Optical Character Recognition (OCR)

- CV

  Tesseract 3 (A*)
  Binarizuje, naporcuje obrazok na kúsky a snaží sa z nich poskladat symboly

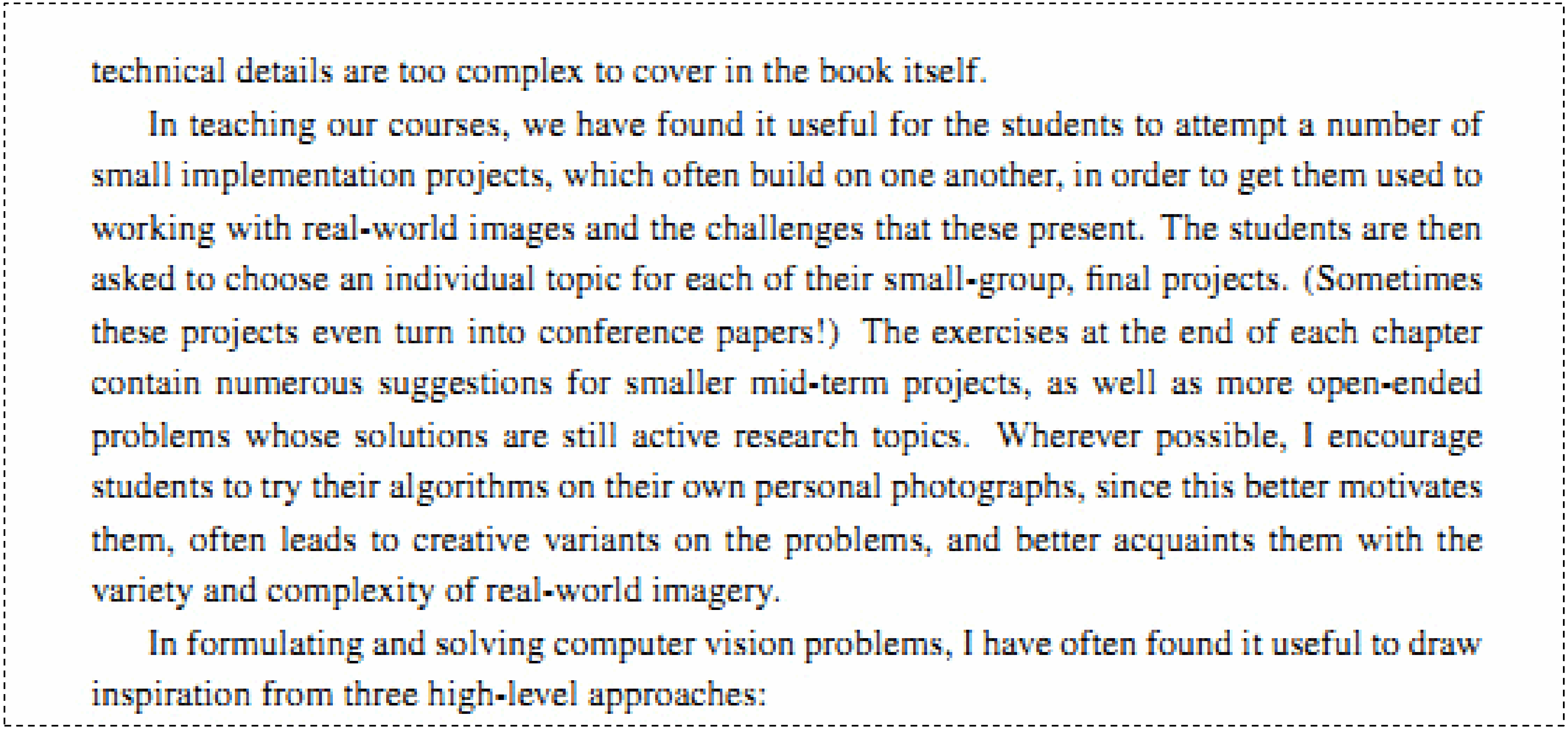
- CNN+RNN

  Pre každý pixel povie pravdepodobnosť že je súčasťou textu, z oblastí z vysokou pravdepodobnosťou spraví obdĺžniky a tieto rozpoznáva rekurentnou neurónovou sieťou

- Holistic

  Zákoduje obraz na príznakovú mapu a z nej generuje texty (transformer typu encoder-decoder)

Vstup



technical details are too complex to cover in the book itself.

In teaching our courses, we have found it useful for the students to attempt a number of small implementation projects, which often build on one another, in order to get them used to working with real-world images and the challenges that these present. The students are then asked to choose an individual topic for each of their small-group, final projects. (Sometimes these projects even turn into conference papers!) The exercises at the end of each chapter contain numerous suggestions for smaller mid-term projects, as well as more open-ended problems whose solutions are still active research topics. Wherever possible, I encourage students to try their algorithms on their own personal photographs, since this better motivates them, often leads to creative variants on the problems, and better acquaints them with the variety and complexity of real-world imagery.

In formulating and solving computer vision problems, I have often found it useful to draw inspiration from three high-level approaches:

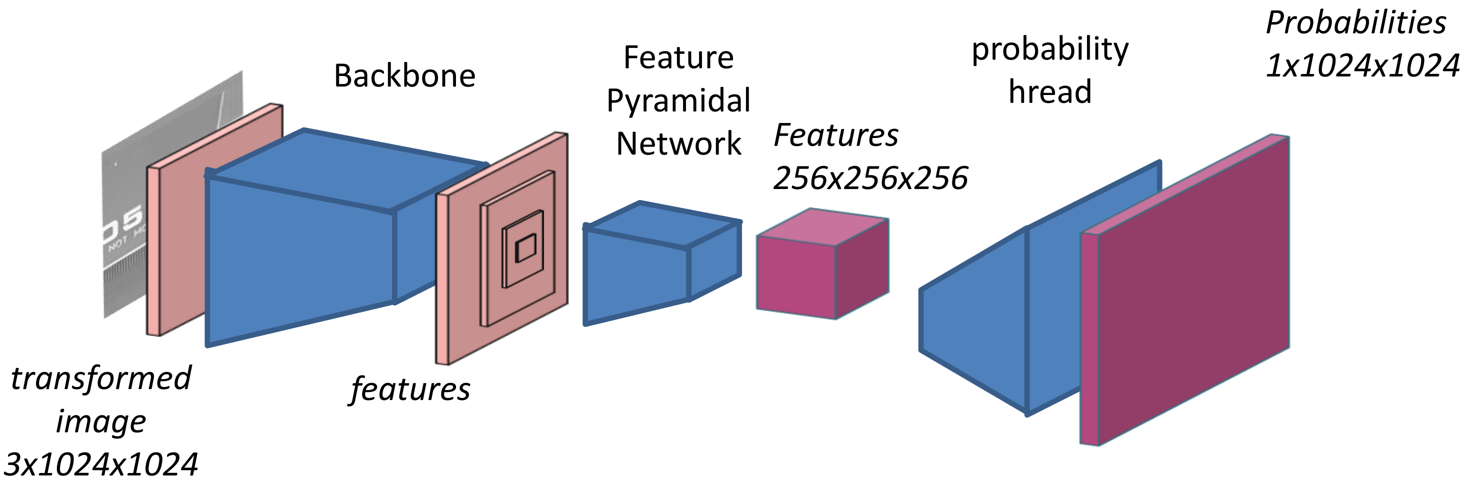
CNN+RNN

OCR tohto druhu sa skladá z dvoch hlbokých modelov:

