OSTRAVSKÁ UNIVERZITA

# DIPLOMOVÁ PRÁCE

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OSTRAVSKÁ UNIVERZITA
PŘÍRODOVĚDĚCKÁ FAKULTA
KATEDRA INVOFMATINY A POČITAČŮ

# Celularní neuronové sítě

Diplomová práce

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UNIVERSITY OF OSTRAVA
FACULTY OF SCIENCE
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# Cellular neural networkse

Diploma thesis

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2018

Detail tématu čekajícího na realizaci

| | |
|---|---|
| Katedra: | *Katedra informatiky a počítačů* |
| Obor: | |
| Název VŠKP: | *Celulární neuronové sítě* |
| Anglický překlad názvu: | *Cellular neural networks* |
| Typ práce: | *diplomová (Nav.)* |
| Vedoucí práce: | Volná, Eva |
| Pokyny pro vypracování: | 1. Rešerše problematiky celulárních neuronových sítí a jejich zařazení do oblasti umělých neuronových sítí a celulárních automatů s důrazem na jejich aplikaci.<br>2. Výběr vhodného problému a jeho implementace.<br>3. Zhodnocení výsledků experimentální části.<br>4. Zhodnocení přínosu práce. |
| Doporučená literatura: | Chua, L. O., Yang, L., Cellular Neural Networks: theory. IEEE Transactions on Circuits and Systems, Vol.35, No.10, 1988, pp. 1257-1272.<br>Chua, L. O., Yang, L., Cellular Neural Networks: Applications. IEEE Transactions on Circuits and Systems, Vol.35, No.10, 1988, pp. 1273-1290.<br>Dolan, R., DeSouza, G. GPU-based simulation of cellular neural networks for image processing, IJCNN, pp.730-735, 2009 International Joint Conference on Neural Networks, 2009.<br>Yang, T. Cellular Neural Networks and Image Processing. Nova Science Publishers, 2002. |

## Abstrakt

Abstrakt v prvním jazyce

**Klíčová slova:** Klíčová, slova

## Abstract

Abstract in the second language

**Key Words:** Key, words

Já, níže podepsaný student, tímto čestně prohlašuji, že text mnou odevzdané závěrečné práce v písemné podobě i na CD nosiči je totožný s textem závěrečné práce vloženým v databázi DIPL2.

Prohlašuji, že předložená práce je mým původním autorským dílem, které jsem vypracoval samostatně. Veškerou literaturu a další zdroje, z nichž jsem při zpracování čerpal, v práci řádně cituji a jsou uvedeny v seznamu použité literatury.

V Ostravě dne 2. 4. 2018 ......................

podpis

# Contents

# 1 Introduction

## 1.1 Objectives

- Study of the Cellular neural network field with focus on its application.
- Selection of proper application and its implemantation.
- Selection of the documentation structure for theexperimental part of the work.
- Evaluation of the experimental part of the work.
- Evaluation of added value of the thesis.

# 2 Implementations

## 2.1 UI elements

# 3 Experiments

This chapter will deal with the examples of experiments plausible with this work. Each of the following reports contains description, parameters and results of a given experiment.

## 3.1 Common properties.

Following experiments are using several common properties in setup, in order to keep the reports clear all go over them here.
**Input:** inputs are general gonna be ether gray-scale pictures or binary ones with the values -1/1.
**Boundary conditions:** Boundary conditions defines the networks behavior on the edges of the picture. Two of them are used, Fixed where the outline of the picture is "surrounded" by fixed value, or Flux where the edge pixels are copied outwards.
**Initial output:** this setting states the initial values of output matrix, commonly its not an important since the calculations are not working with it. but i some experiments its set to some picture or other specific value.

## 3.2 Edge detection in gray-scale picture.

### 3.2.1 Description

This example shows the ability to use Cellular neural networks to find edges of different objects in grey-scale picture. It uses a grey-scale picture as an input, matrix setting shown bellow(1) and fixed value boundary condition to produce a binary picture with the edges.

### 3.2.2 Setup

**Input:** Grayscale picture.
**Boundary conditions:** Flux.
**Initial output:** Unimportant (all zeros)

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 0 \end{bmatrix} B = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix} Z = -0.5 \tag{1}$$

Figure 1: Chosen values of A,B and Z for this experiment

### 3.2.3 Results

Figure 2 show input used in this example, it is a picture with several objects of different shade of grey. The Figure 3 shows typical result of this experiment. This functionality is based on removing all pixels that have all only pixels with the same color around them.

Figure 2: Input

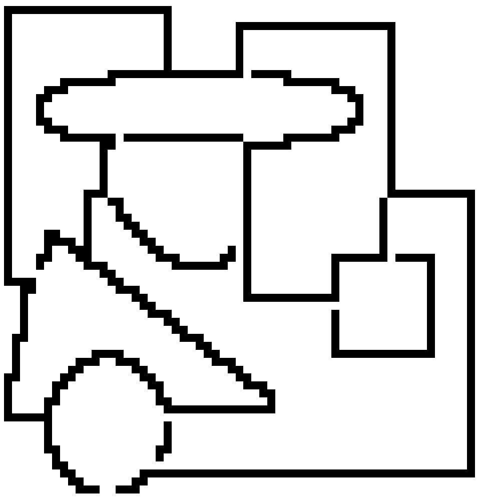

Figure 3: Output

## 3.3 Directional deletion.

### 3.3.1 Description

This example shows the ability to use Cellular neural networks to delete lines in specific directions. It uses a binary picture as an input, matrix setting shown bellow and fixed value boundary condition to produce a binary picture with the edges.

