Further Errors in Roadcraft

By

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Full Member since 1966.

Introduction & Quick Recap

- Last time we discussed various matters to do with vision scans and examples of the driving process in action applying the correct:-
  - Position
  - Speed
  - Gear
- Tonight we are discussing aspects of:-
- Limit Point and its application to complex bends by effective use of:-
- Use of Vision Scans and most important,
- Observation Links
- For Human drivers and Autonomous vehicles

Sentient Human Beings

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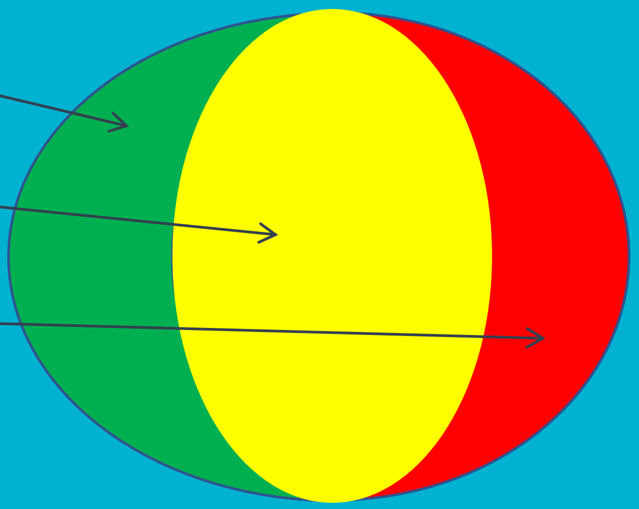
- “I think therefore I am…………” Henri Descartes [1598-1679]
- His ‘Theory of Mind’:-
- “….explaining mental activities such as
- sensation,
- memory,
- imagination
- and
- how they result from interaction between the environment, the senses and processing of the brain……..”.
- Sound familiar – Advanced Driving??

Venn Diagram

These are three vital questions that we do give attention.

1. What do you know?
2. What do you know, you don't know?
3. What don't you know, you don't know?
4. Which is the biggest problem of these 3?
5. We can deal with this by investigation and education. Improving 1, sorting 2 and recognising 3
6. Because we are sentient beings, we usually can handle our limitations most but I admit not all of the time



Roadcraft - Typical Double Apex Bend

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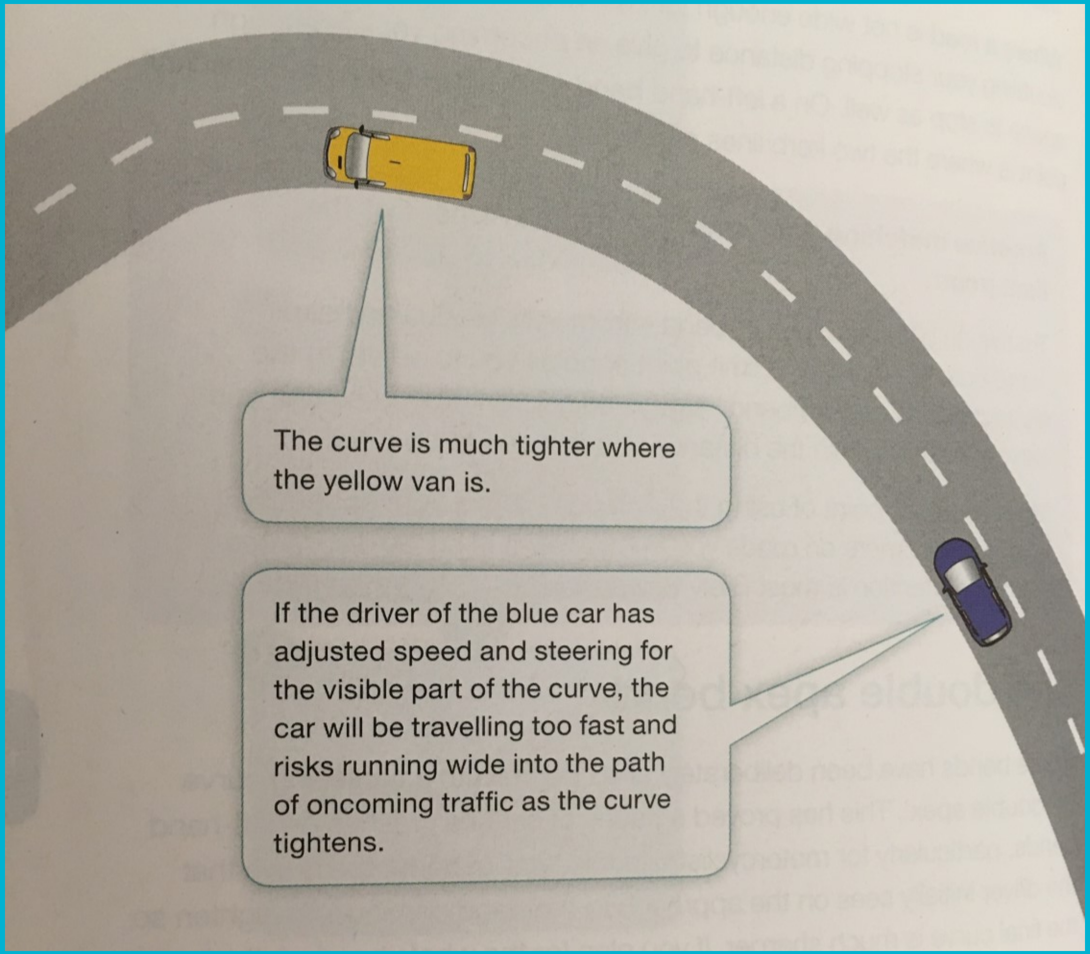

