



Kampus  
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INDONESIA JAYA



ICAMSAC  
2023

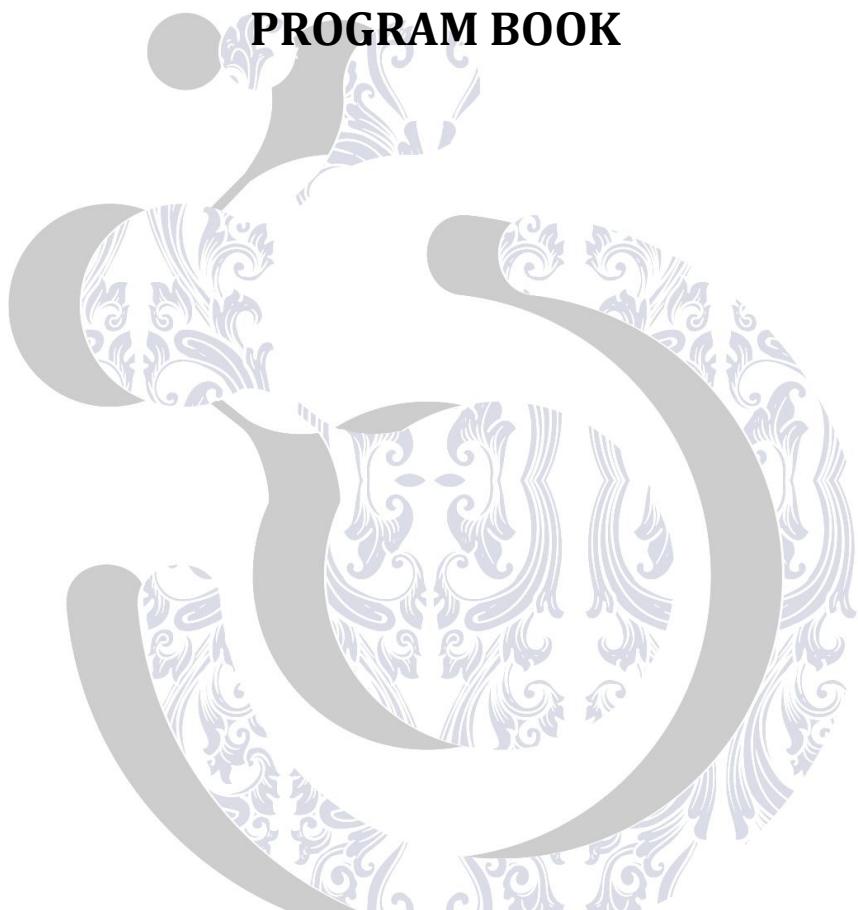
# ABSTRACT AND PROGRAM BOOK

INTERNATIONAL CONFERENCE ON  
APPLIED MATHEMATICS,  
STATISTICS, AND COMPUTING  
(ICAMSAC) 2023



Udayana University, Bali - Indonesia  
21 - 22 November 2023

# **ABSTRACT AND PROGRAM BOOK**



**INTERNATIONAL CONFERENCE ON  
APPLIED MATHEMATICS, STATISTICS,  
AND COMPUTING (ICAMSAC) 2023**





## Welcome Speech from the Dean of Faculty of Mathematics and Natural Sciences, Udayana University

We express our profound gratitude to the Almighty for the abundant blessings bestowed upon us, so that the International Conference on Applied Mathematics, Statistics, and Computing can be held successfully.

The honourable Keynote Speaker, invited speakers, the conference speakers and all attendants. I welcome all of you to this International Conference which being held in Udayana University and has received great attention and been attended by scientists from 6 different countries who are going to present, share and exchange the experience and research results in all aspects of mathematics, statistics, and computing. I believe that this conference will be the source of innovative ideas, concept and breakthroughs in the development of applied mathematics, statistics, and computing for the future, to support and fulfil the Sustainable Development Goals (SDGs) to change the world for the better. Through this international conference, we hope that scientists can have a platform to share their research and knowledge. Presenters at the international conference are also welcomed to publish their fullpaper in international proceeding which is indexed by Web of Science as well as reputable scientific journals in Indonesia.

I extend my utmost gratitude and appreciation to the organizing committees for their diligent efforts, hard work, perseverance, and patience in preparing and organizing this conference so that it can go well, smoothly, and successfully. This conference happens also due to the financial and inkind supports from many parties, therefore I express my gratitude and appreciation. Finally, let us expand our networks and foster collaborations in the realms of research, academics, and various other domains.

Denpasar, 16 November 2023  
Sincerely,

Prof. Ni Luh Watiniyah, M.Sc., Ph.D.  
Dean of Faculty of Mathematics and Natural Sciences  
Udayana University, Bali.



## **Chairperson Report**

This book abstract compiles all works presented in the Internasional Conference on Applied Mathematics, Statistics, and Computing. This conference is held at the Udayana University, Bali – Indonesia on 21-22 November 2023. The conference aims to bring together leading academic scientists, researchers, and research scholars to exchange and share their experiences and research results on all aspects of application of Mathematics, Statistics, as well as Computing. It also provides a scientific interdisciplinary platform for researchers, practitioners, and educators to present and discuss recent innovations, current issues, trends, and challenges faced and solutions adopted in the field of Mathematics, Statistics, and Computing.

More than 100 persons from seven countries participated in this conference, which are from Austria, USA, UK, Germany, Korea, Taiwan, and Indonesia. There were six plenary presentations, and forty-five research abstracts were presented in this conference consisting of 24 from computer sciences and 21 from mathematics and statistics. The whole abstracts presented in this conference can be accessed in the abstract book that is circulated during the event. Some of those abstracts will be published as full papers in an international proceeding indexed by Web of Science, as well as in selected reputable scientific journals in Indonesia.

The efforts of the presenters to prepare their contribution papers for this symposium are highly appreciated. Special thanks should go to all those who have been involved in the committee of this international conference, for their tremendous supports and works to make the event was possible to be conducted. We do hope that all works presented in this conference will provide useful information for further studies in mathematics and natural sciences.

Thank you.

Chairperson of the Organizing Committee,  
Dr. Ngurah Agus Sanjaya ER, S.Kom., M.Kom.



## **Rector's Remark**

To our honourable Keynote Speaker, our invited speakers, conference speakers and all conference attendees. I would like to express my greatest appreciation to the organizing committee who has been working tirelessly to ensure that the first International Conference on Applied Mathematics, Statistics, and Computing (ICAMSAC 2023) runs smoothly. This conference is certainly a big milestone for us here at Udayana University, especially to our Faculty of Mathematics and Natural Sciences.

I am happy to welcome you all here in Bali, which is well known as one of the most favourite tourist destinations in the world. Not only as a tourist destination, but Bali has also recently been a favourite location to host international conferences. As this conference aims to gather scientists, engineers, practitioners and industry experts in the field of Mathematics, Statistics and Computing, I don't doubt that many brilliant ideas will come into fruition here throughout the duration of the conference and it certainly would be of great benefit as well to the fields of Mathematics, Statistics and Computing should such ideas be contributed through both reputable international proceedings and reputable journals here in Indonesia.

