



From CIDOC CRM to CRM-ACA

Ontology Extension and Knowledge Graph Construction
for Ancient Chinese Artifacts at the Palace Museum

Yipei YE
The Palace Museum

- Who we are
- Why we launched this initiative
- How we did and doing it
- The practical achievement
- Future plan



Who we are

The Forbidden City - imperial palace of the Ming and Qing dynasties
built in 1420 CE, 600 + years
on UNESCO's World Heritage List
The Palace Museum, established in 1925





Architecture complex
1.9 million artifacts
17 million visitors annually



爱上紫禁城

爱上故宫

爱上紫禁城

爱上紫禁城 摄影张林



图 A.4 金银器类文物影像采集示例

Why we launched this project

Provide better service, let our users easily find what they are looking for.
Provide high-quality data (structured, standardized, machine-readable) to AI.



院有影像藏品数量1,075,649件套，进度55.13%

1.9 million+ pieces in collection

Digitized 1,075,639 pieces (55.13%)

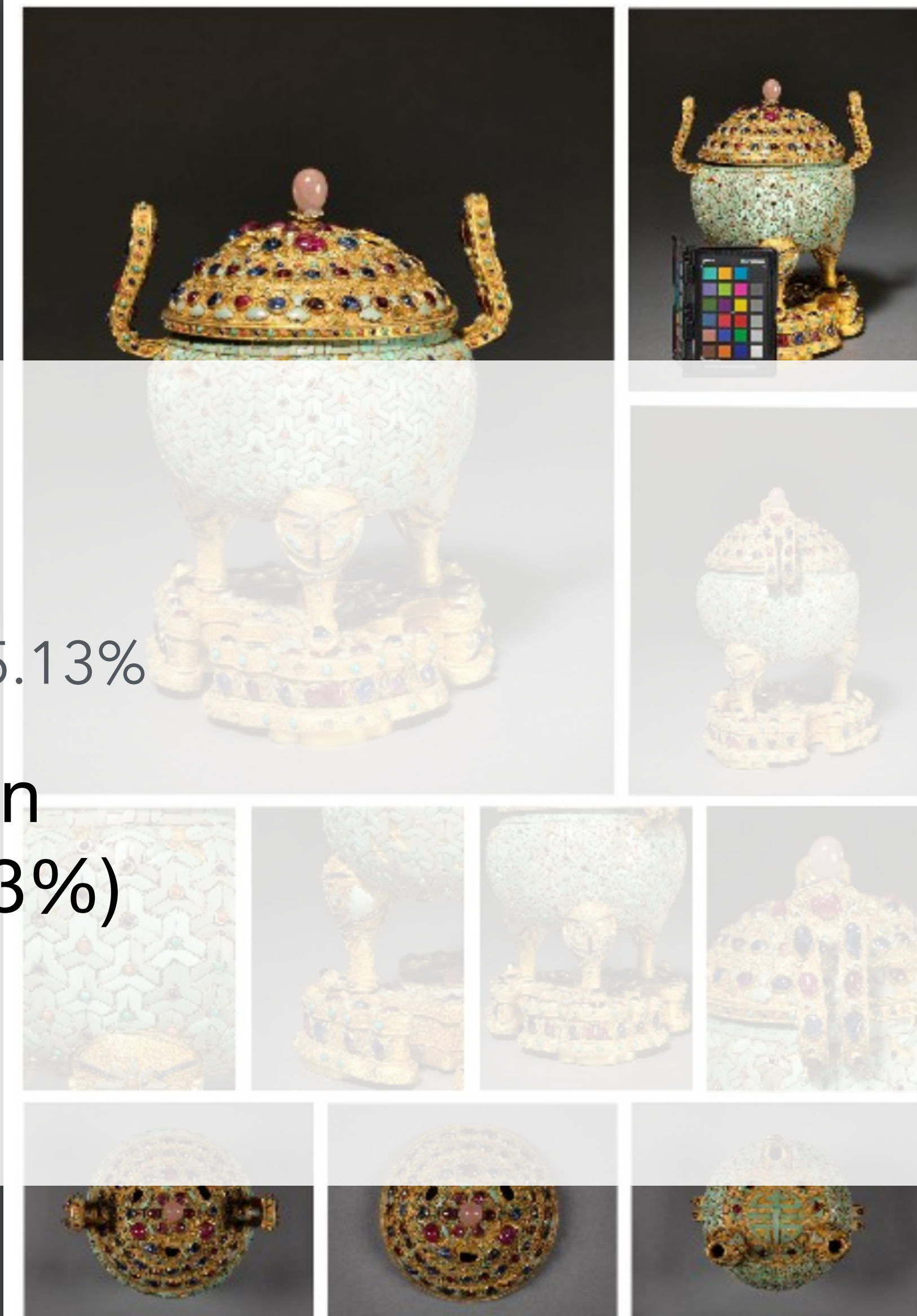


图 A.4 金银器类文物影像采集示例

Why we launched this initiative

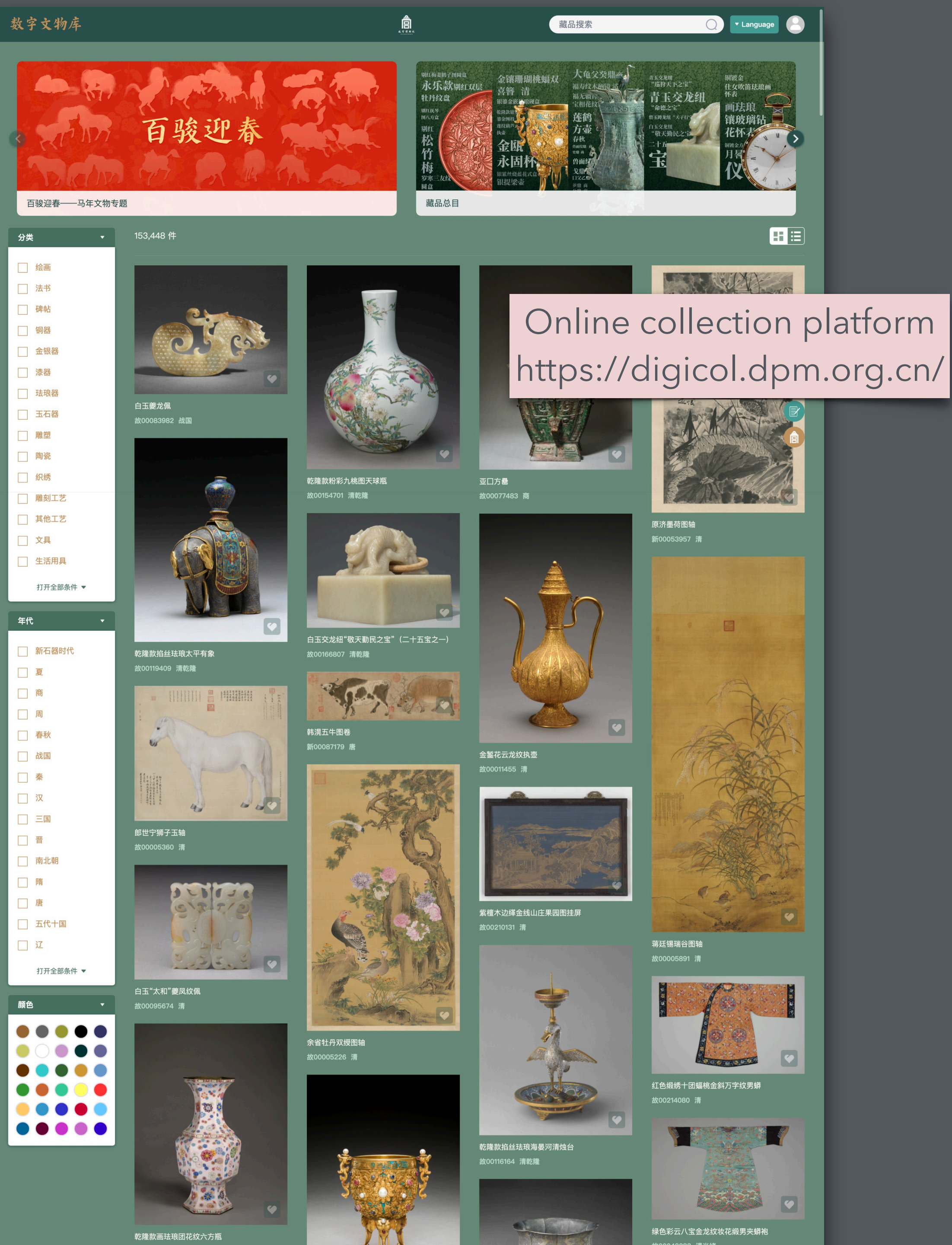
Provide better service, let our users easily find what they are looking for.
Provide high-quality data (structured, standardized, machine-readable) to AI.