- Detektor textu (konvolučná sieť)
- Rozpoznávač textu (dvojsmerná rekurentná sieť)

Výstup prvého je z výstupom druhého prepojený algoritmami klasického počítačového videnia

Detektor textu



Backbone

Feature
Pyramidal
Network

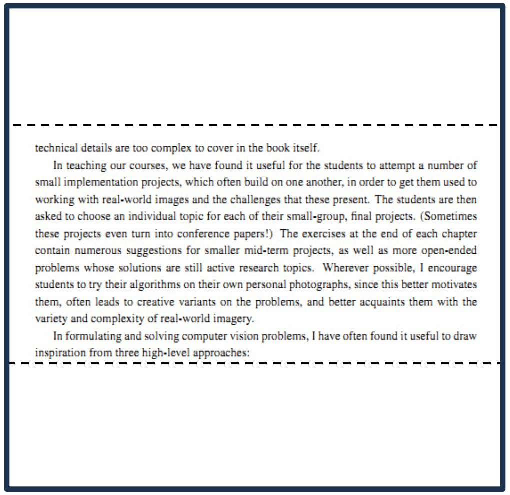
Features
256x256x256

probability
hread

Probabilities
1x1024x1024

transformed
image
3x1024x1024

features



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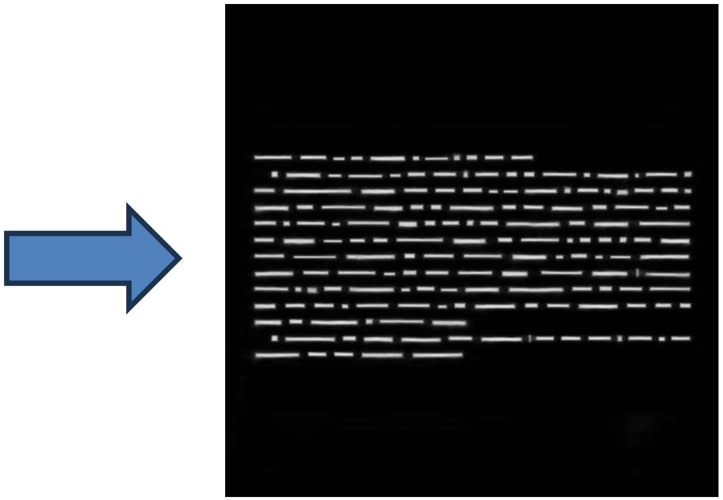
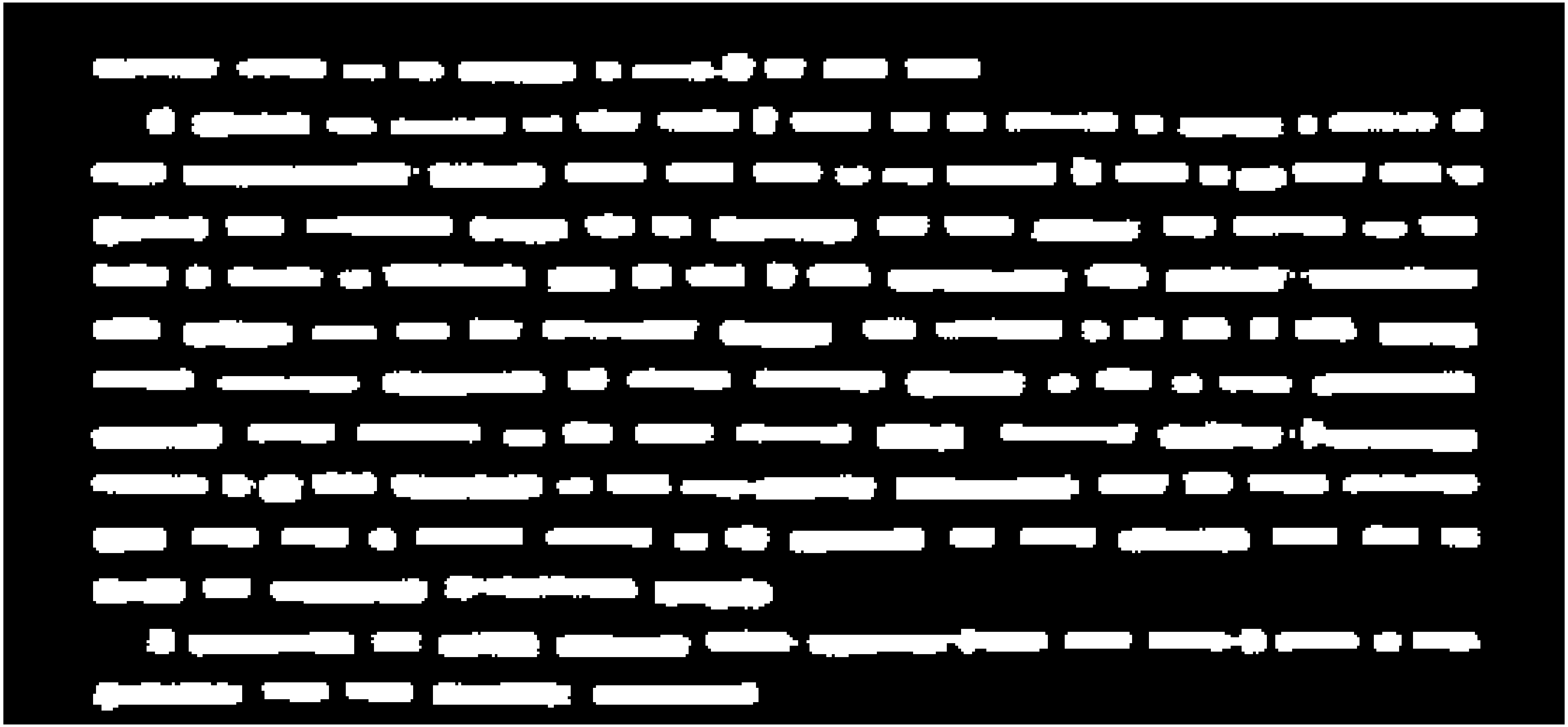
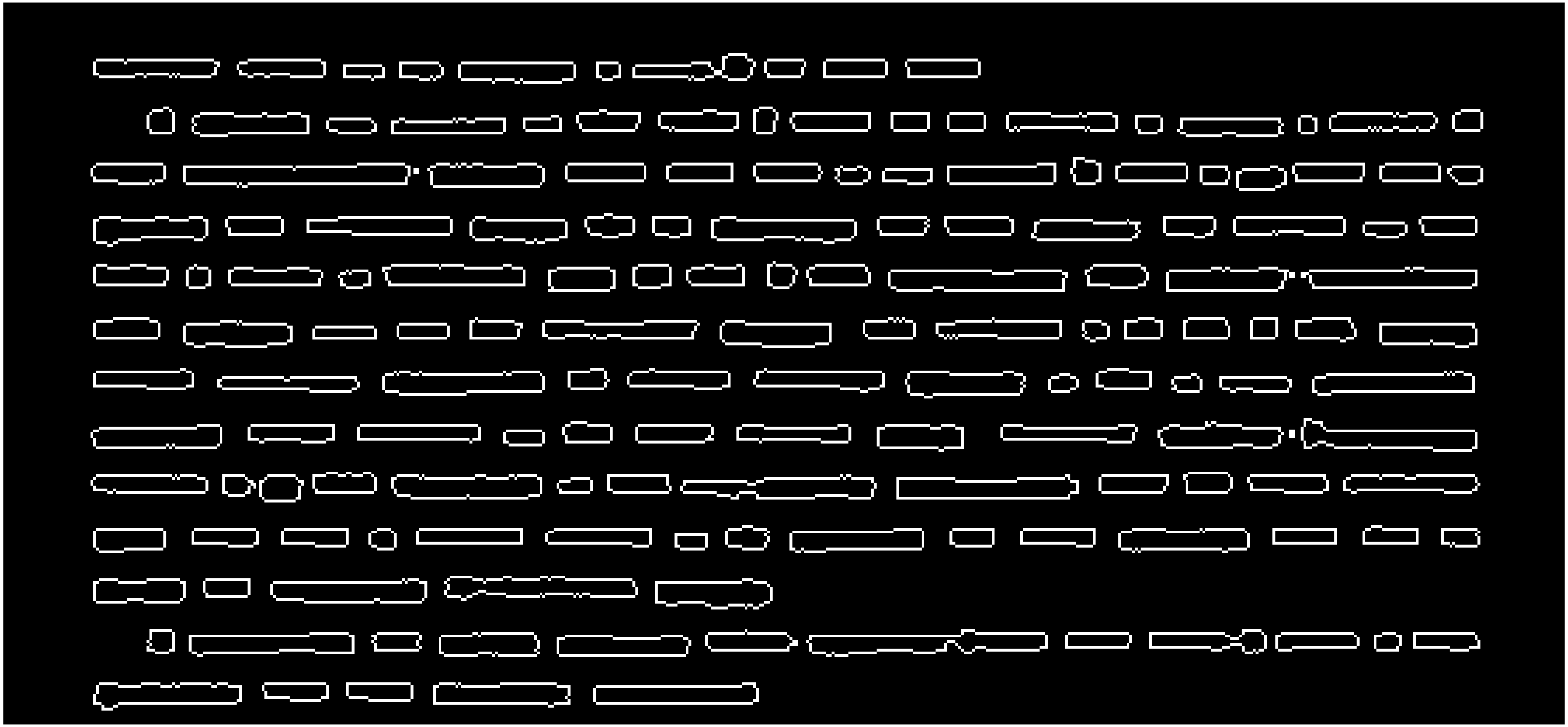


