



DEPARTAMENTO DE CIENCIAS DE LA COMPUTACIÓN  
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# Armenian Khachkars: Towards an Automated Handling of Segmentation and Classification

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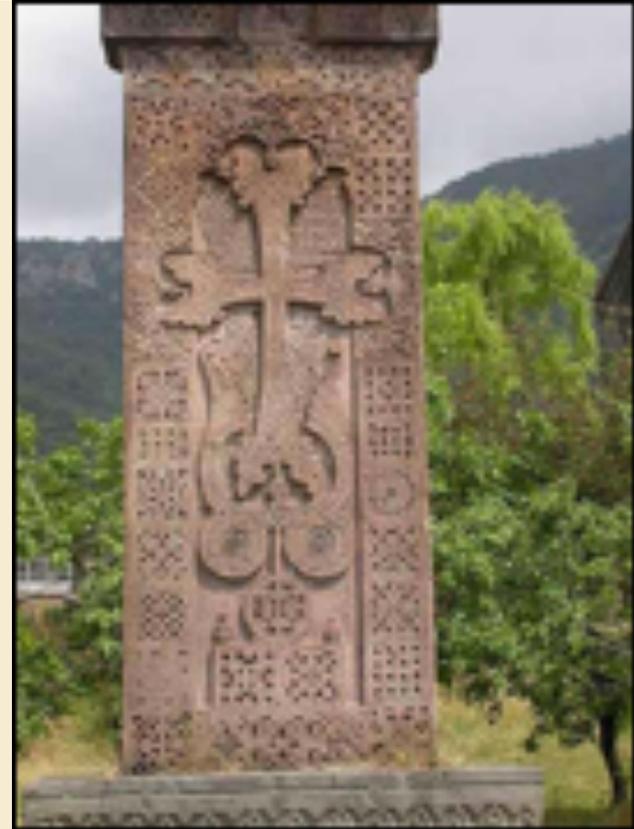


*American University of Armenia*  
Հայաստանի Ամերիկյան Համալսարան

MORE THAN AN EDUCATION - A COMMITMENT

# UNESCO description of Khachkars

“Khachkars reach 1.5 meters in height, and have an ornamentally carved cross in the middle, resting on the symbol of a sun or wheel of eternity, accompanied by vegetative-geometric motifs, carvings of saints and animals. Khachkars are created usually using local stone and carved using chisel, die, sharp pens and hammers.”



- **DiKEViMA project** (Digitization of Khachkars: Establishing a Virtual Museum in Armenia)
- **Realization of the multipurpose system ViMEDEAS** (Virtual Museum Exhibition Designer Using Enhanced ARCO Standard)
- **ViMCOX metadata standard** (Virtual Museum and Cultural Object Exchange Format)

- **ViMCOX Metadata attributes**
  - Encoding
  - Naming
  - Content
  - Presentation
  - **Structuring/Classification**



(Semi-)Automate this step!

## **H. Khatchadourian and M. Basmadjian: *L'art des khachkars: Les pierres à croix arméniennes d'Isphahan et de Jérusalem***

- **Excellent photographs**
- **Rich metadata**
- **Complemented by codes**

# Structuring and Classification

## Proposal by Khatchadourian & Basmadjian



### Domains covered:

- Inscriptions
- Typology
- Epigraphy
- Ontology

Example: Grigor's Khachkar from Durand, J., Rapti, I., Giovannoni, D.: *Armenia sacra: Mémoire chrétienne des Arméniens*. Musée du Louvre Editions. Somogy (2007), p.171

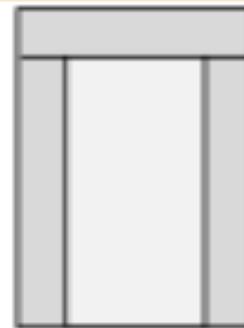
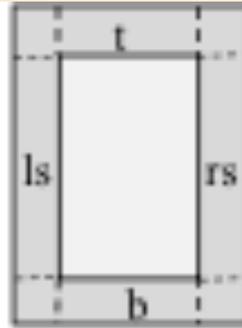
## Limitations

- **Hierarchical coding of ornaments & their compositions (→ incomplete)**
- **Digital tool support (→ none)**
- **Variety of khachkars (→ 2 locations)**

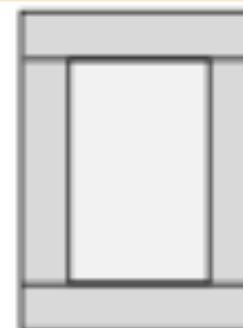
# Proposal of an extended approach Border structure



