INTELIGENȚĂ ARTIFICIALĂ

Sisteme inteligente

Sisteme care învaţă singure

– generative AI–

Laura Dioşan

Sumar

A. Scurtă introducere în Inteligenţa Artificială (IA)

C. Sisteme inteligente
- Sisteme care învaţă singure
  - Arbori de decizie
  - **Reţele neuronale artificiale**
  - kNN
  - Algoritmi evolutivi
  - Maşini cu suport vectorial
- Sisteme bazate pe reguli
- Sisteme hibride

B. Rezolvarea problemelor prin căutare
- Definirea problemelor de căutare
- Strategii de căutare
  - Strategii de căutare neinformate
  - Strategii de căutare informate
  - Strategii de căutare locale (Hill Climbing, Simulated Annealing, Tabu Search, Algoritmi evolutivi, PSO, ACO)
  - Strategii de căutare adversială

Materiale de citit şi legături utile

- https://www.tensorflow.org/text/tutorials/word2vec
- *https://radimrehurek.com/gensim/models/word2vec.html*
- *https://www.ruder.io/word-embeddings-1/*
- *https://aylien.com/blog/a-review-of-the-recent-history-of-natural-language-processing?ref=ruder.io*
- *https://nlp.stanford.edu/~manning/ - a lot of lectures about NLP*

De ce reprezentari vectoriale ale intelesului unui cuvant/text?

- Permit determinarea similaritatii intre cuvinte/texte
  - ***fast*** is similar to ***rapid***
  - ***tall*** is similar to ***height***

Question answering:

- *Q: "How **tall** is Mt. Everest?"*

*Candidate A: "The official **height** of Mount Everest is 29029 feet"*

Intuitia din spatele similaritatii

- Exemplu: Ce este o Sirrus X 3.0?

*The **Sirrus X 3.0** invites you to explore beyond boundaries. With confidence-inspiring tires, an upright riding position, and intuitive components, **Sirrus X 3.0** is your ticket to adventure.*

- Din context, o persoana poate ghici ca Sirrus X 3.0 este un model de bicicleta

- Pentru un algoritm, intuitia e ca **doua cuvinte sunt similar daca ele sunt folosite in context similare**

Diferite reprezentari vectoriale pentru text

- Reprezentari rare (*sparse*):
  1. Mutual-information weighted word co-occurrence matrices

- Reprezentari dense (compacte) :
  2. Singular Value Decomposition (si Latent Semantic Analysis)
  3. Neural-network-inspired models (skip-grams, CBOW)
  4. Altele (e.g. brown clusters)

Vectori rari *vs*. densi

- Vectorii → matricea de co-ocurenta a termenilor
  - **lungi** (length |V|= 20,000 -> 50,000)
  - **rari** (f multe elemente sunt 0)
- Alternativa: vectori invatati (prin AI/ML)
  - scurti (length 200-1000)
  - **densi** (multe elemente nu sunt 0)
- De ce vectori densi?
  - Vectorii scurti -> folositi mai usor ca si *features* in algoritmii de invatare (mai putini coeficienti de invatat)
  - Vectorii densi pot generaliza mai bine, captand sinonimia termenilor
    - Bike – scooter
    - Car – automobile
    - House – apartment

Modele de predictie (invatare) a reprezentarilor

- Evolutie
  - Word-level
    - 2003 - N-gram Neural language model (Montreal - Bengio)
      - https://www.jmlr.org/papers/volume3/bengio03a/bengio03a.pdf
      - Probability of the target word based on previous k words
      - Estimation of the probability by an ANN -> prediction of the next word in a sequence
    - 2008 – multi-task model (Princeton – Collobert)
      - https://ronan.collobert.com/pub/matos/2008_nlp_icml.pdf
      - Probability of MORE target words (a sequence of words)
      - Estimation of the probability by an ANN –similar to Bengio's model,
    - 2013 – word2vec (Google – Mikolov)
      - https://papers.nips.cc/paper/2013/file/9aa42b31882ec039965f3c4923ce901b-Paper.pdf
      - Continous BOW model -> try to predict a word based on its context (neighbours); input = neighbour words, output = target word
      - Skip-gram model -> try to predict context (neighbours) of a word; input = target word; output = neighbour words;
      - Visualisation of embeddings https://ronxin.github.io/wevi/
      - Trained vectors https://radimrehurek.com/gensim/models/word2vec.html or https://github.com/3Top/word2vec-api#where-to-get-a-pretrained-models
  - Sentence (document) level (2014 - …)
    - 2014 - Paragraph embedding https://arxiv.org/abs/1405.4053
  - Contextual word-vectors (Word vectors compress all contexts into a *single vector) (2016 - …)*
    - 2016 context2vec https://www.aclweb.org/anthology/K16-1006.pdf
    - 2017 tagLM https://arxiv.org/abs/1705.00108
    - 2017 CoVe https://papers.nips.cc/paper/2017/hash/20c86a628232a67e7bd46f76fba7ce12-Abstract.html
    - 2018 ELMo https://www.aclweb.org/anthology/N18-1202/
    - 2018 ULMFiT https://arxiv.org/abs/1801.06146
    - 2019 BERT https://arxiv.org/abs/1810.04805

