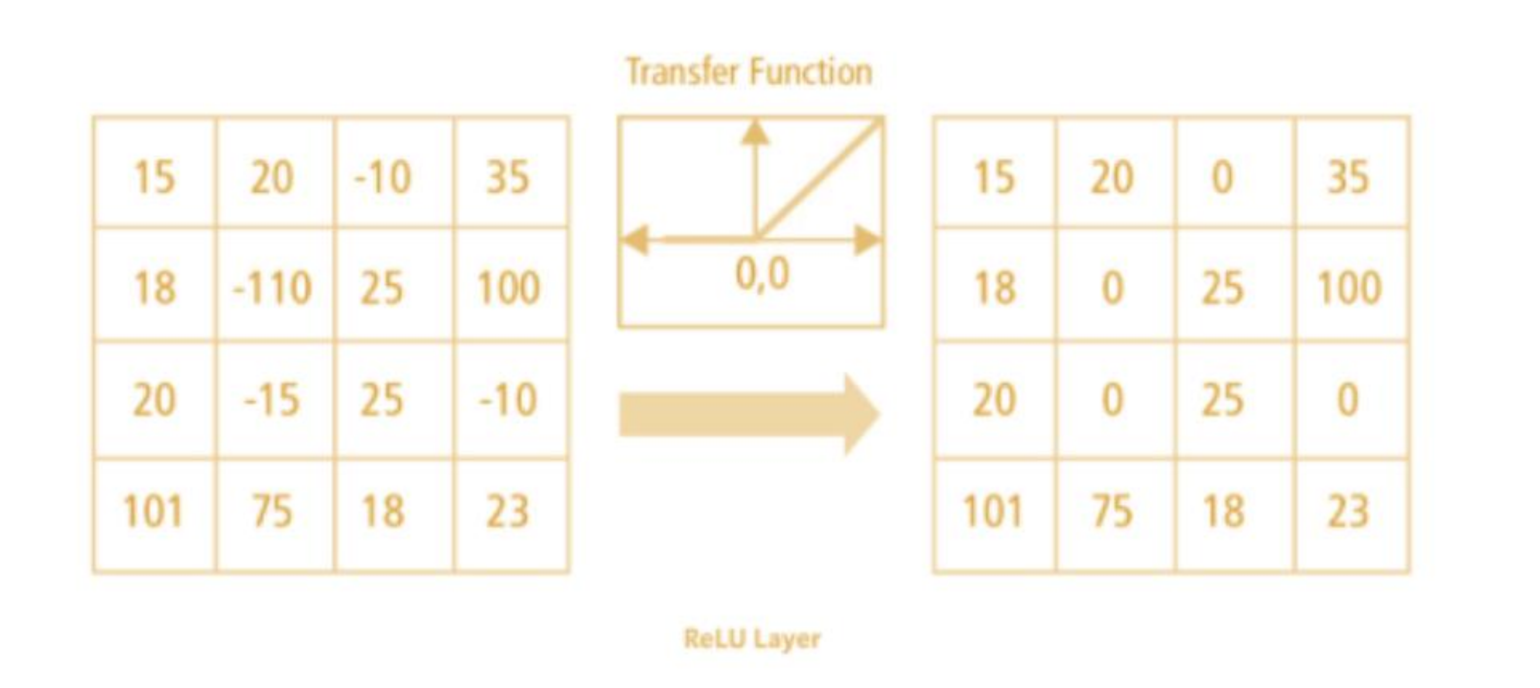
Padding

- Sometimes filter does not fit perfectly fit the input image. We have two options:
- 1.Pad the picture with zeros (zero-padding) so that it fits.
- 2.Drop the part of the image where the filter did not fit. This is called valid padding which keeps only valid part of the image.

ReLU

- ReLU stands for Rectified Linear Unit for a non-linear operation.
- The output is ***f(x) = max(0,x).***
- ReLU’s purpose is to introduce non-linearity in our ConvNet.
- real world data would want our ConvNet to learn would be non-negative linear values.
- other non linear functions such as tanh or sigmoid can also be used instead of ReLU.
- Most of the data scientists uses ReLU since performance wise ReLU is better than other two.

