

¹ **Nose-First. Towards an Olfactory Gaze for Digital
2 Art History**

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¹⁷ — **Abstract** —

¹⁸ What are the historical smells and olfactory narratives of Europe? How can we make use of digital
¹⁹ museum collections to trace information on olfactory heritage? In recent years, European cultural
²⁰ heritage institutions have invested heavily in large-scale digitization, which provides us with a wealth
²¹ of object, text and image data that can be browsed and analysed by humans and machines. However,
²² as heritage institutes, as well as humanities and computer science scholars, have had a long-standing
²³ tradition of ocular-centric thinking, it is difficult to find relevant information about smell in digital
²⁴ collections. The historical gaze, for a long time, has been visually biased and collections turn a blind
²⁵ eye to smell.

²⁶ This paper offers a roadmap towards an olfactory gaze for digital cultural heritage collections.
²⁷ The work we present here is part of the Odeuropa project, an action of the Horizon 2020 programme,
²⁸ which promotes research and innovation. It presents a work in progress on olfactory heritage
²⁹ and sensory mining in digital art collections. First, we will describe the current state of the art,
³⁰ showing how olfactory information is traditionally missing or even omitted from digital art collection
³¹ management systems. We present a baseline research, which maps the gaps and biases in art
³² thesauruses and iconographic classification systems. Next, we will present two connected solutions
³³ that we are currently developing in the Odeuropa project: a) a database with olfactory information
³⁴ related to historical artworks, aimed to enrich existing metadata and improve search solutions b)
³⁵ computer vision methodologies for sensory mining. Finally, we pitch a new idea: a nose-first scent
³⁶ wheel. When integrated into current digital collection interfaces, the scent wheel would encourage
³⁷ audiences to develop an olfactory gaze and offer new ways to uncover the rich storylines of olfactory
³⁸ heritage within digital collections.

³⁹ **2012 ACM Subject Classification** Applied computing → Arts and humanities; Applied comput-
⁴⁰ ing → Digital libraries and archives; Computing methodologies → Object detection; Comput-
⁴¹ ing methodologies → Object recognition

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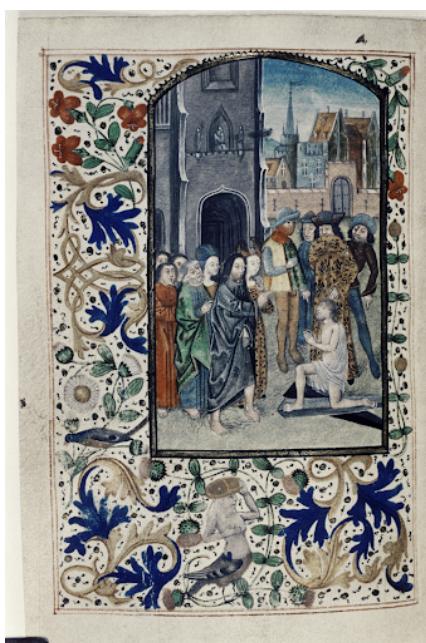
Figure 1 Computer vision techniques employed to extract olfactory information from historical artworks in digital heritage collections. Nicolaes de Bruyn (after a design by Maerten de Vos), Allegory of Smell (1581-1656). Rijksmuseum, Amsterdam, RP-P-BI-5098.

47 1 Introduction

48 What are the historical smells and olfactory narratives of Europe? How can we make use
 49 of digital museum collections when tracing information on olfactory heritage? In recent
 50 years, European cultural heritage institutions have invested heavily in large-scale digitization,
 51 which provides us with a wealth of object, text and image data that can be browsed and
 52 analysed by humans and machines. However, as heritage institutes, as well as humanities
 53 and computer science scholars, have had a long-standing tradition of ocular-centric thinking,
 54 it is difficult to find relevant information about smell in digital collections [9]. The historical
 55 gaze, for a long time, has been visually biased and collections turn a blind eye to smell.[21]

56 This is a pity, as the notion of sensory heritage could help museums to enhance the impact
 57 of their collections. Although largely neglected today by cultural heritage institutions, the
 58 so-called “lower senses” of which our sense of smell is a part, offer a powerful and direct
 59 entry to the emotions and memories of the public [25, pp. xiv, 3]. Museums can restore
 60 some of the materiality lost in the process of collection digitisation by including the sensory
 61 information in the metadata of historical documents and artefacts. This metadata would
 62 assist in the discovery of underlying sensory storylines, and bring new perspectives to the
 63 past. Recovering olfactory information in image datasets could thus provide a new way for
 64 individuals and communities to “make sense” of the collections.