关于2026年环卫工人主题免费开放日的公告

website

<https://www.dpm.org.cn/Home.html>



Online collection platform
<https://digicol.dpm.org.cn/>

数字文物库

唐三彩 0件

分类

- 绘画
- 法书
- 碑帖
- 铜器
- 金银器
- 漆器
- 珐琅器
- 玉石器
- 雕塑

暂无文物信息

No results

数字文物库

元青花 0件

分类

- 绘画
- 法书
- 碑帖
- 铜器
- 金银器
- 漆器
- 珐琅器
- 玉石器
- 雕塑
- 陶瓷

暂无文物信息

No results

数字文物库

铜镜 0件


分类

- 绘画
- 法书
- 碑帖
- 铜器
- 金银器
- 漆器
- 珐琅器
- 玉石器

暂无文物信息

No results

Search Results



明黄色纱绣彩云金龙纹女单龙袍


Number 故00042032

Category 织绣

Period 清乾隆

Color

release only 4 metadata: item name, item number, category, period



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Embroidered on gauze fabric

For women

Dragon robe,
a kind of
festive dress

明黄色|纱绣彩云金龙纹|女单龙袍

Bright yellow

Golden dragon
floating among
polychrome
clouds

Single layer
without
padding



女龙袍
女吉服
女装

women's dragon robe
women's festive dress
women's wear/women's clothes

Test with the DingTalk LLM



故宫文物 机器人 2024年02月01日 10:26

叶祎珮
我想看衬衣

目前我学习的故宫文物知识还没有办法回答你的问题，接下来我会用之前学习的通用知识进行回答。

在故宫博物院中，由于衬衣属于现代服饰，并非馆藏文物范畴，因此您无法在故宫内欣赏到古代衬衣展品。故宫主要收藏和展示的是中国古代各个时期的珍贵文物，如瓷器、书画、青铜器、玉器、宫廷生活用品等。如果您想了解故宫的展览信息，建议您访问故宫博物院官方网站或者前往实地参观时查询最新的展览目录，以获取最准确的信息。

该结果由模型推理生成，仅供参考



叶祎珮 (叶祎珮)



我想看衬衣 @故宫文物

3人未读

Translation: I want to see some *chenyi*.

Translation: At present, the knowledge of collection of the Palace Museum that I have learned has not been able to answer your question. I will answer with the general knowledge I have learned before. Because the shirt is a kind of modern costume, not a category of the Palace Museum's collection, you cannot see any shirts in the Palace Museum.



衬衣 (*chenyi*)
a kind of robe

≠

衬衣 (*chenyi*)
shirt



How we did and doing it

Ontology
Controlled Vocabulary
Knowledge Graph

Ontology Development 101: A Guide to Creating Your First Ontology

Natalya F. Noy and Deborah L. McGuinness
Stanford University, Stanford, CA, 94305
noy@smi.stanford.edu and dlm@ksl.stanford.edu

1 Why develop an ontology?

In recent years the development of ontologies—explicit formal specifications of the terms in the domain and relations among them (Gruber 1993)—has been moving from the realm of Artificial-Intelligence laboratories to the desktops of domain experts. Ontologies have become common on the World-Wide Web. The ontologies on the Web range from large taxonomies categorizing Web sites (such as on Yahoo!) to categorizations of products for sale and their features (such as on Amazon.com). The WWW Consortium (W3C) is developing the Resource Description Framework (Brickley and Guha 1999), a language for encoding knowledge on Web pages to make it understandable to electronic agents searching for information. The Defense Advanced Research Projects Agency (DARPA), in conjunction with the W3C, is developing DARPA Agent Markup Language (DAML) by extending RDF with more expressive constructs aimed at facilitating agent interaction on the Web (Hendler and McGuinness 2000). Many disciplines now develop standardized ontologies that domain experts can use to share and annotate information in their fields. Medicine, for example, has produced large, standardized, structured vocabularies such as SNOMED (Price and Spackman 2000) and the semantic network of the Unified Medical Language System (Humphreys and Lindberg 1993). Broad general-purpose ontologies are emerging as well. For example, the United Nations Development Program and Dun & Bradstreet combined their efforts to develop the UNSPSC ontology which provides terminology for products and services (www.unspsc.org).

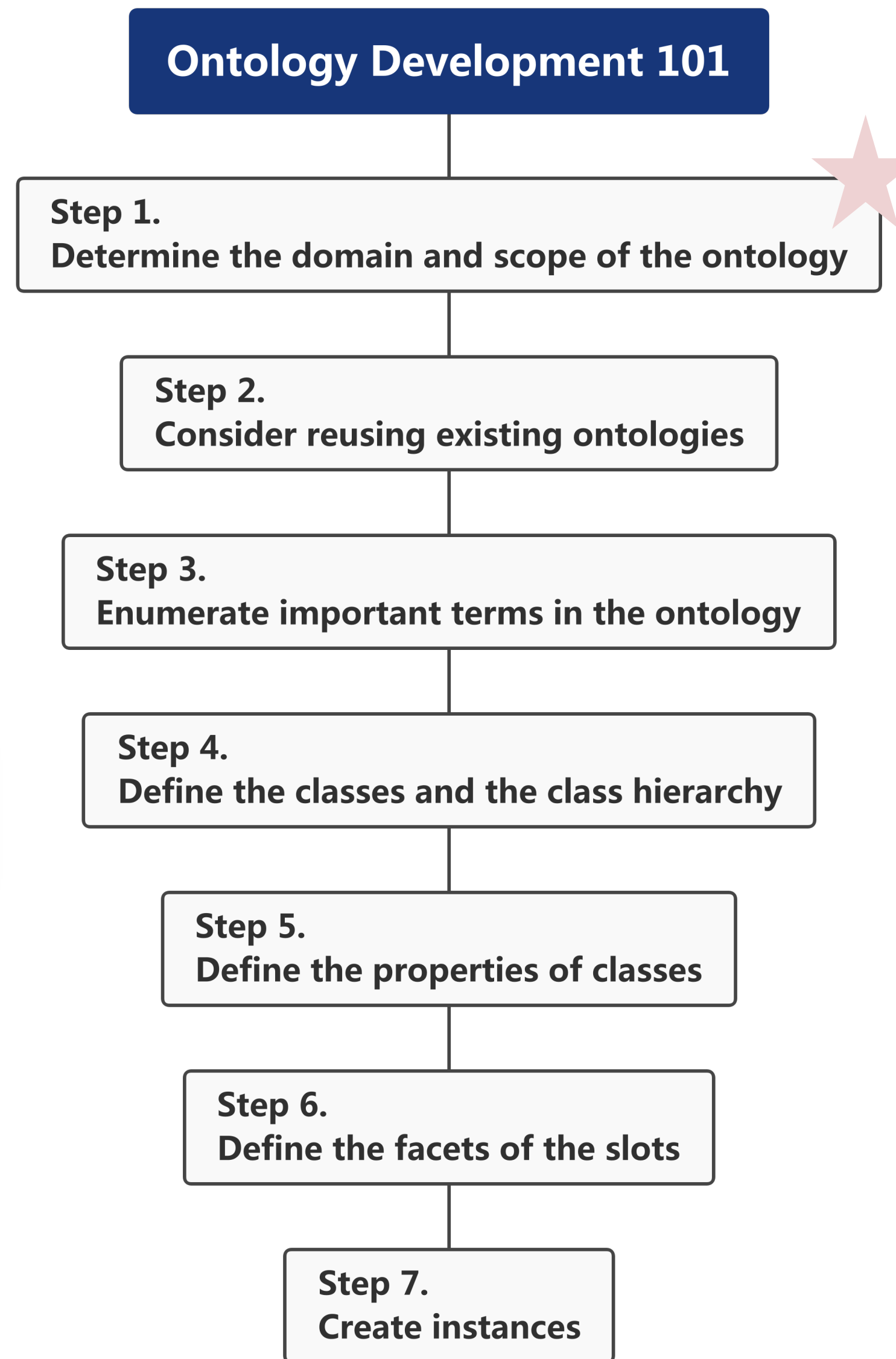
Ontology Development 101 methodology (Noy et al., 2002)

software agents

- To enable reuse of domain knowledge
- To make domain assumptions explicit
- To separate domain knowledge from the operational knowledge
- To analyze domain knowledge

Sharing common understanding of the structure of information among people or software agents is one of the more common goals in developing ontologies (Musen 1992; Gruber 1993). For example, suppose several different Web sites contain medical information or provide medical e-commerce services. If these Web sites share and publish the same underlying ontology of the terms they all use, then computer agents can extract and aggregate information from these different sites. The agents can use this aggregated information to answer user queries or as input data to other applications.

Enabling reuse of domain knowledge was one of the driving forces behind recent surge in ontology research. For example, models for many different domains need to represent the notion of time. This representation includes the notions of time intervals, points in time, relative measures of time, and so on. If one group of researchers develops such an ontology in detail, others can simply reuse it for their domains. Additionally, if we need to build a large



CRM-ACA

Its aim is to serve all cultural heritage institutions that house ancient Chinese artifacts to better organize collection cataloguing data.

Based on CIDOC CRM, CRM-ACA is further aligned with the terminology and metadata system used in Chinese museum cataloging.

Even users who are not familiar with CIDOC CRM can more easily identify matches between CRM-ACA and the metadata they currently use, allowing them to map their data efficiently.