Roadcraft 2013 edition page 178 with Police Foundation permission.

- Double apex bend, difficult to navigate.
- Match limit point at start of the bend, result the wrong side of the road at end of the bend.
- ‘Retardation accelerator sense’ – match slower rate of limit point progression during the bend.
- May apply additional braking whilst in the bend. Not an ideal requirement. Bikers a definite ‘NO’
- ‘Eye’s on main beam’ topography observation links
- Any activation of dynamic traction control systems in a bend means very poor technique entering it.

Cornering and the Limit point (1)

This sequence of pictures were taken by my wife in the front passenger seat

I'm driving, approaching the bend, already matching the clearly defined progression of the limit point

Its downhill. No obvious problems.

What can I reasonably expect next??

Cornering and the Limit point (2)

The bend goes back on itself into a sharp downhill right hander

I need to be setting up the right position, speed and gear taking into account all road traffic conditions, using ‘acceleration sense’.

Corner tightens and the Limit point (4)

- Downhill bend becomes tighter with adverse camber
- Limit point progression slows down. Match it continuously with the throttle
- Too much throttle – into the barrier
- Or
- To much 'lift off' & induce Oversteer ??
- To little 'lift-off'
- you are Into the barrier!

Cornering and the Limit point (5)

- Immediately into the next corner
- Conflicting advice from the hazard signs
- Keep in a low gear, Yes
- Brake in a sharp bend - handling??
- Why an ‘escape lane’?

Cornering and the Limit point (6)

And we progress into yet another downhill left hand bend

Cornering and the Limit point (7)

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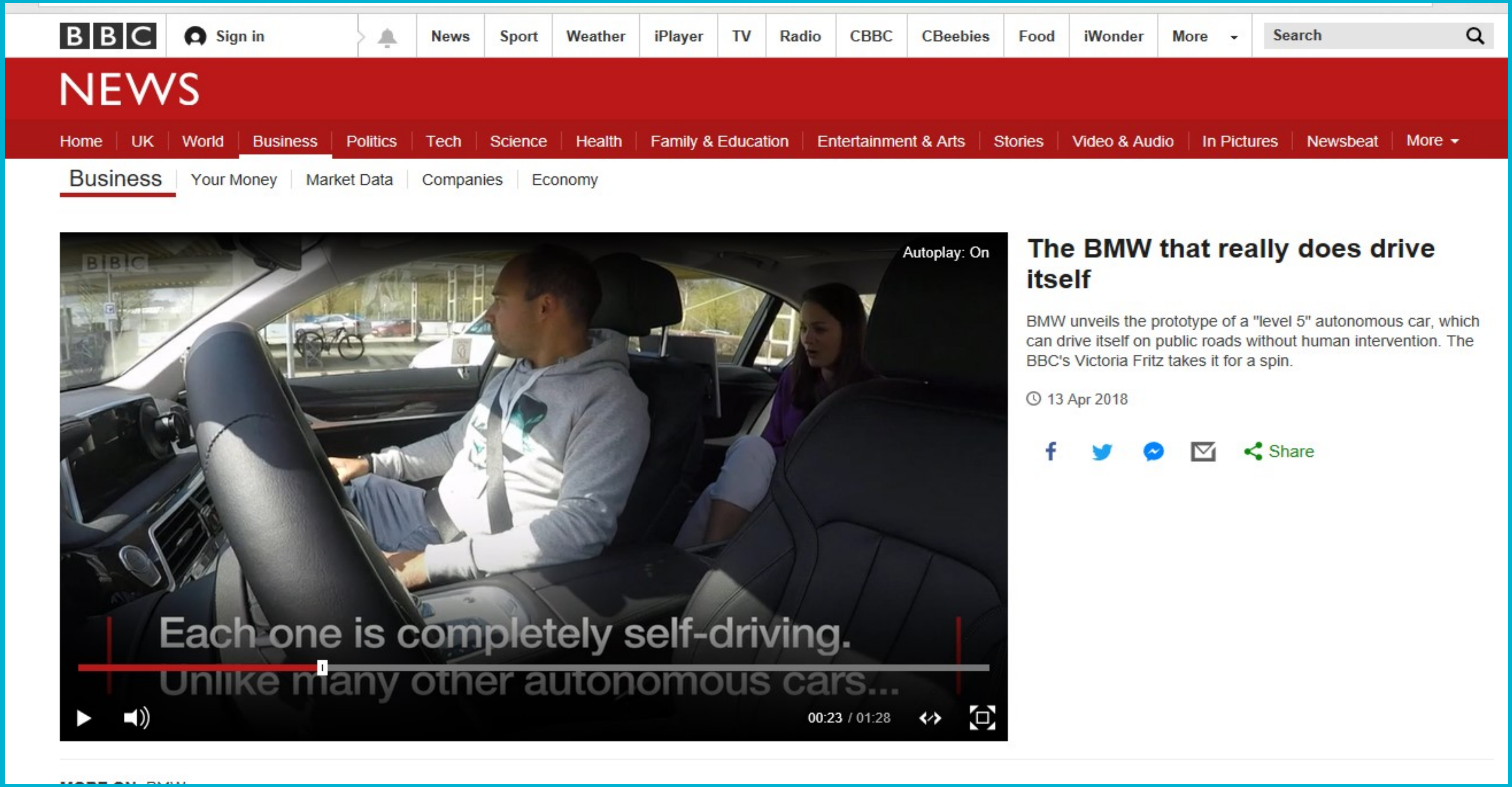
That
changes
into
another
sharp right
hander