ReLU operation



15	20	-10	35
18	-110	25	100
20	-15	25	-10
101	75	18	23

15	20	0	35
18	0	25	100
20	0	25	0
101	75	18	23

ReLU Layer

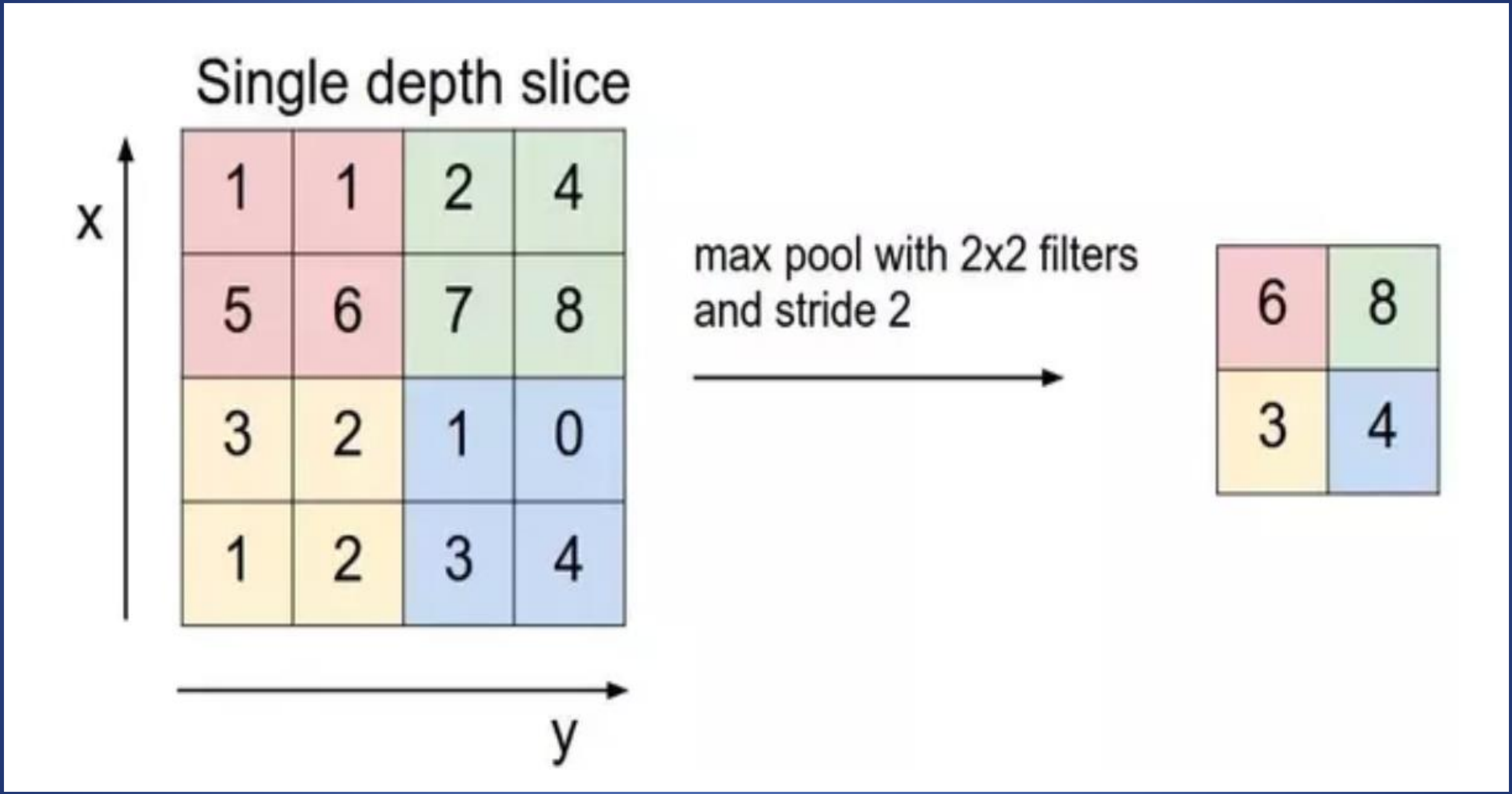
Pooling

- Pooling layers section would reduce the number of parameters when the images are too large.
- pooling can be of different types:

1. Max pooling
2. Average Pooling
3. Sum Pooling.

- Max pooling take the largest element from the rectified feature map. Taking the largest element could also take the average pooling. Sum of all elements in the feature map call as sum pooling.