Modele de predictive (invatare) a reprezentarilor

- **Modelul Word2vec**
  - **Skip-gram** (Mikolov et al. 2013a), **CBOW** (Mikolov et al. 2013b)
  - Se invata reprezentari, numite embeddings, ca parte din procesul de predictive/generare a textului
  - Se antreneaza o retea neuronala pentru prezicerea urmatorului cuvant
  - Avantaje
    - Rapid, simplu de antrenat
    - Modele gata antrente disponibile online

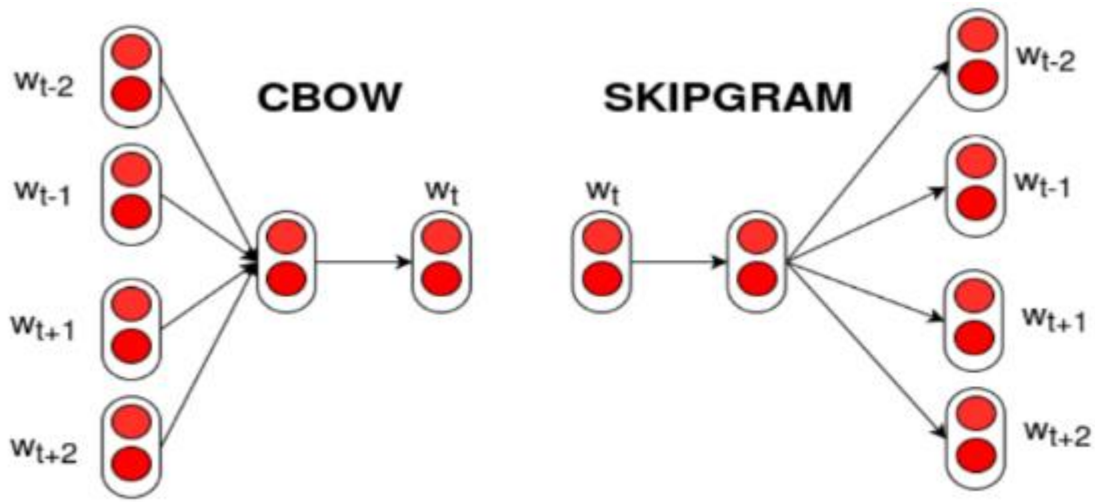
Invatare supervizata fara etichetare manuala de date

- Text: "*She rides a bike. He rides a scooter in park. My father drives a motorcycle. …*"
- Vocabular V = {*she, ride, bike, he, scooter, park, my, father, drive, motorcycle*}
- Perechi (context, cuvant)

Negative sampling

[she ride] bike	1		[she ride] he	0
[ride bike] he	1		[she ride] scooter	0
[he ride] scooter	1		[she ride] park	0
[ride scooter] park	1		[she ride] my	0
[my father] drive	1		[she ride] father	0
[father drive] motorcycle	1		[she ride] drive	0
			[ride bike] scooter	0
			[ride bike] park	0
			…	
			[father drive] she	0

