ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

FAKULTA INFORMAČNÍCH TECHNOLOGIÍ

ZADÁNÍ BAKALÁŘSKÉ PRÁCE

Název: Detekce objektů v ptačích hnízdech pomocí neuronových sítí
Student: Jan Havlůj
Vedoucí: Ing. Josef Pavlíček, Ph.D.
Studijní program: Informatika
Studijní obor: Softwarové inženýrství
Katedra: Katedra softwarového inženýrství
Platnost zadání: Do konce letního semestru 2017/18

Pokyny pro vypracování

Navrhněte a implementujte knihovnu umožňující zpracovávat data z kamery umístěné v hnízdě (ptačí budce) s cílem rozpoznat počet vajec v hnízdě. Pro rozpoznání použijte
existující algoritmy umělé inteligence využívající data získaná ze serveru PtaciOnline.cz a další sw. nástroje projektu BirdObserver (athena.pef.czu.cz).

Postupujte v těchto krocích:
1. Proveďte detailní specifickaci požadavků.
2. Seznamte se s projektem BirdObserver a strukturou dat na serveru PtáciOnline.cz.
3. Proveďte analýzu a návrh knihovny.
4. Návrh implementujte, zdokumentujte a vhodným způsobem otestujte.
5. Knihovnu navrhněte a implementujte v jazyce Java tak, aby bylo možné ji formou závislostí (dependency) integrovat s ostatními nástroji projektu BirdObserver.

Seznam odborné literatury

Dodá vedoucí práce.

Ing. Michal Valenta, Ph.D.
vedoucí katedry

prof. Ing. Pavel Tvrdík, CSc.
děkan

V Praze dne 12. ledna 2017

České vysoké učení technické v Praze

Fakulta informačních technologií

Katedra softwarového inženýrství

Bakalářská práce

Detekce objektů v ptačích hnízdech pomocí neuronových sítí

Jan Havlůj

Vedoucí práce: Ing. Josef Pavlíček, Ph.D.

29. prosince 2017

Poděkování

Prohlášení

Prohlašuji, že jsem předloženou práci vypracoval(a) samostatně a že jsem uvedl(a) veškeré použité informační zdroje v souladu s Metodickým pokynem o etické přípravě vysokoškolských závěrečných prací.

Beru na vědomí, že se na moji práci vztahují práva a povinnosti vyplývající ze zákona č. 121/2000 Sb., autorského zákona, ve znění pozdějších předpisů. V souladu s ust. § 46 odst. 6 tohoto zákona tímto uděluji nevýhradní oprávnění (licenci) k užití této mojí práce, a to včetně všech počítačových programů, jež jsou její součástí či přílohou, a veškeré jejich dokumentace (dále souhrnně jen „Dílo"), a to všem osobám, které si přejí Dílo užít. Tyto osoby jsou oprávněny Dílo užít jakýmkoli způsobem, který nesnižuje hodnotu Díla, a za jakýmkoli účelem (včetně užití k výdělečným účelům). Toto oprávnění je časově, teritoriálně i množstevně neomezené. Každá osoba, která využije výše uvedenou licenci, se však zavazuje udělit ke každému dílu, které vznikne (byť jen zčásti) na základě Díla, úpravou Díla, spojením Díla s jiným dílem, zařazením Díla do díla souborného či zpracováním Díla (včetně překladu), licenci alespoň ve výše uvedeném rozsahu a zároveň zpřístupnit zdrojový kód takového díla alespoň srovnatelným způsobem a ve srovnatelném rozsahu, jako je zpřístupněn zdrojový kód Díla.

V Praze dne 29. prosince 2017   . . . .

Odkaz na tuto práci

Abstrakt

V několika větách shrňte obsah a přínos této práce v češtině. Po přečtení abstraktu by se čtenář měl mít čtenář dost informací pro rozhodnutí, zda chce Vaši práci číst.

Klíčová slova   Nahraďte seznamem klíčových slov v češtině oddělených čárkou.