65 This paper offers a roadmap towards an olfactory gaze for digital cultural heritage
 66 collections. The work we present here is part of the Odeuropa project, a research and
 67 innovation action in the Horizon 2020 programme. The goal of the Odeuropa project is to
 68 show that critically engaging our sense of smell and our olfactory heritage is an important
 69 and viable means for connecting and promoting Europe’s tangible and intangible cultural
 70 heritage. In the following pages, we present our work in progress on olfactory heritage and
 71 sensory mining in digital art collections. First, we will describe the current state of the art,
 72 showing how olfactory information is traditionally missing or even omitted from digital art
 73 collection management systems. Then, a baseline research will be presented, which maps the
 74 gaps and biases in art thesauruses and iconographic classification systems. Next, we will



(a) Raising of Lazarus. Miniature. (1480-c. 1500). Bodleian Library, Oxford, MS. Douce 266, fol. 078a verso.



(b) Dieric Bouts, Christ in the House of Simon (1440s). Staatliche Museen, Berlin, inv. 533a.

75 present two connected solutions that we are currently developing in the Odeuropa project: a)
 76 a database with olfactory information related to historical artworks, aimed to enrich existing
 77 metadata to improve search solutions b) computer vision methodologies for sensory mining.

78 Finally, we will pitch a new idea: a nose-first odour wheel. When integrated into current
 79 digital collection interfaces, these scent wheels would encourage audiences to develop an
 80 olfactory gaze and offer new ways to discover the rich storylines of olfactory heritage within
 81 digital collections.

82 2 Olfactory Gaze: State of the Art

83 Figures 2a and 2b show two iconic fragrant depictions from the Bible. In the first scene,
 84 Lazarus is risen from the dead by Christ. Martha, the sister of Lazarus, expresses her concern
 85 about resurrecting him as he had been dead for four days: "he stinketh" (John 11:39). In
 86 the second scene, shortly thereafter, Christ revisits Bethany, where Mary, Lazarus' other
 87 sister, washes his feet with costly spikenard oil, after which she dries his feet with her hair.
 88 The resurrected Lazarus also attends the feast (John 12:3). These stories are probably not
 89 recognized by most people for their olfactory qualities, yet this sensory knowledge brings new
 90 depth, and connects them to corresponding olfactory iconographies. The raising of Lazarus is
 91 not only a story about the power of Christ over death, and about faith in the last judgement,
 92 but it could be said that it is also a narrative about (overcoming) the stench of decay by
 93 divine intervention. The rich iconographic tradition of this scene also provides insight to the
 94 history of olfactory gestures, for example, how people coped with stench by pinching the
 95 nose, or by covering the nose with an elbow, hand, sleeve, or other parts of their garments.

96 As mentioned above, the second scene of Mary anointing Christ's feet (figure 2b) introduces
 97 the history of spikenard, a precious aromatic oil derived from the root of a flower. Spikenard
 98 was used in a similar manner to myrrh, a resin extracted from a tree, and are both linked

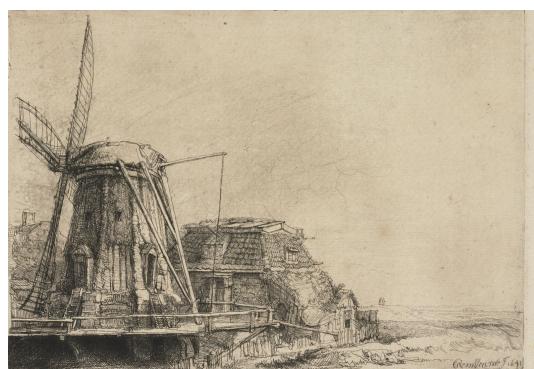
99 to the divine and held at high economic worth. They were traditionally linked to divinity
 100 because of their rich and strong, faintly sweet aromatic quality serving as a fragrant (or burnt)
 101 offering, or wordless prayer to God [18]. In this capacity these substances are affiliated with
 102 biblical figures such as Saint Joseph (who often carries a spikenard plant as an attribute),
 103 Mary Magdalene (who is also associated with anointing Christ's feet), the three Magi (who
 104 offer myrrh, frankincense and gold to the Christ child), the Myrrhbearers (who embalm
 105 Christ) and even the mythological character of Adonis (born from his mother Myrha, who
 106 was transformed into a myrrh tree that produces the resin).