Mama Mia!
Here we go
again!!

BBC News - A Car that Drives Itself



Road Traffic Environment

Sensor System

Software Application Program. [Program Coded Rule based Or 'self-taught' AI Neural network]

Operating System

Hardware

http://www.bbc.co.uk/news/av/business-43756701/the-bmw-that-really-does-drive-itself

A left hand drive example from BMW in Germany.

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Artificial Intelligence System Issues

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- These robotic systems:-
- Use sensors, process data into information & decide what to do
- This does NOT make them sentient or have perceptive consciousness.
- Are incapable of moral judgements
- Have no value or belief system but AI Neural networks are 'learning' some
- AI Neural Networks self-learn being taught 'by example', like a learner driver.
- Rule-based AI systems have to be coded - programmed to recognise and respond properly in ALL types of situations. The good, the bad and the ugly.
- AI systems don't know what they need to know or don't know what they don't know
- They don't know all they need to know to drive a car in all weather, road, and traffic conditions.
- Eventually after lot much more work and many mistakes, they possibly will???

How does ‘Driverless Tech’ SEE?

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- Rapid Iterative updates of approximations and guesstimates of ‘where you are’ [pose], ‘where you are going’, [position, velocity] & mass moment of inertia.
- Correcting the pose approximations with further pose guesstimates.
- No absolute certainties. Uses Probabilities and inferences.
- Present computers don’t like probabilities, only classic logic of IF, THEN, ELSE
- A driverless car systems are being developed using Bayes’ Theorem. Applying probabilities developed from the sometimes conflicting or ambiguous information gathered from the different types of sensing systems.
- No absolute values of where the driverless car is, what it is doing, why it may need a change of position, speed or gear and how and at what rate it must make these changes.

Driverless Cars – Different Sensors

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- In this BMW example shown on BBC News App'
- 13 th April 2018

Limitations of Their Sensor Technologies

Different types of sensors, sometimes conflicting data processed into decision-making and implementing it.

- Cameras see good road markings. Struggle in glaring sunlight and poor conditions of rain, fog, shadows, poor lighting , poor road markings & can't judge distance.
- GPS and Inertial navigation limited accuracy, signal 'drop-out'. Mapping can become obsolete or wrong.
- Laser sensors called LIDAR see fine details, can't see long distances, texture or colour and do not like rain or read road signs
- Radar sensors see distance and speed but can't detect details or shape
- Each sensor can provide misleading, misreading & mis-measured data
- The different types of data can easily conflict in sub-optimal conditions

Source; 'Hello World' by Dr Hanna Fry.(2018) Pub: Penguin. Chapter: Cars.

Practical Demo & Flip Chart Explanation

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1. The Complex Information System Hierarchy