Ontology Development 101

Step 1.
Determine the domain and scope of the ontology

Step 2.
Consider reusing existing ontologies

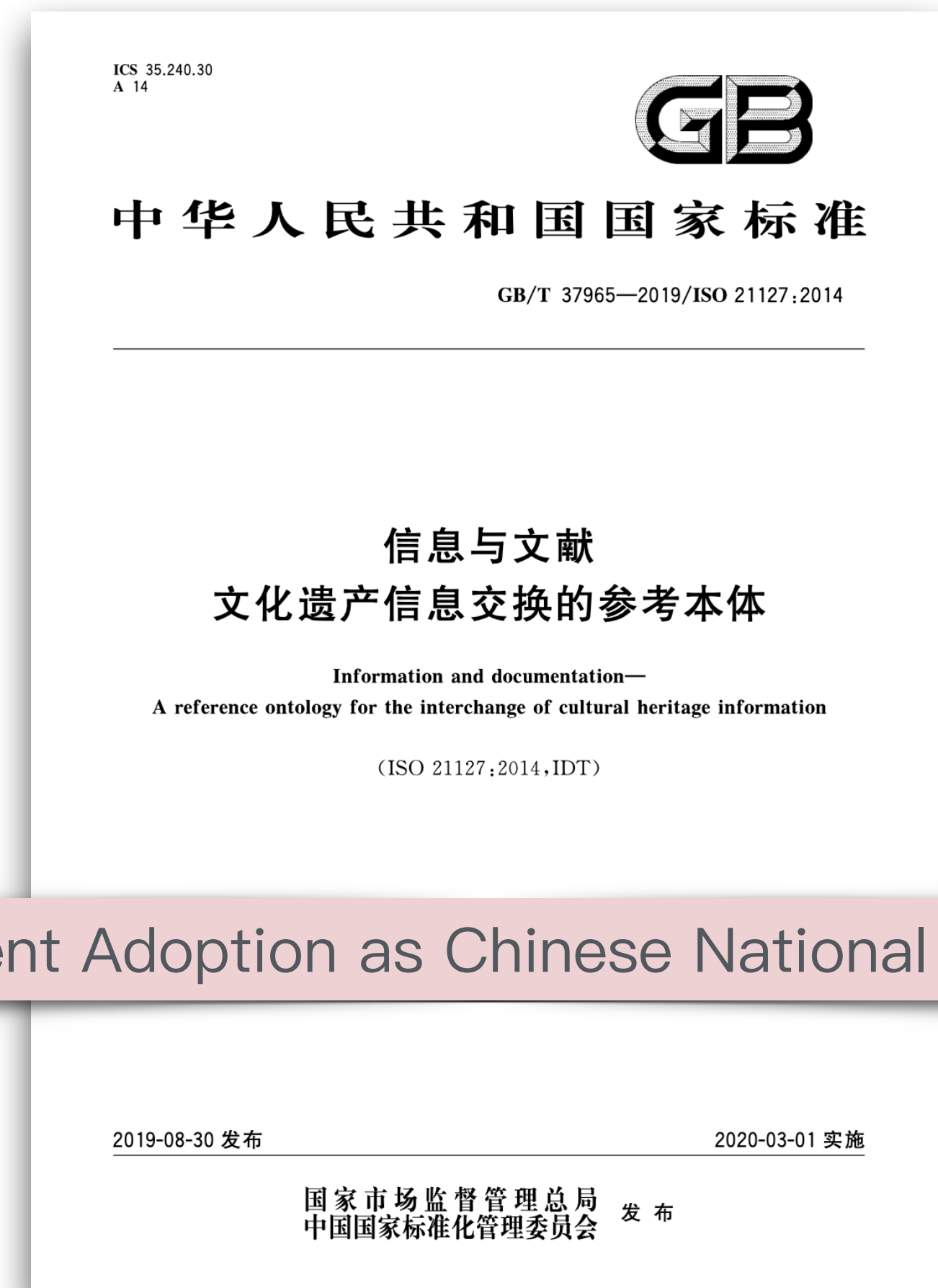
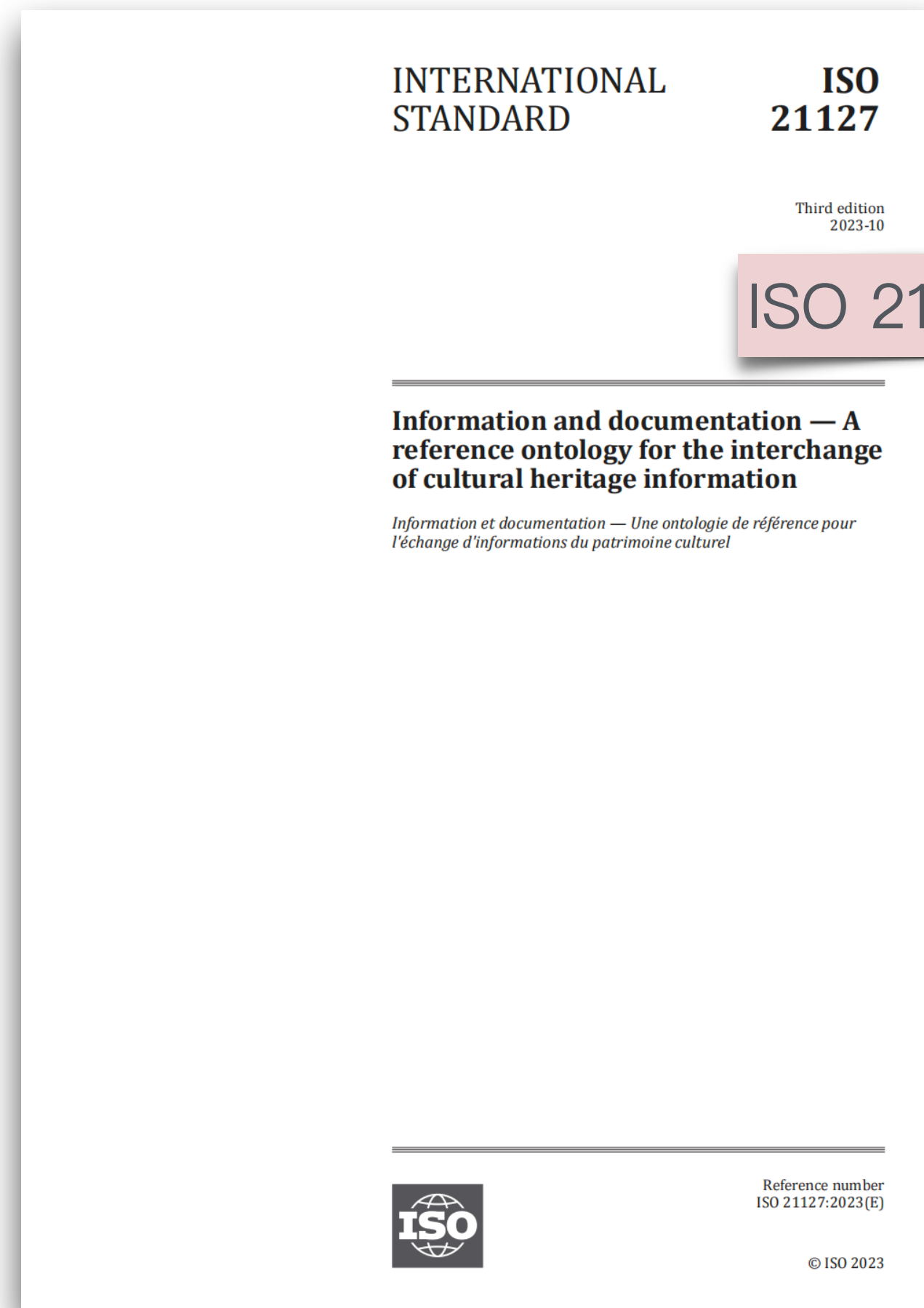
Step 3.
Enumerate important terms in the ontology