107 All of these olfactory stories lay hidden behind the scenes, for none of the olfactory
 108 information we just highlighted is provided in the (meta)data of major digital art collections.
 109 The scenes are described in databases as "the raising of Lazarus" and "the anointing of Jesus",
 110 with no indication of the scents, their meaning, nor their associated olfactory gestures. It
 111 would take a trained **olfactory gaze** to identify, interpret and connect these kinds of scented
 112 scenes. But what do we understand by "olfactory gaze" and how could digital collections
 113 offer such a gaze to the public?

114 The term olfactory gaze was coined by art historian Caro Verbeek [48], but the method
 115 is in fact exercised by many scholars of olfaction ([18]; [7]; [27]; [49]). In the arts, the "gaze"
 116 refers to the act of seeing, starting from the premise that how we interpret the visual is
 117 culturally induced. For instance, the "male gaze" and "female gaze" are used to interpret art
 118 through a gendered perspective. The olfactory gaze refers to the act of analyzing images
 119 and texts with olfaction in mind, breaking away from a "scopic regime" or visual dominance,
 120 and thus revealing words, narratives, objects, scents and their related artefacts, which would
 121 have remained invisible from a purely visual perspective. Rereading canonical texts enhances
 122 this type of viewing and assessing of artworks. Primary sources such as the Bible and Ovid's
 123 *Metamorphoses* [1] or secondary sources such as James Hall's *Dictionary of Subjects and*
 124 *Symbols in Art* [17] are instrumental in acquiring information on olfactory cues in images
 125 and texts.

126 What is the current **state of the art** which can help us to further develop an olfactory
 127 gaze? The senses, which have traditionally received little attention from researchers, are now
 128 high on the academic agenda [40]. In the last two decades, a "sensorial revolution" has taken
 129 hold in the humanities and social sciences, which has shifted scholarly attention away from
 130 the visual and textual to the embodied and multi-sensory ([10]; [19]). This reframing was a
 131 reaction against both long-standing, traditional ocular-centric thinking, in which vision was
 132 the main sensory instrument of knowledge, and to the linguistic turn of the 1960s [20]. In the
 133 field of history, the "founding study" for this shift, Alain Corbin's *Le miasme et la jonquille/*
 134 *The foul and the fragrant* (1982) [11], presented a grand narrative about the fundamental
 135 olfactory shift of the eighteenth and nineteenth centuries. In this period, Europe witnessed a
 136 paradoxical shift, with on the one hand Europeans becoming more sensitive to odour, and
 137 attempting to deodorise their environments, while on the other hand the sense of smell also
 138 began losing its importance as an instrument of knowledge ([11]; [45]).

139 More recent scholarship has focussed on describing the meaning of odours in particular
 140 places and times ([13]; [3]; [33]; [43]; [24]), including studies on how smell has signalled
 141 identity, community, and otherness in the past, including race and class ([40]; [44]). However,
 142 the focus on disgust in much of this scholarship has tended to emphasise the power of smell to
 143 exclude rather than its role in forming and sustaining place, community, and inclusion. This
 144 could be one of the reasons for smell's current absence from many definitions of (in)tangible
 145 cultural heritage. Furthermore, the ephemeral and distributed nature of smell makes it
 146 difficult to find catalogued or indexed references to it in textual archives; while the number



■ **Figure 3** Rembrandt van Rijn, The Small Stinky Mill in Amsterdam (1641). Rijksmuseum, Amsterdam RP-P-1962-90

147 of references to smell in images has also been consistently underestimated [45]. Studies on
148 smell in **art history** have also gained more ground [7]; [10]; [35]; [47]; [48]; [49]).