I would also like to thank all of the the national and international keynote and invited speakers for traveling all the way here to Bali to present their outstanding research to us at this conference. I am certain that a lot of time and dedication was taken in order to prepare for the materials for this conference and we are truly honoured and cannot wait to listen and learn and partake in various high-level discussions.

I hope that this conference can become a forum for communication and sharing ideas as well as experiencing all disciplines in Mathematics, Statistics and Computing in the future. I also hope that this forum serves as a forum to promote advancing Mathematics, Statistics and Computing as a means for economic growth and social welfare.

Lastly, I sincerely wish that you all have successful and fruitful conference and hope that it can provide you with new ideas, outlooks, perspectives and strategies for the application of Mathematics, Statistics and Computing in all aspects of our life.

See you again next year (2024).

Prof. Ir. Ngakan Putu Gede Suardana, M.T., Ph.D., IPU.  
Rector of Udayana University, Bali.



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# International Conference on Applied Mathematics, Statistics, and Computing (ICAMSAC) 2023

## THEME

“Applications Multidisciplinary Research”

## SCOPES

1. Mathematical modelling, optimization, numerical analysis, differential equations, mathematical physics, and mathematical biology.
2. Probability theory, statistical modelling, experimental design, data visualization, multivariate analysis, and machine learning.
3. Applications of statistics in various domains such as finance, healthcare, social sciences, and engineering.
4. Cloud computing, programming languages, algorithms, artificial intelligence, data mining, high-performance computing, scientific computing, numerical simulations, and computational modelling.

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Ni Made Telaga, S.H.  
Ni Putu Seri Suwartini, S.E.  
Ni Wayan Trisna Dewi, S.Si.



## KEYNOTE AND INVITED SPEAKERS



**Prof. Ismail Khalil**

Johannes Kepler University Linz

– Austria –



**Emery T. Goossens, Ph.D.**

Foresite Labs

– USA –



**Dr. Ngurah Agus Sanjaya**

Udayana University

– Indonesia –



**Rezzy Eko Caraka, Ph.D.**

Ulsan National Institute of Science and  
Technology

– South Korea –



**Muhammad Najib, Ph.D.**

Heriot-Watt University

– UK –



**Remmy Zen, Ph.D.**

Max Planck Institute

– Germany –



## SCHEDULE

**International Conference on  
Applied Mathematics, Statistics, and Computing (ICAMSAC)  
UDAYANA UNIVERSITY, BALI – INDONESIA  
21<sup>st</sup> – 22<sup>nd</sup> NOVEMBER 2023**

**DAY 1: Tuesday, 21<sup>st</sup> November 2023**

Time (ICT)	Activities	Venue
09.00 – 10.00	<p>Opening Ceremony</p> <ul style="list-style-type: none"><li>• Welcome Dance</li><li>• Indonesia National Anthem</li><li>• Chanting Prayers</li><li>• Chairperson Report</li><li>• Welcome Speech by Dean FMIPA Unud</li><li>• Speech and Official Opening by Rector Unud</li></ul>	Sudirman Campus, Udayana University
10.00 – 10.10	Morning Refreshment	
10.10 – 10.55	<p><b>Plenary 1: Prof. Ismail Khalil</b> <i>Moderator: Fainmarinat S. Inabuy, Ph.D.</i> Panel Discussion</p>	
10.55 – 11.40	<p><b>Plenary 2: Emery T. Goossens</b> <i>Moderator: Fainmarinat S. Inabuy, Ph.D.</i> Panel Discussion</p>	
11.40 – 12.25	<p><b>Plenary 3: Dr. Ngurah Agus Sanjaya</b> <i>Moderator: Dr. Made Agung Raharja</i> Panel Discussion</p>	
12.25 – 13.30	Lunch Break	
13.30 – 14.15	<p><b>Plenary 4: Rezzy Eko Caraka, Ph.D.</b> <i>Moderator: Yan Ramona, Ph.D.</i> Panel Discussion</p>	
14.15 – 15.00	<p><b>Plenary 5: Muhammad Najib, Ph.D.</b> <i>Moderator: Yan Ramona, Ph.D.</i> Panel Discussion</p>	
15.00 – 15.45	<p><b>Plenary 6: Remmy Zen, Ph.D.</b> <i>Moderator: Yan Ramona, Ph.D.</i> Panel Discussion</p>	



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## 15.45 – 15.50 Announcements

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Note: ICT Indonesia Central Time or Waktu Indonesia Bagian Tengah (WITA) is 13 hours ahead of Eastern Standard Time.

Link: <https://www.worldtimeserver.com/time-zones/wita-to-est/> or <https://www.freeconvert.com/time/wita-to-gmt>

## DAY 2: Wednesday, 22<sup>nd</sup> November 2023

Time (ICT)	Activities	Venue
08.00 – 09.00	Registration	Sudirman
09.00 – 09.30	Standby in parallel room	Campus,
09.30 – 12.30	Parallel Session <i>Session 1: 09.30 – 10.20</i> <i>Break session 1: 10.20 – 10.30</i>  <i>Session 2: 10.30 – 11.20</i> <i>Break session 2: 11.20 – 11.30</i>  <i>Session 3: 11.30 – 12.20</i> <i>Break session 3: 12.20 – 12.30</i>	Udayana University
12.30 – 13.00	Lunch Break and Closing	

Note: ICT Indonesia Central Time or Waktu Indonesia Bagian Tengah (WITA) is 13 hours ahead of Eastern Standard Time.

Link: <https://www.worldtimeserver.com/time-zones/wita-to-est/> or <https://www.freeconvert.com/time/wita-to-gmt>



## Oral Presentation Schedule

**DAY 2: Wednesday, 22<sup>nd</sup> November 2023**

### GUIDANCE FOR PRESENTER

1. Please submit your slides (.ppt or .pdf) in the registration table or through email [icamsac@unud.ac.id](mailto:icamsac@unud.ac.id).
2. Each presenter has 7 minutes (maximum) to give a presentation.
3. It is mandatory to deliver your talk in English, as well as your presentation materials.
4. There will be a Question & Answer (Q&A) session **after five presentations**, so please stay in the room to answer questions for you. Each presenter will be given a maximum of 3 minutes to address all questions.
5. For documentation purposes, our room time-keeper will take your picture at the end of your presentation.



