DESIGN ORIENTATION OF ILLUMINATED FRONTISPIECES OF QUR'AN MANUSCRIPTS AND ITS RELEVANCE TO THE FUSION OF ORGANIC AND GEOMETRIC DESIGN FORMS "OF ISLAMIC ART

The Project is submitted for the fulfilment of the requirement of Postdoc Islamic Art and Design

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INTRODUCTION

Manuscript art is known to be one of the artistic orientations taken by Muslim artists. These efforts were introduced for recitation, and word understanding initially. Gradually, it was designed as a symbolic representation towards translation and explanation that most probably flourished during the Islamic expansion. It transformed into the most distinguished art forms related to Islamic art and also related to the content of manuscripts.

The importance of the frontispieces of the manuscripts is basically related to the significance of the content. Islamic manuscripts have been full of coloured geometric and foliage designs. Initially, Muslim artists took inspiration from nature and then associated it with the aspects of human life and the world of spirituality.

The production of these manuscripts has been follow-up by the artists and under the patronage of royal courts of Muslim rule for several periods continuously. Despite this, very few prominent schools of art prevailed in the history of Indo-Pakistan. The most prominent reason such as might have unfordable costs and time-consuming activity that limited the public interest.

This study would evaluate the manuscript's design (organic and geometric), its significance, and its relevance to Islamic art. Islamic art is proved to be a good example of visual art. A visual design is a combination of lines, textures, and colours. The creation of design depends upon the emergence of different types of lines. The development of this creative activity is associated with the evolution of the civilizations of mankind as well. Initially, the orientation of lines was used for communication and then for beautification.

According to the Lawson “Design is a highly complex and sophisticated skill” (Lawson 1991). In the design activity, he also emphasizes the importance of skills that anyone can be acquired with a specific learning process and practice over a time period. This activity has encompassed an artist’s ability, skill, and creativity. Somehow artists’ creativity and

ability rely on the skill of drawing. According to Jones (Jones 1970) in the design process, the weakness and the strength of a design depend upon the skill of drawing. The continuity of practice may cause fundamental reforms and creative innovation within the design layout. It may also encourage the artist/designer to explore new ideas and materials for the creation of the design.

The illuminated manuscripts have historic and literary value but now their production is very rare. The introduction of printing devices has reduced manual work and its importance, so initially, the production of these manuscripts was limited to some areas and gradually withdrawn from the scene. The changes in the technology, patronage and the behaviours of the client also affected the production of illuminated manuscripts of the Qur'an. The aim of this investigation is to analyze the organic and geometric orientation of design that prevailed in frontispieces of illuminated manuscripts of the Qur'an. These patterns of design either depicted in the architectural monuments, ceramics, upholstery, and tile-work of Islamic and non-Islamic cultures.

The monograph will explore how the Illuminated frontispieces of Qur'an manuscripts (IFQM) have been designed and formed in different areas of the Islamic world and how it took influence and formed in non-Islamic culture or land. This monograph also highlights the empirical chapters: transformation, evolution, critical analysis, and fusion of design. It will be written with a broad audience in mind and targeted at quality publication.

STATEMENT OF THE RESEARCH PROBLEM

- The decorated pages of the book have literary, cultural and economic value.
- Is it associated with a specific cultural practice or a common practice among the different cultures?

PROPOSED GOALS/OBJECTIVES

- The Project is aimed to:
- To develop my analytical approach towards frontispieces of Qur'an Manuscripts annualized Physically and further categorizes with the help of Artificial Intelligence.

- To progress my study by executing the monograph for the academic and non-academic audiences and creating a comparative analysis of organic and geometric design forms incorporated in illuminated frontispieces of Qur'an Manuscripts

BACKGROUND OF THE PROBLEMS TO BE EXPLORED

• This study will evaluate the design patterns and their importance within the Islamic art.

• It will discuss the different culture's art of the book and the correlation between calligraphic expression with patterns.

• This study will debate and focus on the decoration of Indo-Pak Qur'an manuscripts. At the end of the study, the results will be showing the true attributes of art and design that are incorporated with the formation of the manuscripts.

LITERATURE REVIEW

Many investigations were held to find out the amalgamation, assimilation, and overlapping of cultures, symbolic representation of images, iconography, the transformation of designs and colour palettes, etc. There is very limited published research regarding the illuminated frontispieces of Qur'an manuscripts (IFQM). Only the patterns of geometric and organic forms are acceptable for the designing of IFQM. The current study correlates not only with Muslim civilization tradition as well as the foreign relationship with Muslim society and designing the aesthetic sense of artists. This study will also fill the gap of specific knowledge of IFQM and its orientation of the design.

The frontispieces of the Sa'di's Bustan, a study by Shela S Blair (2022) examined the frontispieces by their structure, text and pictorial orientation. Fakhria Al, Yahyai 's study (2019) discusses manuscript paintings' artistic and aesthetic values in both Arabic and Persian schools. Mortez Karimi Nia's study (2019) belongs to the Qur'an manuscripts placed at Mashhad in the Astan-i-Quds library. This orthographic study has examined manuscripts that unveiled some identical features of the early Qur'an. Its results show that the overall style was inspired by the official Uthmanic Qur'an and the sura's arrangement was based on Ibn Masood's work. EloïsE Brac DE la PErrièrE (2016) 's study was on

Bihari Qur'an. The style of the Bihari Qur'an is associated with the Indo -Pak. This study encamps the overall style of the Bihari Qur'an. Frantz chaigne's work (2016) on the ornamentation of the Gwalior Qur'an, here scholar adopted Marianne Barricade's deconstructive approach for the understanding of the ornamentation of a manuscript.

There are no specific studies on the Qur'an's frontispieces and relevance to the fusion of design.

The study of illuminated frontispieces of manuscripts of the Qur'an (IFQM) has historic value and it will also indicate the development of art forms. It will specify the transformation of ideas, art material, forms, and relations with other communities or civilizations. The study of illuminated frontispieces of manuscripts will be showing the behaviour, intentions, tradition, norms, the social and economic condition of that specific region or society. This study would be helpful for the scholar of manuscript study, designer, artist, and art historian (academic & non-academic).

Primary data has been collected from Qatar national library, Doha and Ganjbkhsh Library Islamabad. Its inductive reasoning and data are analyzed with the help of Physical Analysis and Artificial Intelligence. The limitation of the study, primary data has been collected from two libraries one from Pakistan (Ganjbkhsh Library Islamabad) and the second from Qatar national library, Doha. Only Indo-Pak illuminated Qur'an Manuscripts considered here. In this study, the design orientation of frontispieces has been examined.

Physical analysis, Artificial Intelligence and art historical evidence are helpful to adopt as the methodology for this investigation. The techniques of Artificial Intelligence (AI) would prove to be very effective in the investigation of the Islamic Art of the book. It would also reduce human error and quickly analyse the changing patterns of the design and also reduce the subjectivity in the study

This monograph will cross-examine the Illuminated frontispieces of Qur'an manuscripts (IFQM), design orientation, the artistic sense, and its values. How these designs and colour palettes are associated with specific region and societies and their impact on economic, religious, and social society.

The question arises what is the main reason (which can explain why) IFQM became significant in the art of the book of the Islamic world and then declined afterwards? It will be comprised of the following headings along with an introduction and conclusion.