Step 4.
Define the classes and the class hierarchy

Step 5.
Define the properties of classes

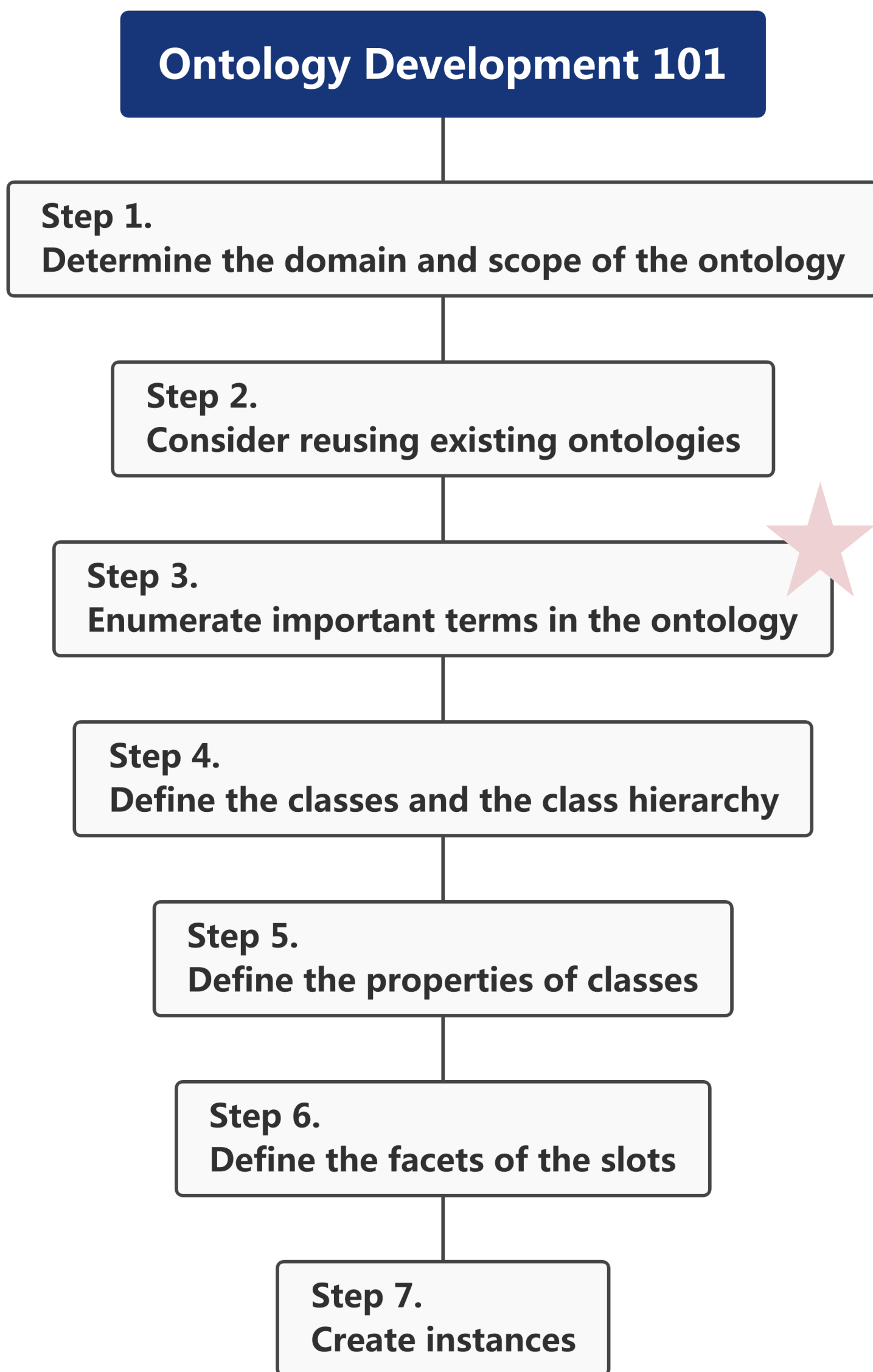
Step 6.
Define the facets of the slots

Step 7.
Create instances



Equivalent Adoption as Chinese National Standard

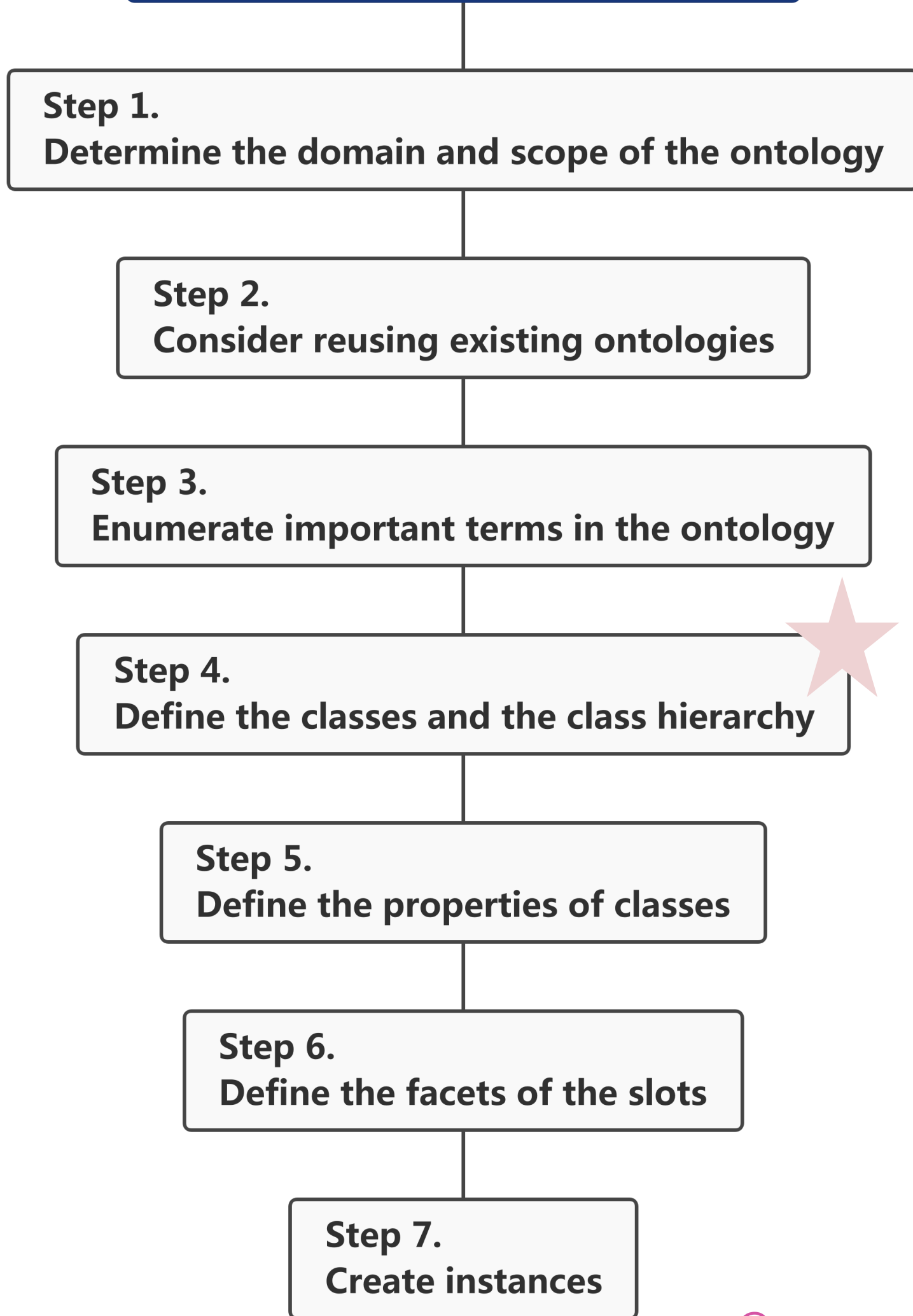
Ontology Development 101



Scattered Terms	Terms Cluster
Kangxi reign, red, bronze zun, stem cups, Qianlong reign, flower watering jugs, plant motif, fans, ruyi, Yongzheng reign, blue, vase, famille-rose, blue-and-white, hill-shaped censers, flying-dragon pattern, yellow, jewelry, robes, osmanthus flower, kids..... object type, decorative motif, creator, periods.....	(Reign Title) Kangxi reign, Qianlong reign, Yongzheng reign...
	(Process and Technique) famille-rose, blue-and-white...
	(Color) red, blue, yellow...
	(Object Type) bronze zun, stem cups, flower watering jugs, fans, ruyi, vase, hill-shaped censers, jewelry, robes...
	(Motif and Pattern) plant motif, flying-dragon pattern, osmanthus flower...
	(Role) kids...
	(Metadata) object type, decorative motif, creator, periods...

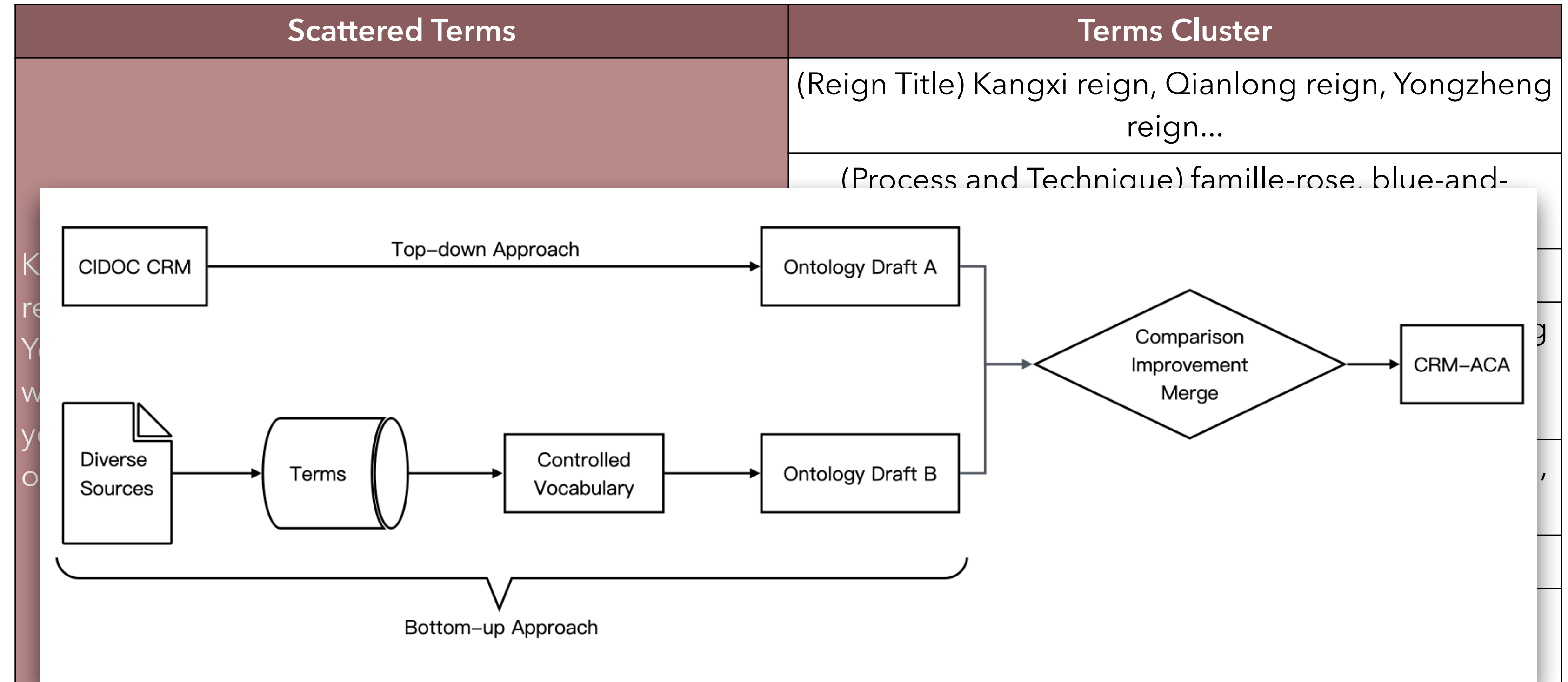
Term sources	
descriptive terms	Terms from our CMS
	Terms from dictionaries
	Search record from online collection platform
metadata terms	collected from several Chinese museums' CMS (including the Palace Museum)
	Getty CDWA

Ontology Development 101



Creator

E22 Human-Made Object --- was produced by --- E12 Production
 E12 Production --- was carried out by --- E39 Actor



Term sources	
descriptive terms	Terms from our CMS
	Terms from dictionaries
	Search record from online collection platform
metadata terms	collected from several Chinese museums' CMS (including the Palace Museum)
	Getty CDWA

<Image of CRM extension logo>

Definition of the CRMaca
<An extension of CIDOC CRM to support
ancient Chinese artifacts knowledge
organization>

<Proposal for approval by the CIDOC CRM-SIG>
<Approved by the CIDOC CRM-SIG>

Version <x.x>

<March 2026>

Currently maintained by Yipei Ye, the Palace Museum
Contributors: The Palace Museum

At present, we successfully pilot the full workflow of cataloging data reconstruction with CRM-ACA in practice.