## SCHEDULE FOR PRESENTER

ICAMSAC ROOM 1	Session 1	Session 2	Session 3
	09.30 – 10.20	10.30 – 11.20	11.30 – 12.20
ICM – 01	ICM – 06	ICM – 11	
ICM – 02	ICM – 07	ICM – 12	
ICM – 03	ICM – 08	ICM – 13	
ICM – 04	ICM – 09	ICM – 14	
ICM – 05	ICM – 10	ICM – 15	

ICAMSAC ROOM 2	Session 1	Session 2	Session 3
	09.30 – 10.20	10.30 – 11.20	11.30 – 12.20
ICM – 16	ICM – 21	ICM – 26	
ICM – 17	ICM – 22	ICM – 27	
ICM – 18	ICM – 23	ICM – 28	
ICM – 19	ICM – 24	ICM – 29	
ICM – 20	ICM – 25	ICM – 30	

ICAMSAC ROOM 3	Session 1	Session 2	Session 3
	09.30 – 10.20	10.30 – 11.20	11.30 – 12.20
ICM – 31	ICM – 36	ICM – 41	
ICM – 32	ICM – 37	ICM – 42	
ICM – 33	ICM – 38	ICM – 43	
ICM – 34	ICM – 39	ICM – 44	
ICM – 35	ICM – 40	ICM – 45	



## Abstract ID and Title

No	Abstract ID	Title and Author/s
1	<b>ICM - 01</b>	<b>Katuturangsatwa.com: a digital portal for Balinese folklore stories</b> Ngurah Agus Sanjaya ER, Ni Luh Nyoman Seri Malini, I Made Widiartha, Pijar Candra Mahatagandha
2	<b>ICM - 02</b>	<b>Optimization of travelling salesman problem with genetic algorithm in the case of distribution of PT. Wahana Prestasi Logistik in Special Region of Yogyakarta Province</b> Fathiyarizq Mahendra Putra, Muhammad Edu Agritama, Trional Novanza, Aina Musdholifah
3	<b>ICM - 03</b>	<b>Development of an automatic summarization system application for Indonesian language journals based on deep learning</b> AAIN Eka Karyawati, Ngurah Agus Sanjaya ER, LAA Rahning Putri
4	<b>ICM - 04</b>	<b>Usability evaluation of the KPN PNB mobile application using the usability testing and system usability scale</b> Ni Kadek Dessy Hariyanti, I Wayan Edi Arsawan, I Gusti Ngurah Sanjaya
5	<b>ICM - 05</b>	<b>Factors that promote community compliance with implementing health protocols after the Covid-19 pandemic</b> Made Susilawati, I Wayan Sumarjaya, Ni Luh Putu Suciptawati, Made Tresia Pramasta Diva
6	<b>ICM - 06</b>	<b>Livelihood survival strategies of informal sector workers</b> Desak Putu Eka Nilakusmawati, Ni Luh Putu Suciptawati
7	<b>ICM - 07</b>	<b>A study of LAB color space and its visualization</b> Ida Ayu Putu Febri Imawati, Made Sudarma, I Ketut Gede Darma Putra, I Putu Agung Bayupati



## ABSTRACT ID: ICM-07

### A study of LAB color space and its visualization

Ida Ayu Putu Febri Imawati<sup>1,\*</sup>, Made Sudarma<sup>2</sup>, I Ketut Gede Darma Putra<sup>3</sup>,  
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#### Abstract

With the increasing need for digital images in everyday life, images are collected through various devices such as digital cameras, cell phone cameras, and scanners. This image data will be further processed, one of which is to segment objects from the background. The technique that can be used is segmentation using the LAB color space. This technique is done by converting the image color space into LAB color space so that the object or foreground can be separated from the background. This research uses 20 random images from 3 sources: The Oxford-IIIT Pet dataset, Github Real Python material, and DeepLontar dataset. The experimental results show that The Oxford-IIIT Pet dataset and Github Real Python material have a more extended range of minimum-maximum values of L, a\*, and b\* components compared to DeepLontar dataset. This extended minimum-maximum value range causes the object images in The Oxford-IIIT Pet dataset and Github Real Python materials to be more visually visible (segmented) than in the DeepLontar dataset.

**Keywords:** *color space, cielab, color space segmentation, image processing, preprocessing*



## A Study of Lab Color Space and Its Visualization

Ida Ayu Putri Febri Imawati<sup>1</sup>, Made Sudarma<sup>2</sup>, I Ketut Gede Darma Putra<sup>3</sup>, I Putu Agung Bayupati<sup>4</sup>

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**Abstract.** With the increasing need for digital images in everyday life, images are collected through various devices such as digital cameras, cell phone cameras, and scanners. This image data will be further processed, one of which is to segment objects from the background. The technique that can be used is segmentation using the LAB color space. This technique is done by converting the image color space into LAB color space so that the object or foreground can be separated from the background. This research uses 20 random images from 3 sources: The Oxford-IIIT Pet dataset, Github Real Python material, and DeepLontar dataset. The experimental results show that The Oxford-IIIT Pet dataset and Github Real Python material have a more extended range of minimum-maximum values of L, a\*, and b\* components compared to DeepLontar dataset. This extended minimum-maximum value range causes the object images in The Oxford-IIIT Pet dataset and Github Real Python materials to be more visually visible (segmented) than in the DeepLontar dataset.

**Keywords:** Color space, Cielab, Color space segmentation, Image processing, Preprocessing.

### 1 Introduction

Currently, the need to use digital images in everyday life is increasing. These digital images are recorded through various devices such as digital cameras, cell phone cameras, and scanners. The need for digital images is widely used to make copies of documents stored and back up physical files into digital documents.

Digital images that have been obtained can also be further processed, such as in the process of recognition or detection of characters[1], [2], hand geometry detection [3], and face recognition for the authentication process [4]. However, the resulting digital images sometimes have relatively similar foregrounds and backgrounds, so they experience difficulties when further processing[5]. Therefore, object segmentation is needed to separate the object from the background. Segmentation is a process to separate an object from the background so that the object can be processed for further purposes [3], [4], [5].



Digital images that have been obtained can also be further processed, such as in the process of recognition or detection of characters [1], [2], hand geometry detection [3], and face recognition for the authentication process [4]. However, the resulting digital images sometimes have relatively similar foregrounds and backgrounds, so they experience difficulties when further processing [5]. Therefore, object segmentation is needed to separate the object from the background. Segmentation is a process to separate an object from the background so that the object can be processed for further purposes [3], [4], [5].

## 2 Literatures review

### 2.1 RGB Color Space

By using the characteristics of color and light intensity, we can recognize images. Colorspace is used as one of the techniques in digital image processing. RGB color space (Red, Green, Blue) is a color space that is based on how the human eye works [6]. The human eye has two sensors on retina sensors: rod and cone cells. In the processing of digital image analysis, color space RGB is preferred because it does not require conversion to another color space. The color produced follows the vision representation of the human eye.

### 2.2 Lab Color Space

This color space was defined by the CIE in 1976 to communicate color widely, which is widely used in industry for color control and management. CIELAB is a three-dimensional color space model dimensions. In this color space, a slice is taken from components  $a^*$  and  $b^*$ , and from the slices of components  $a^*$  and  $b^*$  obtained  $a^* b^*$  chromaticity diagram with the meaning of each dimension formed.

CIE\_L\* magnitude is used to show the description of color brightness. The CIE\_a\* dimension is used to indicate the description of the color type green - red color type. The CIE\_b\* dimension is used for the blue-yellow color type [6], [7]. The RGB to CIELAB color space conversion calculation can be presented as in equation 1 to equation 4 obtained from the OpenCV library [8].

