Adaptive User Interface Approach for Efficient Transfer of Control

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Bachelor/ Master Seminar

Saarland Informatics Campus

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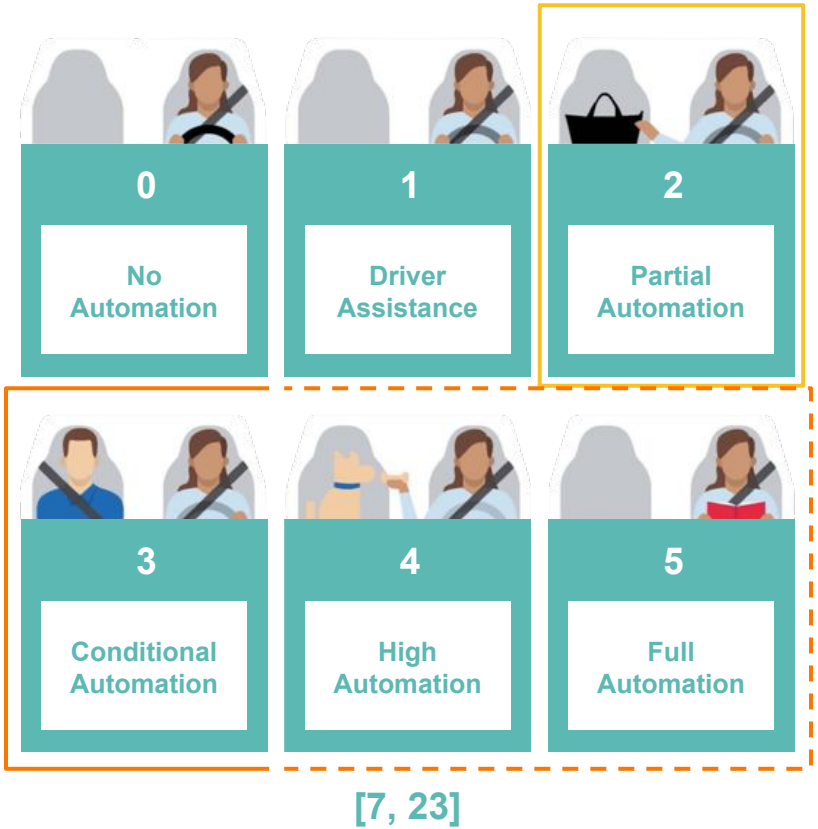
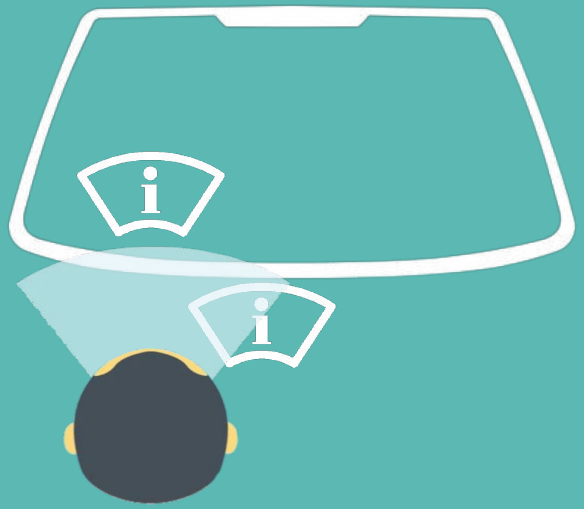

0
No Automation
1
Driver Assistance
2
Partial Automation
3
Conditional Automation
4
High Automation
5
Full Automation

[7, 23]


15:39
John Doe
Adaptive User Interface Design for Efficient Transfer of Control. We were able to track the eye gaze with great accuracy. Now we really need to discuss the details about the study as well as the scenario creation in OpenDS.
15:23
15:23
Oh and please have a look at different network architectures that we could use for training on the eye gaze data.
15:24
TRAFFIC SAFETY FACTS
Research Note
Distracted Driving 2018
Distracted Driving 2018.pdf
7 pages • 598 kB • PDF
15:25
Hey, could you please send me the location of today's meeting venue?
15:27
Message

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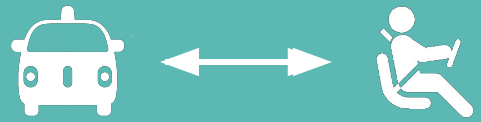
Transfer of Control