   The focus of tonight's discussion – handling conflicting sensor data

2. The 'Inference Engine' using Bayes Theorem works something like this:-

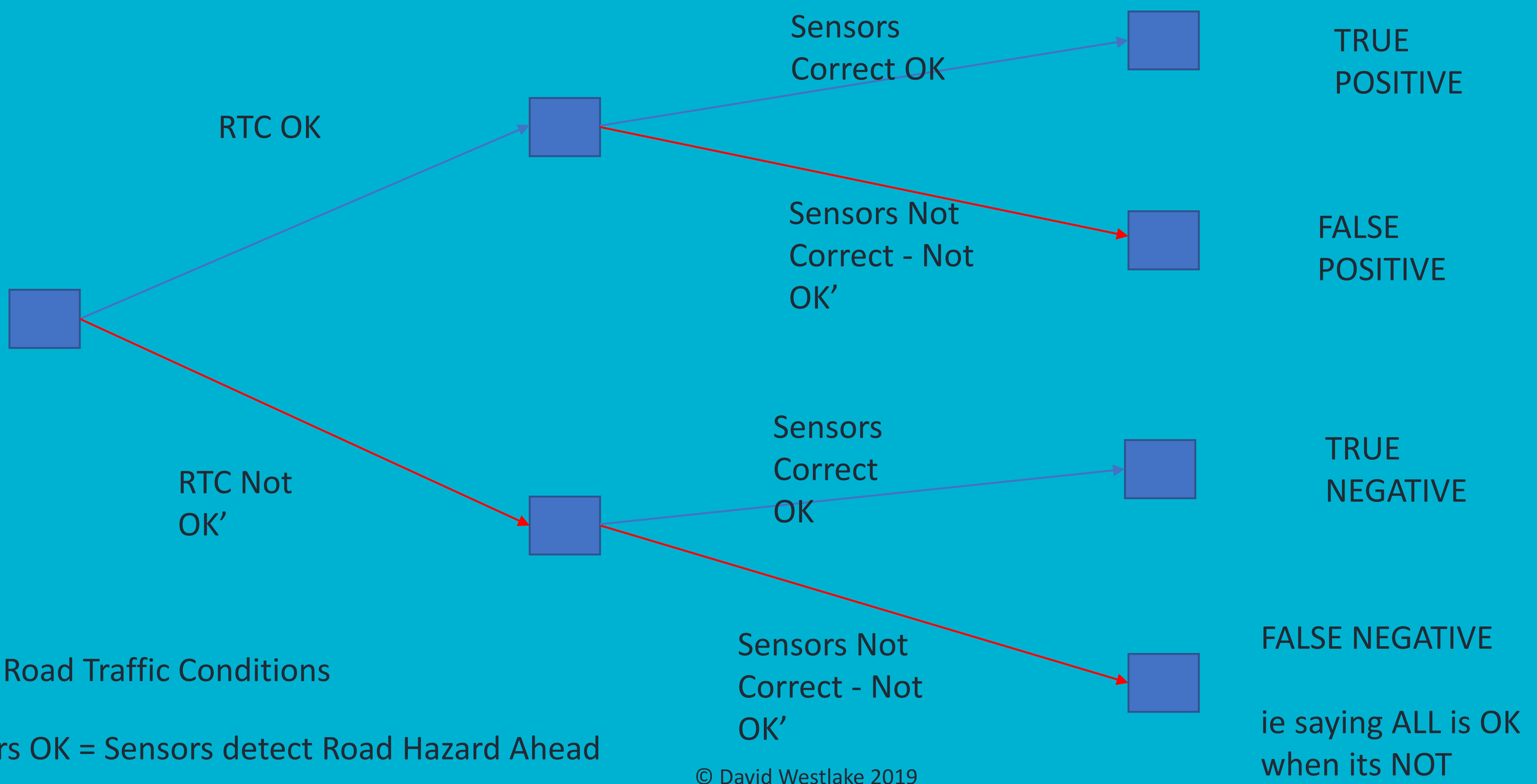
   Red tennis Ball then series of Yellow tennis balls giving feedback about their relative position to the Red Ball, not their absolute, positions relative to the Observer. Where is the Red Ball??

3. Decision Tree diagrams of the Bayes Theorem at work

   Mapping Probabilities of Events, using branches from an event node, that sum to 100%. We draw a simple tree diagram of the chain of events, adding labels for each event & identifying probabilities. These are postulated as being the best the sensor (vision) system possibly can provide. It has strengths & weakness.

   Note:- Bayesian Statistics is a complex powerful tool. A very simplified case is applied here for purposes of illustration to none-mathematicians, to stimulate discussion. It is not a rigorous in depth mathematical study. Such studies need publishing and given peer group review in the public domain.

Apply Rev Thomas Bayes (1701-1761)
Basic Decision Tree



RTC = Road Traffic Conditions

Sensors OK = Sensors detect Road Hazard Ahead

Observation Links – A Scenario

- It's the autumn, bright sunshine, sudden showers, reflective glare along with intermittent very heavy thundery showers.
- Seagulls have been driven inland by recent storms and following farm tractors that are ploughing the fields. This 'Eyes on main beam' 'wide-angle' scanning of the countryside and sky-line has given you the human advanced driver warning well before any hazard comes into view. You are already proactively reducing speed approaching the series of bends.
- There is slippery mud on the road from the field entrances, in the bends
- The Driverless Car Control System does not have this advanced foresight or perception to accomplish such proactive action. Only capable of Reactive Driving by what its sensors can detect and what its driving process can do.

