DATA NOTE

Prenatal brain MRI samples for development of automatic segmentation, target- recognition and machine-learning algorithms to detect anatomical structures [version 1; peer review: 2 not approved]

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Abstract

In this data note, we present a sorted pool of fetal magnetic resonance imaging (MRI) specimens, selected for a project seeking to further develop a computer-vision software called MaZda, originally created for magnetic resonance (MR) image analysis. A link to download the samples is provided in the manuscript herein. This data descriptor further explains how and why these fetal MRI samples were selected. Firstly, thousands of cross-sectional images obtained from fetal MRI scans were processed and sorted semi-manually with other software. We did so because a built-in “samplesort” (sorting algorithm) is missing in MaZda version 5. Additionally, the software is unfortunately lacking effective and efficient algorithms to allow automatic identification and segmentation of anatomical structures in fetal MRI samples. Hence, the final sorting steps were carried out manually via time-consuming methods — i.e. human- visual detection and classifications by the gestational age of pregnancy and the rotational plane of the MR scanner. Thus the latter correlates with the anatomical plane of the mother, rather than the hypothetical plane used to transect the fetus. In brief, we collated these fetal MRI samples in an effort to facilitate future research and discovery, especially to aid the improvement of MaZda.

Keywords

fetal MRI, automatic segmentation, algorithms, fetal brain, neuroinformatics, cybernetics, applied artificial intelligence

Open Peer Review

Approval Status

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1. Ivana Išgum , University Medical Center Utrecht, Utrecht, The Netherlands 2. Feng Shi , Cedars-Sinai Medical Center, Los Angeles, USA Any reports and responses or comments on the article can be found at the end of the article.

This article is included in the **INCF** gateway.

This article is included in the **Artificial Intelligence and Machine Learning** gateway.

This article is included in the **Data: Use and Reuse** collection.

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Competing interests: No competing interests were disclosed.

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Introduction

Sample sorting can be useful for clinical research seeking to measure the feasibility of new ideas and to develop new technology. MaZda software (<http://www.elel.p.lodz.pl/programy/mazda/>) makers and developers have shown that they are listening to their users, by continuing to release updates and new versions^{1,2}. The samples provided with the manuscript herein were collected and sorted especially for testing upcoming versions of MaZda. The aim is to continue to collaborate with MaZda software engineers in order to code target-recognition semantics and eventually build ideal algorithms for automatic segmentation of prenatal brain. It is important to also note that it is not an easy task to deconstruct the scientific knowledge acquired by radiologists after several hours of practice to master the skills of diagnostic imaging. Moreover, we have recently tested MaZda version 4.6 and version 5.0 and made some recommendations to the software engineers³⁻⁵. In reaction to our need, the MaZda team announced an upcoming version called qMaZda, being co-developed with Weka (www.elel.p.lodz.pl/pms/SoftwareQmazda.html; www.cs.waikato.ac.nz/ml/weka). We are expecting to see some improvements in qMaZda.

Methods

This dataset was created to improve the efficacy of MaZda. Sample collection was approved by the Research Ethics Committee of the Medical University of Lodz (permit number: RNN/213/13/KE). Subjects were informed with a written statement of consent for research and publication. As per agreement, personal information was removed from the original specimens.

Dataset 1. Fetal MRI dat

<http://dx.doi.org/10.5256/f1000research.10723.d150296>

1.5/3T samples were manually sorted by gestational age and anatomical plane. Format: 32-bit BMP.

In terms of subject demographics and phenotypes, the background of the patients was consistent with the majority of the Polish population. In 2015, the World Health Organization (WHO) reported 2.68 million neonatal deaths (WHO fact sheet on congenital anomalies, updated September 2016: www.who.int/mediacentre/factsheets/fs370/en/). The estimate of children born with at least one congenital malformation is about 2-3% worldwide (www.who.int/genomics/anomalies/en/Chapter02.pdf). In Poland, the prevalence rate of birth defects was estimated at 52-53 per 1000 live births (<http://www.marchofdimers.org/materials/global-report-on-birth-defects-the-hidden-toll-of-dying-and-disabled-children-full-report.pdf>). Known birth defects can be detected early in pregnancy using non-invasive and/or invasive techniques⁶⁻⁹. Some can be even treated *in-utero*^{10,11}. There flows the rationale behind this collation of fetal magnetic resonance imaging (MRI) data to improve the efficacy of MaZda.