In chapter 1 the study discusses the art of the book and its valuable addition to the field of art. In Islamic art, Qur'an manuscripts have been decorated without zoomorphic and anthropomorphic. It has a variety of foliage and geometric patterns, not only for the decoration of the book as well as for the recitation signs as it is helpful for the readers. The study of the Illuminated Qur'an manuscripts has diversity for the researchers as it invites the researchers to investigate the style of illumination (may indicate different schools of art, amongst the different regions), calligraphic style and transformation, typology and its usage. Types of papers, ink, colours and bookbinding etc. Different techniques (such as gilding, paper mâché, stamping and engraving etc.) can be investigated with reference to the art of the book.

These manuscripts can be evaluated by investigating their colour scheme, calligraphy, incipit, frontispieces, regional orientation and by the significant calligraphers. Many scholors have adopted different methodologies such as Palaeography (the study of calligraphy (letters, paper, pen and ink) codicology (the study of the structure of the book and covers decoration of the book as well) and chronology (the study of typology with the help of timeline) for the investigation of manuscripts of Quran. This study uses Artificial Intelligence to identify the changes within the patterns of the design chronologically.

In chapter 2 the study will discover the design formation and orientation of design of Illuminated frontispieces of Qur'an manuscripts (IFQM). The organic and geometrical orientation of design, here study discusses the choice of line formation for making design and overall repetition of motifs along with interlaced patterns would be examined in the context of Illuminated frontispieces of Qur'an manuscripts (IFQM). Art historical evidence, physical analysis, and design principles would be helpful for the study of Illuminated frontispieces of Qur'an manuscripts (IFQM). Fusion of foliage and geometric design forms under the title of this paragraph Illuminated frontispieces of Qur'an

manuscripts (IFQM) would be examined to organize the data to form the typology such as geometric, organic, and hybrid style. It will also be highlighting the esthetic and repeat of the design. Evolution and transformation of Islamic design, this paragraph will be explaining the key factors that may be leading to organize, reform, and exchange of Islamic design incorporated with Illuminated frontispieces of Qur'an manuscripts (IFQM). Traditional regional and geographical impact on the formation of Islamic art of the book especially for the study of the Illuminated frontispieces of Qur'an manuscripts (IFQM). Comparative Analysis will be discussed here among the Illuminated frontispieces of Qur'an manuscripts (IFQM) and their typology.

In chapter 3 this study is investigated with the help of Artificial Intelligence (AI). It's an innovative idea to investigate the art and design form incorporated in the illuminated manuscripts of the Qur'an. The systematic way of AI identifies the minute changes in the design patterns over time and common features as well. The advantages can be achieved by using AI to reduce human error and fasten decision-making, provide digital assistance, and improve security and efficiency in communication. The significance of AI is given below

- The introduction of Artificial Intelligence (AI) in the field of manuscripts study will improve the quality of investigation of design and Islamic art.
- AI also play a vital role to develop the relative chronology among the manuscripts.
- This study will correlate the attribute of design patterns with the mood of the society of that time.
- It will also investigate the transformation of design patterns and limitation of transforming factors.

The academic and non-academic audiences will be included in the beneficiaries of this research. The study will contribute to scholarship across disciplines including, art history, design, manuscriptology, codicology, and cultural study.

Chapter 2

FRONTISPIECES OF QURAN MANUSCRIPTS: THE SIGNIFICANT FEATURE OF ARABESQUE PATTERN IN ILLUMINATED QUR'AN MANUSCRIPTS FROM THE 16TH TO 18TH CENTURY

Ornamentation increases the economic and aesthetic value of a manuscript in many ways. The beautification of a religious manuscript is considered a sacred act and an integral part of the faith of a believer (Grases 2010). The purpose of the illuminated manuscript is to enhance the text with illumination, or it may be prepared for the appreciation of holy words. Religious manuscripts were decorated in a formal way from ancient times, mostly decorated with organic (especially with botanical forms) motifs. Human and Zoomorphic figures are forbidden in Islam. So, the religious scriptures are decorated with foliage and geometrical patterns only. Historical evidence shows that ancient, Egyptian, Roman, Greek and Iranian artists decorated buildings, scriptures and clothes with flowers and different plants along with zoomorphic images. As Ansari (Ansari 1987) mentions that Sassanid buildings were decorated with vine stems, leaves and clusters of grapes (Pope 2003). A variety of plant motifs was used by the Achaemenid's artist such as lotus flower, palm, cypress and multi-petal flowers. These motifs inspired the Sassanid artist. Gradually, the artists took active part to amalgamate these motifs (palm, lotus and multi-flowers) with vine leaves, grapes and pomegranate (Azmai 2013).

According to the historian, the development of ornamentation is belonging to the Umayyad and Abbasid periods of the Muslim era (Maghsoudy 2019). Though the Muslim art forms flourished and developed in an impressive way, these art forms were inspired by the Iranian and Byzantine civilizations (Rice 2005).

There is a little bit confused approach to the Arabesque either it is an identical pattern of vegetal/ geometric motif or a combination of different lines and motifs. There is a common

perception it is derived from nature, but the question is about its significant creation. Why, when and for whom it is created? It is a model of a design that is created by artists of different eras and regions to beautify the borders, upper and lower parts of the page, wall or door. The significance of this style is to enhance the beauty of the text, elaborate the text with botanical motifs or present the symbolized motifs that incorporate with the text such as heaven garden, fruits and plants. It is noted that it has been used for many mediums (ceramics, architecture, books, clothes etc. It has a very bright past and present as well.

From the mid of 20th century, endeavours were taking place in different languages (Austrian, German, French, English, Arabic, Turkish and Persia investigate and analyzed Muslim art forms. According to Terry Allen (Allen 1988), Alois Riegl (the art historian) critically examines the arabesque at first glance, its formation based on vegetal. Alois Riegl (Riegl 1992) associated the arabesque of vegetal motif derived from the classical motif of palmetto and tendril. According to Ernst Kuhnel, it had its origin in late antiquity and transformed into its latest version under the Abbasids (749-1258 AD).

Another view about arabesque is as it is a word that refers to the "Moresque" the Muslim art of Spain. However, Ernst Herzfeld explained this word in the German language, this word is associated with the foliage design of Muslim Art. But A. U Pope discusses it as an inspirational work, that Muslim artists received from Greek architectural ornamentation of anthemion (palmetto). His suggestion indicates that the origin of this art form is based on classical palmetto and tendril, which was also the ornamentation style of early Sasanid art (226-642 AD). George Marcais, Simin Daneshvar, Carl Duri and Dimand believed that the influence of Persian and Greek art traditions on arabesque design is obvious (Maghsoudy 2019).

Arabesque plays a vital role in the process of Qur'an manuscript illumination. It may connect to the core of the text with the marginal design of arabesques (Chevalier n.d.). This art form has been modified by the artist with the help of different elements of art, vegetal, geometric and abstract forms. Initially, arabesques are based on a single pattern with twisting branches of palm leaves and rose flowers (Maghsoudy 2019).

In this study, the specimen of Illuminated Qur'an manuscripts (16th century -18th century) has been collected from Ganjbkhsh library Islamabad (GBL). This study is conducted under the framework of physical analysis with the help of Artificial intelligence, a comparative analysis of Arabesque's typology and its attributes during the 16th to 18th century. In total, 96 Qur'an manuscripts are included in this study, chronologically 30 manuscripts are from the 16th century, 24 from 17th century and 42 from the 18th century.