Arhitecturi

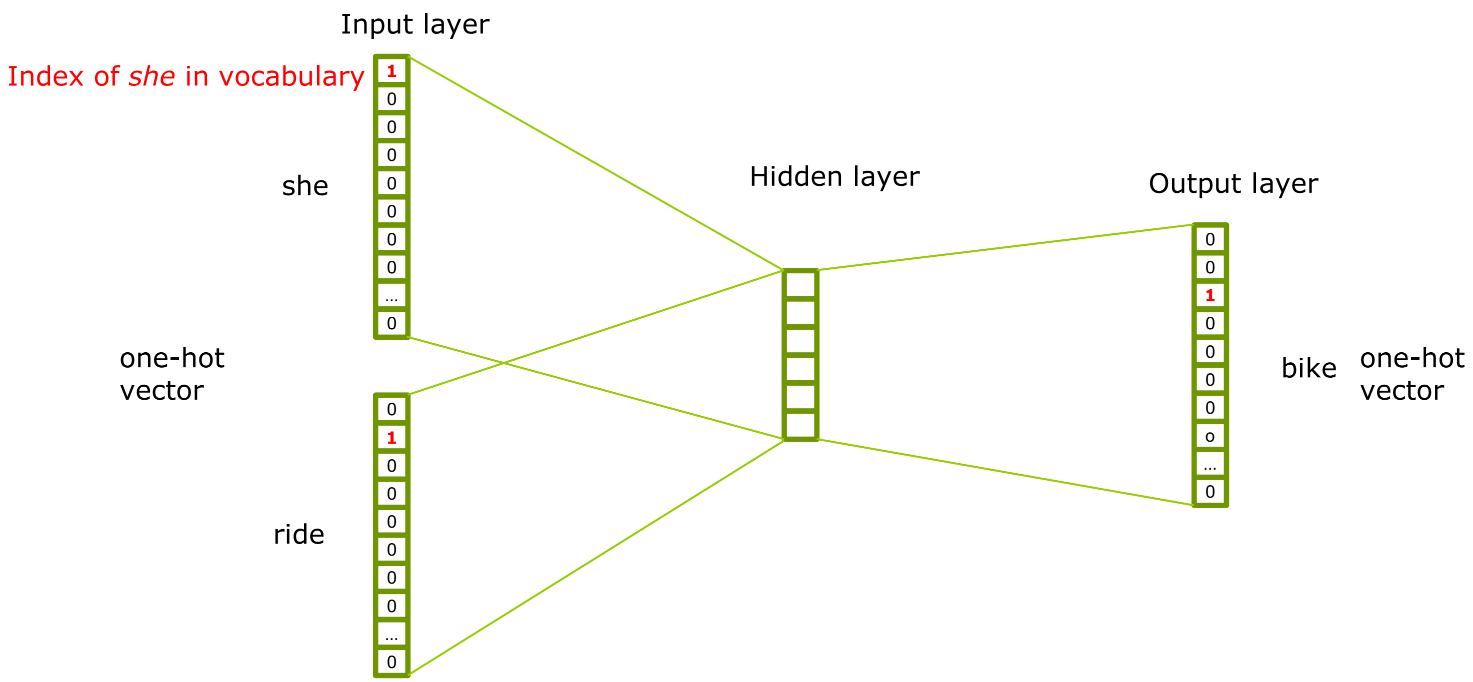


$$\frac{1}{T}\sum_{t=1}^{T}\sum_{-c\leq j\leq c, j\neq 0} logp(w_t|w_{t+j})$$

$$\frac{1}{T}\sum_{t=1}^{T}\sum_{-c\leq j\leq c, j\neq 0} logp(w_{t+j}|w_t)$$

CBOW (Continuous Bag of Words)

	she	ride	bike	he	scooter	park	my	father	drive	motorcycle
She	1	0	0	0	0	0	0	0	0	0
Ride	0	1	0	0	0	0	0	0	0	0
Bike	0	0	1	0	0	0	0	0	0	0