Výstup detektora

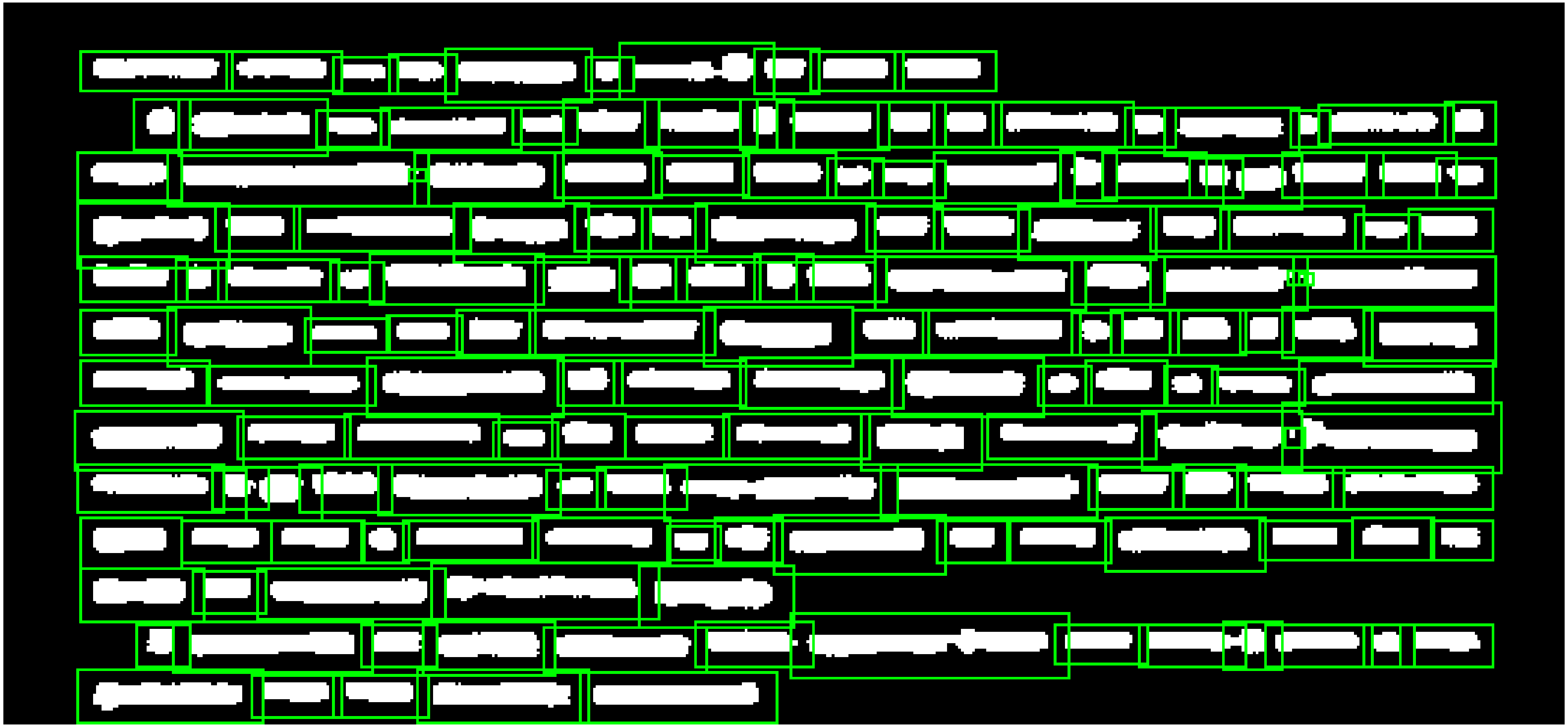


Kontúry



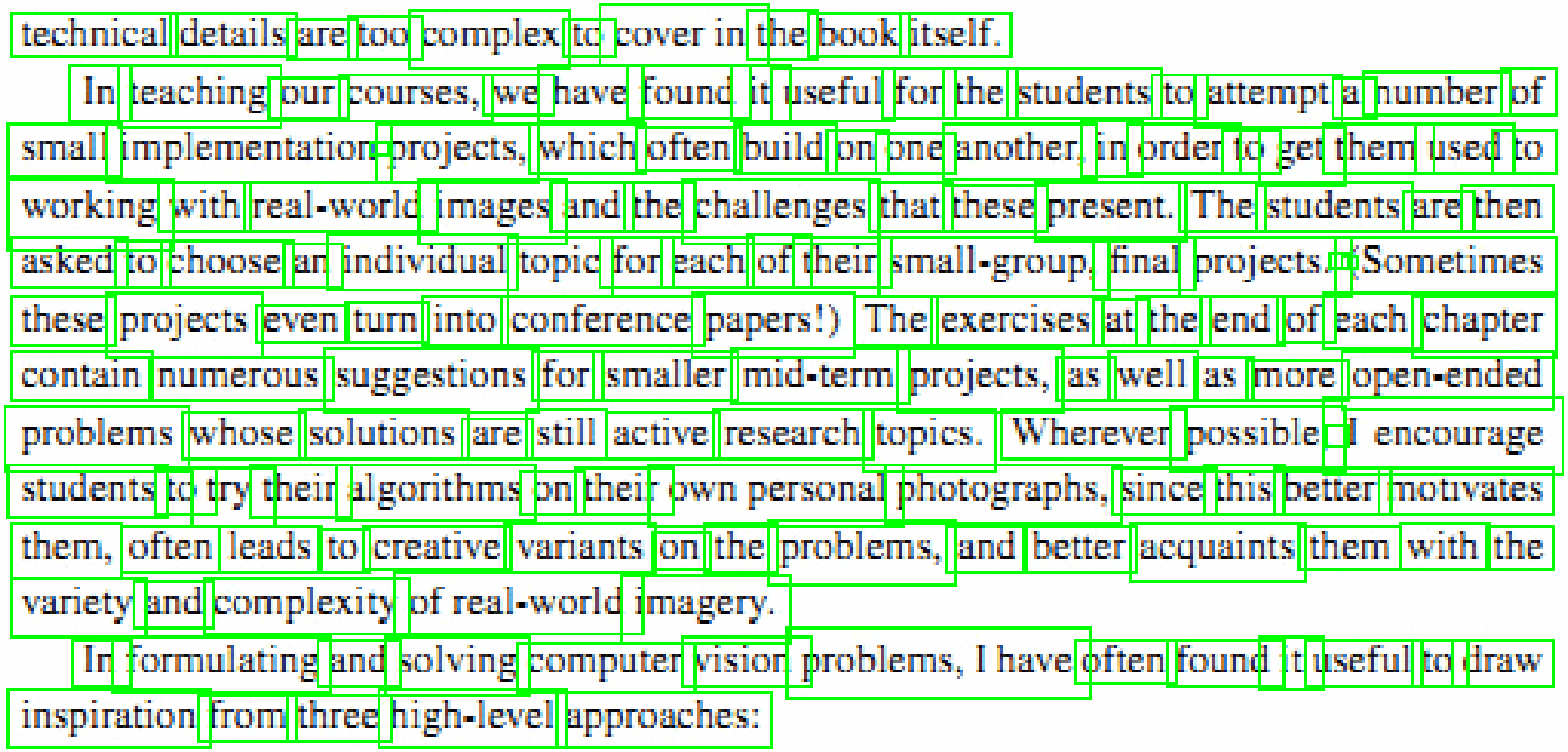
Kontúry môžeme aproximovať štyrmi alebo viacerými bodmi

Obdĺžniky alebo Polygóny



Pritom oblasti zodpovedajúco zväčšíme, aby sme zachytili celý text

Výsledok spracovania detekcie



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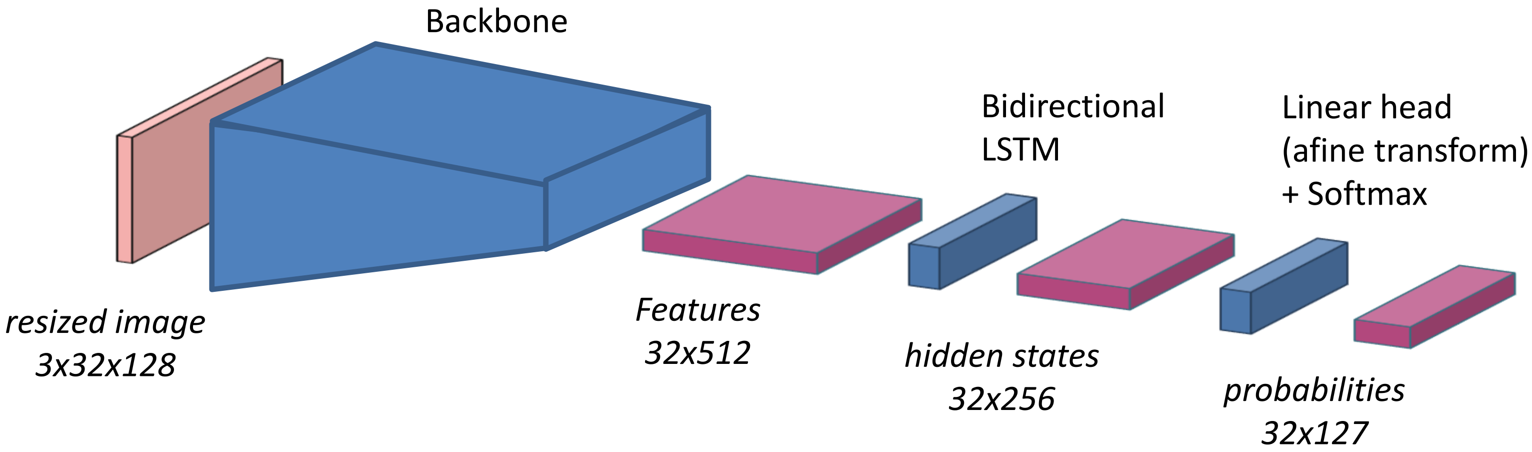
Každý obĺžnik či polygón vyjmene z textu a budeme rozpoznávať

Rozpoznávač



Backbone

Bidirectional
LSTM

Linear head
(afine transform)
+ Softmax

resized image
3x32x128

Features
32x512

hidden states
32x256

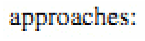
probabilities
32x127

vocab (126 characters):

0123456789abcdefghijklmnopqrstuvwxyzABCD
EFGHIJKLMNOPQRSTUVWXYZ!"#$%&'()*+,-
./:;<=>?@[\]^_`{|}~°£€¥¢ö
àâéèêëîïôùûüçÀÂÉÈÊËÎÏÔÙÛÜÇ