- Reasons for TOC:
  - Bad Vision
  - Missing lane markings
  - Objects blocking the ego lane
  - …



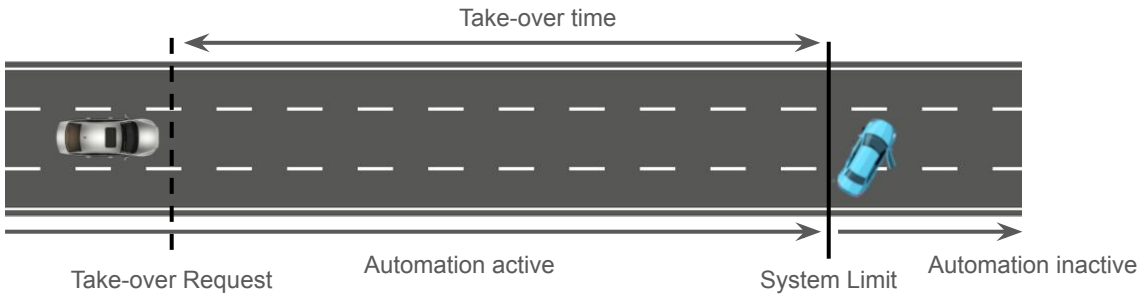
3

Conditional Automation

[5,6]

Transfer of Control

- Shifting responsibilities
- Fundamental for HMI in self-driving cars
- Ensures safe operation in all conditions



3

Conditional Automation

[5,6]

Transfer of Control

- Multi-modal requests reduce reaction time
- Transfer quality influenced by
  - Modality
  - Driver mental workload
  - NDRT
  - Context (weather, road type, …)
- Metrics:
  - Take-over time
  - Take-over quality

[3]

Head-up Display

- Projects info onto transparent display
- Aviation → Automotive

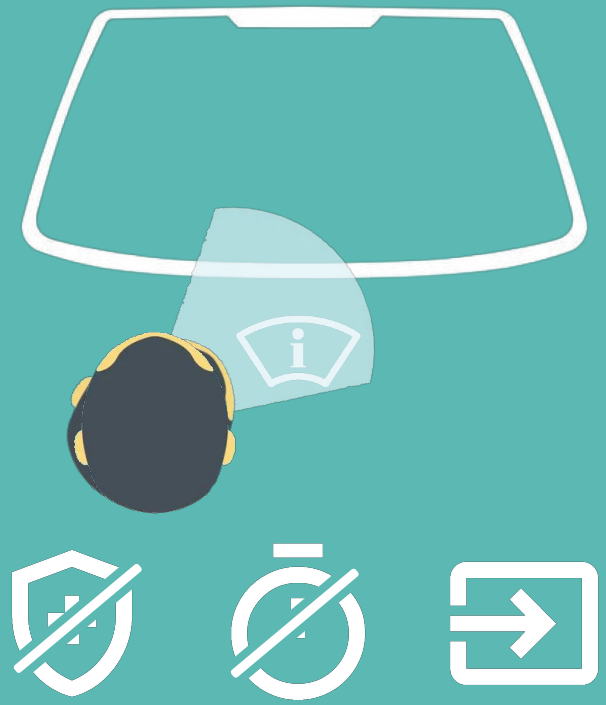
Head-up Display

- Projects info onto transparent display
- Aviation → Automotive
- Shorter reaction times
- Better vehicle control
- Danger of over-stimulation

[5,8,9,10]

Head-down Display

- Eyes of road → Shared attention
- Surrounding input modalities
- Fewer design restrictions
- Insensitive to light incidence



[5,8,9,10]

Study Design: Overview

- Simulator
- Scenario
- Non-driving-related Tasks
- Mental Workload Measures

Study Design: Field vs Lab

- Valuable, ecologically valid data
- Higher driver motivation
- Dangerous

[11, 12, 13]

- Controlled and replicable
- Accurate, precise data collection
- Results reproducible in field study

Study Design: Simulator

[14]

Study Design: Scenario

- Rural → urban
- Low density traffic → High density
- No weather changes
- Take-over situations:
  - Different objects blocking ego lane

[13,22]

Study Design: NDRT

- Limited attentional resources
- Driving: Visual-manual activity
- Metrics:
  - Completion time
  - Error rate