1ST Bend with Poor RTC and poor 'Vision'

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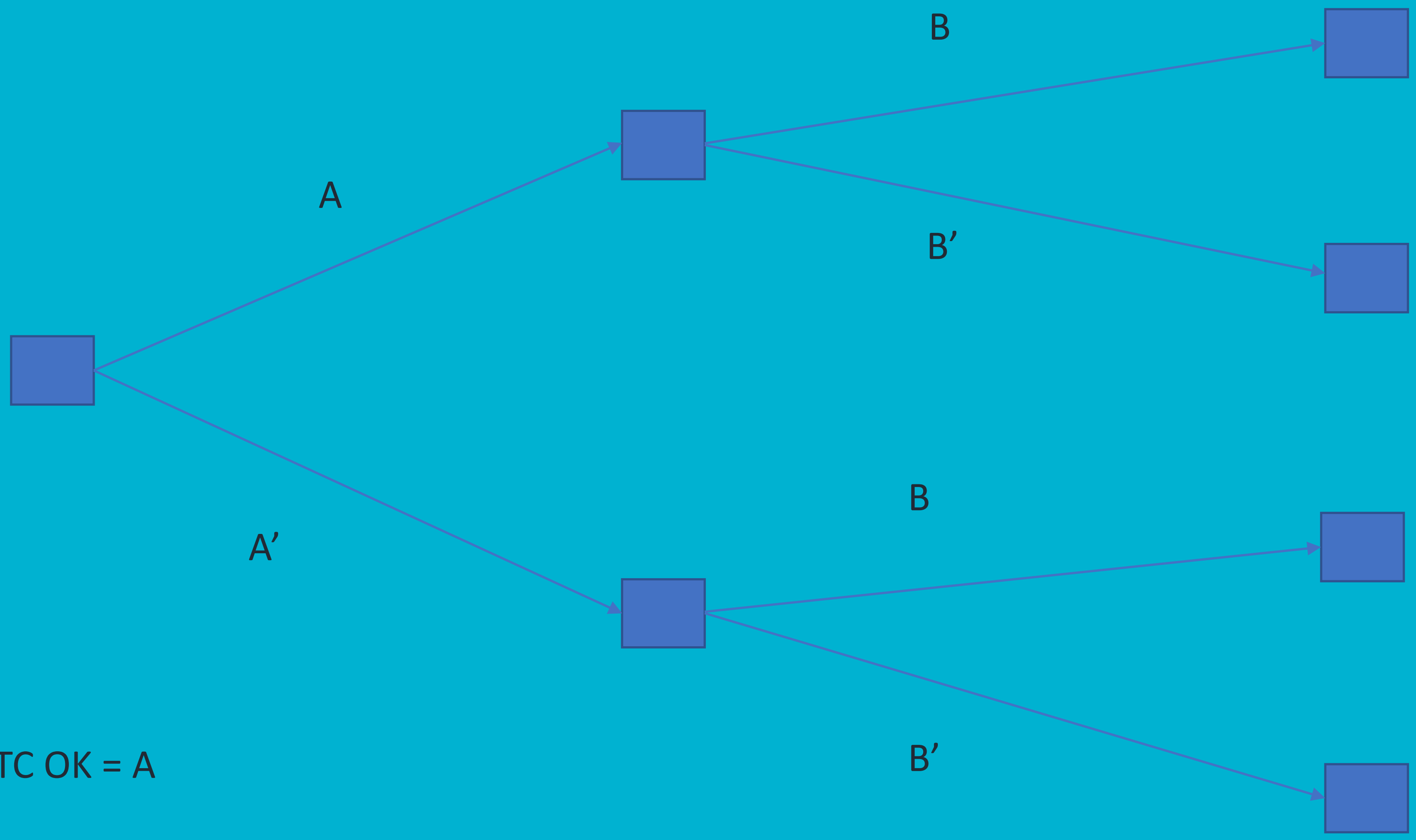
The driverless car passenger is taking scenic pictures.

Assume the 'Driving Process' system is fully adequate and functional. It's roadworthy.

Assume the various sensors and systems are working properly, passing all the 'ignition sequence' and ongoing function checks.

If not, surely it would 'fail-safe' and properly park in a lay-by initiating Roadside rescue?
As it's not Roadworthy.

Decision Tree and Bayes Theorem (1 - A)