Max Pooling



Single depth slice

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

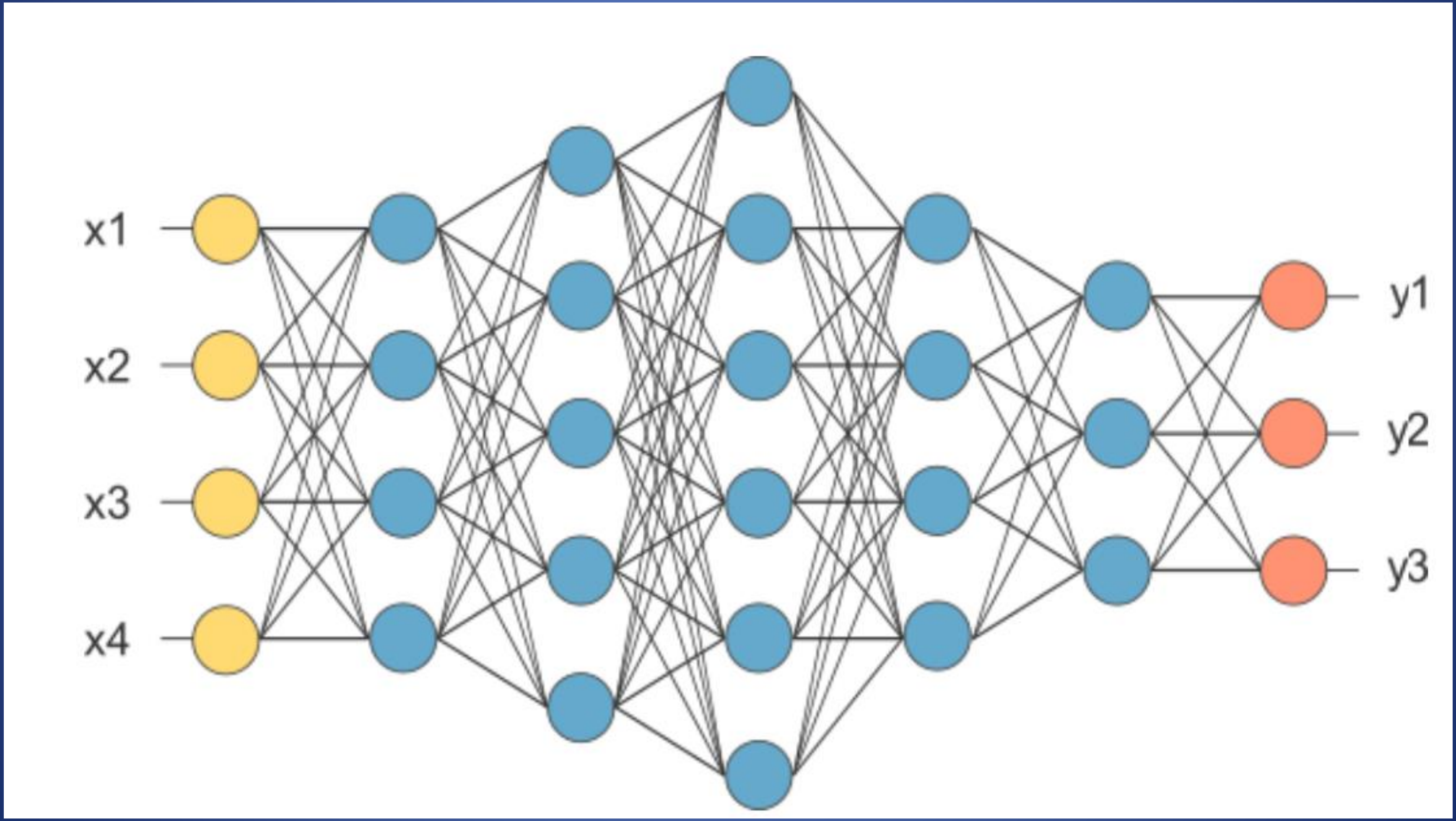
max pool with 2x2 filters and stride 2

6	8
3	4

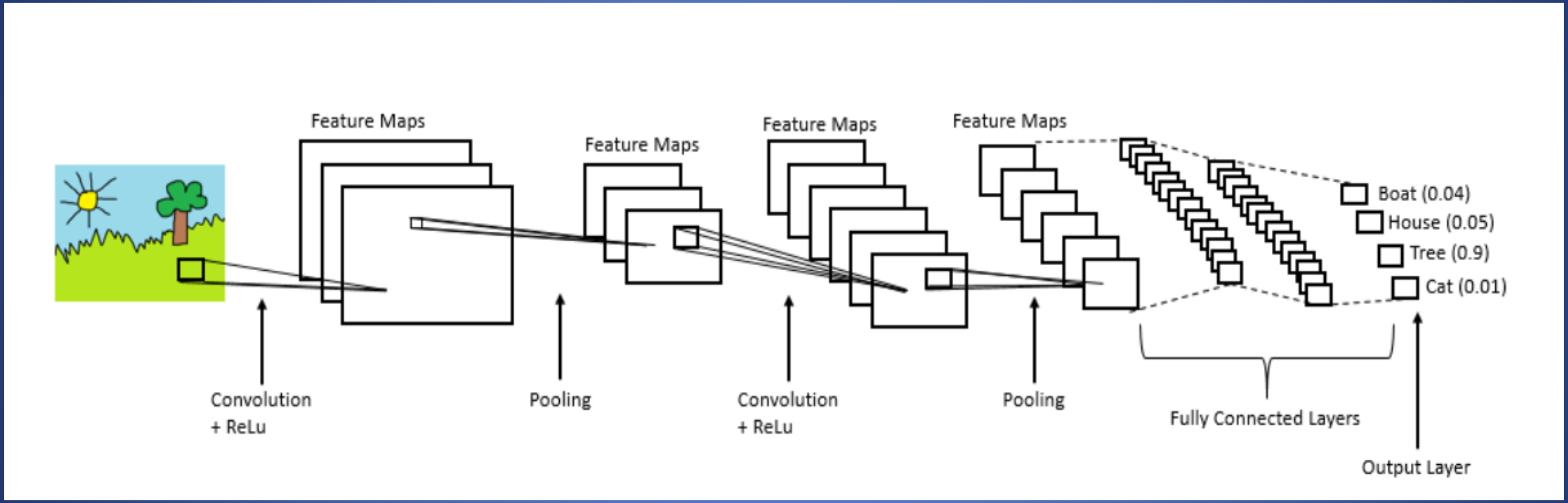
Fully Connected Layer

- This layer is called as FC layer.
- Here flattened our matrix into vector and feed it into a fully connected layer like neural network.
- In the diagram, feature map matrix will be converted as vector (x1, x2, x3, …). With the fully connected layers, we combined these features together to create a model.
- Finally, we have an activation function such as softmax or sigmoid to classify the outputs as cat, dog, car, truck etc.