149 A new way to explore digital art collections is brought in by computer science. Advances
150 in computer vision make it possible to analyse large amounts of visual data and to apply
151 techniques of distant viewing, shifting the focus to broader contexts and enabling the
152 application of quantitative methods [2]. Clustering visual data according to quantitatively
153 defined categories may lead to insights that escape the close inspection of art historians.
154 This has led to surprising results in a broad range of applications, e.g. in the context of
155 compositional image structures [26] or the Warburgian Pathosformeln [22].¹

156 It is the ambition of the Odeuropa project to advance the “sensory turn” and offer new
157 perspectives for humanities research and the cultural heritage communities. Below, we will
158 elaborate on how we aim to do this.

159 **3 Searching for olfaction in the metadata of digital cultural heritage 160 collections**

161 Imagine you are a scholar interested in researching olfactory history and heritage. If you
162 would use digital art collections as a source of information, what kind of knowledge would
163 you gain? The answer lies in the currently limited metadata of digital collections which does
164 not provide easy access to olfactory heritage and history. Many museum collections hold
165 interesting olfactory objects and artworks presenting smell narratives, but in most cases the
166 olfactory information is not made explicit in the metadata of the objects. When references
167 to smell are presented in the metadata, it is often impossible to navigate from a single object
168 to other related objects or scenes, due to a lack of overarching categories.

169 To explain the current situation, we have analysed the rich digital collections of Rijksstudio,
170 Museum Digital, and Europeana. The Dutch Rijksstudio, which is the digital repository of
171 artworks from the Rijksmuseum, Amsterdam, consists of 715.643 items (d.d. March 2021).
172 The German Museum Digital provides access to nearly 550.000 digital objects of around
173 700 German museums. Europeana collection provides access to over 50 million digitized
174 items from over 3.500 European cultural heritage institutions which are divided into different

¹ However, although digital art history, and specifically computer vision for digital collections, are fast expanding fields, they have not yet had a lot of interest for the sensory gaze.

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175 thematic collections. We believed that the art and fashion collections would hold the most
 176 olfactory related results. More information might be found in museum collection management
 177 systems such as Adlib, which are generally not available to the public.

Search terms	Europeana (all)	Europeana (art)	Europeana (fashion)	Rijksstudio	Museum Digital	Iconclass
smell	1234	52	3	133 (Geruch) 30	11	
scent	702	23	8	154 (Duft) 16	9	
olfaction	97	0	0	0 (Geruchssinn) 45	0	
stench	58	3	0	(stank) 16 (Gestank) 9	0	
smoke	5080	118	24	195 (Rauch) 500	22	
smoking	9336	1008	477	412 (rauchen) 103	22	
incense	1833	213	8	266 (Weihrauch) 70	37	
odour	534	19	0	12 0	65	
malodour	2	0	0	0 0	0	
aroma	2230	22	56	1 0	0	
fragrance	179	17	5	7 -	1	
perfume	1365	146	31	209 (Parfüm) 19	12	
burnt offering	36	9	0	19 (Brandopfer) 111	6	

■ **Table 1** Search results for olfactory terms in diverse digital collections. #Hits. Search performed April 27, 2021.

178 Simple searches with obvious search terms such as “smell”, “stench”, “aroma”, “perfume”,
 179 or more expert terms like “olfaction”, “incense”, or “malodour” render interesting, but often
 180 meager results in the different datasets (table 1). The Europeana art collection, which holds
 181 3.215.971 items, only renders 52 results for “smell”, 23 for “scent” and none for “olfaction”.
 182 The results of the fashion collection are even lower. In “Europeana all” smell has a higher
 183 representation (1.234 hits). Around 400 of those hits consist of samples of plants and animals
 184 from natural history collections, such as the Royal Botanical Gardens in Kew. “Smoking”,
 185 brings up results like pipes and cigarettes, but also many suit jackets. The Europeana
 186 collection is unstable, as we discovered while undertaking the research for this study that
 187 the number of results from the same searches fluctuated by the day.