The aim and objective of this study are to examine the layout of the arabesque in Qur'an manuscripts (16th to 18th century). To identify significant features and explore the different patterns that incorporate the formation of arabesques. To maintain the visual typology according to chronological order, under cultural and religious influence.

1. Analysis of Arabesques in illuminated Qur'an manuscript

This art form is not developed at a specific time and same geographical boundaries. It transformed into many shapes, patterns and design layouts with the passage of time among the different areas of the Muslim world.

The formation of arabesque design is distinguishable from geometric to organic which incorporates different motifs and their repeat orientation.

Most scholars divide the arabesque motifs into three or four types, geometric (Fig 1), organic or realistic (vine leaves etc. Fig 4), hybrid (Fig 1) and abstract motif or palmette (Fig 7). The formation of floral arabesques is commonly designed in a circle or in a triangular shape (Fig 5). In architecture, both forms of geometric and organic are considered sacred concepts. These formations of arabesques are also found in illuminated Qur'an manuscripts.

Eva Baer (1998) mentions in the book "Islamic Ornamentation that vegetal ornamentation is divided chronologically into three periods, she indicates the first period (7th -10th century) is "formative", the second (10th -13th century) "ornamental integration" and third (14th to 17th century) "final phase". According to her chronological order, the recent study lies in the final phase.

Physical examination of the arabesque design of the Qur'an manuscript indicates that it is not a simple design. It consists of different line formations (straight, curved, wave, cross and zigzag line), flowers and buds (lotus, lily, rose, pomegranate etc.), foliage (leaves and stems of the vine, pomegranate, lotus, acanthus), fruits (grapes and pomegranate) and geometric shapes (squares, triangles and circle). For arabesque different terms were used such as, Islimi/Islami (in Persian language, defined as a combination of two significant motifs of vine and split leaves) and Rumi (in the Turkish language denoted as, long pointed leaves, from the curved side of which a second lobe often branches off).

2. Typology of Arabesque according to the formation of design

There are two main types of arabesque, geometric and non-geometric. There are different techniques were used to create the design formation by line work, repetition of motifs and colour contrast (Fig 5). The line work is incorporate with the formation of geometric and foliage motifs such as ovoid[1], ogee[2], ogive[3], six/eight-pointed star, rhomboid[4], diamond shapes, and 'V' shaped joint, repetition of a motif creates different, *sarloh* (Fig2), *toranj* (Fig3), *guilloche*[5] (Fig 6) and borders with simple, mirror, brick, split mirror and brick design, in colour contrast the positive and negative shapes can easily be separated (Fig 9).

3. The Elements of Arabesque Design and its Transformation

Initially, the vegetal and foliage motifs were used predominantly for the decoration of manuscripts, textile, ceramics, architecture and jewelry. There are many design layouts that were used for the manuscript decoration such as simple and complex/ hybrid. The simple layout of a design (Fig 5, B and C) consists of a single motif that designed in the different repeat for the formation of a border. Whereas hybrid layout (Fig 4) consists of different motifs. Sometimes a single floral motif is designed with heterogeneous motifs of leaves, buds, fruits or split palmettes and fir cones. This fusion of design formed a complex style.

[1] An egg shaped, solid or three-dimensional surface.
[2] An 'S' shaped line or moulding.
[3] . A pointed shape or Gothic arch
[4] A rhomboid is a parallelogram in which adjacent sides are of unequal lengths and angles are non-right angled.
[5] An ornamentation resembling braided or interlaced ribbons.

3.1 Islimi/Islami

According to the Thackston (Thackston 1989) the term Islami used by the Baysunghur's atelier (Jafar Tabrazi) for the marginal decoration of Shahnama (Book of Kings). He also mentioned that Ali Ibn-e Abi Talib was the inventor of this art form called *Islami*. Mir Sayyid Ahmed related this form to the Islamic design. The foundation of Islami motif inspired by Sassanian and Byzantine decorative design such as found in Dome of the Rock of 691 AD. These motifs are present in the form of full and half palmettes, wing, symmetrical or stylize floral motifs, vine and leaves. Sometimes these natural motifs used as it is or simplified motifs by the artist. Gradually these arabesque motifs transform in different shapes such as half palmette transform into kidney shape, the lotus is created and vine leaves into circular motifs.

The marginal design and the incipit of Qur'an manuscript (*sar-i-lauh, unwan* were decorated with *Islami* by the eleventh century. According to Tanindi, Ettinghausen, Petersen and Dimand the motifs used for Qur'an illumination were derived from several sources of Coptic, Hebrew manuscripts and Sassanian minor arts (Flood 2012).

Toranj[6] (Fig 2, 3) is the earliest form of Islami that took place in Qur'an illumination during the 10th century. It is a composition of two leaves in the form of triangular, mostly filled with blossom (Abbas 2018).

3.2 Band-I Rumi

Band-i- Rumi refers to the style of knotting, interweaving vines with split leaves. By the 10th to early 11th century, a new formation introduced towards *Islami* was the overlay and interlace formation of design (Abbas 2018). The interweaving of fleurons and split leaves created the fusion of arabesque. According to Takistani this style refers to the interlacing or knotting formation of vine stems either vertically or horizontally. It is flourished in 10th to 12th century in both organic and geometric form. It can be divided into three types of knotting (complex forms of organic or geometric in Fig 1 A), interlacing (Fig 8, not complicated) and interlocked (Fig 6 chain or mostly a vine with half palmettes). Devellioglu argues that this formation of design associated to the Byzantine nit Anatolian

[6] In Persian the word Toranj means to place or draw together.

Seljuk period due to its knotting and braiding. It is most frequent used by the artist of different parts of Iran, Central Asia and India (Ghurid invasion in 11th century).

3.3 Khata I /*Cathay*

Cathay[7]consists of the Chinese style of floral motif, buds and leaves.

The addition of Khata I creates beauty in the formation of arabesque in the 13th century. the influential style of Chines lotus, water lily, stylized floral motifs, floral spray (Fig 2) and variation of *Islami* (dragon Islami[8]) enhance the Cathay style of arabesque (Fig 10).

Cathay is used for the decoration of Qur'an manuscripts, valuable books, palaces, rugs, carpets and pots. With the passage of time, it flourished and transformed into different shapes and types which increased the beauty of an arabesque.

3.4 Fassali

During the second half of the 15th century, the endeavors of Timurid artist created the *fassali*[9] style. Which is a combination of Islami and *khata-I*. It is created with the help of two separate plant stems that overlapping or interlaced with each other (Fig 11), but they seem joined such as *toranj*. According to modern illuminators, the supremacy of *Islami* is shown in *fassali* or maybe the imaginative association of Timurid with the Ming court (Abbas 2018). The rules to produce the *Islami khata-I* is practised by the artist of Iran, Turkey, India and Pakistan as traditional rules for arabesque ornamentation.

3.5 Farangi

The idea regarding a combination of different styles was not new amongst the artists of different areas. At the beginning of the 14th century the overlapping of motifs seen in the field of design. The enlarged *Islami* motif is filled with *khata I* (Fig 12) is known as *guldar*

[7] It is one of the Iranian decorative arts created by combining flowers, buds and leaves and every rhythmic circle is called a Band (cutaway).
[8] Inspired from Chinese motifs.
[9] Means division or separation.