After pooling layer, flattened as FC layer



Complete CNN architecture

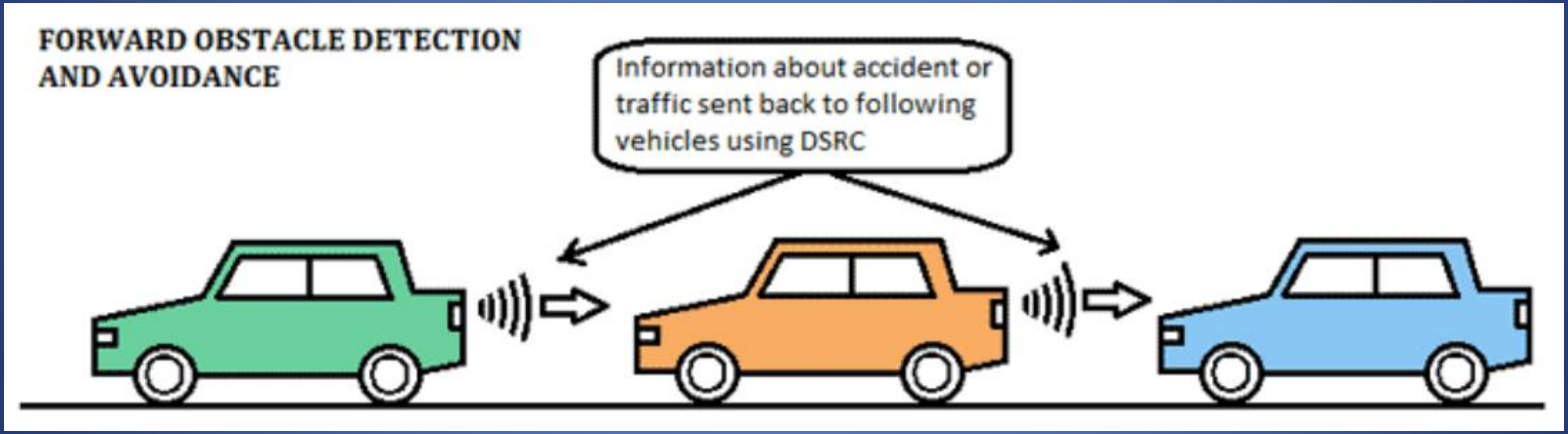


Dedicated Short Range Communication(DSRC).

- It is a wireless communication technology designed to allow automobiles in the intelligent transportation system (ITS) to communicate with other automobiles or infrastructure technology.
- It operates on the 5.9 GHz band of the radio frequency spectrum and is effective over short to medium distances.