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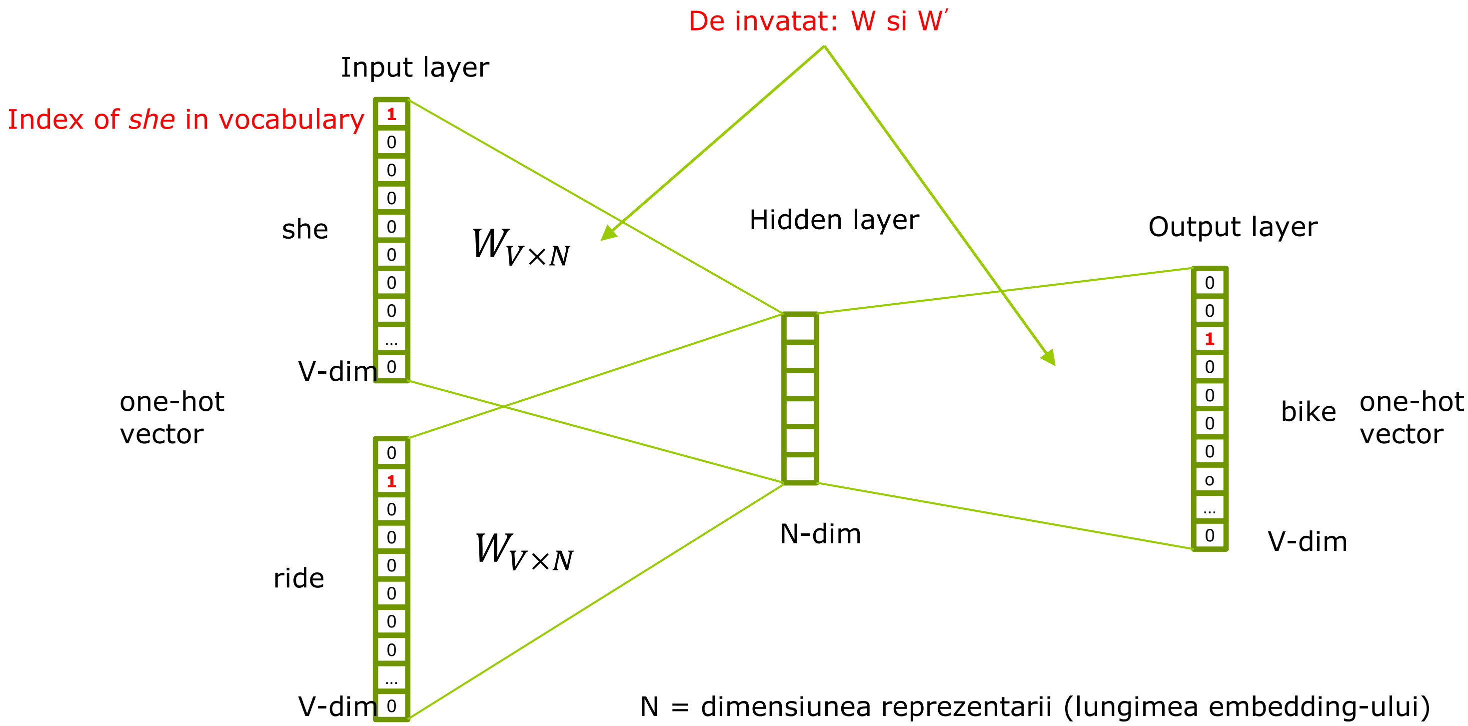

N = dimensiunea reprezentarii (lungimea embedding-ului)