The enrolled subjects underwent MRI examination for the purpose of investigating suspected congenital, obstetrical and placental anomalies that could not be detected by routine ultrasound and genetic amniocentesis. Volunteers who donated fetal MRI samples to create this dataset were in need of fetal, obstetrical or placental

care. The criteria for inclusion and exclusion were as follows: 1) 1.5T or 3T MRI; 2) all three anatomical planes were scanned (axial, coronal, sagittal); 3) individual cross-sectional images are “usable” — i.e. not heavily degraded by noise and artifacts, as well as motion blur, due to uncontrollable movement of fetal head; 4) visible fetal brain with no significant malformation; 5) thalamus, grey matter, white matter, and ventricles are also visible (Figure 1). The request to collect MRI scans was sent long after MRI examination was performed. Hence, MRI examination was not prescribed for the purpose of creating this dataset. After looking at 1358 MRI scans in two teleradiology databases, we manually selected 6 patients who had undergone 1.5T MRI examination at Barlicki University Hospital (Łódź, Poland) and 11 patients who had undergone 3T MRI examination at Polish Mother’s Memorial Hospital- Research Institute (Łódź, Poland).

Electro-radiology technicians performed fetal MRI as per details provided on the prescription and hospital regulations¹². Hence, we did not have control of MR scanners settings, for example. The technicians stored the MRIs on compact discs (CD). By default, MaZda version 4.6 and 5 are lacking an automatic samplesort (sorting algorithm) to extract images and arrange them into folders and subfolders. An option was to create a plugin especially written for MaZda. Due to time consumption, we used other software to carry out image acquisition (Micro Dicom 0.9, Dimensions 2, Sante Dicom 4, Photoshop CS6 64-bit Extended)⁵. For the extraction of Digital Imaging and Communications in Medicine (DICOM) data, we used the 64-bit portable version of Micro Dicom 0.9.1. Most CDs could be accessed with Micro Dicom or Photoshop CS6 64-bit Extended. We used the rescue feature in Sante Dicom 4 to recover the data and export them in DICOM format. Micro Dicom was the preferred samplesort because it also allowed image selection, batch-conversion and export of DICOM files as 32-bit BMP. Sorting of the sample by MR strength (3T, 1.5T) was carried out with Dimensions 2. Clinical arrangements of the sample by gestational age of pregnancy and anatomical plane of the mother were carried out manually. The primary goal was to select images that had clearly identifiable anatomical regions such as grey matter, white matter, ventricles and thalamus. It was not possible to complete the task with MaZda version 5 package as the available algorithms were lacking automatic segmentation to detect anatomical structures of fetal brain. Additional details about in-depth sorting as well as MRI specifications and file formats are provided in the methods of the cited article⁵.

Ethics and informed consent

Permission to collect samples was approved by the Research Ethics Committee of the Medical University of Lodz. Written informed consent was obtained from all subjects (permit number: RNN/213/13/KE).

Data and software availability

Dataset 1: Fetal MRI data. 1.5/3T samples were manually sorted by gestational age and anatomical plane. Format: 32-bit BMP. doi: [10.5256/f1000research.10723.d150296](http://dx.doi.org/10.5256/f1000research.10723.d150296)¹³

MaZda Package v5 RC HG available from: <http://dx.doi.org/10.17632/dkxyrwpzs.1>

Figure 1. Schematic view of the clinical arrangement of the data. Fetal magnetic resonance imaging studies were extracted from compact discs and sorted by gestational age of pregnancy and anatomical plane of the mother.

Micro Dicom 0.9: www.microdicom.com/downloads.html

Dimensions 2: www.skwire.dcmembers.com/wb/pages/software/dimensions-2-folders.php

Sante Dicom 4: www.santesoft.com/downloads.html

Photoshop CS6 64-bit Extended: <https://helpx.adobe.com/photoshop/using/dicom-files.html>

Author contributions

HG conceived, designed, and wrote this data descriptor; LS and MRL contributed to sample collection and sorting. LS, MRL and MS helped with the description and the clinical arrangement of the data. MS helped with editing the research notes, coordinated with the software engineers to get technical feedback, and provided the latest updates. All authors were involved in the revision process and have agreed to the final content.

Competing interests

No competing interests were disclosed.

Grant information

Medical University of Lodz & Polish Research Committee and affiliated institutions and hospitals; Self-funded; MRI cost was covered by Polish National Health Fund, grants and financial aid from Swedish Ministry of Education and Research/Centrala Studiestödsnämnden and from U.S. Department of Education.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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[Data Source](#)

Open Peer Review

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Reviewer Report 03 July 2017

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Feng Shi

Cedars-Sinai Medical Center, Los Angeles, CA, USA

The authors proposed a sample sorting method for fetal MR images. Below are several suggestions to potentially improve the clarity of the paper.