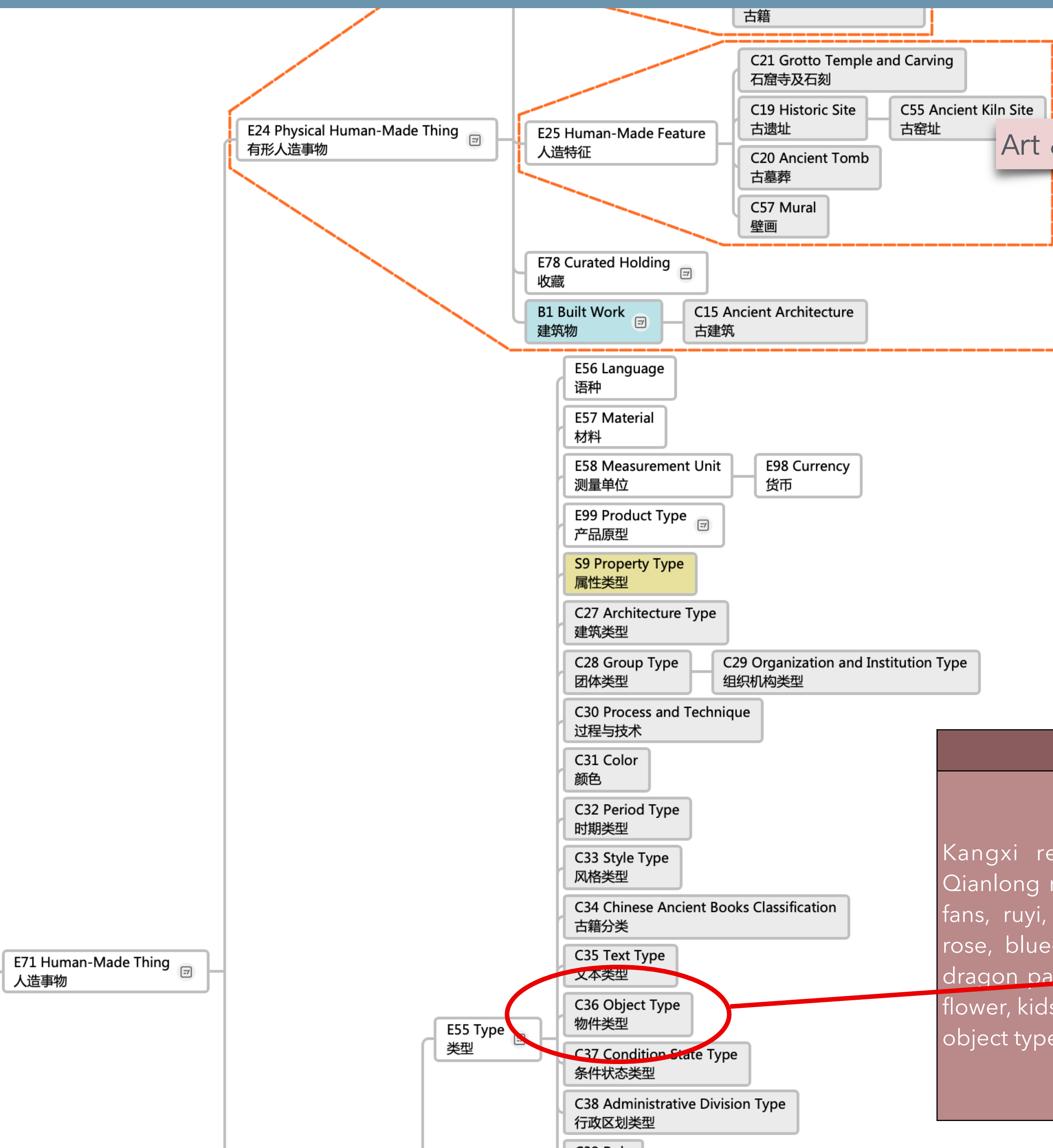
Our plan is to release this extension, as well as the thesaurus and knowledge graph data.

<License information>

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Controlled Vocabulary - Thesauri



Art & Architecture Thesaurus

尊 (容器)
Zun (vessels)
AAT ID: 300265850

P127 has broader term

<依形式区分的尊>
<zun by form>

<依材料区分的尊>
<zun by material>

P127 has broader term

青铜尊
Bronze zun



瓷尊
Porcelain zun



珐琅尊
Enamel zun



Scattered Terms	Terms Cluster
Kangxi reign, red, bronze zun, stem cups, Qianlong reign, flower watering jugs, plant motif, fans, ruyi, Yongzheng reign, blue, vase, famille-rose, blue-and-white, hill-shaped censers, flying-dragon pattern, yellow, jewelry, robes, osmanthus flower, kids..... object type, decorative motif, creator, periods.....	(Reign Title) Kangxi reign, Qianlong reign, Yongzheng reign...
	(Process and Technique) famille-rose, blue-and-white...
	(Color) red, blue, yellow...
	(Object Type) bronze zun, stem cups, flower watering jugs, fans, ruyi, vase, hill-shaped censers, jewelry, robes...
	(Motif and Pattern) plant motif, flying-dragon pattern, osmanthus flower...
	(Role) kids...
	(Metadata) object type, decorative motif, creator, periods...

E71 Human-Made Thing
人造事物

E55 Type
类型

Controlled Vocabulary - Thesauri

尊 (容器) /
zun (vessels) /
300265850 /
CIT285914 /

- 琵琶尊 /
- 灯笼尊 /
lantern-shaped zun /
- 观音尊 /
- 太白尊 /
- 菊瓣尊 /
chrysanthemum-shaped zun /
- 花瓣尊 /
- 无当尊 / 无挡尊 /
- 英雄尊 /
- 鱼篓尊 /
- 鱼式尊 /
fish-shaped zun /
- 五孔尊 /
- 橄榄尊 /
olive-shaped zun /
- 双陆尊 /
- 交泰尊 /
- 青铜尊 /
bronze zun /
- 瓷尊 /
porcelain zun /
- 珐琅尊 /
enamel zun /
 - 掐丝珐琅尊 /
cloisonne enamel zun /
 - 画珐琅尊
- 铜尊 /
copper zun /
- 漆尊 /
lacquer zun /
 - 剔红尊
- 玉尊 /
jade zun /
- 陶尊 /
pottery zun /
 - 三彩尊 /
tri-color pottery zun /
- 竹尊 /
bamboo zun /
- 玻璃尊 /
glass zun /
- 水晶尊 /
crystal zun /
- 玛瑙尊 /
agate zun /

依材料区分的尊 /
<zun by material> /

鉴 (容器) /
jian /
300265827 /

依形式区分的鉴 /
<jian by form> /

- 素鉴 /
plain jian /
- 三足鉴 /
three-foot jian /
- 青铜鉴 /

Knowledge Graph

Collection Information Annotation System

故宫博物院 控制台 知识图谱标记 标注审核员 欢迎您 叶祎珊

标注预览

标注预览 输入主体进行搜索 搜索 标注结果 标注日志

主体 故00077565 龙纹**奩** 铜器 汉

刘曦 2026-01-14 14:56:20 **奩** 100%

主体 故00077567 铜车**缸** 铜器 商

刘曦 2026-01-14 14:56:20 **缸** 100%

主体 故00076988 万父丁**解** 铜器 商

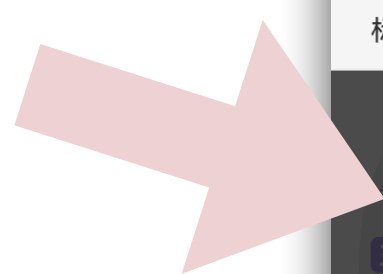
刘曦 2026-01-14 14:56:20 **解** 100%

主体 故00076991 父辛**罍** 铜器 商

刘曦 2026-01-14 14:56:20 **罍** 100%

主体 故00076993 口父戊**罍** 铜器 商

刘曦 2026-01-14 14:56:20 **罍** 100%



故宫博物院 控制台 知识图谱标记 标注审核员 欢迎您 叶祎珊

标注预览 输入主体进行搜索 搜索 标注结果 标注日志

查看标注结果

标注结果管理 | 数字文物库文物信息标注 > 测试-数字文物库-铜器 (部分)

Class A Instance A Property Class B Instance B

ID	概念A	实例A	关系	概念B	实例B	原文	标注类型	标注时间	标注人
27502	人造对象	新00106583	有类型	物件类型	带钩	错银 带钩	自动	2026-01-14 14:56:49	刘曦
27501	人造对象	新00106777	有类型	物件类型	爵	兽面纹 爵	自动	2026-01-14 14:56:49	刘曦
27500	人造对象	新00106768	有类型	物件类型	豆	蟠螭纹 豆	自动	2026-01-14 14:56:49	刘曦
27499	人造对象	新00106769	有类型	物件类型	觚	兽面纹 觚	自动	2026-01-14 14:56:49	刘曦
27498	人造对象	新00106775	有类型	物件类型	觚	弦纹 觚	自动	2026-01-14 14:56:49	刘曦
27497	人造对象	新00106580	有类型	物件类型	爵	兽面纹 爵	自动	2026-01-14 14:56:49	刘曦
27496	人造对象	新00097740	有类型	物件类型	带扣	蟠螭纹 带扣	自动	2026-01-14 14:56:49	刘曦
27495	人造对象	新00104737	有类型	物件类型	刀	环把 刀	自动	2026-01-14 14:56:49	刘曦
27494	人造对象	新00104737	有类型	物件类型	环刀	环把 刀	自动	2026-01-14 14:56:49	刘曦
27493	人造对象	新00104977	有类型	物件类型	戈	兽面纹 戈	自动	2026-01-14 14:56:49	刘曦
27492	人造对象	新00104575	有类型	物件类型	钺	兽面纹 钺	自动	2026-01-14 14:56:49	刘曦
27491	人造对象	新00104963	有类型	物件类型	带钩	鎏金嵌松石 带钩	自动	2026-01-14 14:56:49	刘曦