⇒ Visual Search

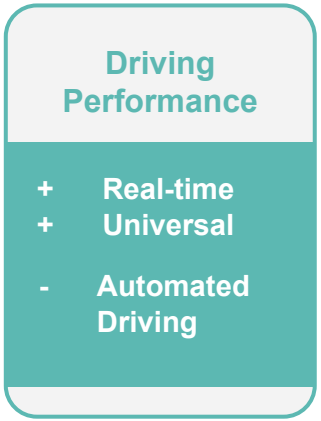
⇒ Text Entry

Distractors	n
Mobile Game	3
Video	4
Reading	4
Search Task	7
Listening	1
Email	3

[6,13,15]

Study Design: Workload Measures

- Impact on driver safety and experience



[16,17,18,19]

Study Design

H1 There are distinct positions for different road segments that decrease the driver's reaction time

H2 There are distinct positions for different secondary tasks that decrease the driver's reaction time

H3 A dynamic learnable model is superior to the baseline approach when prompting TOC in terms of driver's reaction time

NDRT	Interface	Road Segment
Visual Search	HDD	urban
Text Entry	HDD	urban
Visual Search	HDD	rural
Text Entry	HDD	rural
Visual Search	HUD	urban
Text Entry	HUD	urban
Visual Search	HUD	rural
Text Entry	HUD	rual

Eye Gaze

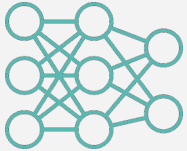
+ Simple
+ Accurate

- Restricted to monitor

+ Simple
+ Accurate

- Excludes spectacle wearers
- No head pose

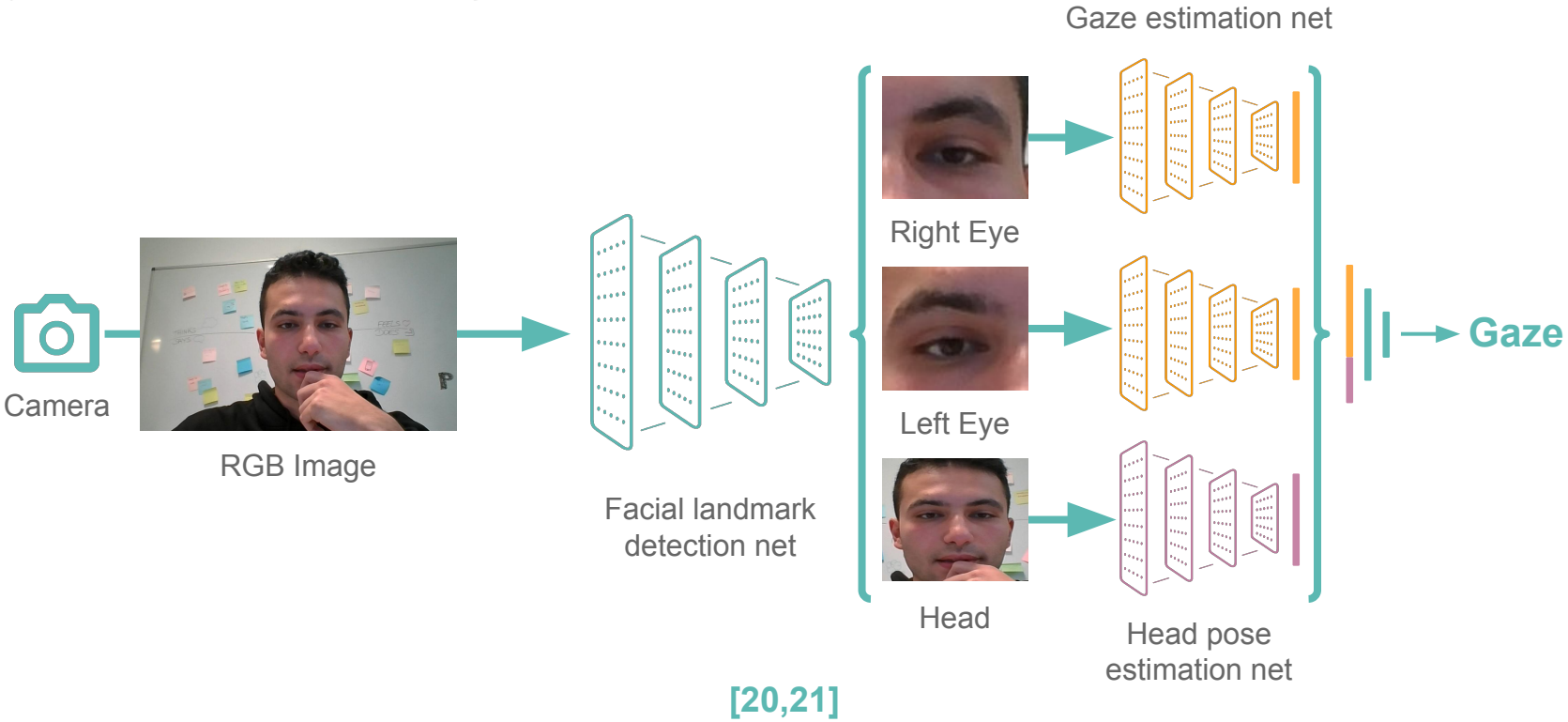
[20]