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \leftarrow \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

Description:

R = Red color values

G = Green color values

B = Blue color values

After converting to XYZ, the CIELAB color space can be calculated using Equation (2).



$$\begin{aligned} L &\leftarrow 116 * Y^{1/3} - 16 \text{ For } Y > 0.008856 \\ L &\leftarrow 903.3 * Y \text{ For } Y \leq 0.008856 \\ a^* &\leftarrow 500(f(X) - f(Y)) \\ b^* &\leftarrow 200(f(Y) - f(Z)) \end{aligned} \quad (2)$$

The reference values of Xn, Yn, and Zn can be seen in Equation (3).

$$\begin{bmatrix} Xn \\ Yn \\ Zn \end{bmatrix} = \begin{bmatrix} 0.950456 \\ 1.0 \\ 1.088754 \end{bmatrix} \quad (3)$$

The transformation function equation  $f(t)$  can be implemented as in in Equation (4).

$$f(t) = \begin{cases} t^{1/3} & \text{for } t > 0.008856 \\ 7.787t + \frac{16}{116} & \text{for } t \leq 0.008856 \end{cases} \quad (4)$$

**The advantages of CIELab.** This research aims to implement CIELab on 20 images to represent color features. Color features are one of the features that separate image objects from their background (color space segmentation). This color space segmentation can be done on facial images, batik, and copper and papyrus inscriptions. Inscriptions are unique because there is a low color difference between the letters (objects) and the media for writing them.

Many studies related to CIELab have been conducted. Fawaz et al. [4], the CIELab model is used because it can express the colors seen by the human eye, and also, this model compensates for the inequality of the color distribution of the RGB color model because the RGB model has too many transition colors between blue and green. The CIELab model was chosen to identify the characteristics of a batik cloth [7], [9]. Identifying the characteristics of batik cloth is necessary because the development of batik cloth patterns resulting from manual coloring or printed motifs is easy to imitate and reproduce. In addition, the CIELAB model was chosen because of the homogeneous space for visual perception.

The CIELab model is also implemented on inscriptions. Based on Sudarma's papyrus lontar research results [5], CIELab color space can identify and separate Balinese script colors from their background colors. Using the L\* value of the CIELab, experimental results show the brightness of the color as a little differentiator. Rasmana's research [10] measured the color difference of carved letters with copper inscription plates. The measurement was done with the CIELAB model. The results of this research state that the color feature is unsuitable for recognizing the carved letters on the inscription because the color difference between the carved letters and the plate is tiny. The measurement results of the color difference in the a\* and b\* layers are small. The big difference is in the L\* layer. The L\* layer is the layer that represents the color intensity of the image. However, this research uses the L\* layer combined with texture features for the following segmentation process. Previous studies repre-

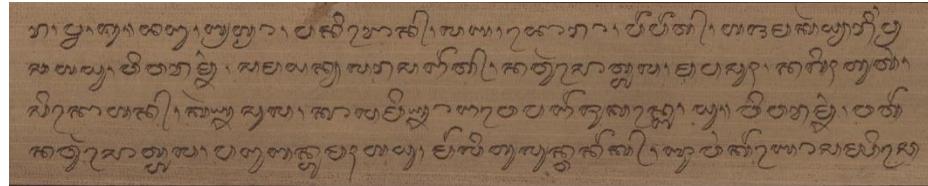


senting the CIELab color space were limited to only one specific object or image. The authors conducted CIELab color space experiments on three data sources in this study. This research contributes to illustrating that CIELab color space can be one way of extracting image features with different image characteristics.

### 3 Method

#### 3.1 Preprocessing and Generating Data

This research uses 20 images. The images were obtained from several sources: The Oxford-IIIT Pet Dataset [11], Github Real Python material [12], and the DeepLontar dataset [13]. The author preprocessed the image first on the DeepLontar dataset ground truth data, namely the image with the name 8a.jpg, as in Fig 1. The preprocessing was done because the image dimensions were too large at 1500 x 300 pixels. The image from the DeepLontar dataset is cropped randomly with varying dimensions: 1) the author cropped per character as many as five characters to see the visualization results per character, 2) the author also cropped randomly (5 times) for a collection of several characters or free text along the dimension of 1500 x 300 pixels in the image 8a.jpg.



**Fig. 1.** An image from DeepLontar Dataset namely 8a.jpg.

Second, for the dataset from The Oxford-IIIT Pet Dataset, the author took five random image samples (Bombay\_220.jpg, Bengal\_197.jpg, Ragdoll\_27.jpg, Sphynx\_142.jpg and Russian\_Blue\_187.jpg) and from Github Real Python material as well as five images (nemo1.jpg, nemo2.jpg, nemo3.jpg, nemo4.jpg, nemo5.jpg), as in Fig 3. The image generation process, as in Fig 2.

#### 3.2 Implemented Algorithm

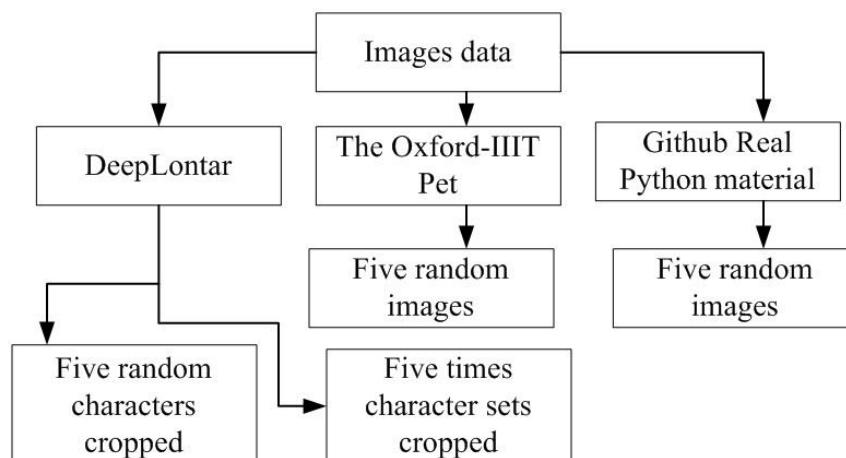
This algorithm is modified from the GitHub source [14] and applied, as shown in Figure 3.

1. Read image data and load example images.
2. Read the five images, then save them into a list.
3. Convert each of the images into numpy array.
4. Extract the first few example images. RGB color images consist of three layers: a red layer, a green layer, and a blue layer. Each layer in a color image has a value



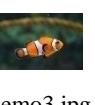
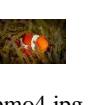
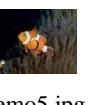
from 0 - 255. In this layer, the image mean has no color if the value is 0, and the pixel is black if the value is 0 for all color channels.

5. Convert RGB to LAB. Conversion from the sRGB color space (IEC 61966-2-1:1999) to the CIE Lab colorspace under the given illuminant and observer. The range of the dimensions for RGB and LAB in skimage.color.rgb2lab and lab2rgb are:  $\text{rgb}_\text{lab}:[0,1] \times [0,1] \times [0,1] \rightarrow [0,100] \times [-128,128] \times [-128,128]$  and  $\text{lab}_\text{rgb}:[0,100] \times [-128,128] \times [-128,128] \rightarrow [0,1] \times [0,1] \times [0,1]$ .
6. Inverse the process (LAB to RGB), lab2rgb has to have a dimension (-, -, 3).
7. Check if the RGB  $\rightarrow$  LAB  $\rightarrow$ RGB worked by plotting.
8. Check if the 0th dimension of the LAB image is showing the brightness. Finally, each dimension of the LAB image can be visualized.