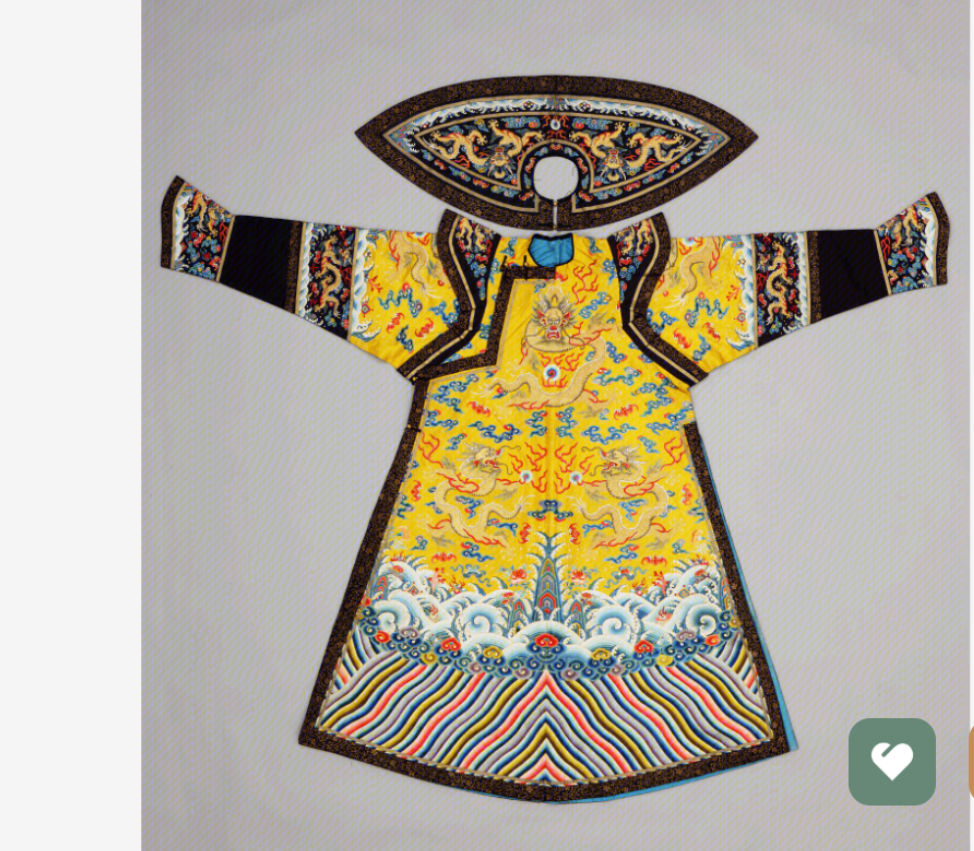
数字文物库

AutoComplete

women

- women's regular dress robe
- women's regular dress
- women's casual wear robe
- women's festive robe
- women's dragon surcoat
- women's festive dress
- women's robe
- women's festive surcoat
- women's casual wear
- women's outerwear

< Search Results



明黄色纱绣彩云蝠金龙纹女夹朝袍

Number 故00042496

Category 织绣

Period 清嘉庆

Color

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Topic Trails [Powered by Ancient Chinese Artifacts Knowledge Graph](#)

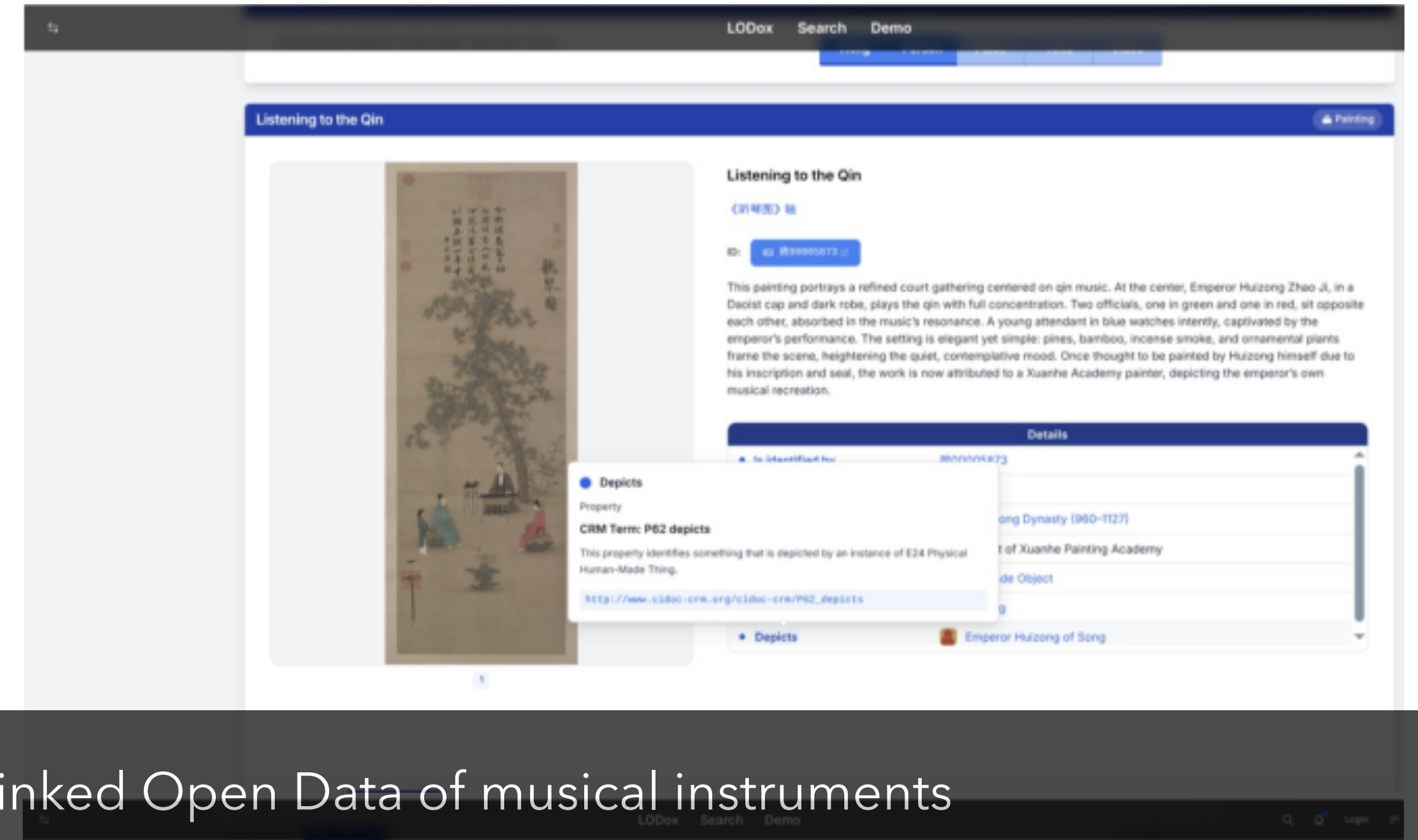
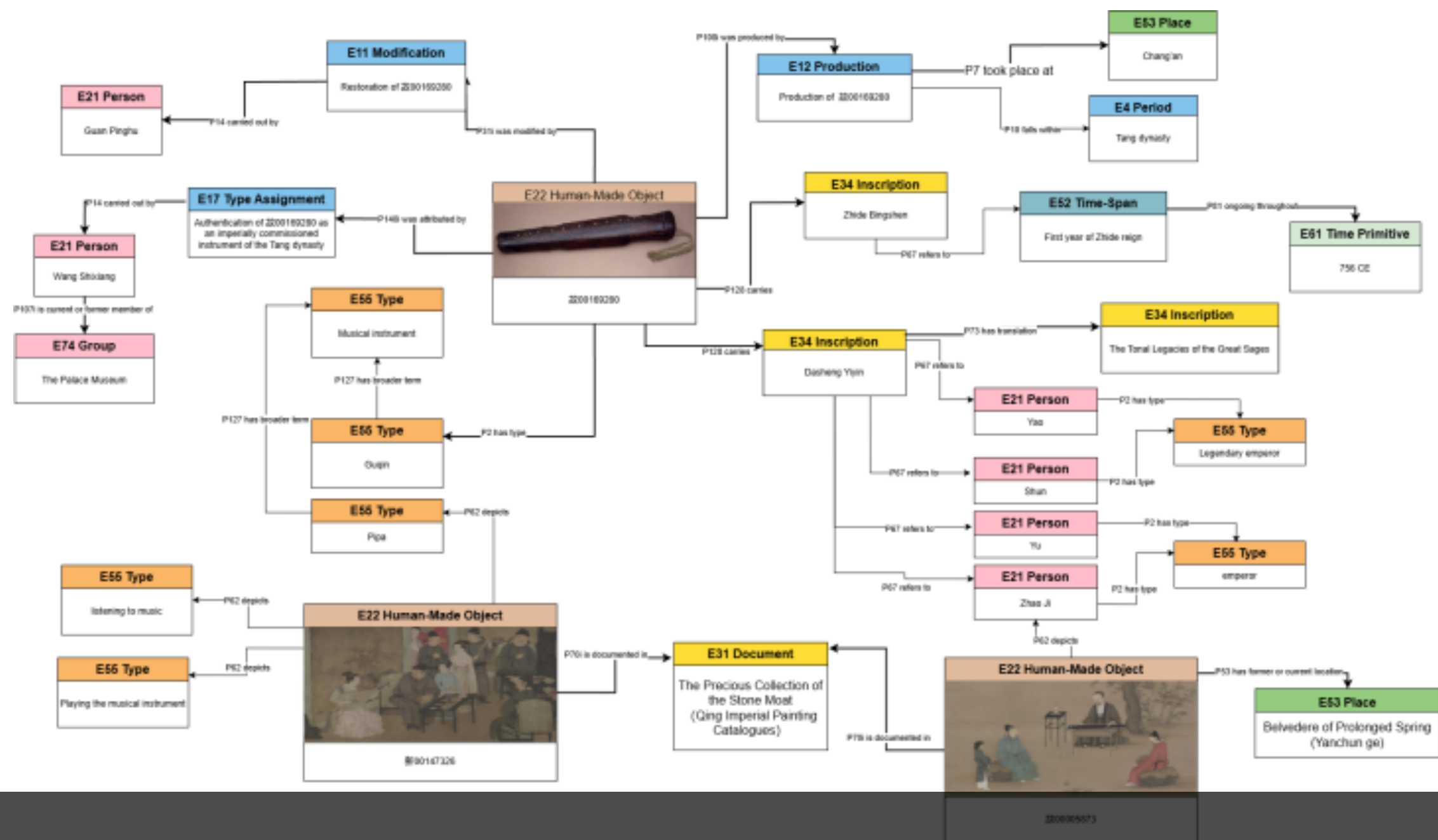
Object Type

costume clothing robes court dress ceremonial costume court robe court dress suit components imperial consort's court dress