### 3.3.2 Setup

**Input:** Binary picture.
**Boundary conditions:** Fixed.
**Initial output:** Unimportant (all zeros)

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} B = \begin{bmatrix} 0 & 0 & 0 \\ -1 & 1 & -1 \\ 0 & 0 & 0 \end{bmatrix} Z = -2 \tag{2}$$

Figure 4: Chosen values of A,B and Z for horizontal deletion

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} B = \begin{bmatrix} 0 & -1 & 0 \\ 0 & 1 & 0 \\ 0 & -1 & 0 \end{bmatrix} Z = -2 \tag{3}$$

Figure 5: Chosen values of A,B and Z for vertical deletion

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} B = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} Z = -2 \tag{4}$$

Figure 6: Chosen values of A,B and Z for top left diagonal deletion

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} B = \begin{bmatrix} 0 & 0 & -1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix} Z = -2 \tag{5}$$

Figure 7: Chosen values of A,B and Z for top right diagonal deletion

### 3.3.3 Results

This functionality works by deleting pixel if there is any other pixel right next to it in chosen direction. Bellow you can see the input used for this experiment and the standard outputs for the several directions mention above.

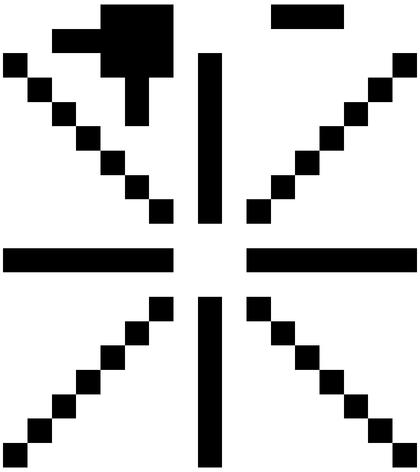

Figure 8: Input

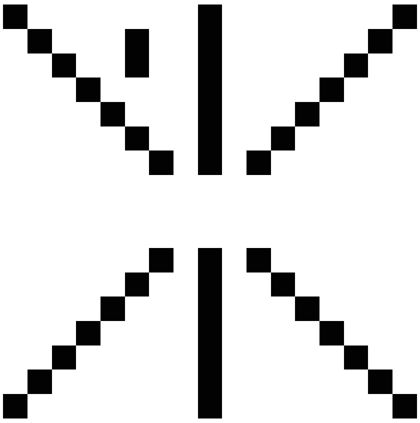

Figure 9: Horizontal deletion

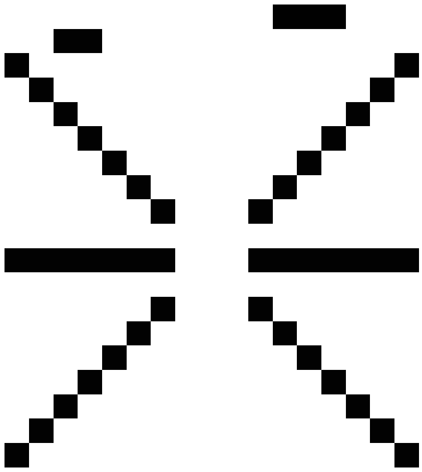

Figure 10: Vertical deletion

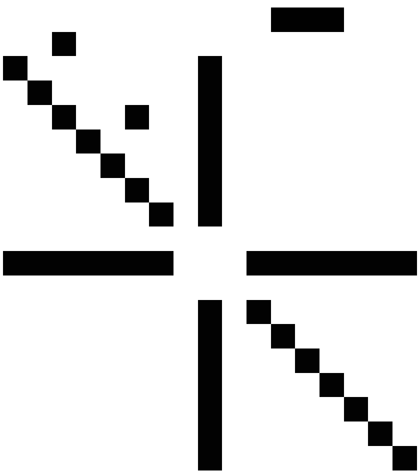

Figure 11: Top right diagonal deletion

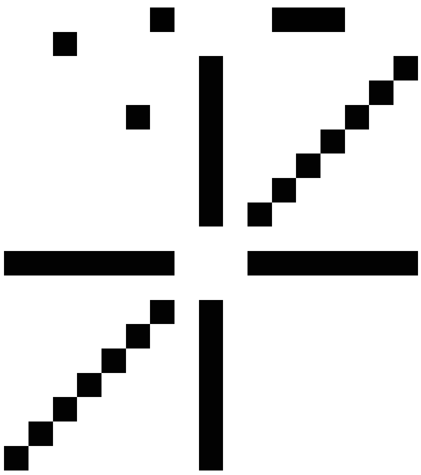

Figure 12: Top left diagonal deletion

## 3.4 Average.

### 3.4.1 Description

This example shows the ability to use Cellular neural networks to produce a binary representation of grey-scale picture base on the average of the pixels. It uses a binary picture as an input, matrix setting shown bellow and fixed value boundary condition to produce a binary picture with the edges.

### 3.4.2 Setup

**Input:** Unimportant (all zeros)
**Boundary conditions:** Fixed.
**Initial output:** Grey-scale picture

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 0 \end{bmatrix} B = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} Z = 0 \tag{6}$$

Figure 13: Chosen values of A,B and Z for this experiment

### 3.4.3 Results

Figure 14: Input

Figure 15: Output

# Resumé

Resumé v prvním jazyce

# Summary

Summary in the second language

# References

[1] *Ryanne Dolan and Guilherme DeSouza* GPU-Based Simulation of Cellular Neural Networks for Image Processing, 2009, International Joint Conference on Neural Networks, 2009.