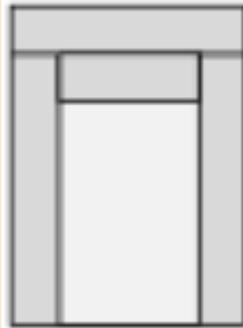
S



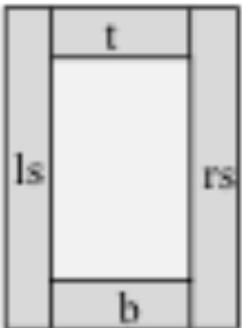
Strsls



Stbrsls



Strslst



Srslstb



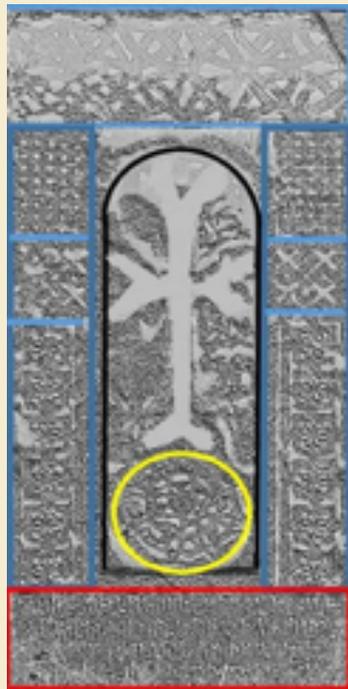
Sb



Slsb

# Structuring and Classification

## Proposal by Khatchadourian & Basmadjian

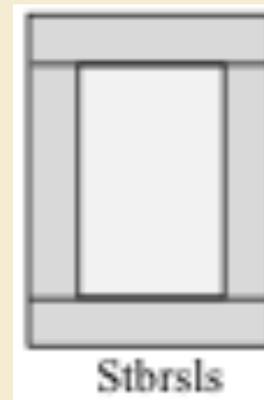


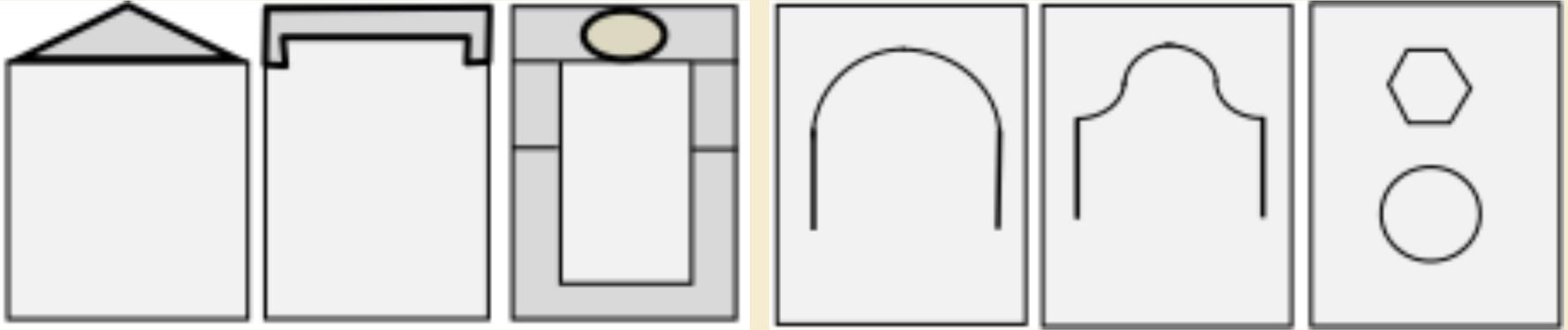
### Example: Khachkar in memory of P'alik Noravank monastery, 1285,

from: Durand, J., Rapti, I., Giovannoni, D.: Armenia  
sacra: Mémoire chrétienne des Arméniens. Musée du  
Louvre Editions. Somogy (2007), p.326, sizes:  
164x70x26 cm

