

CLAIMS

1. A method of predicting one or more road attributes (20) corresponding to roads in a geographical area (10), the geographical area (10) comprising road segments (21), the method comprising:

- providing trajectory data (110) of the geographical area (10);
- providing map data (120), wherein the map data comprises image data (122) of the geographical area;
- extracting trajectory features (210) from the trajectory data (110);
- extracting map features (220) from the map data (120); and
- using at least one processor to predict road attributes (20) by inputting the trajectory features (210) and the map features (220) in a neural network (300) and by classifying an output of the neural network (300) into prediction probabilities (500) of the road attributes (20).

2. The method of claim 1, wherein the neural network (300) is configured to receive the trajectory features (210) and the map features (220) and to generate task-specific fused representations (330), and wherein classifying is executed by a classifier (400), the classifier (400) being configured to calculate one or more of the prediction probabilities (500) based on the task-specific fused representations (330).

3. The method of claim 1 or claim 2, wherein the trajectory features (210) are processed by a first sub-neural network (311) into shared global trajectory features (316), wherein the first sub-neural network (311) comprises one or more fully-connected (312, 314) layers.

4. The method of claim 2 or claim 3, further comprising determining attention scores (α^v) of pre-defined indicators (216) corresponding to road attributes (20) based on the trajectory data (110), wherein the pre-defined indicators (216) are processed by a fully connected layer (317), and wherein the attention scores (α^v) are determined based on activation functions.

5. The method of claim 4, wherein trajectory task-specific weighted representations are calculated based on the fusion of the attention scores (α^x) with the shared global trajectory features (316) of the first sub-neural network (311).
6. The method of any one of the previous claims, wherein the map features (220) are processed by a second sub-neural network (321) into shared global map features (326).
7. The method of claim 6, further comprising calculating second attention scores (α^y) of pre-defined indicators (226) based on the shared global map features (326), wherein the pre-defined indicators (226) are processed by a second fully connected layer (327), and wherein the second attention scores (α^y) are determined based on activation functions.
8. The method of claim 7, wherein map task-specific weighted representations are calculated based on the fusion of the second attention scores (α^y) with the shared global map features (326) of the second sub-neural network (321).
9. The method of claim 5, wherein
 - the map features (220) are processed by a second sub-neural network (321) into shared global map features (326);
 - the method further comprises calculating second attention scores (α^y) of pre-defined indicators (226) based on the shared global map features (326), wherein the pre-defined indicators (226) are processed by a second fully connected layer (327);
 - the second attention scores (α^y) are determined based on activation functions, wherein map task-specific weighted representations are calculated based on the fusion of the second attention scores (α^y) with the shared global map features (326) of the second sub-neural network (321); and
 - task-specific fused representations (330) are determined based on the map task-specific weighted representations and the trajectory task-specific weighted representations.
10. The method of any one of the previous claims, wherein extracting map features (220) from the map data (120) comprises generating cropped images (123) by cropping images

from the image data (122), wherein the cropped images (123) are centered at a corresponding road segment (22) of the road segments (21).

11. The method of any one of the previous claims, wherein extracting trajectory features (210) from the trajectory data (110) comprises determining group of traces (23) of the trajectory data (110) that are associated with a road segment (22) of the road segments (21).

12. The method of claim 11, wherein extracting trajectory features (210) from the trajectory data (110) further comprises calculating respective distributions of one or more of location, bearing, and speed, and using the distributions as the trajectory features (210).

13. The method of any one of the previous claims, wherein the trajectory data (110) comprises a plurality of data points, each data point comprising latitude, longitude, bearing, and speed.

14. A data processing system comprising one or more processors configured to carry out the method of predicting road attributes (20), comprising:

- a first memory configured to storing trajectory data (110) of the geographical area (10);

- a second memory configured to storing map data (120), wherein the map data (120) comprises image data (122) of the geographical area;

- a trajectory feature extractor (211) configured to extract trajectory features (210) from the trajectory data (110);

- a map feature extractor (221) configured to extract map features (220) from the map data (120);

- a neural network (300) configured to predict road attributes (20) based on trajectory features (210) and map features (220);

- a classifier (400) configured to classify an output of the neural network (300) into prediction probabilities (500) of the road attributes (20).