V2V and V2I Analysis

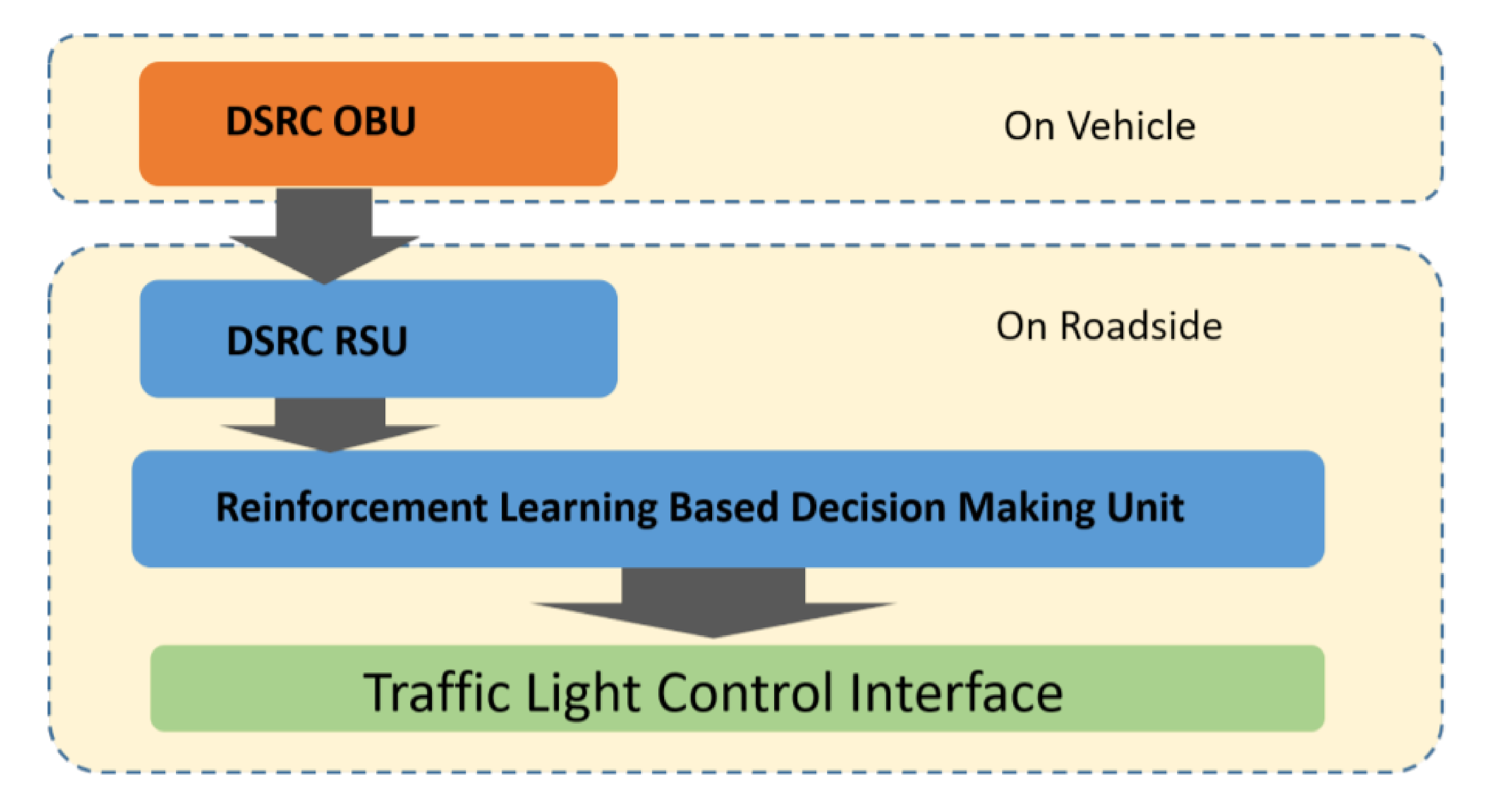
Intercommunication between vehicles


FORWARD OBSTACLE DETECTION AND AVOIDANCE
Information about accident or traffic sent back to following vehicles using DSRC