Islami by Iranian artist and called *hurdeleme* by Turkish artist (Abbas 2018). It is known as *firangi* style that resembles to *siyah* Qalam[10] (Roxburgh 2002)

The word firangi is used for Europeans in Arabic and Persian language. According to the historian the significant trade relations of Italian and other European with Persia cause the cultural linkages in 14th and 15th century (Blair 2009). The modern artist describes the formation of firangi as it is consisting of large leaves overlapping the small blossoms (Abbas 2018).

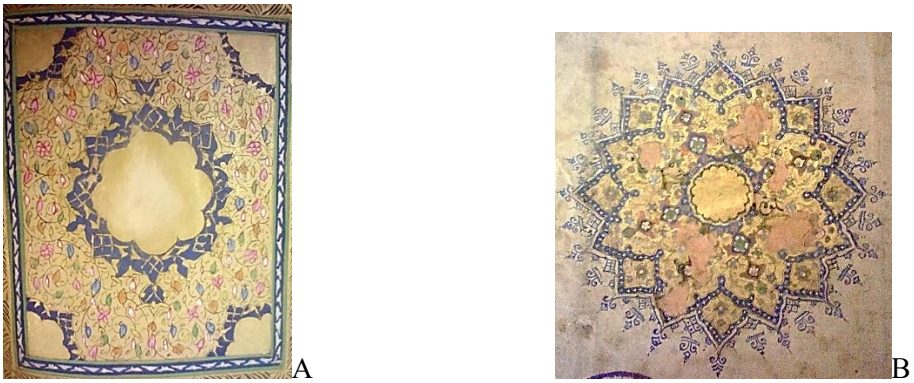


Figure 13 QMs 4488 hybrid style of Arabesque in A and B a collection of Ganjbkhsh library

Figure 14 border design of QMs 9570 (A). A significant Persian style of toranj, QMS 2390(B) Ganjbkhsh library

[10] A style of drawing from Iran and Central Asia in 15th century.

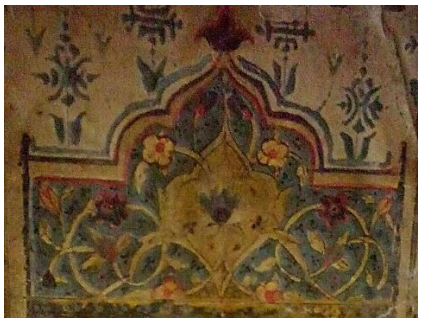


Figure 15 toranj style of 10th century

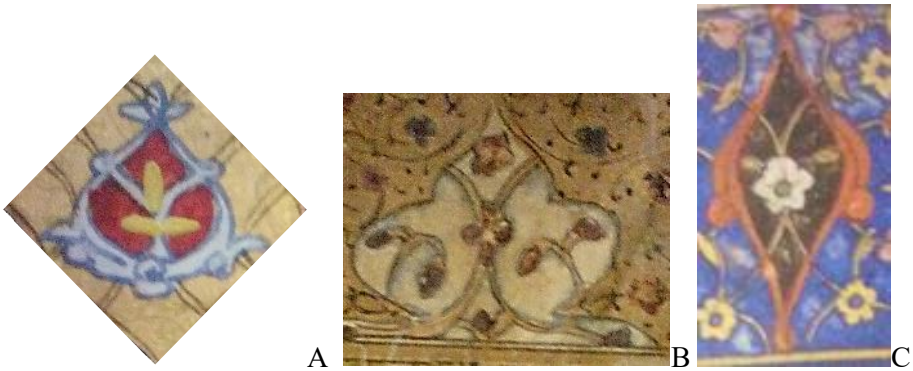
Figure 16 A complex layout of foliage design (Pomegranate leaves, flowers and fruits), QMs 1998 a 18th century Qur'an Ganjbkhsh library.

A  B 

C  D 

Figure 17 A border adjacent to Arabic text box of different QMs A colour contrast with positive and negetive, Band C Single motif with simple repeat, D , Ganjbkhsh library

Figure 18 interlaced border



A B C

Figure 19 Palmate motif, QMs 1176(A) QMs 902(B) QMs 1176 (C)

Figure 20 borders design, QMs 773


A

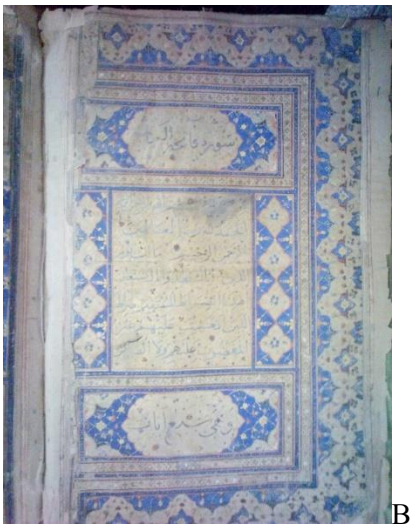

B

Figure 21 by the colour contrast positive and negative spaces creates the design formation in simple repeat, Ganjbkhsh library.

A   B

Figure 22 (A)stylized lily flower, (B) lotus flower

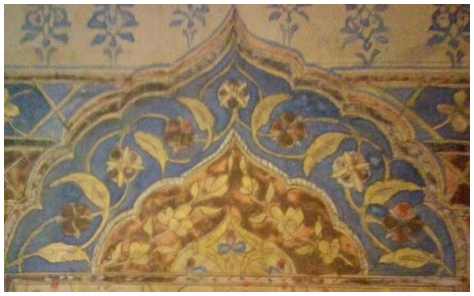


Figure 23 interlace design

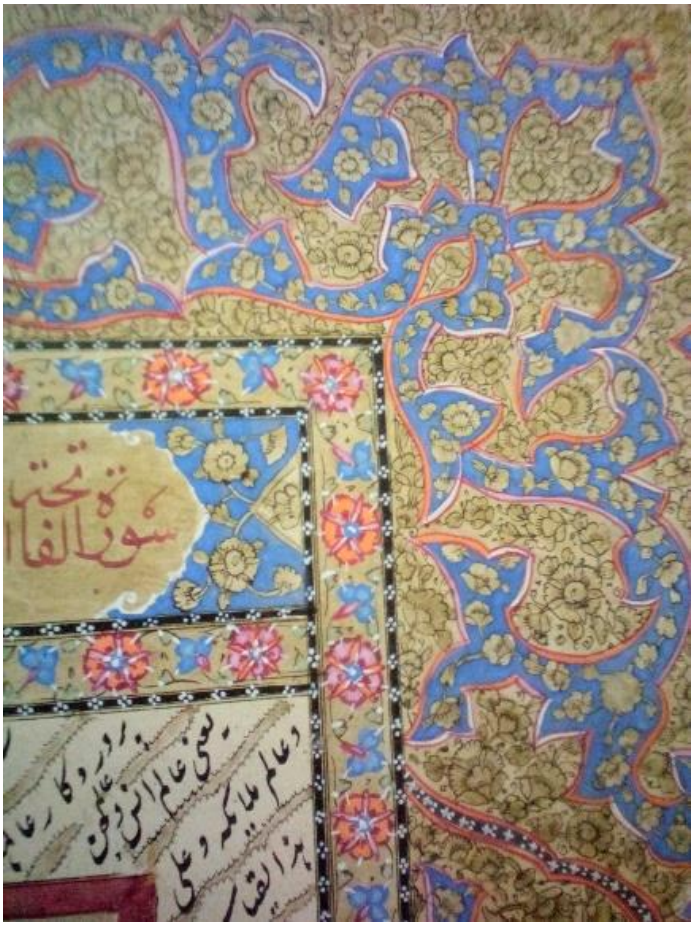


Figure 24 Islami motif filled with flowers

Chapter 3

ARTIFICIAL INTELLIGENCE AND ANALYSIS OF DATA

The purpose of this study is to highlight the different forms that incorporate the formation of arabesques in the illuminated manuscript of the Qur'an from the 16th to 18th century. Arabesques are formed with geometric and organic motifs in interlaced orientation. The data (primary) source is Ganjbkhsh library Islamabad and Qatar national Library. This study is conducted under the framework of physical analysis and Artificial intelligence (AI)software. The typology of arabesque basically shows the transformation of motifs due to time laps and different cultural impacts on design and motifs. The results are produced after the AI findings in this chapter.