Abstract

Sem doplňte ekvivalent abstraktu Vaší práce v angličtině.

Keywords   Nahraďte seznamem klíčových slov v angličtině oddělených čárkou.

Obsah

Seznam obrázků

Úvod

Cíl práce

Cíl práce

Where does it come from?

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by

Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece

of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Analýza a návrh

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during

the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum"(The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet..", comes from a line in section 1.10.32.

The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum"by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

Realizace

Závěr

Literatura

Seznam použitých zkratek

GUI Graphical user interface

XML Extensible markup language

Dokumentace API knihovny

B.1 Package org.cvut.havluja1.eggdetector

Package Contents *Page*

Classes

B.1.1 Class EggDetector

B.1.1.1 Count the number of eggs in given images

The egg detector is a library that helps you count the number of eggs in a given folder. Egg detector works by using TeonsorFlow Object Detection API in the background. To learn more, see https://www.tensorflow.com.

Example usage:

```
EggDetector eggDetector = new EggDetector();
SequenceClassifier sequenceClassifier = eggDetector.evaluate(new File("image_dir"));
System.out.println("final count: " + sequenceClassifier.getFinalCount());
System.out.println("individual scores: " + sequenceClassifier.getIndividualCounts());
eggDetector.closeSession();
```

B.1.1.2 Declaration

```
public class EggDetector
 extends java.lang.Object
```

B.1.1.3 Constructor summary

    EggDetector()
    Constructor loads the pre-trained frozen graph into memory.

B.1.1.4   Method summary

closeSession()
Closes the EggDetector session.

evaluate(File)
Runs egg detection on a given *dir*.

getMinimalConfidence()
Get the minimalConfidence setting for this instance.

isDebugMode()
Get this instance's debug mode setting.

setDebugMode(boolean)
Set this instance's debug mode setting.

setMinimalConfidence(float)
Set the minimalConfidence setting for this instance.

toString()

B.1.1.5   Constructors

- *EggDetector*

```
public EggDetector()
```

  – **D**escription
    Constructor loads the pre-trained frozen graph into memory.
    It also checks whether TensorFlow is supported on your platform.

B.1.1.6   Methods

- *closeSession*

```
public void closeSession() throws java.lang.IllegalStateException
```

  – **D**escription
    Closes the EggDetector session. This instance of EggDetector will not be usable
    again.
  – **T**hrows
    * `java.lang.IllegalStateException` – if the session has been closed already by
      calling `closeSession()`

- *evaluate*

  ```
  public SequenceClassifier evaluate(java.io.File dir) throws
      java.lang.IllegalArgumentException, java.lang.IllegalStateException
  ```

  - **D**escription
    Runs egg detection on a given *dir*.
  - **P**arameters
    * `dir` – a directory containing .jpg or .png files for object detection
  - **R**eturns –
  - **T**hrows
    * `java.lang.IllegalArgumentException` – if *dir* is not a directory or contains no images
    * `java.lang.IllegalStateException` – if the session has been closed already by calling `closeSession()`

- *getMinimalConfidence*

  ```
  public float getMinimalConfidence()
  ```

  - **D**escription
    Get the *minimalConfidence* setting for this instance.

    Minimal Confidence score is used as a confidence boundary during the process of object detection. An object that has been detected with a confidence score lower than *minimalConfidence* is ignored. An object that has been detected with a confidence score higher or equal than *minimalConfidence* is added to the final result list.
  - **R**eturns – This instance's *minimalConfidence* setting.

- *isDebugMode*

  ```
  public boolean isDebugMode()
  ```

  - **D**escription
    Get this instance's debug mode setting.

    If debug mode is enabled (set to true), the library will open a `JFrame` for each processed image with detections graphically highlighted.
  - **R**eturns – debug mode setting for this instance

- *setDebugMode*

  ```
  public void setDebugMode(boolean debugMode) throws
      java.lang.IllegalStateException
  ```

– **D**escription

Set this instance's debug mode setting.