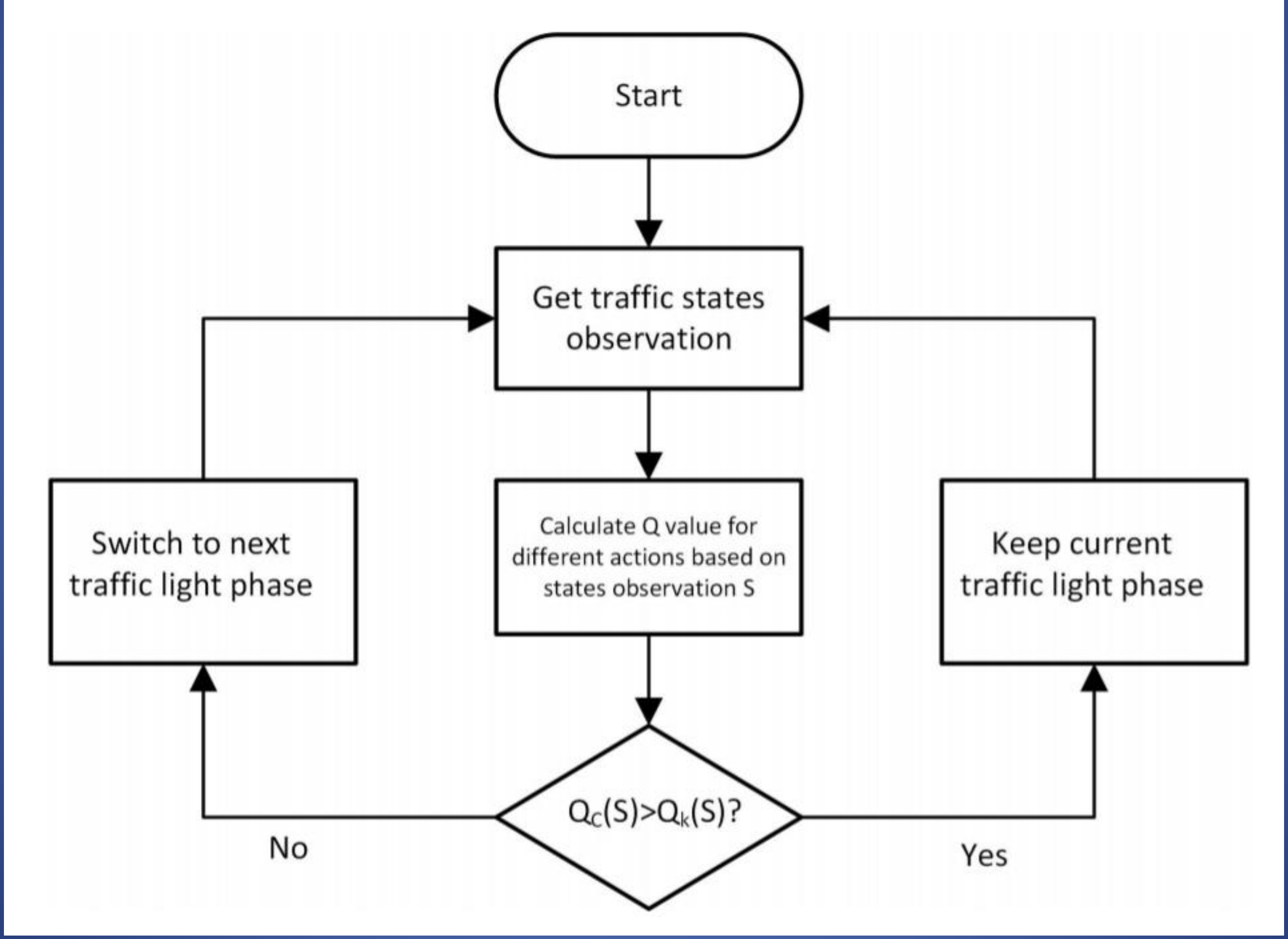
Traffic Control System Designing

- System Design
  - We provide here one of the possible system realizations for the proposed scheme, based on DSRC.
  - The system has an ’On Roadside’ unit and an ’On Vehicle’ unit.
  - RSU senses the Basic Safety Message (BSM) broadcast by the DSRC OnBoard Unit (OBU), parse the useful information out, and send them to the Reinforcement Learning Based Decision Making Unit.
  - This unit will then make a decision based on the information provided by the RSU.

One possible system design for the proposed scheme


DSRC OBU
On Vehicle
DSRC RSU
On Roadside
Reinforcement Learning Based Decision Making Unit
Traffic Light Control Interface