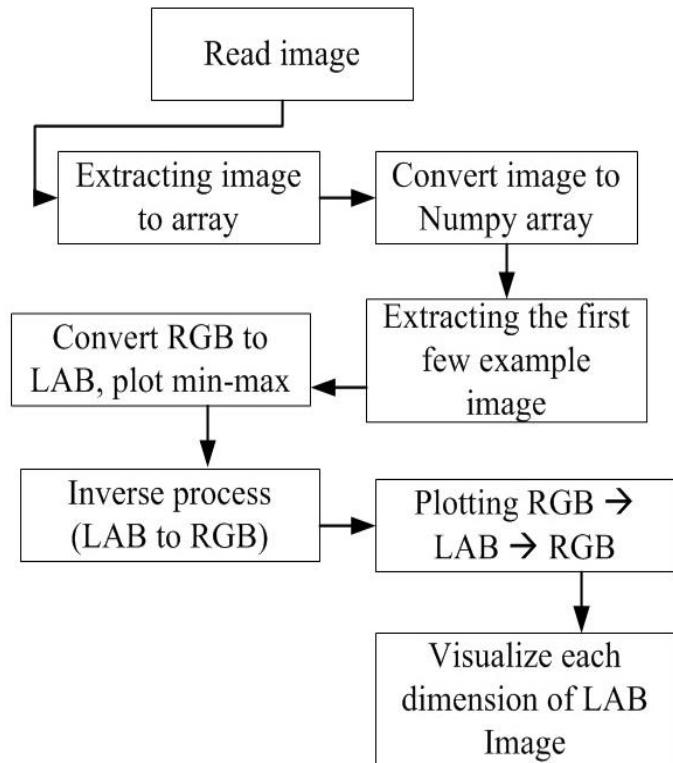
**Fig. 2.** Image generation process

**Table 1.** Image data

Data source name	Images				
The Oxford-IIIT					
	Bombay_220.jpg	Bengal_197.jpg	Ragdoll_27.jpg	Sphynx_142.jpg	Russian_Blue_187.jpg
Github Realpython material					
	nemo1.jpg	nemo2.jpg	nemo3.jpg	nemo4.jpg	nemo5.jpg



DeepLontar (five random character cropped)					
DeepLontar (five times character sets cropped)					
	8a-cropped.jpg	8a-cropped2.jpg	8a-cropped3.jpg	8a-cropped4.jpg	8a-cropped5.jpg



**Fig. 3.** Implemented algorithm



## 4 Result and Discussion

The results of the experiments in this study are in the form of values or values of each component, namely the minimum-maximum value in RGB color space and the minimum-maximum value in LAB color space, as shown in Table 2 and Table 3. Based on Tables 2 and Table 3, The Oxford-IIIT Pet dataset and Github Real Python have the same minimum to a maximum range of R, G, and B values, namely 0 to 255. Similarly, the same L (Lightness) value is a minimum of 0 to a maximum of 100. It implicitly states that the images on The Oxford-IIIT Pet dataset and Github Real Python have a more extended range of values in RGB color space and LAB color space. For the DeepLontar dataset, both cropped per character and randomly cropped have a shorter range of values in both color spaces.

Values with a more extended range will impact the visualization of the L, a\*, and b\* components. Visually, we can see the object (foreground) separated from the background, as in Figure 4 and Figure 5. In Figure 5, the image obtained from GitHub Real Python has a range that tends to be significantly prolonged so that we can visually see the segmented fish object from the background. Figure 6 and Figure 7 are data taken from lontar or papyrus. They have shorter range of minimum to maximum values of the color space components (both in RGB and LAB). The LontarDeep dataset has been dealt with by cropping per character (Figure 6), which makes the characters more evident so that in the b\* component (color spectrum blue to yellow), visually, we can still see the segmented object from the background.

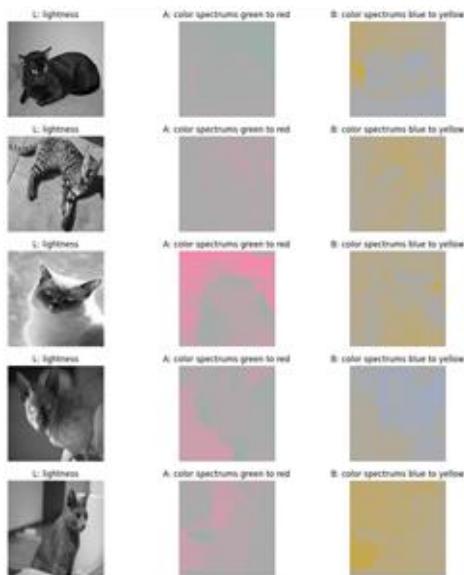
**Table 2.** The result of min max value of RGB

Data	R		G		B	
	min	max	min	max	min	max
The Oxford-IIIT Pet	0.0000	255.00000	0.0000	255.00000	0.0000	255.00000
Github Real Python	0.0000	255.00000	0.0000	255.00000	0.0000	255.00000
DeepLontar (five random character cropped)	42.0000	169.0000	26.0000	143.0000	14.0000	112.0000
DeepLontar (five times character sets cropped)	25.0000	174.0000	10.0000	144.0000	13.0000	116.0000

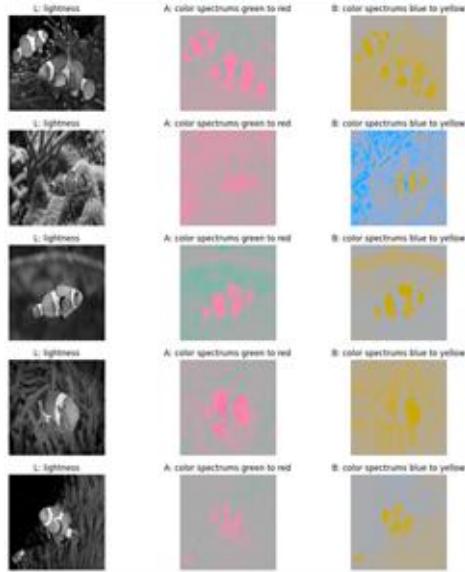


**Table 3.** The Result of min max value of LAB

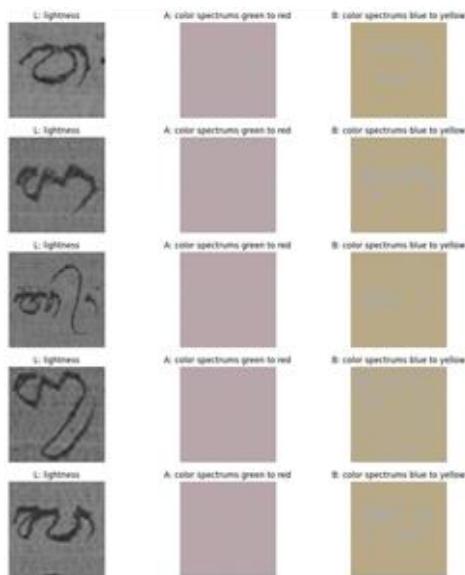
Data	L		a*		b*	
	min	max	min	max	min	max
The Oxford-IIIT Pet	0.0000	100.0000	-29.3345	66.2213	-59.8455	68.8716
Github Real Python	0.0000	100.0000	-31.5718	68.9017	-98.6082	81.6538
DeepLontar (five random character cropped)	11.3153	60.7135	-1.5736	14.1609	-0.7475	27.7050
DeepLontar (five times character sets cropped)	4.2075	61.2767	-1.4154	22.2171	-7.3443	27.5035