188 While searching these databases, a trained olfactory researcher might think of more expert
 189 search terms, such as “civet” (a perfumed secretion from the civet cat), “musk” (a perfumed
 190 secretion from the musk deer), or “pomander” (fragranced jewellery), but how would a non
 191 expert find these categories? Many visitors may not even think about words like “olfaction”
 192 or “olfactory” as overarching terms. This problem could be solved if non-experts could be
 193 helped by the collection specialists, when the overarching category of smell was linked to
 194 these olfactory artefacts, odourants and other smell related terms.

195 Rijksstudio, has the potential to provide access to a wealth of information about historical
 196 art and sensory history. One can use English language search terms (used in the “Subject”
 197 field) or Dutch language terms (mostly used in the “Title” and “Description / Omschrijving”
 198 fields). Dutch terms render more results, but they also invite more irrelevant content. For
 199 example, “Geur*” (Smell*) not only displays paintings and engravings with allegories of the
 200 five senses and works with “Geur” in the title, it also brings up artworks by Geurt van Dijk
 201 (10), Geurt van Eck (9), P.A. Geurts (10) and Joris Geurts (2). Around 30% of the results
 202 turned out to be unrelated to smell. The search for “roken” (to smoke) rendered over 70% of
 203 results irrelevant to smell: most of the objects found were “rokken” (skirts). In Rijksstudio,
 204 the open “Description” field provides cataloguers with the opportunity to mention specific
 205 smells, fragrant materials or smell related artefacts and narratives. For instance, searching

Search term	Entry in Adlib Rijksmuseum?
Geursthof (odorant)	no
Geur* (scent/smell)	no
Ruik* ((to) smell)	no
Olfac* (olfaction/olfactory)	no
Stank (stench)	no
Roken (smoking)	yes
Wierook* (frankincense/incense)	yes (Wieroksheelje, wierokvaat, wierokschaal, etc.)
Reuk* (sense of smell / scent)	yes (reukbal, reukdoos, reukfles, etc.)

Table 2 Search for smell terms in **Adlib - Rijksstudio**. The “*” behind general lexemes was used to allow for broader search results.

for “stank” (stench) in Rijksstudio, we can find an engraving by Rembrandt van Rijn of a windmill. The title and subject categories do not present olfactory information, but the added description field tells us that the mill Rembrandt depicted is the Amsterdam leather mill, also known as the “kleine stinkmolen” (“the small stinky mill”). As indicated in the artwork’s description on Rijksstudio, this name reflects the foul stench of urine which was used in the tanning of leather (figure 3). The “Description” and "Title" fields of the database are valuable, but unreliable. Most official titles of artworks do not highlight olfactory information, and based on these results, it seems that many collection specialists overlook the olfactory related cues in artworks.

The apparent limited results reveal that artworks and objects which have olfactory related content are not properly labeled or tagged with olfactory language and associations. These omissions and inconsistencies lead to limited search results for users who are not acquainted with more specific scent related language, and hence will end up with fewer results when searching for scent related art and artefacts.

Iconographic classification systems: Iconclass

Many digital art collections also make use of iconographic classification systems to order information. Iconclass is a multilingual (English, German, French, Italian, Finnish) iconographic classification system used by museums and other heritage institutions for the description and disclosure of images of works of art, book illustrations, reproductions and photographs [46]. Iconclass is one of the largest content classification systems within visual arts. Initially designed for historical imagery, it is now also used to create subject access to texts and to classify a wide range of images. Like the Dewey Decimal Classification system, Iconclass works with ten main divisions, which give entry to hierarchically ordered subdivisions. In 2021, Iconclass contained over 28,000 unique concepts (classification types) and an entry vocabulary of 14,000 keywords. Iconclass thus offers a rich pathway for structured searches in digital art collections.