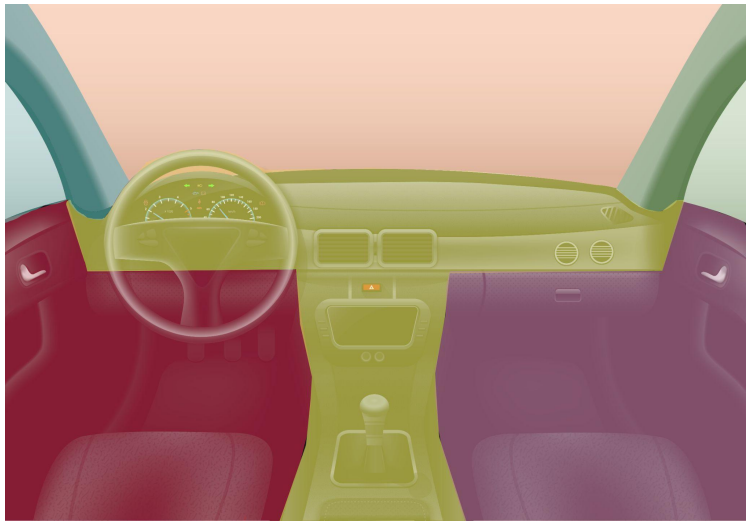
+ Open Source
+ Head pose

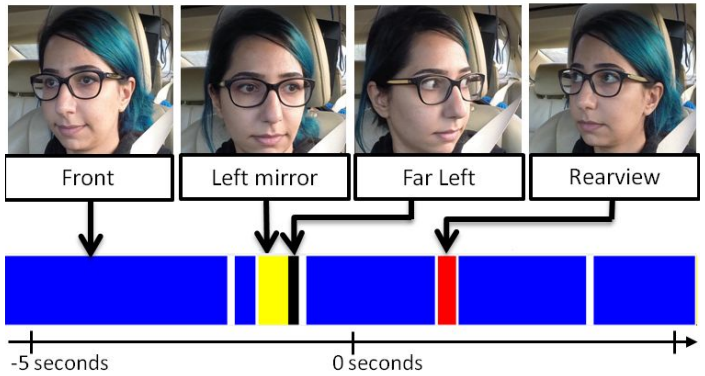
- Computational overhead

Eye Gaze Tracking Pipeline



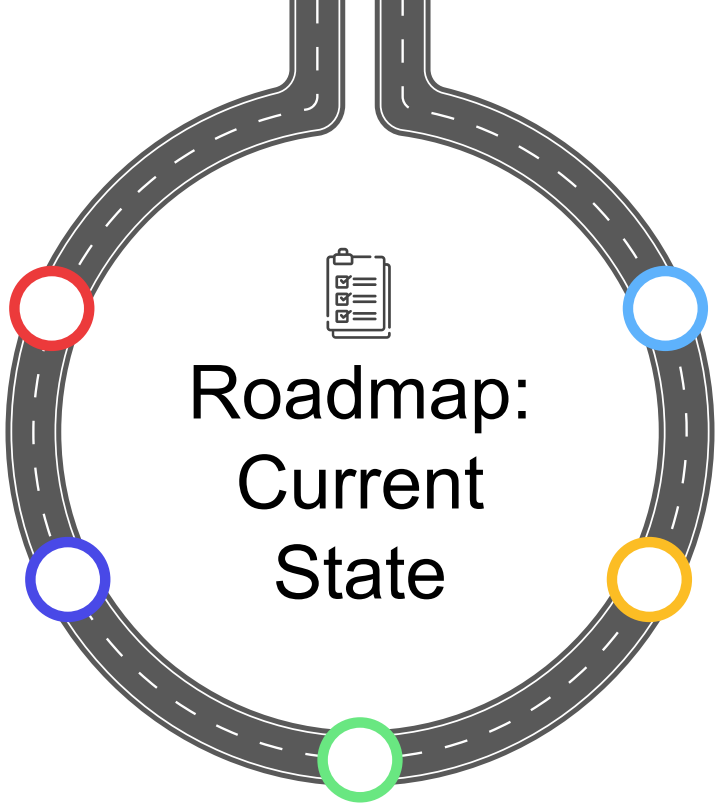
Eye Gaze Modelling





[21]

Roadmap: Current State



Literature research

TOC
HUD vs HDD
Eye Gaze

Summarize Papers

What can my thesis add
to the field?

Presentation

Translate summary into
Presentation

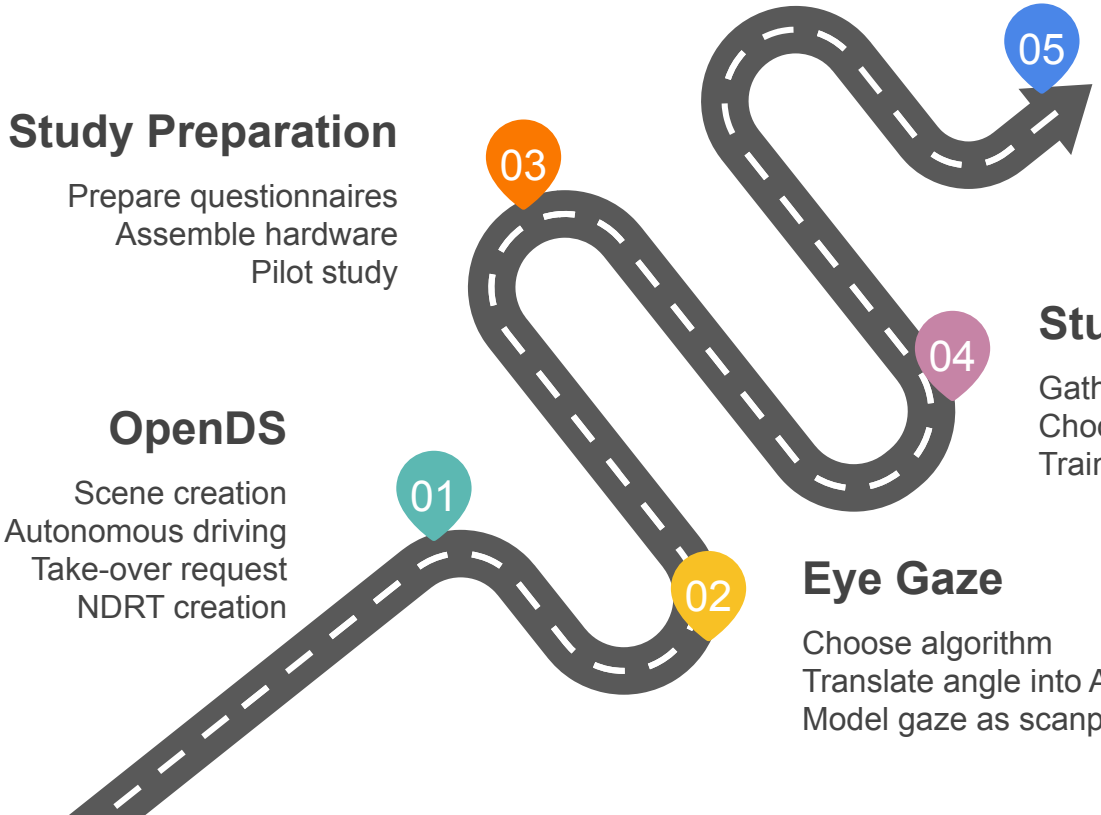
Summary

Bring knowledge into
textual form

Study Design

Follow prior research
iterate, iterate, iterate

Roadmap: Future Steps



OpenDS

Scene creation
Autonomous driving
Take-over request
NDRT creation

Study Preparation

Prepare questionnaires
Assemble hardware
Pilot study

Eye Gaze

Choose algorithm
Translate angle into AOI
Model gaze as scanpath

Study conduct

Gather datasets
Choose suitable network architecture
Train model

Evaluation

Effects on workload?
Effects on reaction time?