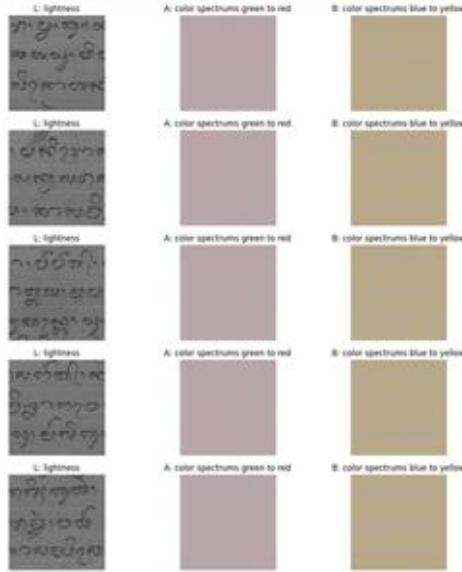
**Fig. 4.** Lab visualizations of The Oxford-IIIT Pet data



**Fig. 5.** . Lab Visualizations of Github real Python data



**Fig. 6.** Lab visualizations of DeepLontar data (five random character cropped)



**Fig. 7.** Lab visualizations of DeepLontar data (five times character sets cropped)

As stated by Sudarma[5] and Rasmana [10] in their research using inscription objects, inscriptions tend to have slight color differences between the object and the media on which it is written. Of the three layers in the CIELab color model, the most significant difference is in the L\* layer. The L\* layer is the layer that represents the color intensity of the image. The results of the two studies align with the results of the range of min-max L\*, a\*, and b\* values in Table 3. In DeepLontar (five random characters cropped), the L\* layer values range from 11.3153 to a maximum of 60.7135, a\* layer values range from -1.5736 to 14.1609, and b\* layer values -0.7475 to 27.7050. In DeepLontar (five times character sets cropped), layer L\* values range from 4.2075 to 61.2767, layer a\* values from -1.4154 to 22.2171, and layer b\* values range from -7.3443 to 27.5035. Layer L\* thus has a more extended range of values than the other two layers. Therefore, CIELab can be used to extract color features in images. However, suppose the characteristics of the object to be separated or segmented from an image have the same characteristics as the inscription. In that case, it must be combined with other feature extraction to get better segmentation results[10].

## 5 Conclusions

The longer the range of minimum to maximum values of the R, G, B, or L, a\*, b\* components in each color space, the more convenient we can see the segmented object from the background. On the other hand, the shorter the range of minimum to maximum values of the R, G, B, or L, a\*, b\* components in each color space, the more difficult it is to segment the object from the background. This research uses input images with various dimensions, so for further research, it is necessary to standardize the dimensions of the input image and the opportunity to combine this CIELab



color feature extraction with other image feature extraction methods such as texture, pattern, shape, or edge features.

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# icamsac dayu

*by Putu Eka*

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# A Study of Lab Color Space and Its Visualization

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**Abstract.** With the increasing need for digital images in everyday life, images are collected through various devices such as digital cameras, cell phone cameras, and scanners. This image data will be further processed, one of which is to segment objects from the background. The technique that can be used is segmentation using the LAB color space. This technique is done by converting the image color space into LAB color space so that the object or foreground can be separated from the background. This research uses 20 random images from 3 sources: The Oxford-IIIT Pet dataset, Github Real Python material, and DeepLontar dataset. The experimental results show that The Oxford-IIIT Pet dataset and Github Real Python material have a more extended range of minimum-maximum values of L, a\*, and b\* components compared to DeepLontar dataset. This extended minimum-maximum value range causes the object images in The Oxford-IIIT Pet dataset and Github Real Python materials to be more visually visible (segmented) than in the DeepLontar dataset.

**Keywords:** Color space, Cielab, Color space segmentation, Image processing, Preprocessing.

## 1 Introduction

Currently, the need to use digital images in everyday life is increasing. These digital images are recorded through various devices such as digital cameras, cell phone cameras, and scanners. The need for digital images is widely used to make copies of documents stored and back up physical files into digital documents.

Digital images that have been obtained can also be further processed, such as in the process of recognition or detection of characters[1], [2], hand geometry detection [3], and face recognition for the authentication process [4]. However, the resulting digital images sometimes have relatively similar foregrounds and backgrounds, so they experience difficulties when further processing[5]. Therefore, object segmentation is needed to separate the object from the background. Segmentation is a process to separate an object from the background so that the object can be processed for further purposes [3], [4], [5].

Digital images that have been obtained can also be further processed, such as in the process of recognition or detection of characters [1], [2], hand geometry detection [3], and face recognition for the authentication process [4]. However, the resulting digital images sometimes have relatively similar foregrounds and backgrounds, so they experience difficulties when further processing[5]. Therefore, object segmentation is needed to separate the object from the background. Segmentation is a process to separate an object from the background so that the object can be processed for further purposes [3], [4], [5].

## 2 Literatures review

### 2.1 RGB Color Space

By using the characteristics of color and light intensity, we can recognize images. Colorspace is used as one of the techniques in digital image processing. RGB color space (Red, Green, Blue) is a color space that is based on how the human eye works [6]. The human eye has two sensors on retina sensors: rod and cone cells. In the processing of digital image analysis, color space RGB is preferred because it does not require conversion to another color space. The color produced follows the vision representation of the human eye.

### 2.2 Lab Color Space

This color space was defined by the CIE in 1976 to communicate color widely, which is widely used in industry for color control and management. CIELAB is a three-dimensional color space model dimensions. In this color space, a slice is taken from components  $a^*$  and  $b^*$ , and from the slices of components  $a^*$  and  $b^*$  obtained  $a^*$   $b^*$  chromaticity diagram with the meaning of each dimension formed.

CIE\_L\* magnitude is used to show the description of color brightness. The CIE\_a\* dimension is used to indicate the description of the color type green - red color type. The CIE\_b\* dimension is used for the blue-yellow color type [6], [7]. The RGB to CIELAB color space conversion calculation can be presented as in equation 1 to equation 4 obtained from the OpenCV library[8].