If debug mode is enabled (set to true), the library will open a `JFrame` for each processed image with detections graphically highlighted.

– **P**arameters

  * `debugMode` – turn the debug mode on or off

– **T**hrows

  * `java.lang.IllegalStateException` – if the session has been closed already by calling `closeSession()`

- *setMinimalConfidence*

```java
public void setMinimalConfidence(float minimalConfidence) throws
    java.lang.IllegalStateException
```

– **D**escription

Set the *minimalConfidence* setting for this instance.

Minimal Confidence score is used as a confidence boundary during the process of object detection. An object that has been detected with a confidence score lower than *minimalConfidence* is ignored. An object that has been detected with a confidence score higher or equal than *minimalConfidence* is added to the final result list.

– **P**arameters

  * `minimalConfidence` – *minimalConfidence* for this instance

– **T**hrows

  * `java.lang.IllegalStateException` – if the session has been closed already by calling `closeSession()`

- *toString*

```java
public java.lang.String toString()
```

B.1.2   Class SequenceClassifier

B.1.2.1   A class containing object detection results for a given directory

SequenceClassifier is a data class containing the results of object detection for a given directory. When constructed, object detection is performed on all images and results are stored in memory.

Example usage:

```java
EggDetector eggDetector = new EggDetector();
SequenceClassifier sequenceClassifier = eggDetector.evaluate(new File("image_dir"));
System.out.println("final count: " + sequenceClassifier.getFinalCount());
System.out.println("individual scores: " + sequenceClassifier.getIndividualCounts());
eggDetector.closeSession();
```

B.1.2.2 Declaration

```
public class SequenceClassifier
 extends java.lang.Object
```

B.1.2.3 Method summary

getFinalCount()
Get the final score for the entire directory.

getIndividualCounts()
Gets the individual egg count for every image provided.

B.1.2.4 Methods

- *getFinalCount*

  ```
  public java.lang.Integer getFinalCount()
  ```

  - **D**escription

    Get the final score for the entire directory.

    The final score is calculated as follows:
    * individual scores of images are sorted and counted
    * the highest egg count is returned as a result if we detected this egg count in at least two different images
    * if no two images contain the same egg count, the highest detected egg count is returned
    * if no eggs are detected in any of the images, 0 is returned
  - **R**eturns – final egg count for this instance

- *getIndividualCounts*

  ```
  public java.util.Map getIndividualCounts()
  ```

  - **D**escription

    Gets the individual egg count for every image provided.
  - **R**eturns – A map of individual scores. The key is the filename. The value is the egg count.

TexStudio psaní bakalářské práce v L A T E X a překlad do PDF UMLet kreslení UML diagramů Sublime Text úprava textových souborů GIT verzování kódu Google Drive zálohování bakalářské práce MDB Viewer prohlížení a editace databází MS Visual Studio 2015 implementace programu

Použité programy

TexStudio psaní bakalářské práce v LaTeXa překlad do PDF

Notepad++ úprava textových souborů

gedit úprava textových souborů

IntelliJ IDEA Ultimate

GIT

JDK 8

python

tensorflow

labelimg

javadoc

TexDoclet

wget

bash

Obsah přiloženého CD

```
  readme.txt ............................................... stručný popis obsahu CD
__bin ........................................ adresář se spustitelnou formou implementace
__doc ............................................... adresář s dokumentací implementace
__src
    __impl ................................................. zdrojové kódy implementace
        __eggdetector ............................... zdrojové kódy implementace knihovny
        __nn_training ........................... zdrojové kódy pro trénování neuronové sítě
        __tools ............... zdrojové kódy pomocných nástrojů k tvorbě bakalářské práce
    __thesis ...................................... zdrojová forma práce ve formátu LaTeX
__text ................................................................ text práce
    __thesis.pdf ............................................. text práce ve formátu PDF
```

25