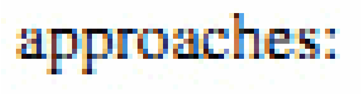
Rozpoznávanie

- Vyrežeme kúsok textu



approaches:

- Upravíme jeho veľkosť na 32x128



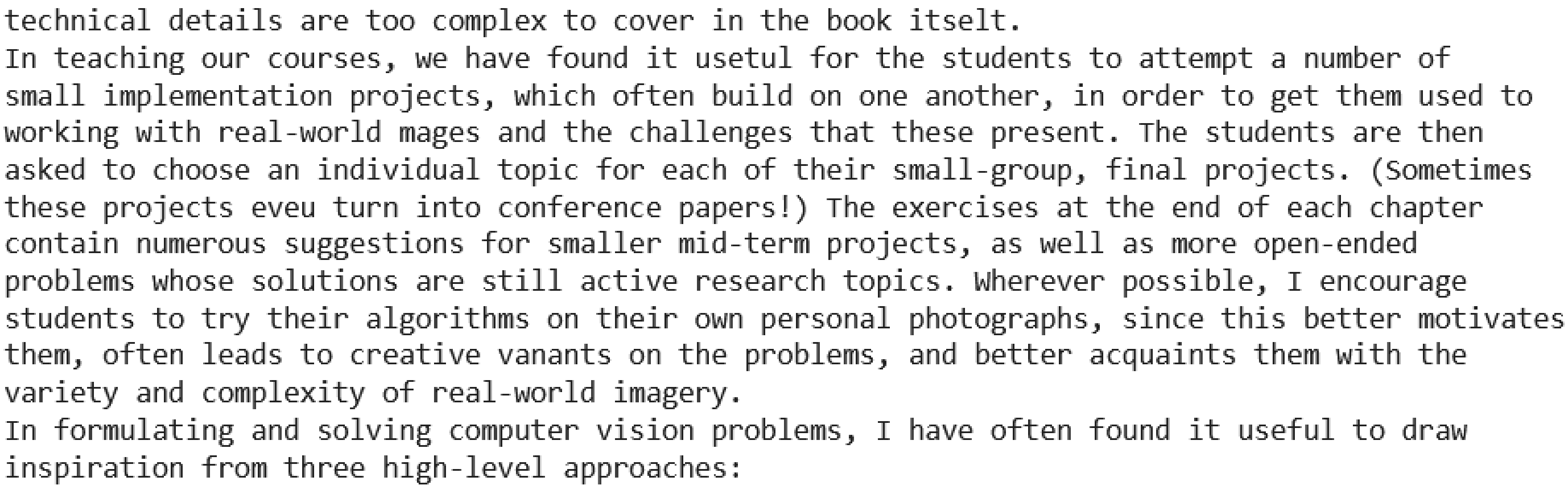
approaches:

- Tento obraz premeníme na mapu príznakov 32x512
- Tú dekódujeme cez LSTM (typ RNN) na skryté stavy 32x256
- Lineárnou hlavou ich premeníme na 32xN logitov, kde N je počet znakov + 1 (BLANK), aplikujeme softmax
- Cez CTC z pravdepodobností vyberieme symboly

Problém s rýchlosťou

- Dvojsmerná (bidirectional) RNN je schopná pracovať na texte rôznej dĺžky (je naťahovacia)
- Ale nevie pracovať na textoch rôznej dĺžky naraz v jednej dávke
- Preto DocTR radšej naseká texty tak, aby mali menej ako 32 symbolov a používame rovnako veľký vstup 3x32x128
- (Ale Pytorch vie pustiť rôzne dĺžky naraz, akurát vyžaduje aby bola dávka utriedená podľa dĺžky zostupne takže treba urobiť správnu permutáciu)

Výstup



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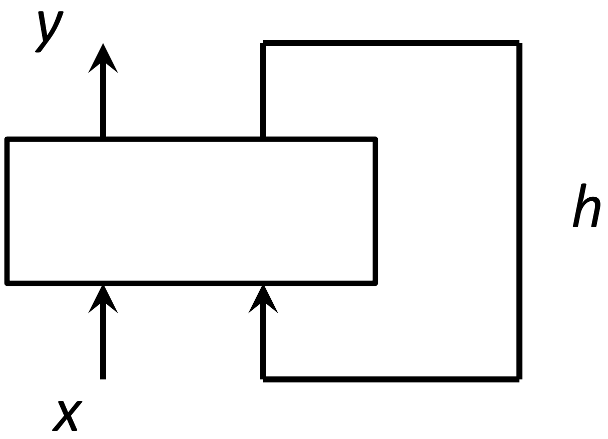
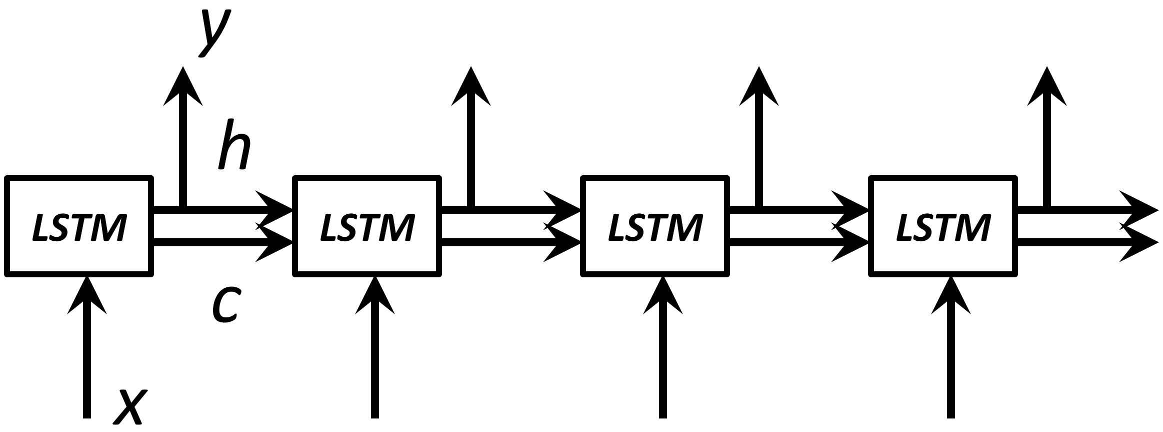
Rekurentná neurónová sieť

- Sieť inšpirovaná spracúvaním postupnosti dát v čase
- V každom okamihu dostáva nový vstup, dáva nový výstup a skrytý stav sa zapamätá a bude pridaný na vstup v ďalšom okamihu