The Iconclass codes are very useful for structured searches, moving beyond single word searches and the limits of language. When searching for “smell”, the Iconclass code 31A33 (“Smell, smelling”) results in 92 hits (both cases render various duplicates). Using Iconclass codes may help the researcher find a path of related classes. When searching for smell in the Iconclass thesaurus, we are presented with the following concepts (table 3):

As has been observed before, Iconclass holds biases, as a result of cultural biases of historical artworks and of the Iconclass developers [8]. The class of smell as one of the five senses, and the allegorical “Odorato” (cf. “Odoratus”) are sided by a classification of smells

31A33	Smell, smelling (one of the five senses)
31A330	“Odorato” (Ripa)
31A331	Agreeable smell
31A332	Disagreeable, repellent smell
25H172	“Locus amoenus” motif: pleasant place with trees (taste), meadows (sight), spring or brook (feeling), singing birds (hearing) and flowers (smell)

Table 3 Smell concepts in Iconclass thesaurus

in “agreeable” and “disagreeable”. This classification is problematic, as it is based on hedonic evaluation, or the categorisation based on a pleasant or unpleasant reaction. The experiences surrounding scents are culturally determined and based on context, and therefore fluctuating over time. We propose that the Iconclass codes should take period and cultural specific biases into consideration by avoiding the use of hedonic and subjective terms such as “agreeable” and “disagreeable”.

Moreover, the Iconclass subclasses of “smell” are gendered, indicating a strong (art) historical connection between smell and women (table 4):

31AA330	“Odorato” (Ripa) - AA - female human figure
31AA33	smell, smelling (one of the five senses) - AA - female human figure
31AA331	agreeable smell - AA - female human figure
31AA332	disagreeable, repellent smell - AA - female human figure

Table 4 Iconclass subclasses of “smell”

While it is true that many historical paintings depict women in the act of smelling (mostly flowers) [6], the association of olfaction being solely feminine as an allegedly transhistorical phenomenon tells only half the story. Historical art also presents numerous men in the act of smelling, pinching their nose, using perfume, or using their nose as a professional instrument of knowledge (think about physicians, perfume makers, or hygiene officers). The gendered prejudices around olfaction manifest themselves in the metadata of Iconclass, where smell is retrospectively attributed to women, even in the case of genderless objects, such as pomanders and perfume bottles. “Using scents, perfumes, ointments, etc for women” (31A514AA) and “pomander - musk ball - AA - (for) women” (31AA51451) are subcategories specially dedicated to women. There are no equivalents for men. The overarching category “using scents, perfumes, ointments, etc” (31A514) is supposedly neutral.

In case of the “pomander for women”, this is positioned in a hierarchy below the upper class “Implements - making toilet - AA (for) women” (31AA5145). This is even more problematic as it limits the use of pomanders to a strictly aesthetic means, when pomanders were multifunctional objects used within fashion, hygiene, and as amulets (good luck charms) [14]. The categorization by Iconclass thus demonstrates a bias where fragrances are associated with aesthetics or hedonics instead of being described as closely intertwined with the history of health, medicine, and religion, utilized by men and women alike. Furthermore, we could question why musk is singled out as an odorant in the label, “Pomander/ muskball” as pomanders contained different herbs and resins and substances of animal origin like ambergris (sperm whale) or civet (civet cat) [27]. Without a mention of these odorants in the case of pomanders, the researcher loses a trail, which could have led to other rich olfactory information and connections.

The most obvious bias in Iconclass is the ocular-centric based approach, which often



Figure 4 Caspar Luyken, Sacrifice of Noah after the Flood (1712). Rijksmuseum, Amsterdam, RP-P-OB-45.769.

disregards, misrepresents, or omits olfactory information. This, for instance, becomes apparent in the realm of religion.² In the Bible, various descriptions are given of burnt offerings (figure 4). In ancient history, burnt offerings were events of (combined) animal sacrifices and/or incense burning. In art both events share the iconography of ascending smoke [18, pp. 14–15]; [10]). In the case of incense burning, by heating fragrant resins (also called “per fumum” or through smoke), fragrant emanations rise to God [18, pp. 14–15]. However, when describing burnt offerings, Iconclass only references the offering of animals. Furthermore, the smoky event of animal sacrifice, known for its fragrant qualities (viz. Psalm 66:15: “I will offer unto thee burnt sacrifices of fatlings, with the incense / fragrant offering of rams”), is stripped of its olfactory information in Iconclass. When Noah performs a burnt offering (“Then Noah built an altar to the Lord and, taking some of all the clean animals and clean birds, he sacrificed burnt offerings on it”, Genesis 8:20), the Iconclass code 71B343 just describes the scene in general as a “sacrifice”. The same happens with the burnt offerings of Solomon (71I531).³