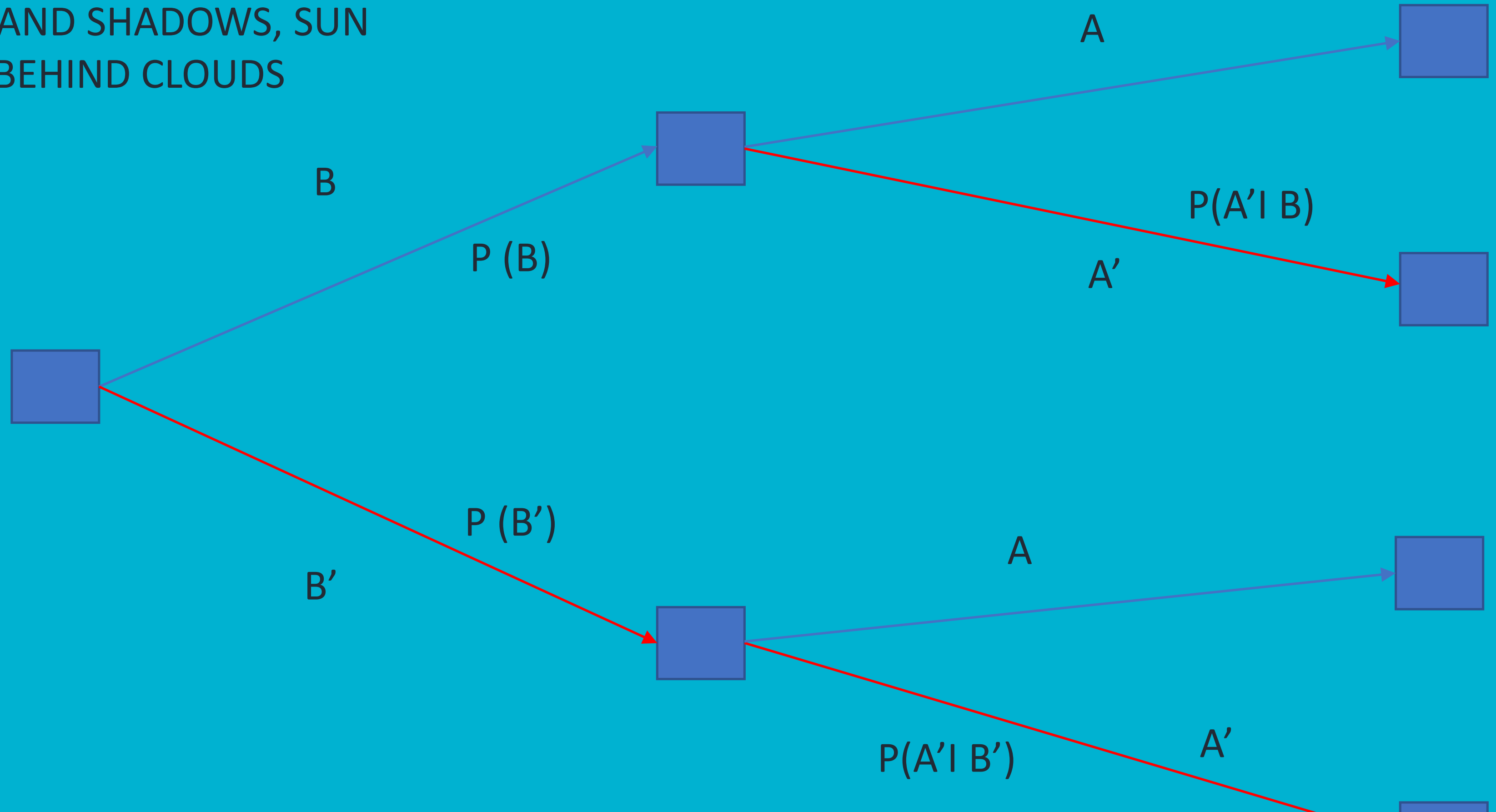


LET RTC OK = A

LET SENSORS OK = B

Decision Tree and Bayes Theorem (1 - B)

1ST BEND. WITH HEAVY RAIN,
CLOUDY AND SHADOWS, SUN
HIDDEN BEHIND CLOUDS



BAYES THEROM ALLOWS US TO LOOK AT THE DECISION TREE IN REVERSE.
WE ARE LOOKING AT PROBABILITY OF B' GIVEN THAT A' HAS HAPPENED. EG, GIVEN THE RTC IS NOT OK' [A'], WHAT IS PROBABILITY OF SENSOR READING NOT OK' [B']?

Bayes Theorem Worked Example (1)

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- Scenario
- Very heavy intermittent rain showers and sunny periods. Thus for purposes of discussion we assume:-
- Probability of sensor error is 10% if RTC are OK
- Probability of sensor error is 95% if RTC are Not OK'
- What is the probability of the DTC's system activating if the mud on the road is not detected with only 40% chance of RTC OK?
- All sensors and systems are working properly and the vehicle is Roadworthy.

Bayes Theorem Worked Example (1)

$$P(A'|B') = \frac{P(A'| B') * P(B')}{P(A')}$$

Where $P(A') = [P(A'| B') * P(B') + P(A'| B) * P(B)]$

$$P(A') = [(0.6*0.95) + (0.4* 0.1)]$$

$$= 0.61$$

$$P(A' | B') = \frac{(0.6*0.95)}{0.61} = 0.934$$

Probability car will not respond to Poor RTC and DTC's will activate on the mud is circa 90%.