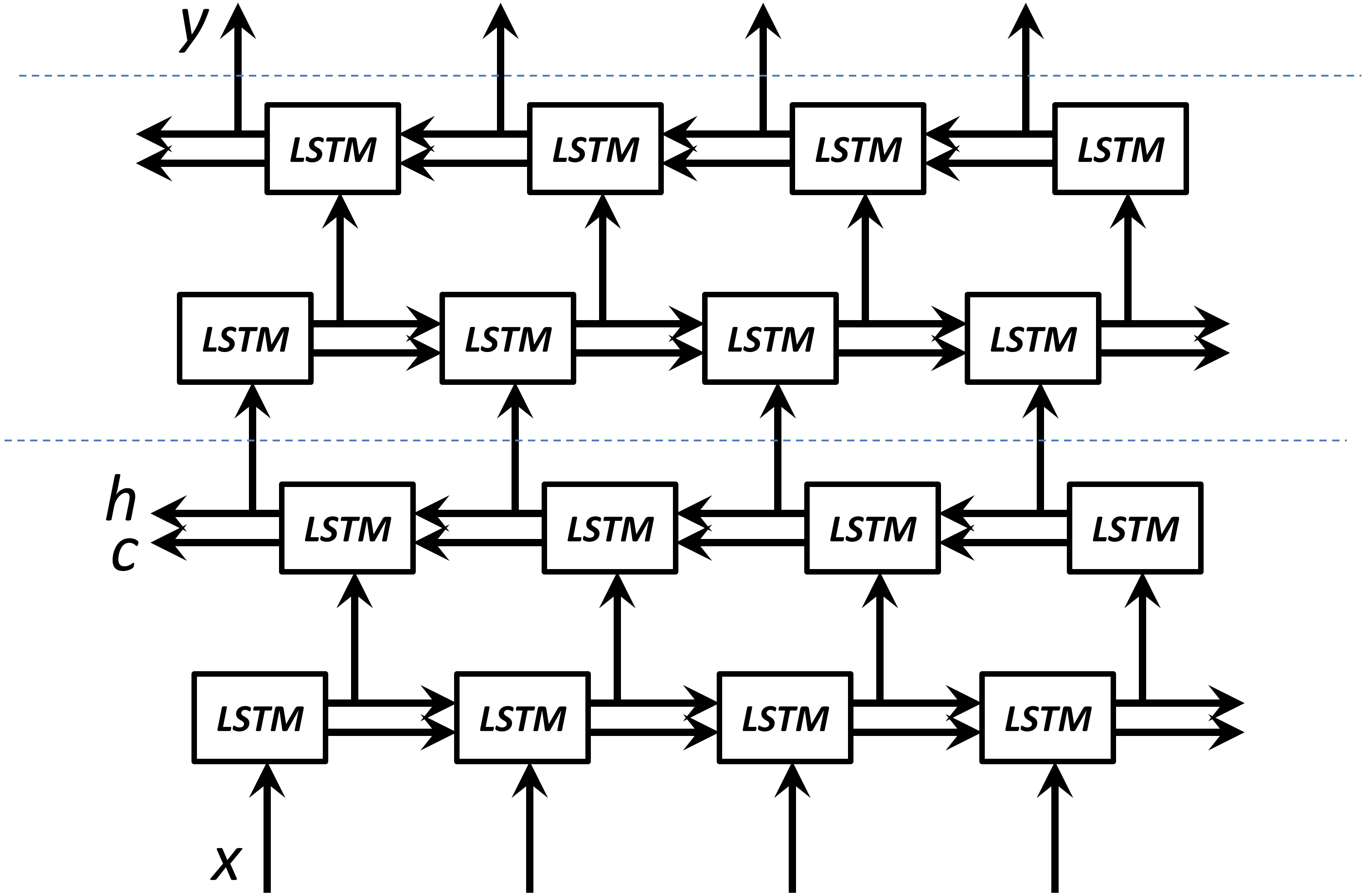
RNN

- Reálne sa nepúšťa na dáta postupne v čase, ale na konci naraz



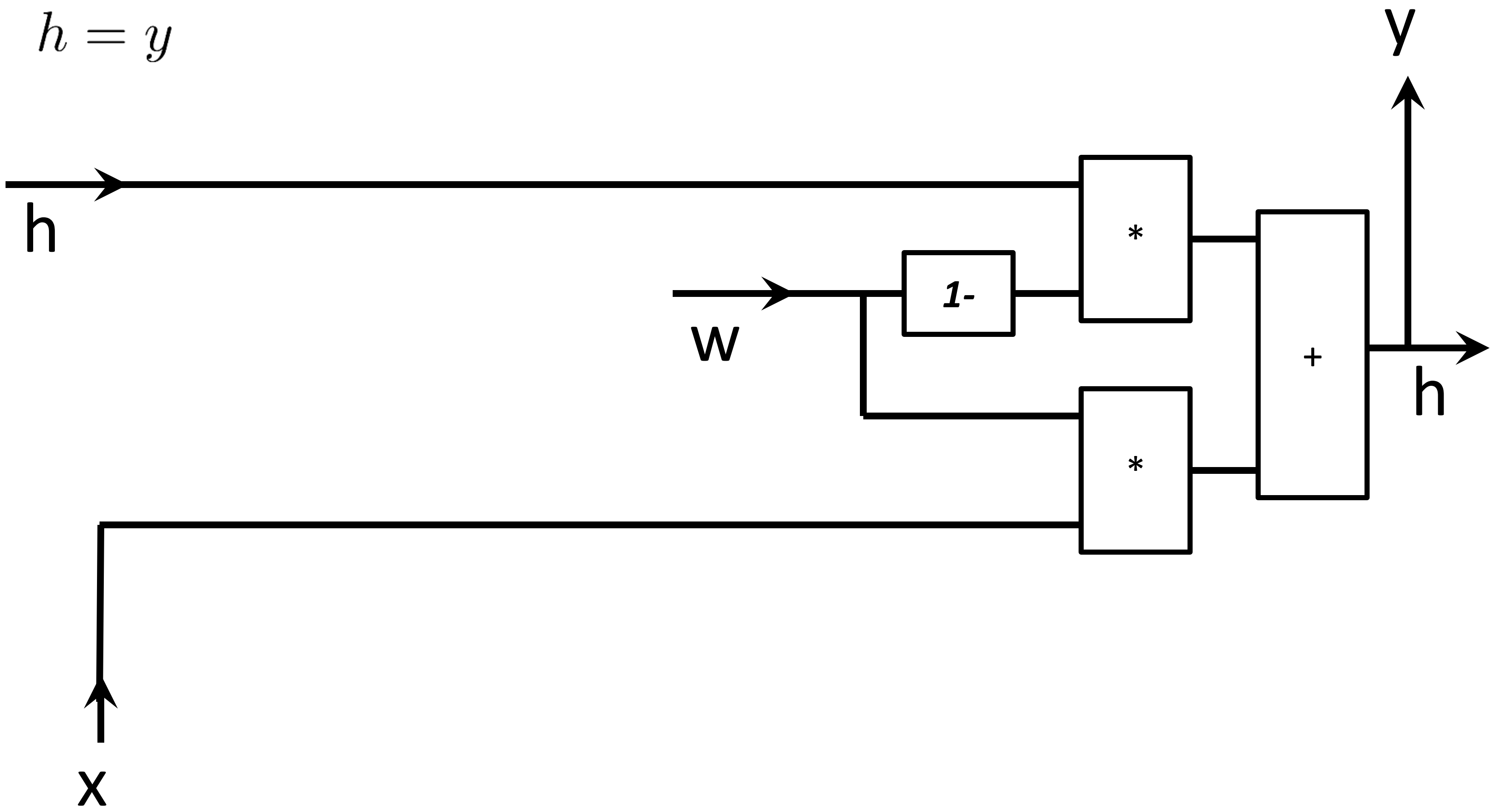
- počet LSTM modulov je daný dĺžkou vstupu