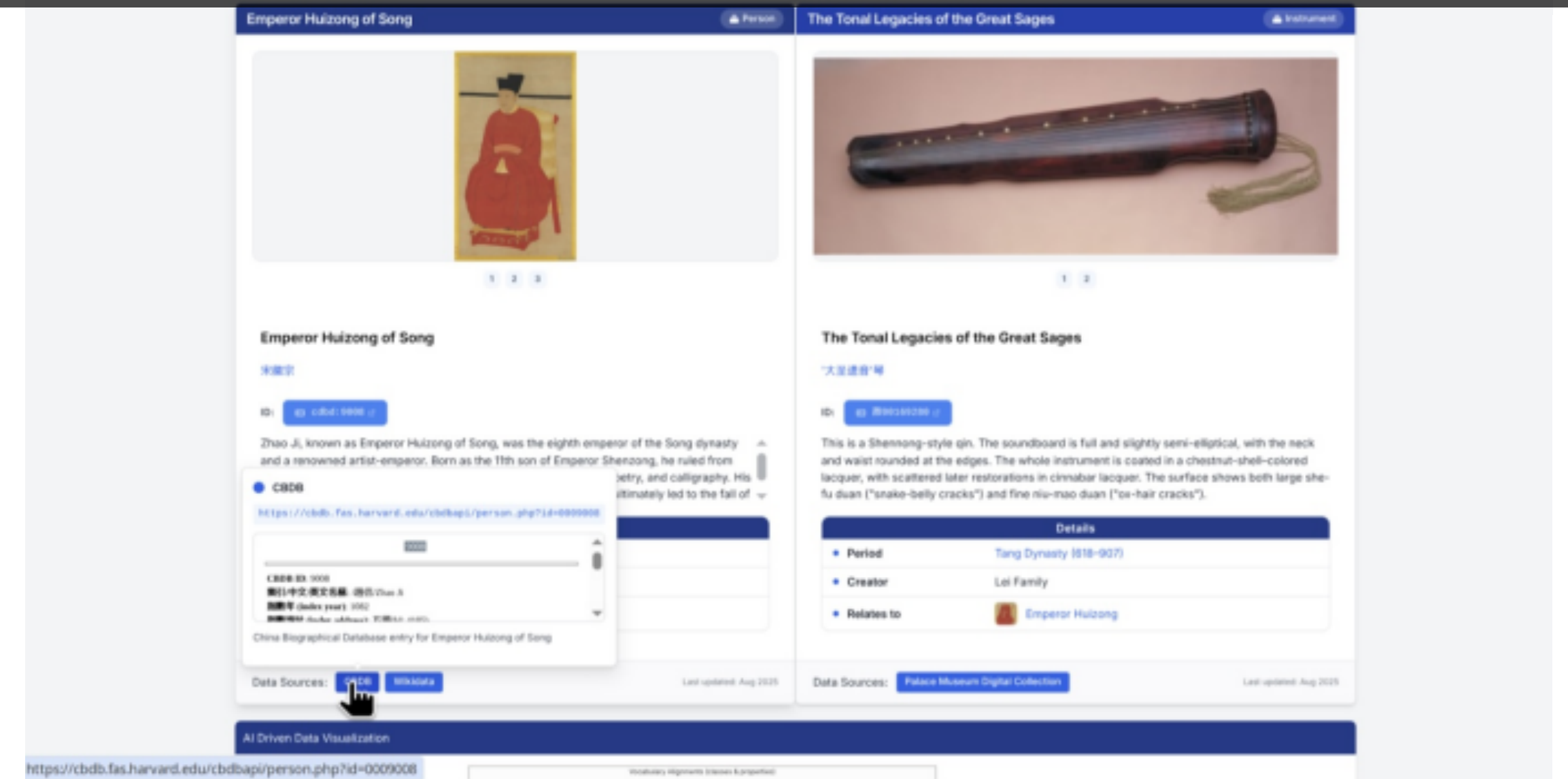
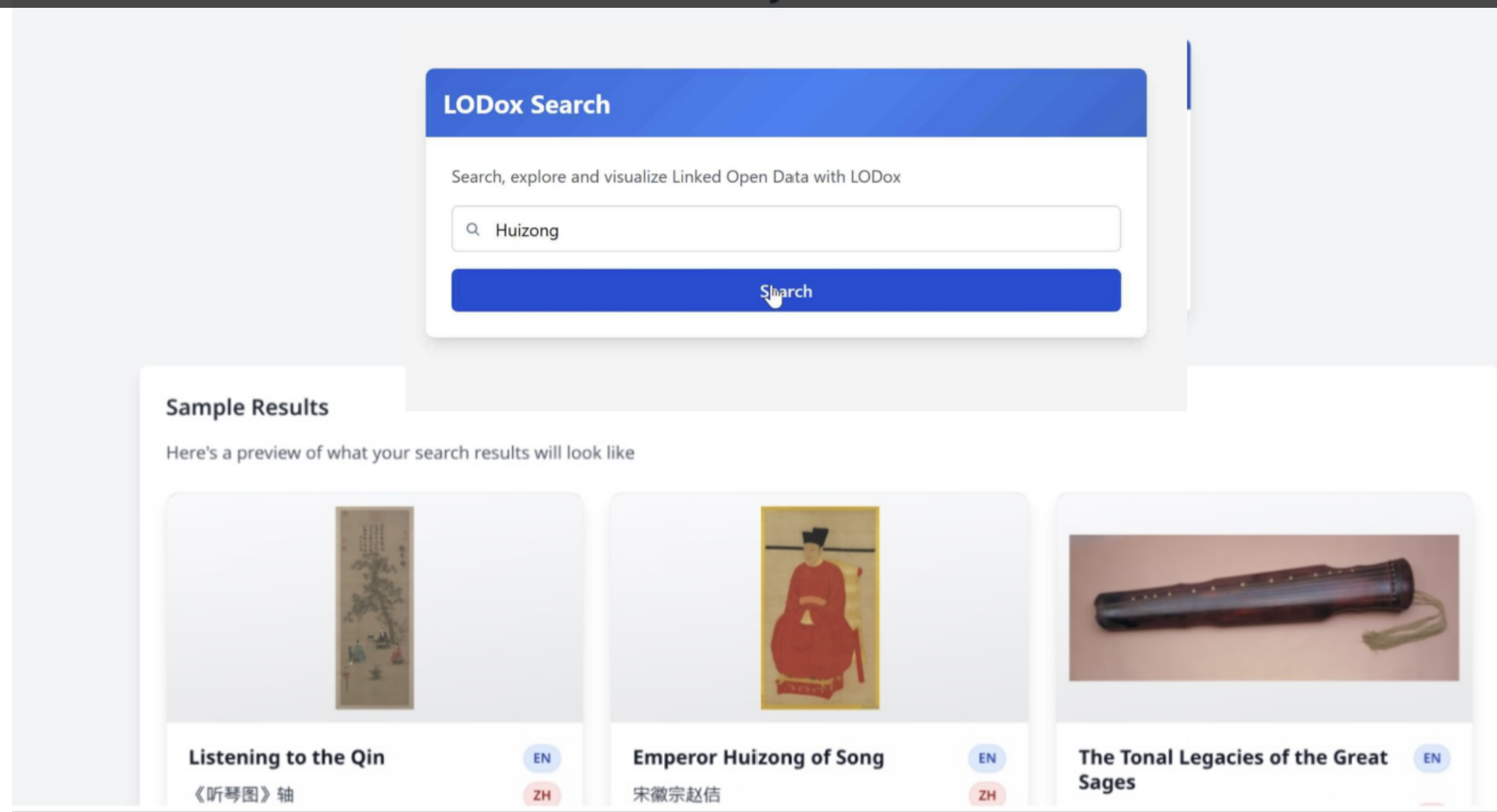
Qing empress dowager and empress's court robe women's court robe women's robe women's court dress court dress in Qing dynasty