2^{ND} BEND WITH BETTER VISION SCANNING

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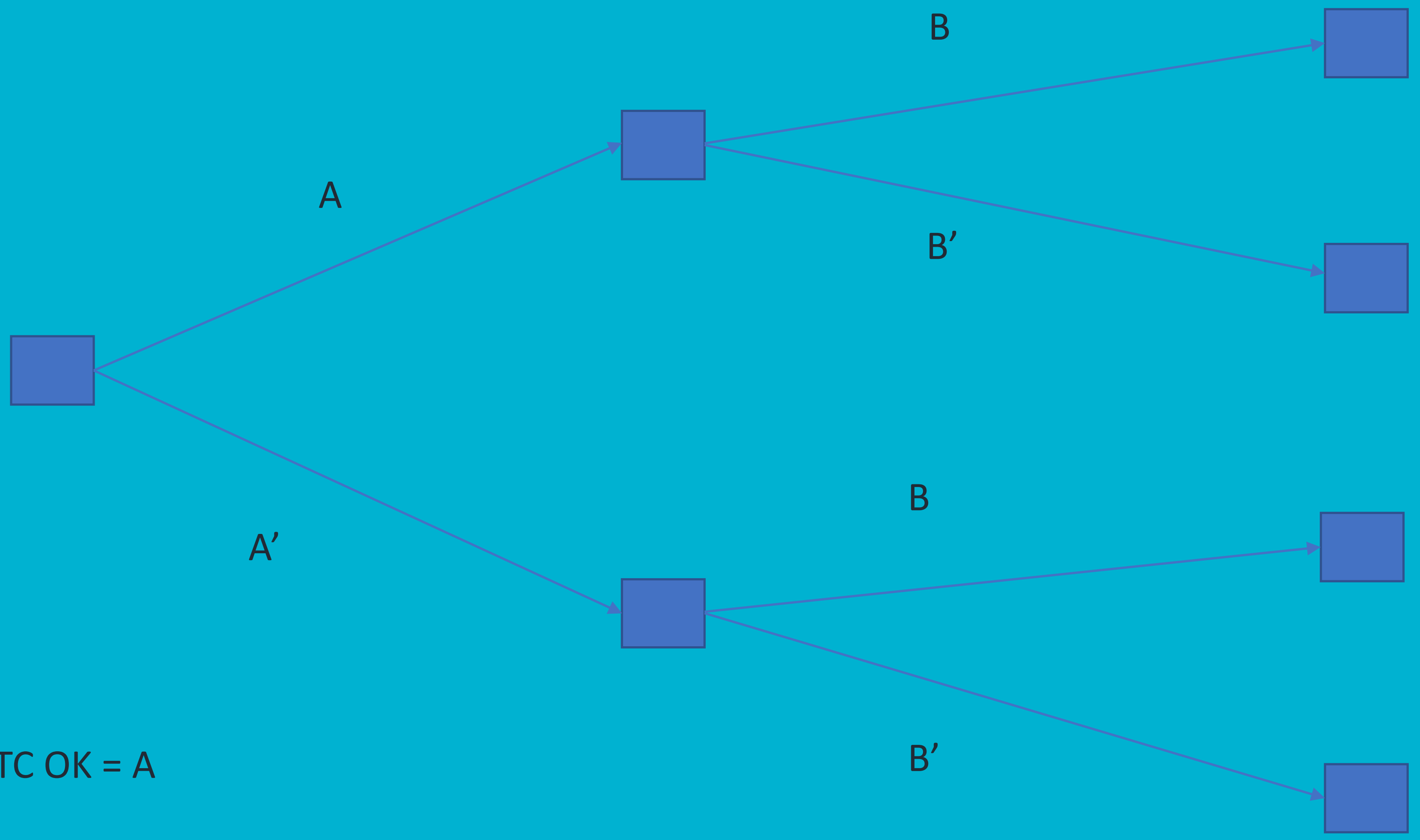
Evident to the naked eye are much better Road Traffic Conditions in better sunlight as you enter the next bend, downhill with oncoming traffic

The probabilities of the sensors detecting the improved Road traffic Conditions and making valid decisions for a safe progressive drive are shown next.