15. The data processing system of claim 14, wherein

the neural network (300) is configured to receive the trajectory features (210) and the map features (220) and to generate task-specific fused representations (330), and

wherein the classifier (400) is configured to calculate one or more of the prediction probabilities (500) based on the task-specific fused representations (330).

16. The data processing system of claim 15, wherein the neural network (300) comprises a first sub-neural network (311) configured to process the trajectory features (210) into shared global trajectory features (316), wherein the first sub-neural network (311) comprises one or more fully-connected (312, 314) layers.

17. The data processing system of claim 15 or claim 16, wherein the neural network (300) further comprises a fully connected layer (317) and wherein the neural network (300) is further configured to determine attention scores (α^x) of pre-defined indicators (216) corresponding to road attributes (20) based on the trajectory data (110), wherein the pre-defined indicators (216) are processed by the fully connected layer (317), and wherein the attention scores (α^x) are determined based on activation functions.

18. The data processing system of claim 17, wherein the neural network (300) comprises a first sub-neural network (311) configured to process the trajectory features (210) into shared global trajectory features (316), wherein the first sub-neural network (311) comprises one or more fully-connected (312, 314) layers.

19. The data processing system of claim 18, wherein the neural network (300) is configured to fuse the attention scores (α^x) with the shared global trajectory features (316) of the first sub-neural network (311) thereby generating trajectory task-specific weighted representations.

20. The data processing system of any one of the previous claims, wherein the neural network (300) comprises a second sub-neural network (321) configured to transform the map features (220) into shared global map features (326).

21. The data processing system of claim 20, wherein the neural network (300) further comprises a second fully connected layer (327), and wherein the neural network (300) is further configured to determine second attention scores (α^v) of pre-defined indicators (226) based on the map features (220), wherein the pre-defined indicators (226) are processed by the second fully connected layer (327), and wherein the second attention scores (α^v) are determined based on activation functions.

22. The data processing system of claim 21, wherein the neural network (300) is configured to fuse the attention scores (α^v) with the shared global map features (326) of the second sub-neural network (321) thereby generating task-specific weighted representations.

23. The data processing system of claim 19, wherein the neural network (300) comprises:

a second sub-neural network (321) configured to transform the map features (220) into shared global map features (326);

a second fully connected layer (327), wherein the neural network (300) is further configured to determine second attention scores (α^v) of pre-defined indicators (226) based on the map features (220), wherein the pre-defined indicators (226) are processed by the second fully connected layer (327), and wherein the second attention scores (α^v) are determined based on activation functions;

wherein the neural network (300) is configured to fuse the attention scores (α^v) with the shared global map features (326) of the second sub-neural network (321) thereby generating task-specific weighted representations; and

wherein the neural network (300) is further configured to determine task-specific fused representations (330) based on the map task-specific weighted representations and the trajectory task-specific weighted representations.

24. A non-transitory computer-readable medium storing computer executable code comprising instructions for extracting road attributes according to the method of any one of claims 1 to 12.

25. A computer executable code comprising instructions for extracting road attributes according to the method of any one of claims 1 to 13.

26. A method for training an automated predictor, the method comprising:

- performing forward propagation by inputting training data into the automated predictor to obtain an output result, for a plurality of road segments (21) of a geographical area (10), wherein the training data comprises:

- trajectory features (210);

- map features (220) having an electronic image format;

- performing back propagation according to a difference between the output result and an expected result to adjust weights of the automated predictor; and

- repeating the above steps until a pre-determined convergence threshold is achieved,

wherein the automated predictor comprises:

- a neural network (300) configured to predict road attributes (20) based on trajectory features (210) and map features (220); and

- a classifier (400) configured to classify an output of the neural network (300) into prediction probabilities (500) of the road attributes (20).

27. A classifier trained by the method of claim 26.