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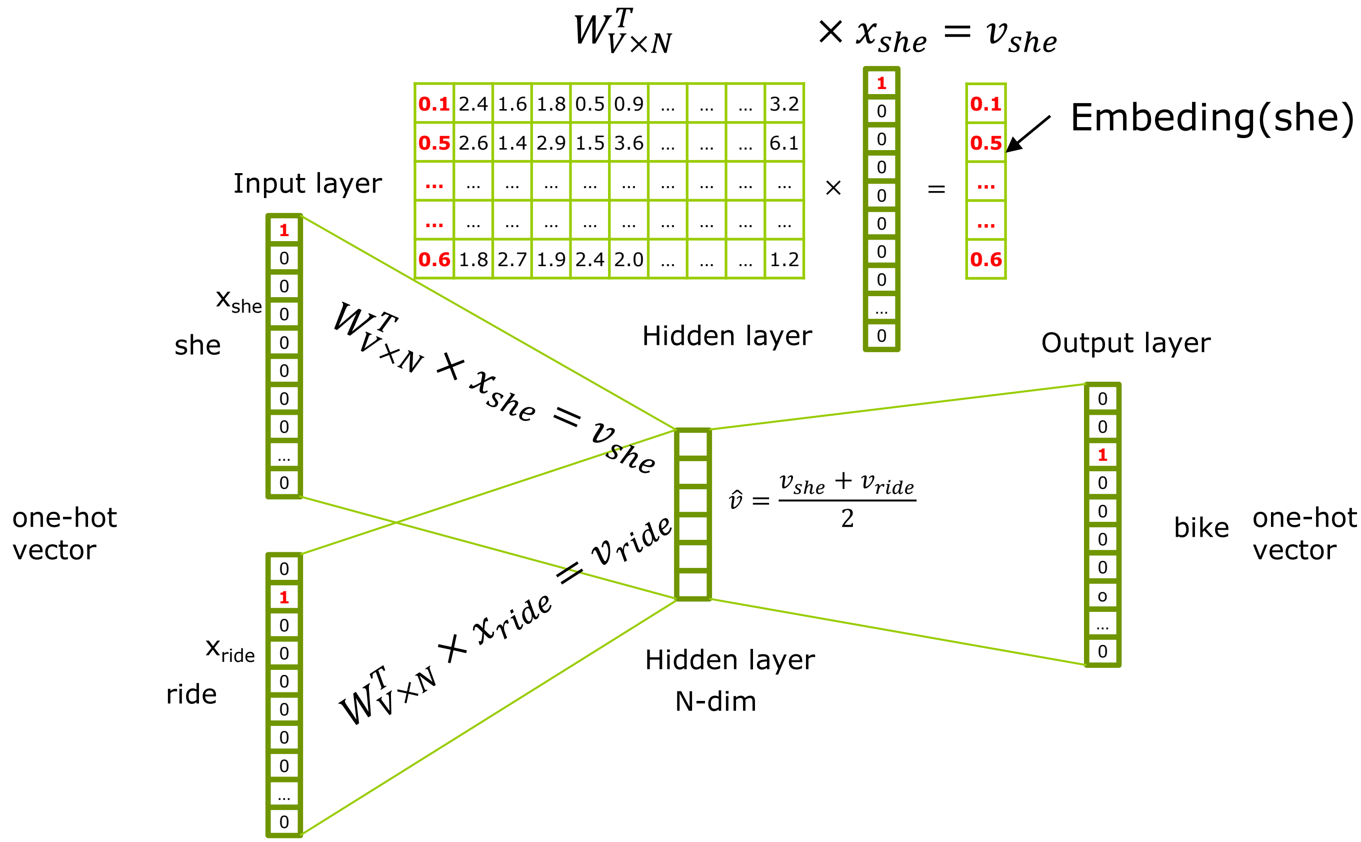

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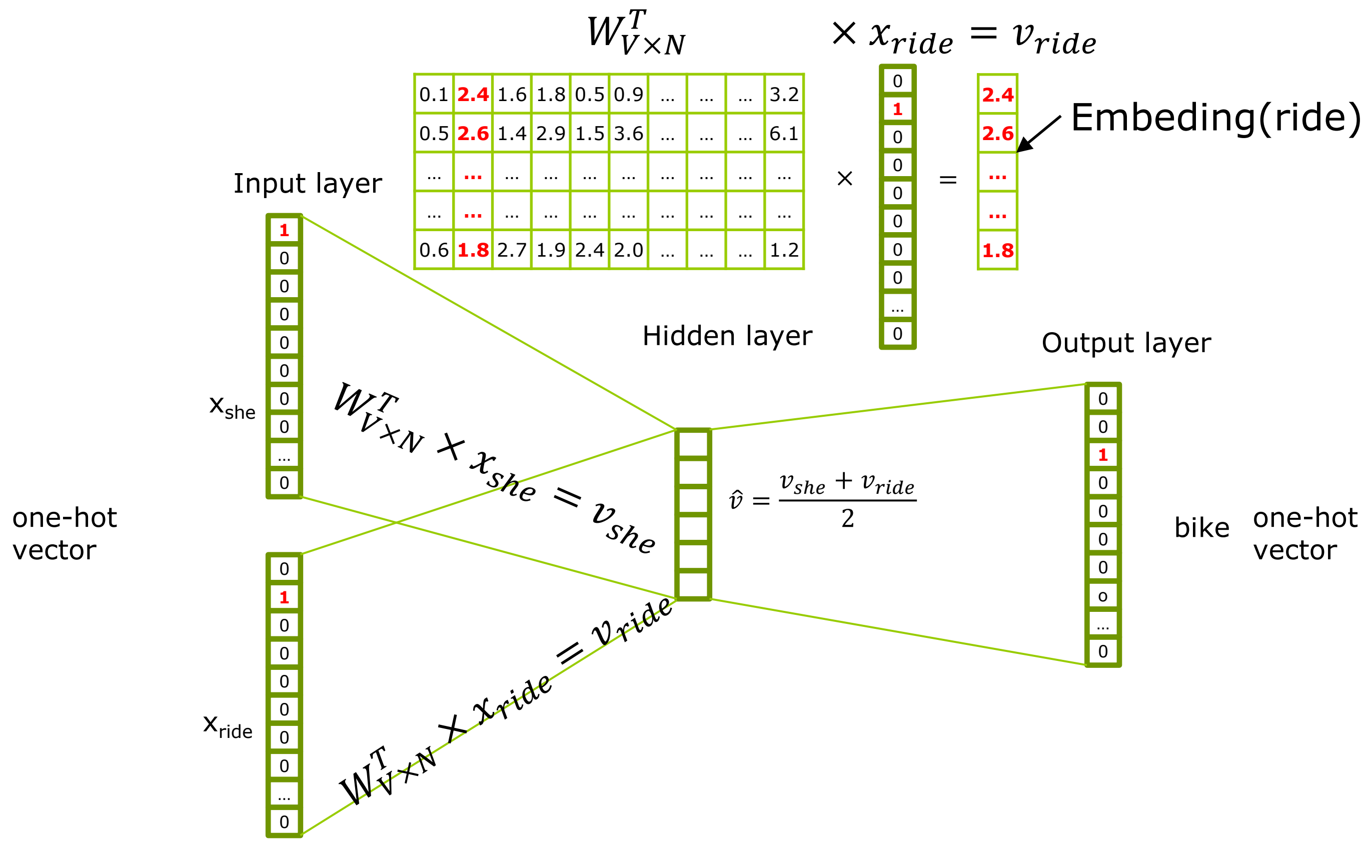