The introduction of the term artificial intelligence (AI) has been associated to the John McCarthy (1956). The importance of AI has been introduced in Vannevar Bush's seminal work where he explains, is machines can really think? Later on, Alan Turing 's study explains how machines are able to simulate the human activities intelligently (Russell 2010).

Artificial Intelligence is a process that may easily help the machine to behave such as human mental behaviour, this field is progressing day by day and has sub fields such as machine learning and deep learning. Machine learning 's aim to improves the computer learning so that it can be achieve the creativity (human like thinking) and predict by using algorithms. Machine learning has a number of learning process such as supervised learning, unsupervised and reinforcement learning. In the process of supervised the labelled data is registered to the machine. Then it is trained by this huge registered data. At the next step it has proved to be trained. At the end of the process it is able to analyze the untrained data.

Machine learning, deep learning, neural network are the fields of AI. Gradually it has been upgraded and many more software are incorporated for better performance and fast work. FastAi (a library built on top of Pytorch) is one of them, it is easy to use that developed by the Jeremy Howard and Rachel Thomas. FastAi has four main areas such as vision, tabular, text and collaborative filtering. Fast Ai has some pre-trained models such as residual network (ResNet introduced in 2015 by Kaiming He et al) 18, 34, 50, 101 and 152. Each

residual network (ResNet) has a different number of layers. The residual network used mostly to analyze the complex data and increasing in layers basically improved the performance and accuracy of deep neural networks. so, these layers learn the complex features of the image/data such as it learns to detect the edges at the first layer and identify textures in the second and objects in the third layer (Kaiming He 2015).

For the evaluation of the classification model, the confusion matrix is used, their matrix generates the differences between actual target values and that predicted by the machine learning model (MLM). It will also high lights the errors in the classification model.

In this study, the specimens of Illuminated Qur'an manuscripts (16th century -18th century) were collected from Ganjbkhsh library Islamabad (GBL). In total, 96 Qur'anic manuscripts are included in this study, A total of 542 images from these Qur'anic manuscripts have been acquired. Out of these digitized images, 434 images were used as train images and 108 as test images. A pre-trained ResNet -18(18 layers), ResNet- 34 (34 layers), and ResNet 50(50 layers) on ImageNet are used (Kaiyu Yang 2015). The dataset is split into an 80:20 ratio; 80% of the dataset is for training purposes and 20% for testing purposes. For the image, we used data augmentation for regulation and for this purpose the parameters that have been used are shown in tables 1 and 2.

Table 1

horizontal_flip	*True*
vertical_flip	*False*
max_rotate	*10.0*
max_zoom	*1.1*
max_lighting	*0.2*
max_warp	*0.2*
p_affine	*0.75*
p_lighting	*0.75*
Image Size	*224*
Normalize	*Normalize using ImageNet*

Table 2

Horizontal_ flip	if True, a random flip is applied with probability 0.5
Vertical_flip	requires horizontal flip=True. If True, the image can be flipped vertically or rotated by 90 degrees, otherwise only a horizontal flip is applied
Max_ rotate	if not None, a random rotation between -max_rotate and max_rotate degrees is applied with probability p_affine
Max _ zoom	if not 1. or less, a random zoom between 1. and max_zoom is applied with probability p_affine
Max_lighting	if not None, a random lightning and contrast change controlled by max_lighting is applied with probability p_lighting
Max_warp	if not None, a random symmetric warp of magnitude between -max_warp and maw_warp is applied with probability p_affine
p_affine	the probability that each affine transform and symmetric warp is applied
p_lighting	the probability that each lighting transform is applied
Image Size	All images were converted to 224x224 dimensions.
horizontal_flip	All images were normalized using ImageNet statics i.e. mean and variances to bring their pixel values between range of 0 to 1.

Results:

In the present study thee convolutional neural network architectures ResNet-18, ResNet-34 and ResNet-50 have been applied for the evaluation of the digitized images from the Illuminated Qur'an manuscripts belonging to the 16th century, 17th century and 18th century. A total of 542 images from the, 96 Qur'anic manuscripts from 16th century to the 18th century are included in this study which comprised 434 images as train images and 108 as test images. With ResNet 18, the F1 scores of 16th, 17th and 18th-century Qur'anic manuscripts are 0.74, 0.586 and 0.776 respectively. The ResNet 34 revealed F1 scores of 16th, 17th and 18th-century Qur'anic manuscripts as 0.81, 0.8 and 0.85 respectively while ResNet 50 showed F1 scores of 16th, 17th and 18th-century Qur'anic manuscripts as 0.82, 0.85 and 0.91 respectively. The results of ResNet -18 are depicted in figures 1-2 and table 3 while the results of ResNet -34 figures 3-4 and table 4 and ResNet -50 are shown in figures 5-6 and table 5.

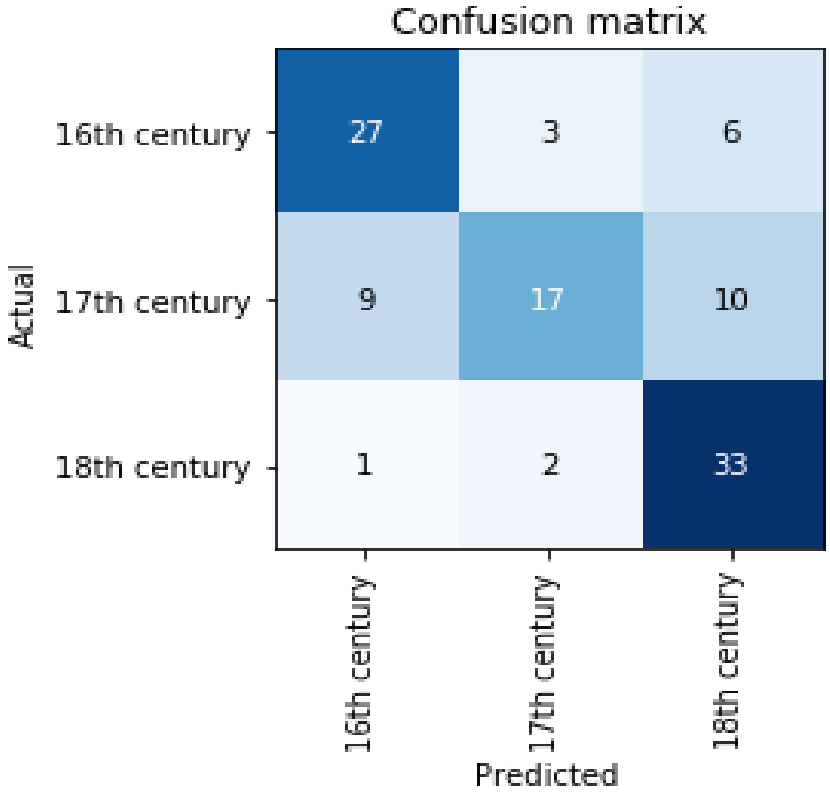


Figure 13 - ResNet -18- Confusion Matrix of Test Images

Rows notified as actual value and columns as predicted values in this matrix. The matrix can be explained as, true positive(TP) (when all positive predicted values has matched to the positive actual values 27, 17 and 33 from the 16th , 17th and 18th century), true negative (TN)(when all negative predicted values has matched to the negative actual values), false positive(FP) (when the actual value is negative but predicted as positive value such as in 16th century, 9and 1 is false positive, 17th century 3 and 2 whereas 18th century 10 and 6 are false positive) it is called type 1 error, False negative (FN) (when the actual value is positive but predicted as negative such as 3 and 6 in 16th century, 10 and 9 in 17th century and 1,2 in 18th century) called type 2 error.