Iconclass could instead create a taxonomy in which these individual animal burnt offerings are connected with the broader Biblical infrastructure of burnt offerings (12A312 the altar of burnt offering, the brazen altar), and with the incense burning that mostly accompanied animal sacrifices (e.g. 12A311 the altar of incense, the golden altar). The taxonomy could also link to the odorants used in offerings. The Bible often specifically mentions frankincense or olibanum while Iconclass often uses the generic term “incense”. This captures how olfactory information is often removed from metadata. The burnt offerings are just one of many

² One example is Isaac smelling Jacob. Iconclass registers this event under 71C274 as “Isaac lying in bed blesses Jacob”. Iconclass mentions goatskin but not Esau’s coat that is “the smell of the field” (Genesis 27:27).

³ Highlighting the inconsistencies of Iconclass cataloging, other Iconclass codes do refer to burnt offerings: 71L2513 (Manasseh sacrifices his own son as a burnt offering), 71E5272 (The Israelites offer burnt sacrifices on Mount Ebal), 71F2132 (Gideon and ten servants destroy the altar of Baal, cut down the grove near it, build an altar to God on the rock, take a bullock and offer a burnt sacrifice).

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examples. Our baseline research shows that digital collections and information management often overlook relevant sensory information. Expert knowledge would be required to restore this information, and to build a classification system in which these scenes can be linked through a structured taxonomy.

In order to overcome these biases and gaps, the Odeuropa project is developing a database for olfactory (art) historical information. On the basis of expert knowledge (literature of the history of smell, iconographic classification systems, digital collection searches, etc.), we are building a database divided into four classes: 1. **Olfactory objects** (odorous substances such as plants and foodstuffs, and olfactory artefacts such as tobacco pipes, perfume bottles ciboriums and pomanders), 2. **Olfactory gestures** (holding the nose, bringing odorants to the nose, or actions that produce a smell, such as urinating), 3. **Fragrant spaces** (built environments such as farms, offices and churches, and natural spaces such as forests and flower fields), 4. **Olfactory iconographies** (smell-related iconographies such as the Adoration of the Magi, and allegories of the sense of smell which include sniffing a rose, or changing a diaper). Where possible, we also added Iconclass codes to the entries. Seven months after the start of the Odeuropa project, the database consists of 354 entries (table 5). Of these 354 entries, we were able to trace Iconclass codes of 180 entries. In the next phase of the project, the database will be expanded with new entries, discovered through computer vision techniques, and archival and literature research.

	# Odeuropa database entries	Iconclass code
Odorants	175	55
Olfactory actions	33	22
Olfactory spaces	75	50
Olfactory iconographies	54	44

Table 5 Description of the Odeuropa Olfactory Art history Database (beta version): number of entries and number of entries with Iconclass code (April 2021).

312 4 Automatic extraction of olfactory information in artworks, using 313 Computer vision techniques, Wordnet and Imagenet

Identifying visual references of olfactory phenomena in artworks is an important way to uncover how Europe may have smelled in the past and how smell was represented. The computer-vision team of the Odeuropa project works to create methods which would automatically extract these references from various large collections of European artworks by applying, modifying, and extending state-of-the-art object detection methods. In order to collect and extract olfactory references using computer recognition, it is necessary to first identify how smell is visually represented or depicted in historical artworks.

To provide an example of how this works, we used the print *Smell* (1581-1656) by Nicolaes de Bruyn, from the Rijksmuseum's collection (figure 1). In the sixteenth century, the pairing of a woman with a dog was used as a visual depiction or personification of the sense of smell [17, p.105]. Since object detection methods are able to identify the dog and the woman, this would seem like an effective system to use for sensory mining. However, there are certain challenges which come with this detection. Firstly, not all pairings of people or women with dogs are olfactory. For example in other periods, a dog on the lap or feet of a woman may represent fidelity [17, p.105], as seen in Jan van Eyck's *Arnolfini Portrait* (1434). This presents us with the challenge of distinguishing when a dog is or is not an

330 indication of olfaction. A second challenge is that computer recognition does not detect
331 the olfactory gesture of the woman smelling the flowers. This poses further challenges for
332 detecting olfactory elements in paintings.