Bidirectional RNN

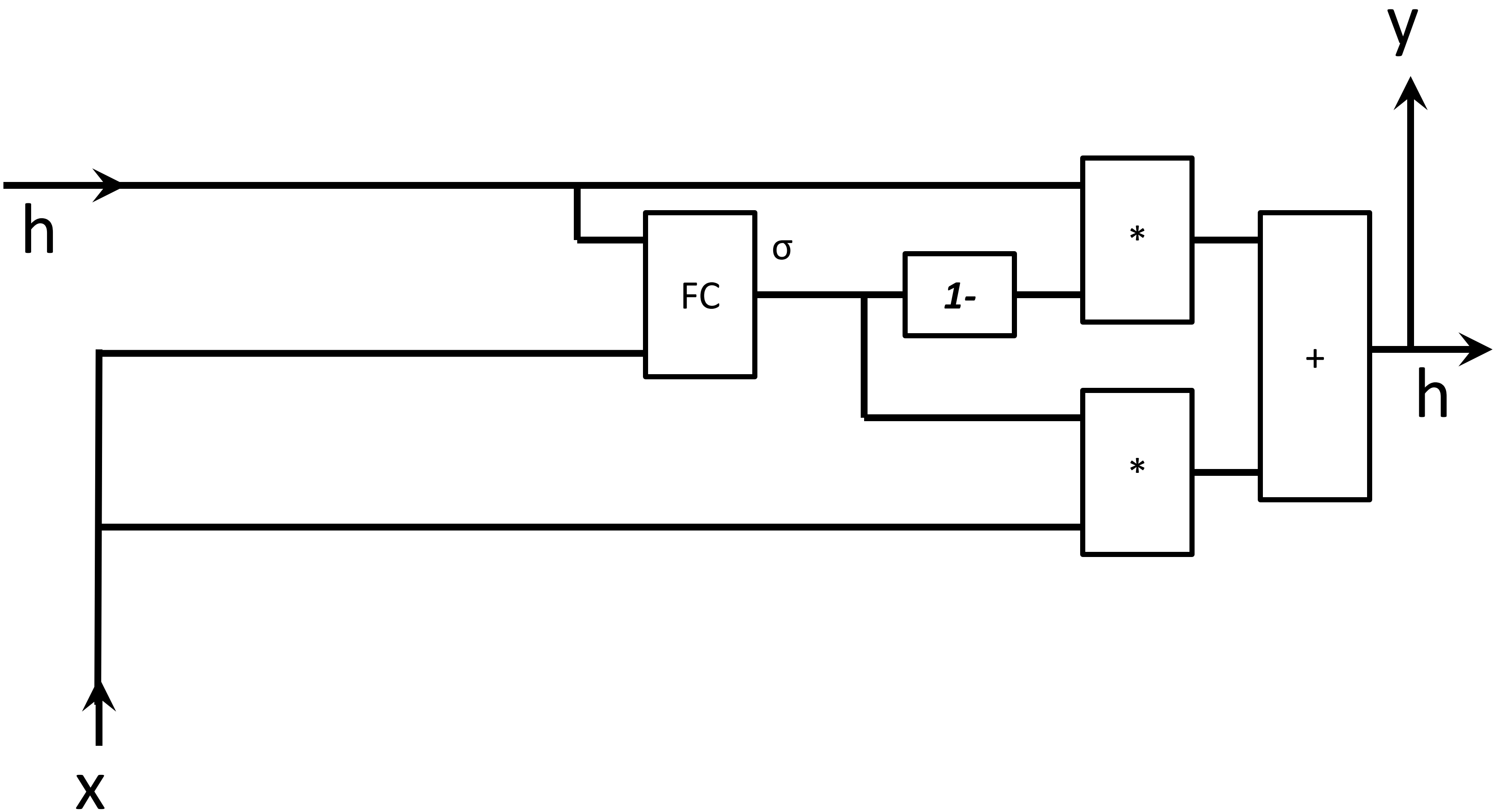


```
x: -1,-1,-1,-1,-1,-1,1,1,1,1,-1,1,1,1,1,1,1,-1,1,1,1,1,1…
y: 0,-0.4,-0.7,-0.9,-1,-0.9,-0.7,-0.4,0.1,0.5,0.9,1,1,1,1,…
```