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \leftarrow \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

Description:

R = Red color values

G = Green color values

B = Blue color values

After converting to XYZ, the CIELAB color space can be calculated using Equation (2).

$$\begin{aligned}
 L &\leftarrow 116 * Y^{1/3} - 16 \text{ For } Y > 0.008856 \\
 L &\leftarrow 903.3 * Y \text{ For } Y \leq 0.008856 \\
 a^* &\leftarrow 500(f(X) - f(Y)) \\
 b^* &\leftarrow 200(f(Y) - f(Z))
 \end{aligned} \tag{2}$$

The reference values of Xn, Yn, and Zn can be seen in Equation (3).

$$\begin{bmatrix} Xn \\ Yn \\ Zn \end{bmatrix} = \begin{bmatrix} 0.950456 \\ 1.0 \\ 1.088754 \end{bmatrix} \tag{3}$$

The transformation function equation  $f(t)$  can be implemented as in Equation (4).

$$f(t) = \begin{cases} t^{1/3} & \text{for } t > 0.008856 \\ 7.787t + \frac{16}{116} & \text{for } t \leq 0.008856 \end{cases} \tag{4}$$

**The advantages of CIELab.** This research aims to implement CIELab on 20 images to represent color features. Color features are one of the features that separate image objects from their background (color space segmentation). This color space segmentation can be done on facial images, batik, and copper and papyrus inscriptions. Inscriptions are unique because there is a low color difference between the letters (objects) and the media for writing them.

Many studies related to CIELab have been conducted. Fawaz et al. [4], the CIELab model is used because it can express the colors seen by the human eye, and also, this model compensates for the inequality of the color distribution of the RGB color model because the RGB model has too many transition colors between blue and green. The CIELab model was chosen to identify the characteristics of a batik cloth [7], [9]. Identifying the characteristics of batik cloth is necessary because the development of batik cloth patterns resulting from manual coloring or printed motifs is easy to imitate and reproduce. In addition, the CIELAB model was chosen because of the homogeneous space for visual perception.

The CIELab model is also implemented on inscriptions. Based on Sudarma's papyrus lontar research results [5], CIELab color space can identify and separate Balinese script colors from their background colors. Using the L\* value of the CIELab, experimental results show the brightness of the color as a little differentiator. Rasmana's research [10] measured the color difference of carved letters with copper inscription plates. The measurement was done with the CIELAB model. The results of this research state that the color feature is unsuitable for recognizing the carved letters on the inscription because the color difference between the carved letters and the plate is tiny. The measurement results of the color difference in the a\* and b\* layers are small. The big difference is in the L\* layer. The L\* layer is the layer that represents the color intensity of the image. However, this research uses the L\* layer combined with texture features for the following segmentation process. Previous studies repre-

#### 4 Wrong Article

senting the CIELab color space were limited to only one specific object or image. The authors conducted CIELab color space experiments on three data sources in this study. This research contributes to illustrating that CIELab color space can be one way of extracting image features with different image characteristics.

### 3 Method

#### 3.1 Preprocessing and Generating Data

This research uses 20 images. The images were obtained from several sources: The Oxford-IIIT Pet Dataset [11], Github Real Python material [12], and the DeepLontar dataset [13]. The author preprocessed the image first on the DeepLontar dataset ground truth data, namely the image with the name 8a.jpg, as in Fig 1. The preprocessing was done because the image dimensions were too large at 1500 x 300 pixels. The image from the DeepLontar dataset is cropped randomly with varying dimensions: 1) the author cropped per character as many as five characters to see the visualization results per character, 2) the author also cropped randomly (5 times) for a collection of several characters or free text along the dimension of 1500 x 300 pixels in the image 8a.jpg.

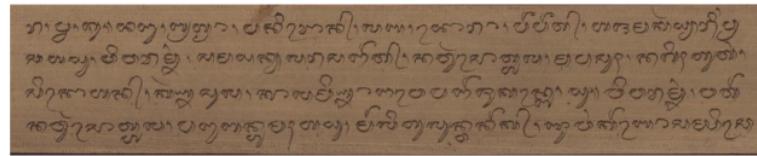


Fig 1. An image from DeepLontar Dataset namely 8a.jpg.

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Second, for the dataset from The Oxford-IIIT Pet Dataset, the author took five random image samples (Bombay\_220.jpg, Bengal\_197.jpg, Ragdoll\_27.jpg, Sphynx\_142.jpg and Russian\_Blue\_187.jpg) and from Github Real Python material as well as five images (nemo1.jpg, nemo2.jpg, nemo3.jpg, nemo4.jpg, nemo5.jpg), as in Fig 3. The image generation process, as in Fig 2.

#### 3.2 Implemented Algorithm

This algorithm is modified from the GitHub source [14] and applied, as shown in Figure 3.

1. Read image data and load example images.
2. Read the five images, then save them into a list.
3. Convert each of the images into numpy array.
4. Extract the first few example images. RGB color images consist of three layers: a red layer, a green layer, and a blue layer. Each layer in a color image has a value

from 0 - 255. In this layer, the image mean has no color if the value is 0, and the pixel is black if the value is 0 for all color channels.

5. Convert RGB to LAB. Conversion from the sRGB color space (IEC 61966-2-1:1999) to the CIE Lab colorspace under the given illuminant and observer. The range of the dimensions for RGB and LAB in skimage.color.rgb2lab and lab2rgb are: `rgb_lab:[0,1]x[0,1]x[0,1] → [0,100] x [-128,128] x [-128,128]` and `lab_rgb:[0,100] x [-128,128] x [-128,128] → [0,1]x[0,1]x[0,1]`.
6. Inverse the process (LAB to RGB), lab2rgb has to have a dimension (-, 3).
7. Check if the RGB → LAB →RGB worked by plotting.
8. Check if the 0th dimension of the LAB image is showing the brightness. Finally, each dimension of the LAB image can be visualized.

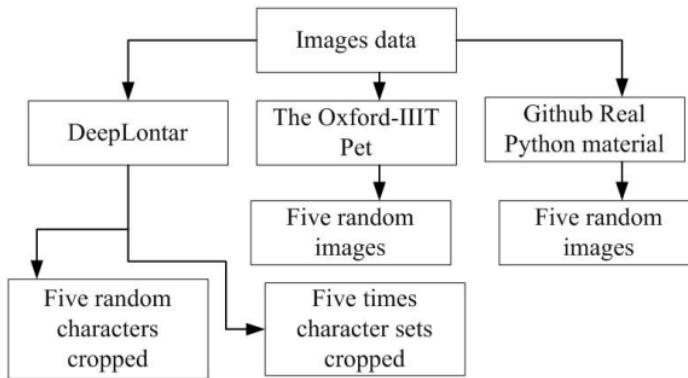
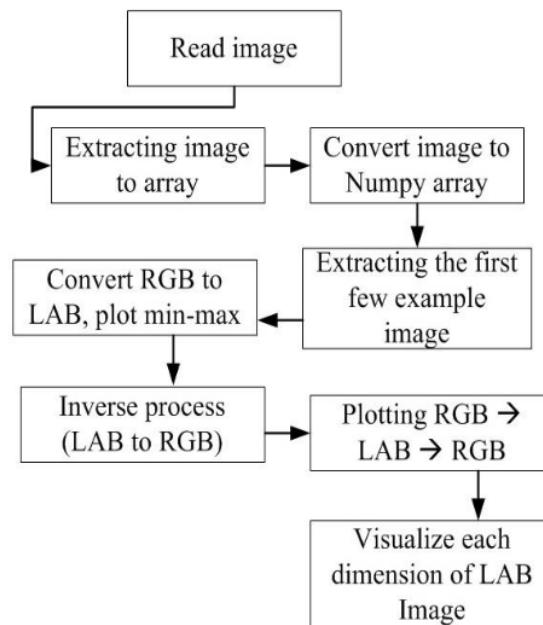
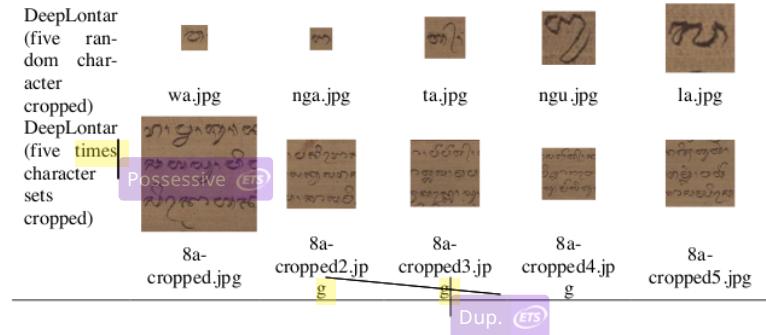