Accuracy= $\frac{Total\ correct\ guess}{dTotal}$ or $\frac{TP+TN}{TP+TN+FP+FN}$

Table 3 - ResNet -18- Confusion Matrix of Test Images

Precision 16th Century	0.75
Precision 17th Century	0.472
Precision 18th Century	0.916
Recall 16th Century	0.73
Recall 17th Century	0.77
Recall 18th Century	0.67
F1 Score 16th Century	0.74
F1 Score 17th Century	0.586
F1 Score 18th Century	0.776

Precision: It is basically identifying the number of positive predicted cases.

Precision=$\frac{TP}{TP+FP}$,(here true positive is divided by the true positive plus false positive).
Recall shows the predicted cases that is actual positive cases of the model.

Recall=$\frac{TP}{TP+FN}$

Precision and recall have an inverse relation such as one's values increasing resulting in the other decreasing and vice-versa. However, the F1 score has shown both trends in a single value in the model. It is the harmonic mean of both precision and recall. It is considered maximum when both have equal values in the model. F1 score becomes 1 if both have 1. F1 score is considered as a better measure than accuracy.

F1- Score = 2÷1/recall +1/precision or

F1 Score=2* Precision * Recall divided by Precision + Recall

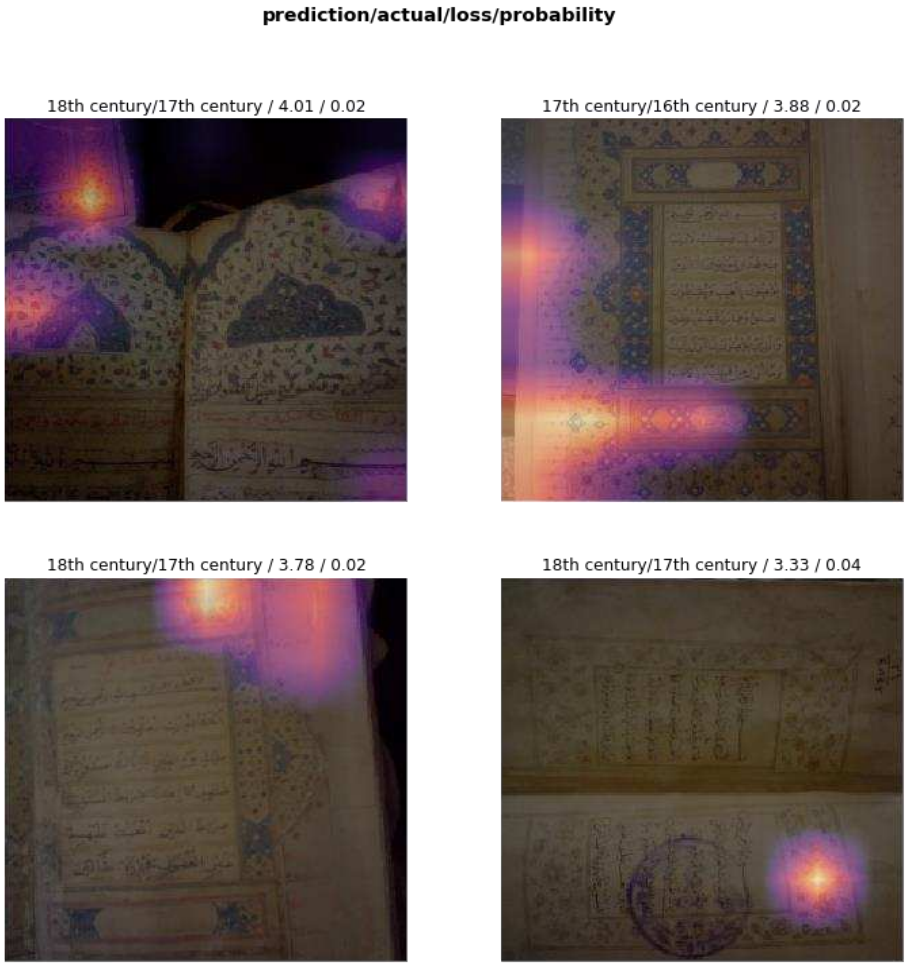


Figure 14 - ResNet -18- Most Confused Answers with heat map

The significance of heatmap is to provide the visual summary of information that is represented by colours. The colour shades in heatmap contain different values which is assigned for an image such as mostly dark shades have higher value than the lighter shades of the colour.

Here heat map shows some similarities in the images of the different centuries (16, 17 and 18^{th})

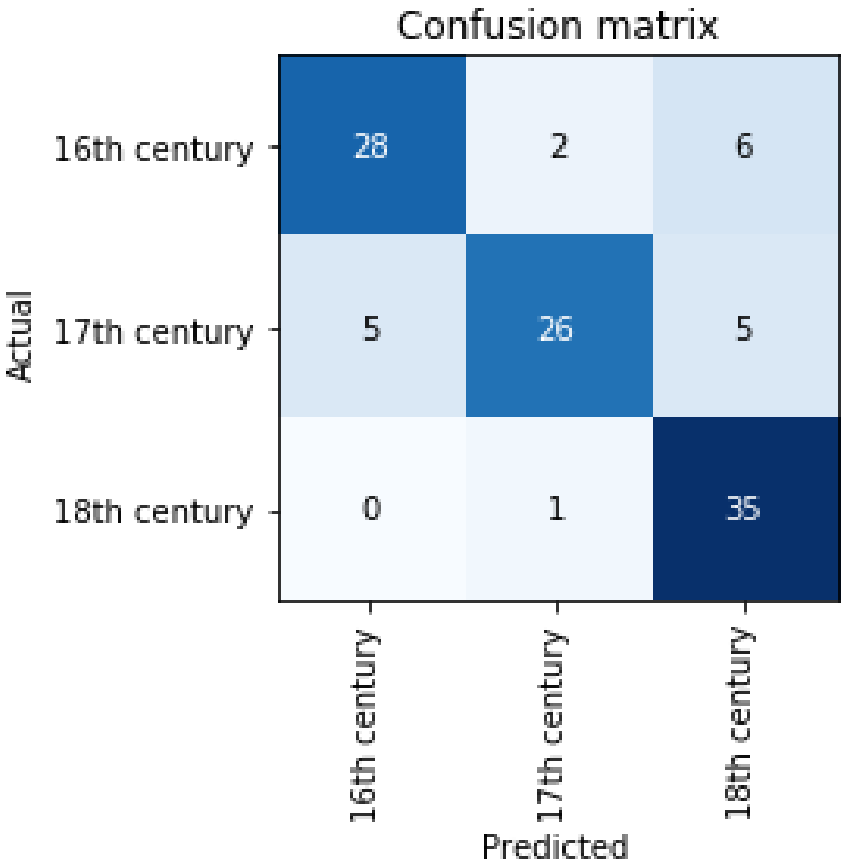


Figure 15: ResNet 34 : Confusion Matrix of Test Images

True Positive values of 16th century = 28
True Positive values of 17th century= 26
True Positive values of 18th century= 35

False Positive values of 16th century = 5 and 0
False Positive values of 17th century =2, 1
False Positive values of 18th century =5, 6

False Negative values of 16th century = 2, 6
False Negative values of 17th century =5,5
False Negative values of 18th century = 0,1

ResNet 34 prove to be better than ResNet 18, because it has more layers to check the image.