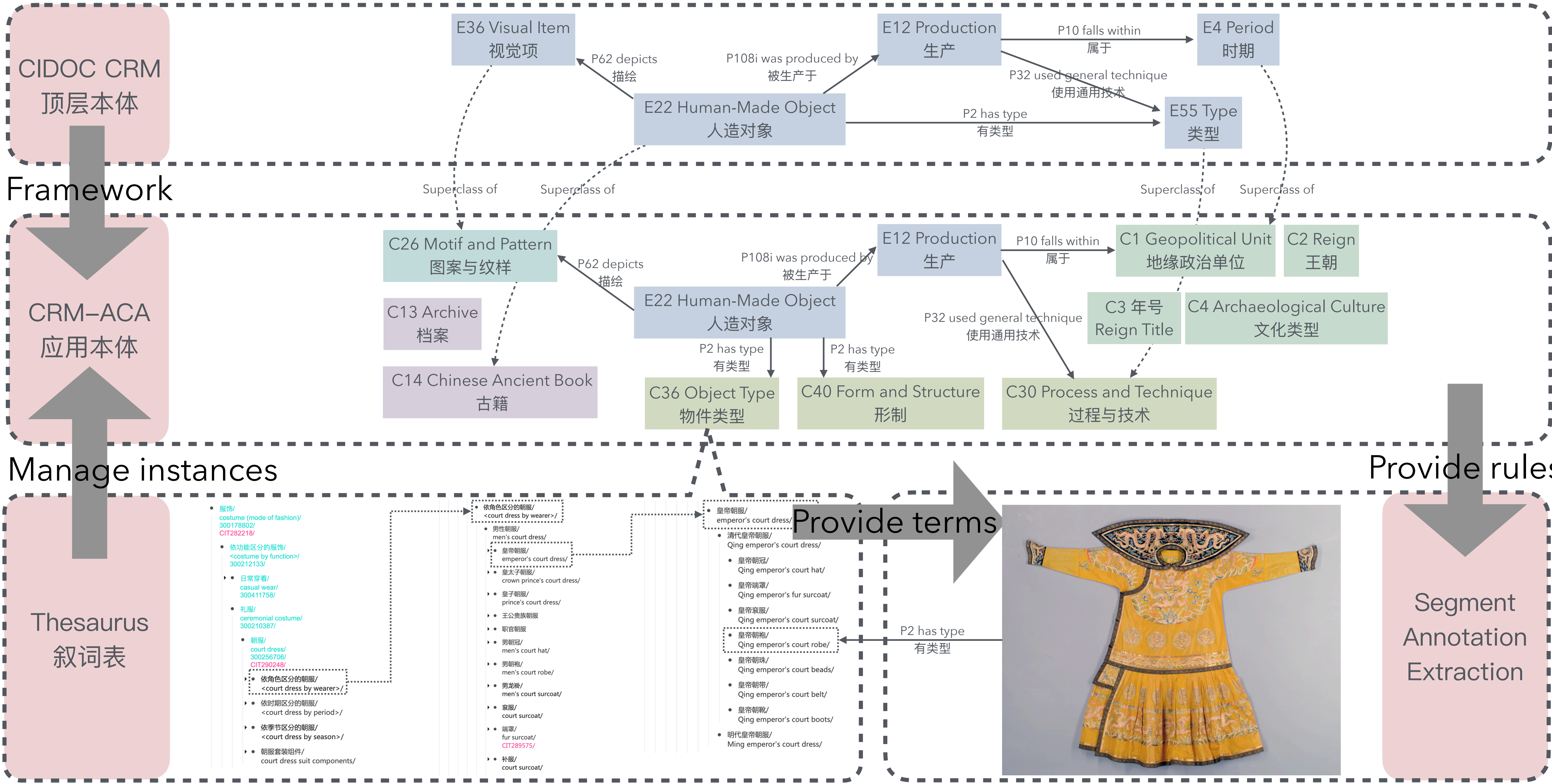
Qing imperial consort's court dress Qing empress dowager and empress's court dress

Multilingual tags



The Palace Museum & Oxford Pilot Project – Linked Open Data of musical instruments





CIDOC CRM
顶层本体

Framework

CRM-ACA
应用本体

Manage instances

Thesaurus
叙词表

Provide rules

Segment
Annotation
Extraction

E36 Visual Item
视觉项

E12 Production
生产

E4 Period
时期

E22 Human-Made Object
人造对象

E55 Type
类型

C26 Motif and Pattern
图案与纹样

E12 Production
生产

C1 Geopolitical Unit
地缘政治单位

C2 Reign
王朝

C13 Archive
档案

E22 Human-Made Object
人造对象

C3 年号
Reign Title

C4 Archaeological Culture
文化类型

C14 Chinese Ancient Book
古籍

C36 Object Type
物件类型

C40 Form and Structure
形制

C30 Process and Technique
过程与技术

- 服饰/
costume (mode of fashion)/
300178802/
CIT282218/
- 依功能区分的服饰/
<costume by function>/
300212133/
- 日常穿着/
casual wear/
300411758/
- 礼服/
ceremonial costume/
300210387/
 - 朝服/
court dress/
300256708/
CIT290248/
 - 依角色区分的朝服/
<court dress by wearer>/
 - 依时期区分的朝服/
<court dress by period>/
 - 依季节区分的朝服/
<court dress by season>/
 - 朝服套装组件/
court dress suit components/

- 依角色区分的朝服/
<court dress by wearer>/
 - 男性朝服/
men's court dress/
 - 皇帝朝服/
emperor's court dress/
 - 皇太子朝服/
crown prince's court dress/
 - 王子朝服/
prince's court dress/
 - 王公贵族朝服
 - 职官朝服
 - 男朝冠/
men's court hat/
 - 男朝袍/
men's court robe/
 - 男龙褂/
men's court surcoat/
 - 袞服/
court surcoat/
 - 端罩/
fur surcoat/
CIT289575/
 - 补服/
court surcoat/

- 皇帝朝服/
emperor's court dress/
 - 清代皇帝朝服/
Qing emperor's court dress/
 - 皇帝朝冠/
Qing emperor's court hat/
 - 皇帝端罩/
Qing emperor's fur surcoat/
 - 皇帝袞服/
Qing emperor's court surcoat/
 - 皇帝朝袍/
Qing emperor's court robe/
 - 皇帝朝珠/
Qing emperor's court beads/
 - 皇帝朝带/
Qing emperor's court belt/
 - 皇帝朝靴/
Qing emperor's court boots/
 - 明代皇帝朝服/
Ming emperor's court dress/

Provide terms

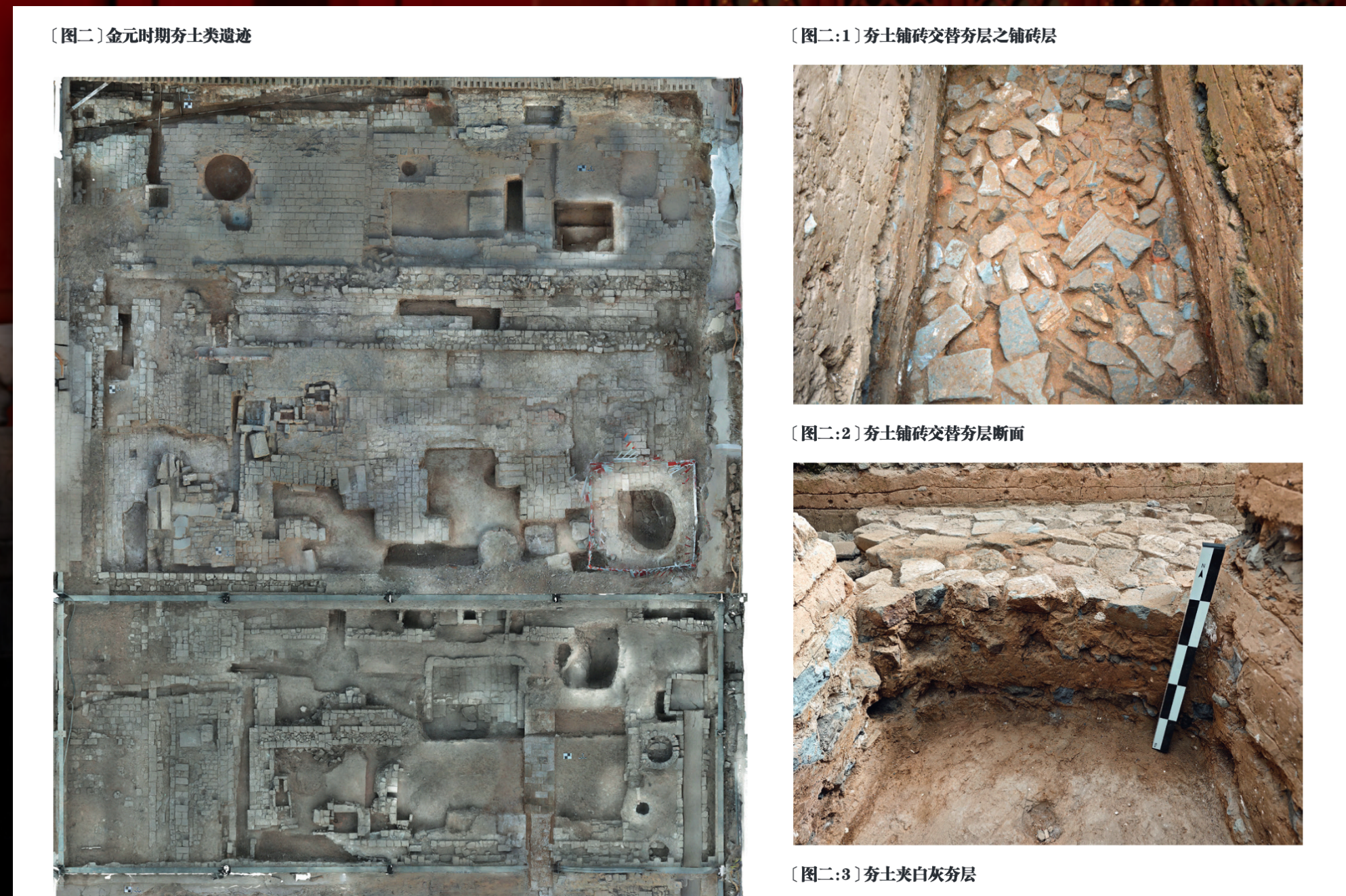


P2 has type
有类型



We have a plan

- CRM-ACA Ontology: develop new property
- extend ontology for more scenario
- Controlled Vocabulary: enrich & update
- Knowledge Graph: annotate more
- explore data with LLMs



Thank you very much !
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爱上紫禁城

摄影朱楷