Fig 2. Image generation process

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Table 1. Image data

Data source name	Images				
The Oxford-IIIT					
	Bom-bay_220.jpg	Ben-gal_197.jpg	Ragdoll_27.jpg	Sphynx_142.jpg	Russian_Blue_187.jpg
Github Realpython material					
	nemo1.jpg	nemo2.jpg	nemo3.jpg	nemo4.jpg	nemo5.jpg



**Fig. 3.** Implemented algorithm

#### 4 Result and Discussion

The results of the experiments in this study are in the form of values or values of each component, namely the minimum-maximum value in RGB color space and the minimum-maximum value in LAB color space, as shown in Table 2 and Table 3. Based on Tables 2 and Table 3, The Oxford-IIIT Pet dataset and Github Real Python have the same minimum to a maximum range of R, G, and B values, namely 0 to 255. Similarly, the same L (Lightness) value is a minimum of 0 to a maximum of 100. It implicitly states that the images on The Oxford-IIIT Pet dataset and Github Real Python have a more extended range of values in RGB color space and LAB color space. For the DeepLontar dataset, both cropped per character and randomly cropped have a shorter range of values in both color spaces.

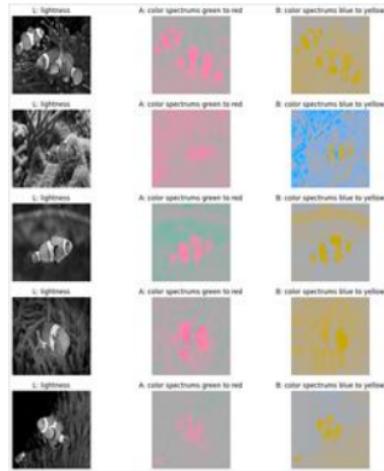
Values with a more extended range will impact the visualization of the L, a\*, and b\* components. Visually, we can see the object (foreground) separated from the background, as in Figure 4 and Figure 5. In Figure 5, the image obtained from GitHub Real Python has a range that tends to be significantly prolonged so that we can visually see the segmented fish object from the background. Figure 6 and Figure 7 are data taken from lontar or papyrus. They have shorter range of minimum to maximum values of the color space components (both in RGB and LAB). The LontarDeep dataset has been dealt with by cropping per character (Figure 6), which makes the characters more evident so that in the b\* component (color spectrum blue to yellow), visually, we can still see the segmented object from the background.

Data	Table 2. The result of min max value of RGB					
	R		G		B	
	min	max	min	max	min	max
The Oxford-IIIT Pet	0.0000	255.00000	0.0000	255.00000	0.0000	255.00000
Github Real Python	0.0000	255.00000	0.0000	255.00000	0.0000	255.00000
DeepLontar (five random character cropped)	42.0000	169.0000	26.0000	143.0000	14.0000	112.0000
DeepLontar (five times character sets cropped)	25.0000	174.0000	10.0000	144.0000	13.0000	116.0000

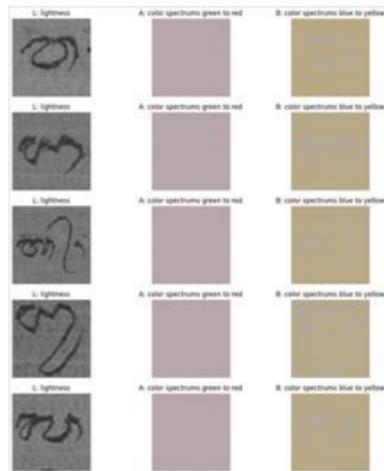
**Table 3.** The Result of min max value of LAB

Data	L		a*		b*	
	min	max	min	max	min	max
The Oxford-IIIT Pet Github	0.0000	100.0000	-29.3345	66.2213	-59.8455	68.8716
Real Python	0.0000	100.0000	-31.5718	68.9017	-98.6082	81.6538
DeepLontar (five random character cropped)	11.3153	60.7135	-1.5736	14.1609	-0.7475	27.7050
DeepLontar (five times character sets cropped)	4.2075	61.2767	-1.4154	22.2171	-7.3443	27.5035

**Fig. 4.** Lab visualizations of The Oxford-IIIT Pet data



**Fig. 5.** Lab Visualizations of Github real Python data



**Fig. 6.** Lab visualizations of DeepLontar data (five random character cropped)

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**Fig. 7.** Lab visualizations of DeepLontar data (five times character sets cropped)

Possessive (ET)

As stated by Sudarma[5] and Rasmara [10] in their research using inscription objects, inscriptions tend to have slight color differences between the object and the media on which it is written. Of the three layers in the CIELab color model, the most significant difference is in the  $L^*$  layer. The  $L^*$  layer is the layer that represents the color intensity of the image. The results of the two studies align with the results of the range of min-max  $L^*$ ,  $a^*$ , and  $b^*$  values in Table 3. In DeepLontar (five random characters cropped), the  $L^*$  layer values range from 11.3153 to a maximum of 60.7135,  $a^*$  layer values range from -1.5736 to 14.1609, and  $b^*$  layer values -0.7475 to 27.7050. In DeepLontar (five times character sets cropped), layer  $L^*$  values range from 4.2075 to 61.2767, layer  $a^*$  values from -1.4154 to 22.2171, and layer  $b^*$  values range from -7.3443 to 27.5035. Layer  $L^*$  thus has a more extended range of values than the other two layers. Therefore, CIELab can be used to extract color features in images. However, suppose the characteristics of the object to be separated or segmented from an image have the same characteristics as the inscription. In that case, it must be combined with other feature extraction to get better segmentation results[10].

## 5 Conclusions

The longer the range of minimum to maximum values of the R, G, B, or  $L^*$ ,  $a^*$ ,  $b^*$  components in each color space, the more convenient we can see the segmented object from the background. On the other hand, the shorter the range of minimum to maximum values of the R, G, B, or  $L^*$ ,  $a^*$ ,  $b^*$  components in each color space, the more difficult it is to segment the object from the background. This research uses input images with various dimensions, so for further research, it is necessary to standardize the dimensions of the input image and the opportunity to combine this CIELab

color feature extraction with other image feature extraction methods such as texture, pattern, shape, or edge features.

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**Possessive** You may need to use an apostrophe to show possession.

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