Table 4: **ResNet 34: Confusion Matrix of Test Images**

Precision 16th Century	0.78
Precision 17th Century	0.72
Precision 18th Century	0.97
Recall 16th Century	0.85
Recall 17th Century	0.90
Recall 18th Century	0.76
F1 Score 16th Century	0.81
F1 Score 17th Century	0.8
F1 Score 18th Century	0.85

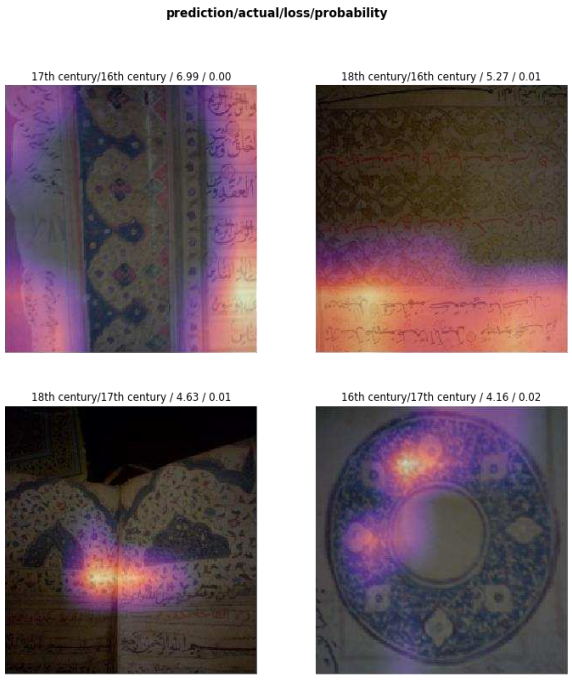


Figure 16: ResNet 34: Most Confused Answers with heat map

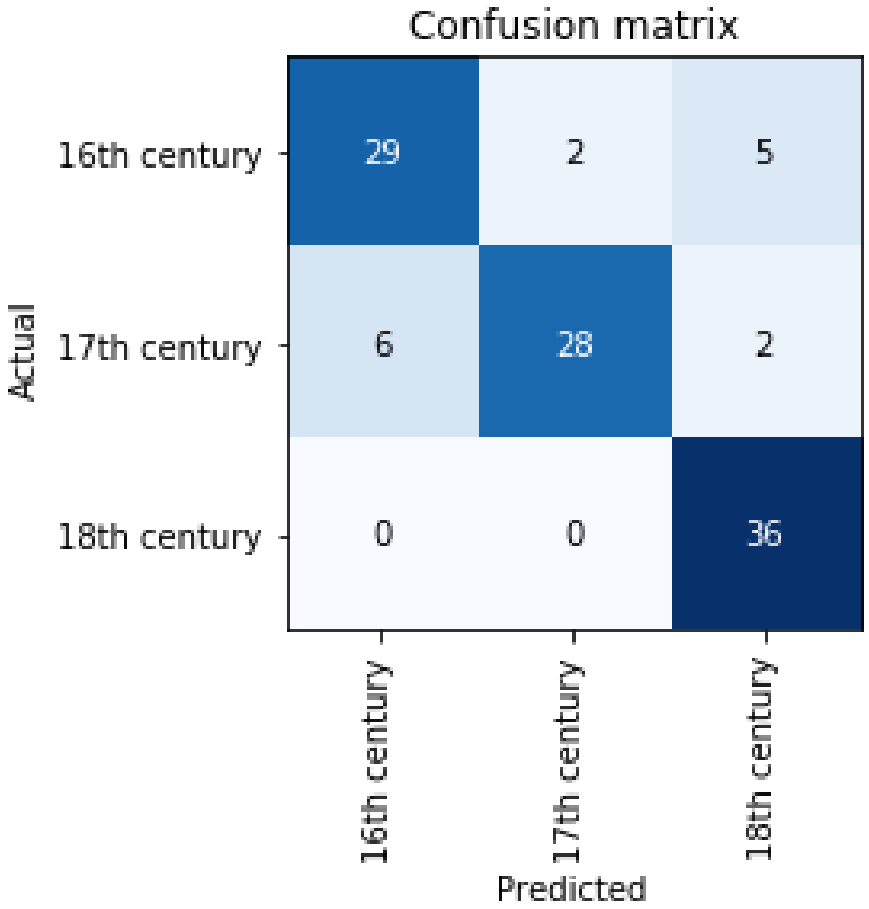


Figure 17: ResNet 50- Confusion Matrix of Test Images

True Positive values of 16th century = 29
True Positive values of 17th century= 28
True Positive values of 18th century= 36

False Positive values of 16th century = 6 and 0
False Positive values of 17th century =2, 0
False Positive values of 18th century =5, 2

False Negative values of 16th century = 2, 5
False Negative values of 17th century =2,6
False Negative values of 18th century = 0,0

Res Net 50 is better than Res Net 18 and Res Net 34.

Table 5: ResNet 50- Confusion Matrix of Test Images

Precision 16th Century	0.81
Precision 17th Century	0.78
Precision 18th Century	1.0
Recall 16th Century	0.83
Recall 17th Century	0.93
Recall 18th Century	0.84
F1 Score 16th Century	0.82
F1 Score 17th Century	0.85
F1 Score 18th Century	0.91

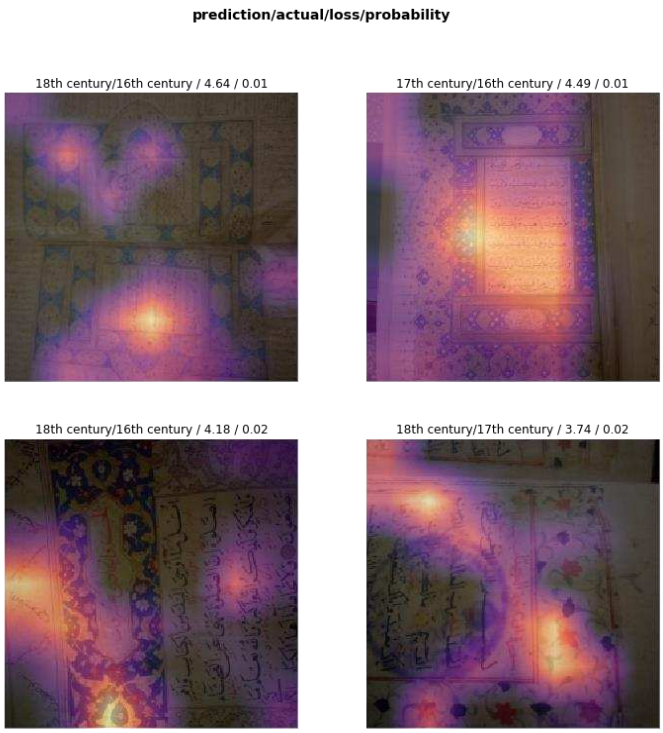


Figure 18: ResNet 50- Most Confused Answers with heat map:

Relative chronology of untrained data of Qater National Library

After trained the data fastAi drawn the relative chronology of the untrained data of Qatar National university and its results. Total 28 images from the 5 illuminated manuscripts of the Qur'an from the Qatar national library have been analyzed by the AI.