**Coded as:**

**Stbls123rs123 Ftq1q2lsrs XC**



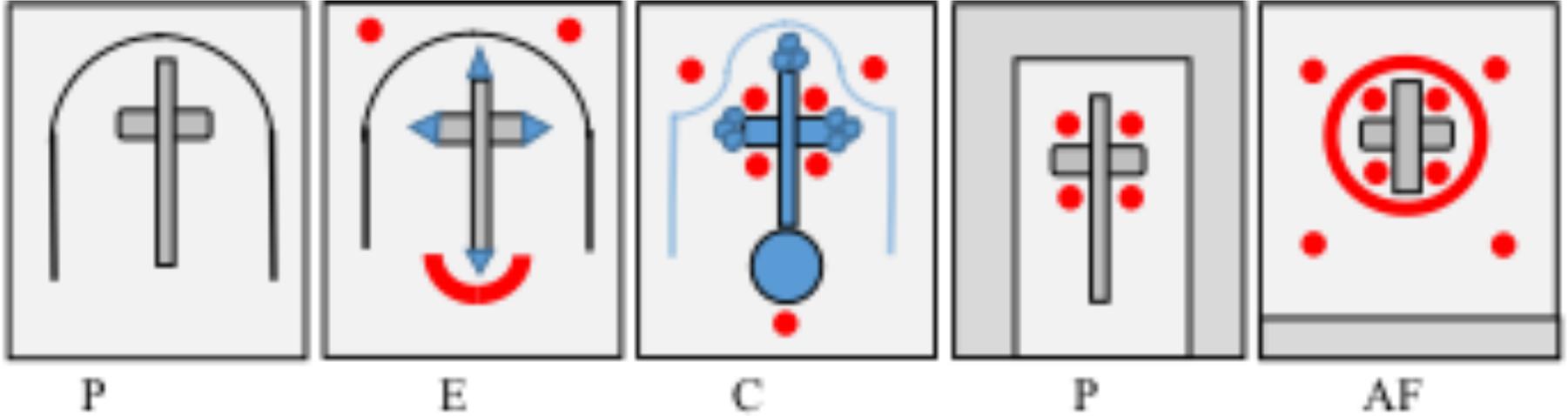


**From left to right:**

- **St triangle**
- **St polygon**
- **St 123 ls12 rs12**

**From left to right:**

- **Ftq1q2lsrs**
- **Ftq1hc2q2lsrs**
- **Fthexagonbcircle**



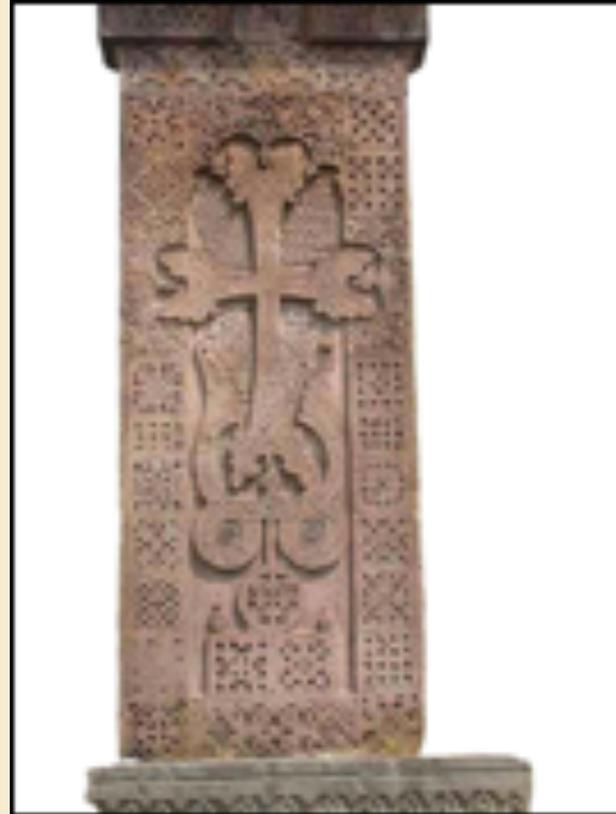
**From left to right:**

- **Primitive (P)**
- **Simple (E)**
- **Complex (C)**
- **Atypical form (AF)**

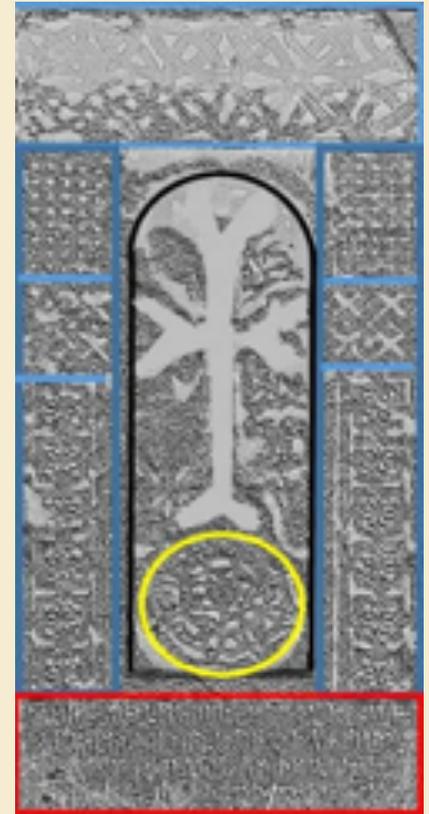
# Implementation proposal (Automated khachkar classification)

- **Filter background noise**
- **Transform to grey scale**
- **Apply sharpening filter**
- **Automatic khachkar classification of deep learning and Convolutional Neural Network (CNN) tools recommended**

# Image segmentation



# Image (pre-)processing



- **Proposal for an extended reference code for the hierarchical description of Khachkar segments and ornaments**
- **Proposal for a tool supported implementation using computer graphics algorithms and neuronal network based approaches**
- **Visual language for khachkar iconography description required**

We dedicate this work to the author, scientist, and expert in historical architecture **Samvel Karapetian**, who died far too early on February 27, 2020. His advice and expertise have accompanied us for years. His untiring work for the historical heritage of Armenia, which he has documented in many books and lectures, remains unfinished. We have lost an irreplaceable supporter of our projects and a friend to whom we owe a debt of gratitude.