The Introduction stated that the goal of this work is to further improve the MaZda software. The authors may consider enlarging its audience size by introducing how this data could benefit other researchers in the fetal research community.

The sample sorting seems totally manual, which may be more efficient with the help of some machine learning algorithms.

Experiments could be added to evaluate the performance/correctness of the sample sorting process.

Some details of the data itself could be useful for readers, such as the final data number, demographic information. The dataset 1 for downloading seem only contain 3 subjects.

Is the rationale for creating the dataset(s) clearly described?

Partly

Are the protocols appropriate and is the work technically sound?

Partly

Are sufficient details of methods and materials provided to allow replication by others?

Partly

Are the datasets clearly presented in a useable and accessible format?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Early brain development

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 03 Jul 2017

Hugues Gentillon

Thank you for your comments and suggestions. Again, on F1000Research's policies, it states that 'Data Notes are brief descriptions of scientific datasets that include details of why and how the data were created; they do not include any analyses or conclusion', and we feel that some of your comments mentioned are a matter of personal preference. For example, you ask us to publish experimental analysis and information about 'patient demographics' but we feel that this is unnecessary, in this case.

We do not agree with some of your comments and suggestions from a practical (clinical) point of view, for the following reasons below.

The main goal of the Mazda software is to evaluate signal-to-noise ratio. In fact, cerebral fluid should be homogeneous in both 1.5T and 3T MR images, regardless of patient demographics (Africans, Europeans, Asians, etc.). If so it is a plus for MaZda and the method, as well as a good reference for MR image quality. It is also a good start to assess the maturation of fetal brain in MR. This process is a fact.

Competing Interests: None.

Reviewer Report 31 May 2017

<https://doi.org/10.5256/f1000research.11563.r22563>

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Ivana Işgum

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To my understanding this manuscript provides a description of a data repository containing fetal MR scans and a description of an analysis software package. This is a very nice idea. However, the manuscript is currently not clearly written which hampers reading and understanding of the paper. In my opinion the purpose of the paper needs to be clarified. Description of the data repository can be more concise, and description of collected images could be more specific. It is

good that patient inclusion is provided but it would be nice to know how many images acquired with what protocol are collected, as well as the patient characteristics.

Furthermore, exact purpose of the software is currently unclear. Reading descriptions available at provided links provides some clarification but it would be much better if this manuscript is self-contained.

The manuscript contains many specific terms that are to the best of my knowledge not generally known and hence need to be introduced and explained to allow understanding of the work. For example, the introduction starts with “sample sorting” which is not introduced. In the same paragraph, the authors mention “target recognition semantics” but it is not known what is meant by this.

The authors mention that personal information has been removed according to agreement, but it is not clear what agreement.

It would be important to describe in the manuscript if and how scientific community can benefit from this image database and the described software.

The title does not reflect the content of the paper well. I would advise to change it accordingly.

Is the rationale for creating the dataset(s) clearly described?

No

Are the protocols appropriate and is the work technically sound?

Partly

Are sufficient details of methods and materials provided to allow replication by others?

No

Are the datasets clearly presented in a useable and accessible format?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Medical image analysis

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 31 May 2017

Hugues Gentillon

Thank you for your comments and suggestions. On F1000Research's policies, it states that 'Data Notes are brief descriptions of scientific datasets that include details of why and how

the data were created; they do not include any analyses or conclusion', and we feel that some of your comments mentioned are a matter of personal preference. For example, you request us to publish information about 'patient characteristics'. It is unnecessary.

Competing Interests: None

Comments on this article

Version 1

Author Response 06 Sep 2017

Hugues Gentillon

We will make some editing changes in version 2 to improve clarity. We also wish to reiterate (emphasize again) that this paper is a "data note" (also known as data descriptor) -- meaning it briefly describes data to help others reuse the data. The focus is on MR images of brain tissues, not the background of the patients. All humans share the same anatomy, regardless of ethnicity. Also, we did not test any hypotheses, did not conduct any experiment and did not present any results. Hence, it is unnecessary to write descriptive analysis/interpretation about findings and speculations about benefit for a scientific community. We hope that the referees will reconsider their negative reviews and will not do any disservice to the integrity and the general role of the peer review."

Competing Interests: None.

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