Table 6: Relative chronology of untrained Data

	label	file
0	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_2_page-0001.jpg
1	17th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_1_page-0004.jpg
2	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/72e696f6-04d4-408a-8aaf-34de775eb9fb_ 11.jpg
3	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/72e696f6-04d4-408a-8aaf-34de775eb9fb_12.jpg
4	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image 2 of 1.jpg
5	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page-.jpg
6	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_6-1.jpg
7	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/Pages From HC_MS_02658 ABC_Page_5 of 2.jpeg
8	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image.jpg
9	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_8-1 of 2.jpg
10	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/Pages From HC_MS_02658 ABC_Page_5.jpeg
11	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_1_page-0004 of 1.jpg
12	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_8-1 of 1.jpg
13	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image 2.jpg
14	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_9-1.jpg
15	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page- of 4.jpg
16	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/Screenshot 2022-03-24 235359.png
17	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_2_page-0001 of 3.jpg
18	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_6-1 of 1.jpg
19	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page- of 3.jpg
20	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image of 3.jpg
21	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60782-i24984668_split_7_page-0001 of 1.jpg
22	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page- of 1.jpg
23	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60782-i24984668_split_7_page-0001 of 2.jpg
24	17th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/Pages From HC_MS_02658 ABC_Page_5 of 1.jpeg
25	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_8-1.jpg
26	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/60782-i24984668_split_7_page-0001.jpg
27	18th Century	/Volumes/Data/Fun Coding/other/saima/Quran/test/72e696f6-04d4-408a-8aaf-34de775eb9fb_5.jpg

The table 6 show in its results that only 2 images (figure 13 and 14) identified by the software are from 17th century and 26 are from 18th century.

Figure 19 : Pages From HC_MS_02658 ABC_Page_5 of 1 Image of Indian Quran of Qatar National Library

Figure 20 : 60780-i24977548_split_1_page-0004 of 1 Indian Quran a collection of Qatar National Library

For the prediction of the relative chronology tensor-based method has been used in this study. For the classification of the images the tensor-based algorithm performed well (Klus 2019). Basically, a tensor is a significant data structure of deep learning algorithms. It is a mathematical object that describes matrices (used for linear transformation) to high dimensions, however, a tensor can be used for many transformations large-scale datasets, multidimensional data such as visuals (patterns, design, images and videos etc.).

Table 7: Relative chronology of untrained Data

	label	probility	file
0	18th Century	TensorBase(0.9097)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_2_page-0001.jpg
1	17th Century	TensorBase(0.6935)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_1_page-0004.jpg
2	18th Century	TensorBase(0.9965)	/Volumes/Data/Fun Coding/other/saima/Quran/test/72e696f6-04d4-408a-8aaf-34de775eb9fb_ 11.jpg
3	18th Century	TensorBase(0.9948)	/Volumes/Data/Fun Coding/other/saima/Quran/test/72e696f6-04d4-408a-8aaf-34de775eb9fb_12.jpg
4	18th Century	TensorBase(0.6275)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image 2 of 1.jpg
5	18th Century	TensorBase(0.9946)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page-.jpg
6	18th Century	TensorBase(0.7536)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_6-1.jpg
7	18th Century	TensorBase(0.7237)	/Volumes/Data/Fun Coding/other/saima/Quran/test/Pages From HC_MS_02658 ABC_Page_5 of 2.jpeg
8	18th Century	TensorBase(0.6906)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image.jpg
9	18th Century	TensorBase(0.9969)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_8-1 of 2.jpg
10	18th Century	TensorBase(0.9087)	/Volumes/Data/Fun Coding/other/saima/Quran/test/Pages From HC_MS_02658 ABC_Page_5.jpeg
11	18th Century	TensorBase(0.9999)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_1_page-0004 of 1.jpg
12	18th Century	TensorBase(0.9983)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_8-1 of 1.jpg
13	18th Century	TensorBase(0.9729)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image 2.jpg
14	18th Century	TensorBase(0.9979)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_9-1.jpg
15	18th Century	TensorBase(0.8665)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page- of 4.jpg
16	18th Century	TensorBase(0.5468)	/Volumes/Data/Fun Coding/other/saima/Quran/test/Screenshot 2022-03-24 235359.png
17	18th Century	TensorBase(0.8327)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60780-i24977548_split_2_page-0001 of 3.jpg
18	18th Century	TensorBase(0.9971)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_6-1 of 1.jpg
19	18th Century	TensorBase(0.8805)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page- of 3.jpg
20	18th Century	TensorBase(0.9817)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60733 image of 3.jpg
21	18th Century	TensorBase(0.9289)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60782-i24984668_split_7_page-0001 of 1.jpg
22	18th Century	TensorBase(0.9350)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_7_page- of 1.jpg
23	18th Century	TensorBase(0.8813)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60782-i24984668_split_7_page-0001 of 2.jpg
24	17th Century	TensorBase(0.7504)	/Volumes/Data/Fun Coding/other/saima/Quran/test/Pages From HC_MS_02658 ABC_Page_5 of 1.jpeg
25	18th Century	TensorBase(0.9057)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60742-i26737310_split_8-1.jpg
26	18th Century	TensorBase(0.9943)	/Volumes/Data/Fun Coding/other/saima/Quran/test/60782-i24984668_split_7_page-0001.jpg
27	18th Century	TensorBase(0.9784)	/Volumes/Data/Fun Coding/other/saima/Quran/test/72e696f6-04d4-408a-8aaf-34de775eb9fb_5.jpg

The image of figure 20 in which AI is saying 17th rest all images it thinks is from 18th

Conclusion

The analysis of the results revealed that the convolutional neural network architectures yielded very good results and the performance by the ResNet-50 is much better than the ResNet-18 and ResNet-34, for relative chronology used tensor-based algorithms for image classification. The application of computer software for pattern recognition based on cognition function and to analyse image-based data have been emerging as an excellent tool. The recognition of image patterns has got vital importance in many fields such as in

medicine and in national security. Artificial intelligence software has got the capability to extract vital information from digitized images that may be very helpful in pattern recognition. In the field of medicine particularly where the study of images is required such as radiology and histopathology, the application of AI has revealed very encouraging results (Syed Usama Khalid Bukhari 2020)

Since arabesques had been used in the illuminated manuscript of the Qur'an. This art form is not developed at a specific time and same geographical boundaries. It transformed into many shapes, patterns and design layouts with the passage of time among the different areas of the Muslim world. The formation of arabesque design is distinguishable from geometric to organic which incorporates different motifs and their repeat orientation.

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