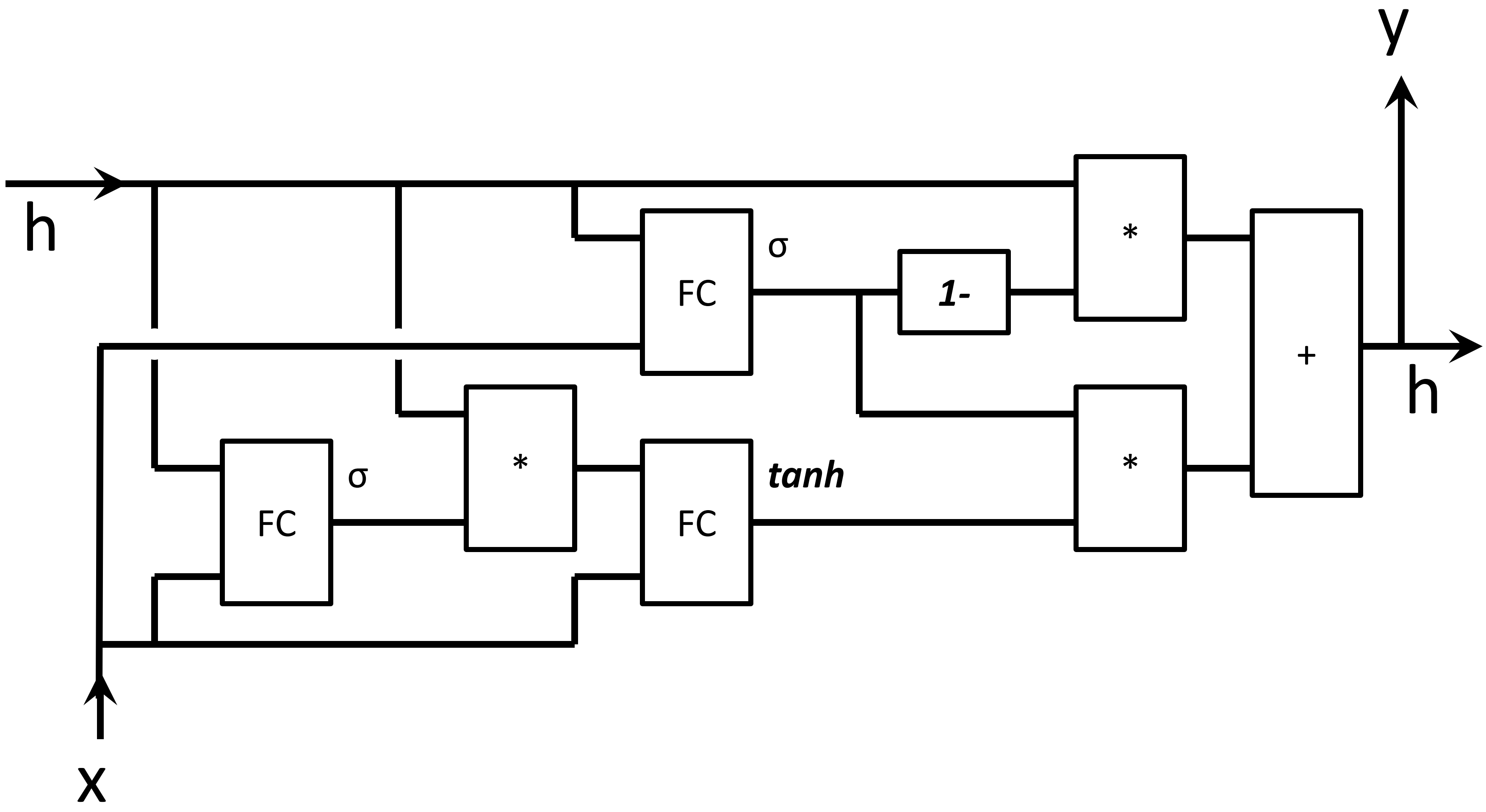
$$y = wx + (1 - w)h$$
$$h = y$$



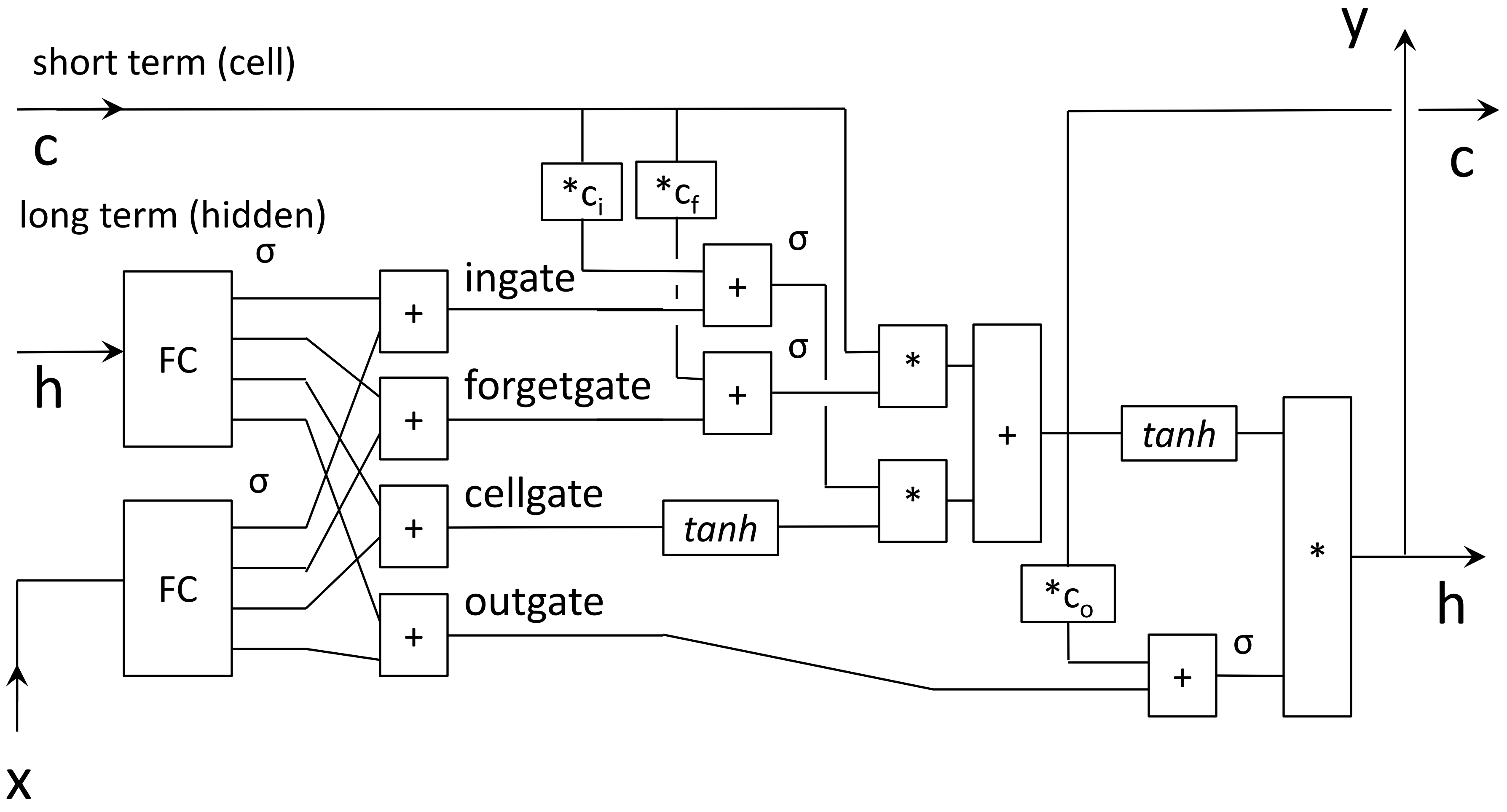
dimension of x, y and h can be > 1


y
h
σ
FC
1-
*
+
*
h
x

Gated recurrent unit (GRU)



Long Short-Term Memory (LSTM)



Connectionist Temporal Classification (CTC)

- Chybová funkcia
- Počíta sumu pravdepodobností pre všetky možné zarovnania
- Zarovnanie je cesta cez tenzor pravdepodobností, ktorá pod odstránení BLANKu dáva požadovanú sekvenciu; pravdepodobnosť cesty je súčinom pravdepodobností krokov
- Počíta sa efektívne cez dynamické programovanie

Connectionist Temporal Classification (CTC)

- Ako vedľajší produkt vie vypočítať najpravdepodobnejšiu cestu, takže ju je možné použiť aj na dekódovanie pri inferencii (beam search)
- Po natrénovaní však celkom dobre funguje aj greedy: pre každý výstup sa vezme najpravdepodobnejší symbol
- Rozdiel: beam nájde cestu s najväčším súčinom pravdepodobností, greedy s najväčším súčtom