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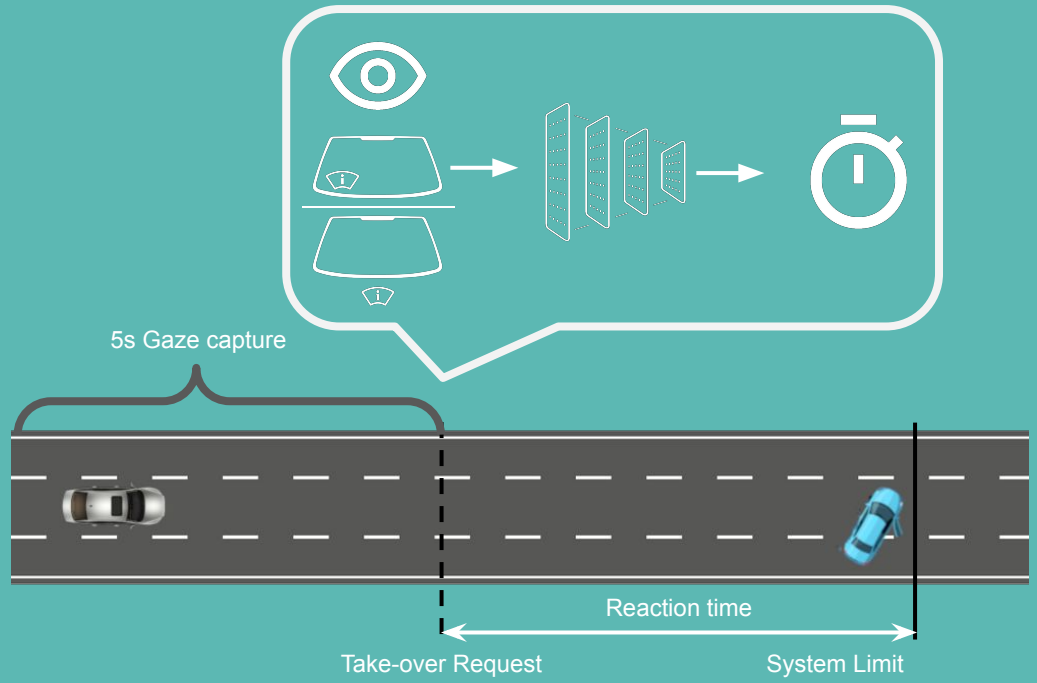
Backup Slides

Backup Slides



Backup Slides

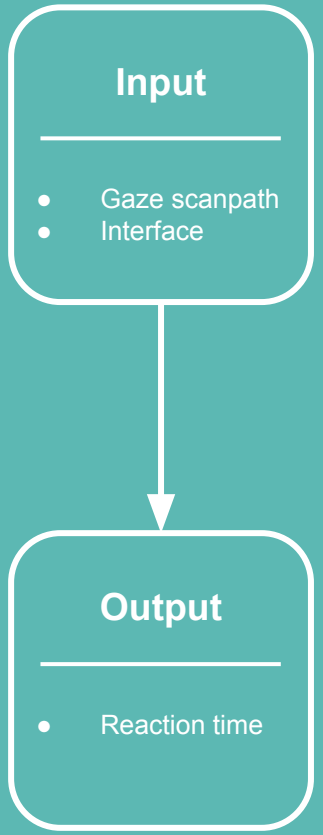
- Model gaze data as timestamp and corresponding area of interest

Time (s)	AOI
0	1
0.1	1
0.2	5
0.3	1
…	4
5	3

Backup Slides

- Regression Problem
  ⇒ Multi Layer Perceptron (MLP)