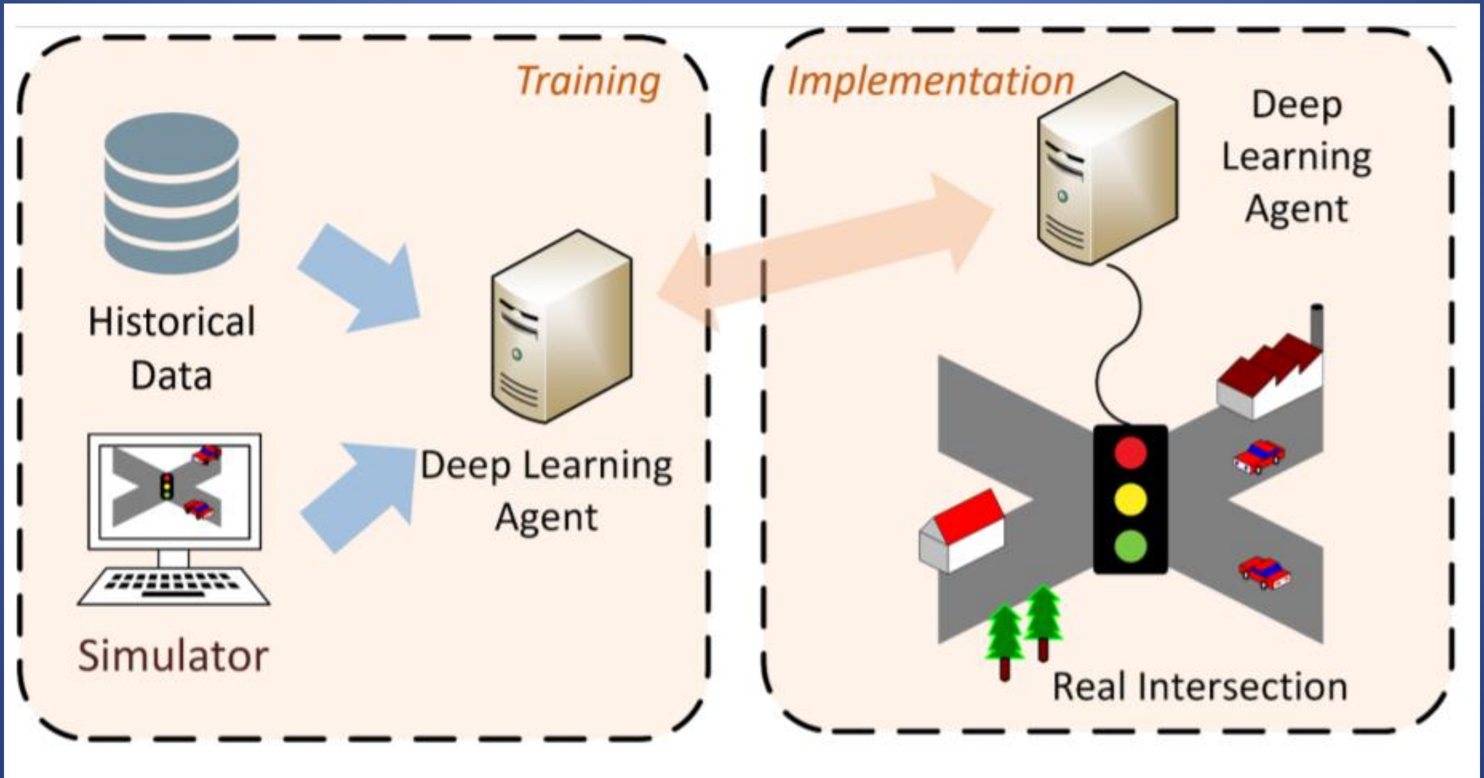
Control logic of RL based decision making unit


Start
Get traffic states observation
Calculate Q value for different actions based on states observation S
$Q_c(S)>Q_k(S)$?
No
Yes
Switch to next traffic light phase
Keep current traffic light phase

Implementation

- The implementation of the system contains two phases, the training phase and the deployment phase.
- the agent is first trained with a simulator, which is then ported to the intersection, connected to the real traffic signal, after which it starts to control the traffic.

The deployment scheme



1.Training Phase

- The agent is trained by interacting with a traffic simulator.
- The simulator randomly generates vehicle arrivals, then determines whether each vehicle can be detected.
- The simulator obtains the traffic state st and calculates the current reward rt accordingly, and feeds it to the agent.
- Using Q-learning , the agent updates itself based on the information from the simulator.
- Meanwhile, the agent chooses an action at, and forwards the action to the simulator.
- The simulator will then update, and change the traffic light phase according to agents indication.

- These steps are done repeatedly until convergence, at which point the agent is trained.
- To obtain similar arrival pattern as the real world, the simulator generates car flow by the historical record of vehicle arrival rate on the same map of the real intersection.
- The goal of training is to have the traffic control scheme achieve the shortest average commute time for all commuters.
- In the training period, the machine tries different control schemes and eventually converges to an optimal scheme which yields a minimum average commute time.

Deployment

- In the deployment phase, the software agent is installed to the intersection for controlling the traffic light.
- Here, the agent will not update the learned Qfunction, but simply control the traffic signal.
- Namely, the detector will feed the agent’s current detected traffic state st; based on st, the agent chooses an action based on the trained Q-network and directs the traffic signal to switch/keep phase accordingly.
- This step is performed in real-time, thus enabling continuous traffic control.

Conclusion

- Our Current Working Traffic Control System is not able to manage traffic in efficient way.
- Cause the high Traffic Congestion.
- We saw Some advance technology which enhance the power of traffic management.
- Software agent is installed to the intersection for controlling the traffic light.
- The traffic control scheme achieve the shortest average commute time for all commuters.

References

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THANK YOU