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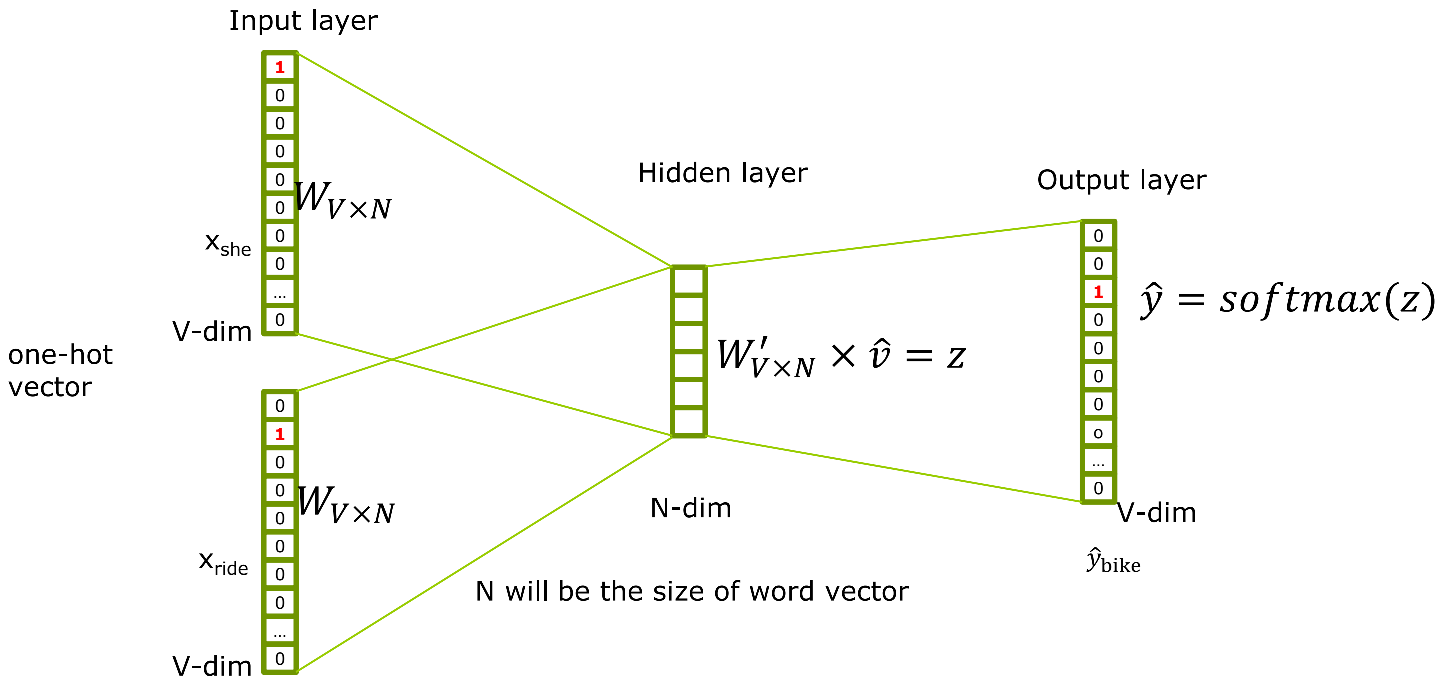