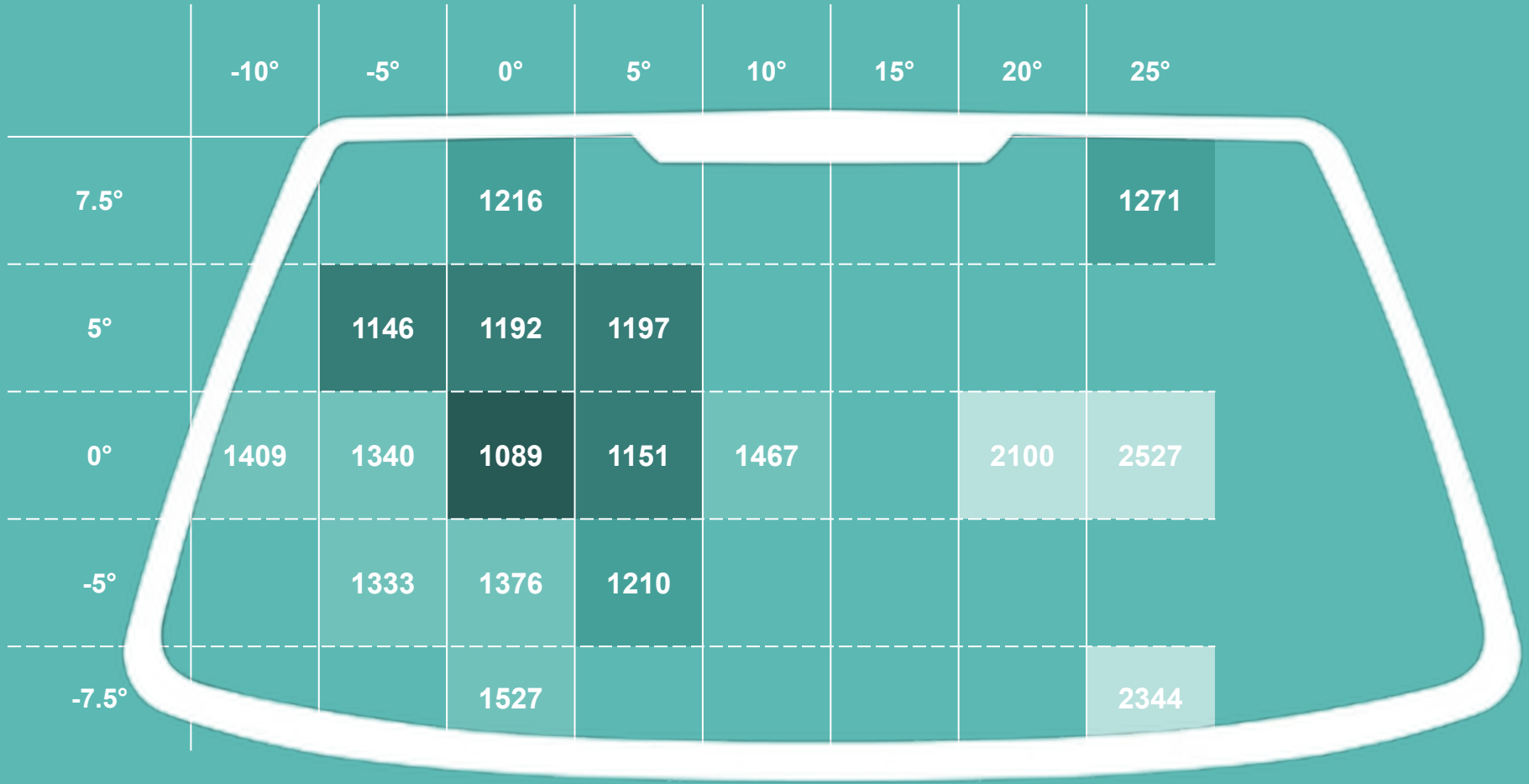
- Sequential data
  ⇒ Recurrent Neural Networks (RNN)



Backup Slides

Critical Event	n
Sudden pedestrian crossing	1
Object in ego lane	9
Curve hazard	1
Object in opposite lane	1
Sudden object appearing	4
Sudden fading lane marking	3

Distractors	n
Mobile Game	3
Video	4
Reading	4
Search Task	7
Listening	1
Email	3


-10°
-5°
0°
5°
10°
15°
20°
25°
7.5°
1216
1271
5°
1146
1192
1197
0°
1409
1340
1089
1151
1467
2100
2527
-5°
1333
1376
1210
-7.5°
1527
2344