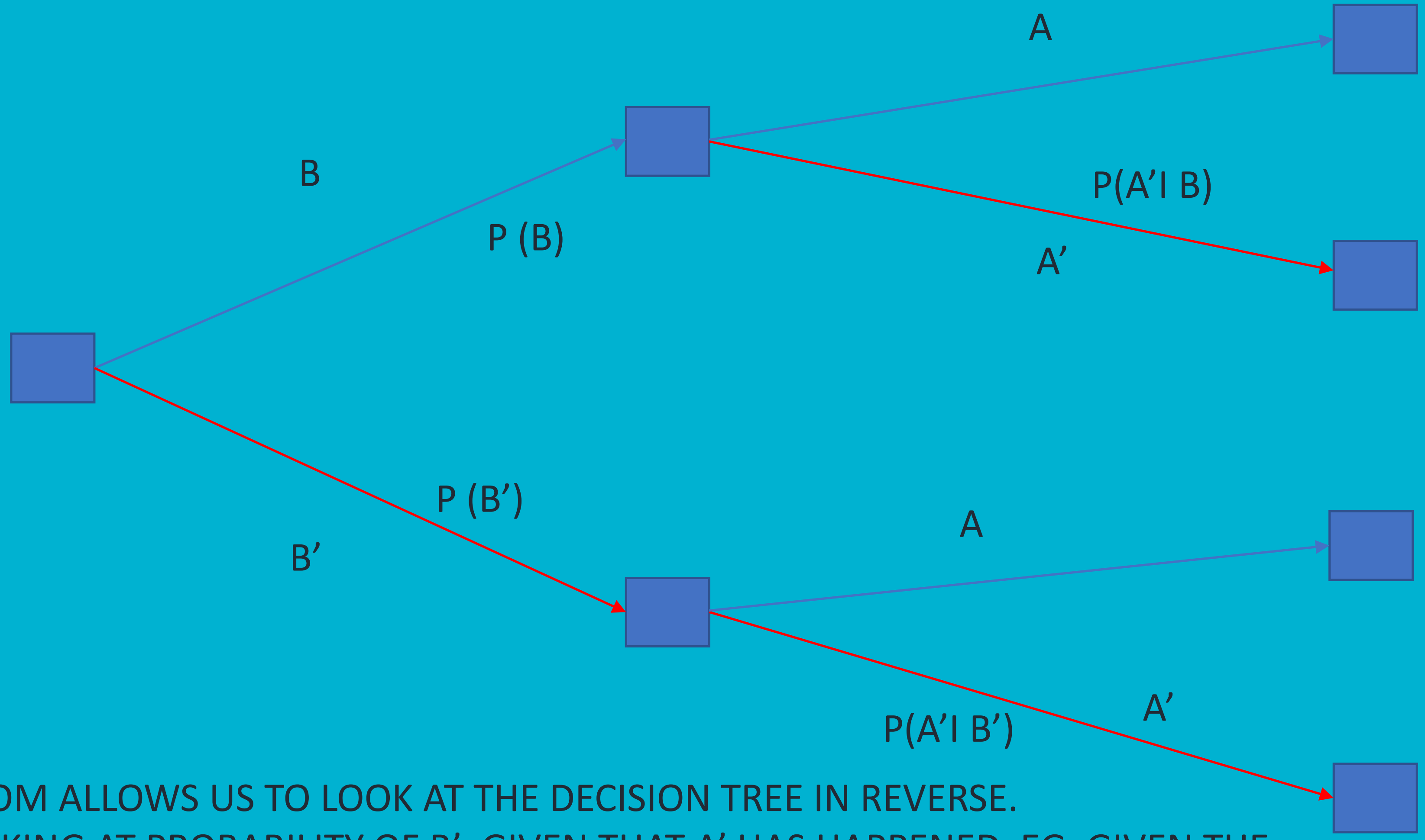
Decision Tree and Bayes Theorem (2 - A)



LET RTC OK = A

LET SENSORS OK = B

Decision Tree and Bayes Theorem (2 - B)



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Bayes Theorem Worked Example (2)

- Scenario
- Cloud Gap - brief Sunshine, thus we assume for purposes of discussion:-
- Probability of sensor error is 1% if RTC are OK
- Probability of sensor error is 2.5% if RTC are Not OK'
- What is the probability of the DTC's system activating if the mud on the road is not detected with 5% chance of RTC OK'?
- All sensors and systems are working properly and the vehicle is Roadworthy.

Bayes Theorem Worked Example (2)

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$$P(A'|B') = \frac{P(A'|B') * P(B')}{P(A')}$$

Where $P(A') = [\, P(A'|B') * P(B') + P(A'|B) * P(B) \,]$

$P(A') = [(0.05*0.025) + (0.95*0.01)]$

$= 0.01075$

$$P(A'|B') = \frac{(0.05*0.025)}{0.01075} = 0.116$$

Probability car will not respond to Poor RTC and DTC's will activate on the mud is circa 10%.

Bayes Theorem – Its Weakness

$$P(A'|B') = \frac{P(A'|B') * P(B')}{P(A')}$$

This probability is an initial estimate and will be assumed to apply to very next sensor sweep. Thus if it's a 'false' thus a NOT OK' value, it will still be used until its proved wrong by the sensor system correctly 'seeing' the hazardous mud. Then it will allocate a much higher probability. The system is NOT sentient. It cannot think, see wide angle eyes-on-main-beam with 'observation links', like a human can do, as explained much earlier.

Recognition of Situation & Surroundings

- Would it ‘See’ these situations in all conditions?
- Does this bend go left or right?

- Thus know what to do?
- I somehow doubt it for a long while
- Severely limit its use to only closely selected routes and good road traffic conditions
- Next time – development of driver assist ‘guardian’ not ‘chauffeur’ autonomous systems??

Summary & Conclusions

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- Are we there yet?? No way!!
- The probabilities used in this study are my conjecture or hypothesis -needs proving.
- The full evidence is not in the public domain. We know a lot of what we don't know. There are many things about 'Driverless Tech', we in the public domain don't know and don't know we don't know.
- The discussion and 'evidence' illustrates the dependency on sensors being able to have valid 'vision scans'. Like humans; but we can if we know how; handle it.
- If the sensor scans are incorrect, even if they are working properly, then the decision making by the insentient AI processing technology will be wrong.
- The driverless car systems work on probabilities and inferences about how correct the 'readings' are at any instant and the course, position and speed adjustment decisions that must be made continuously with a very high probability of being valid and correct.
- If my hypothesis is valid, it appears that small reductions in valid sensor vision scan accuracy and resulting decision making, can be a significant problem.