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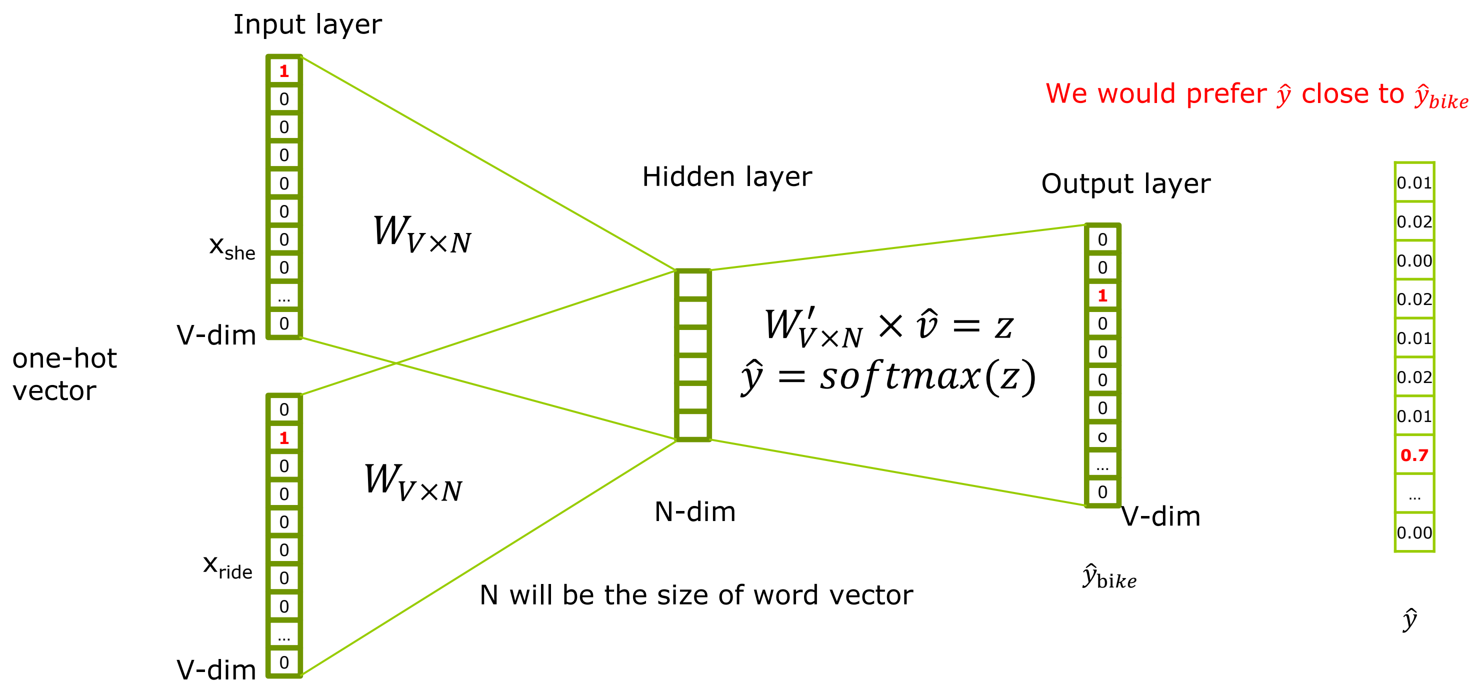

Cursul următor

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- Informaţiile prezentate au fost colectate din diferite surse de pe internet, precum şi din cursurile de inteligenţă artificială ţinute în anii anteriori de către:
  - Conf. Dr. Mihai Oltean – www.cs.ubbcluj.ro/~moltean
  - Lect. Dr. Crina Groşan - www.cs.ubbcluj.ro/~cgrosan
  - Prof. Dr. Horia F. Pop - www.cs.ubbcluj.ro/~hfpop
  - Prof. Dr. Radu Ionescu - https://raduionescu.herokuapp.com/