333 Similar challenges arise when detecting olfactory narratives in Biblical scenes, for instance
334 with the Sacrifice of Noah (Genesis 8:20), discussed before. The print, *Sacrifice of Noah*
335 *after the Flood* by Casper Luyken (figure 4), shows Noah creating a burnt offering of animals,
336 combined with the usual “rainbow of the covenant” in the background. While the people
337 and animals are easily detected, the cloud of smoke is not, hence overlooking the olfactory
338 element of the artwork. These types of olfactory narratives reveal more limitations of existing
339 object detectors. Object detection systems are limited to the data with which they have been
340 trained. Firstly, since the detectors are trained with photographic data, their effectiveness
341 decreases when applied to images with an artistic style, such as historical paintings and
342 prints. Secondly, as computer vision research prioritized humans and animals, objects like
343 smoke are either underrepresented or not at all part of the detector’s training data.

344 In order to tackle these issues, the Odeuropa project will adapt existing techniques to
345 improve the detection abilities on artistic image domains. Various techniques enable models
346 trained on the photographic domain to adapt to a different domain. In **transfer learning**,
347 a detection system is pre-trained on large-scale photographic datasets before fine-tuning it
348 on a smaller dataset in the target domain [32]. **Style transfer** means transferring labelled
349 training data to the target domain before training [38]. Finally, **self-supervised learning**
350 entails training a system to perform an unsupervised pretext task like solving jigsaw puzzles
351 in the target domain before training the actual task of object detection. Prior to the intended
352 application, the system can thus learn attributes about the target domain without need for
353 large amounts of labeled data [23].

354 Detecting predefined odorous entities is a challenge that can presumably be solved by
355 the application, combination and modification of these methods. Another challenge is that
356 many of the olfactory objects we identified are too specific to be found by state-of-the-art
357 object detection methods. We therefore follow an approach similar to [36] or [37] and order
358 the identified objects according to a hierarchy following the structure of the lexical database
359 WordNet [29]. Each object label then carries information about parent terms as well. A
360 depiction of a lily for example can then not only be correctly recognised as a lily, but also as
361 a bulbous plant, a flower, or a living object. Via a suitable weighing of the label specificity
362 we thus enable the system to detect more abstract categories where the concrete object is
363 not recognisable. This approach has the additional advantage that ImageNet [39], a large
364 dataset of photos annotated with object labels that uses WordNet concepts, can be used for
365 pre-training our models.

366 In many cases, the invisible references to olfaction might not be as easily detectable
367 as with objects that emit a strong smell. Iconographic allusions, or reactions to smell are
368 examples of more complex olfactory references that require semantic context knowledge to be
369 recognised. We plan to combine and extend our object detection method with more advanced
370 techniques like analyzing the co-occurrence of detected objects and their relative position,
371 estimation of poses of depicted persons, or the classification of iconographies to enable the
372 recognition of olfactory cues that are not evident on the first sight.

373 These ambitions reveal the need for a pragmatic taxonomy of olfactory phenomena that
374 serves as a tool for object detection. The top level categories are defined by the techniques
375 that can be applied to detect the respective phenomena (see figure 6 for a draft version).
376 Lower level categories depend on the requirement of the specific detection technique - in the
377 case of odorous objects: a hierarchy based on WordNet.

378

5 Advancing the Olfactory Gaze with Odour Wheels

379 Europeana and Rijksstudio offer the opportunity to browse their collections on the basis
 380 of colour.⁴ Under each object, a slide of its colours is presented. Researchers can click on
 381 one of the colour schemes and find related objects, which allows users to create surprising
 382 connections that they might not have come up with themselves, adding the possibility of
 383 new layers of meaning utilization of the collection.⁵

384 Inspired by the colour schemes, we would propose to enrich digital art collections with
 385 **odour wheels**. Odour wheels are visual representations of smell quality containing sensory
 386 information such as smell “families” (floral, woody, etc.) and smell descriptors (such as
 387 fresh, musty, pungent); some odour wheels also display chemical compounds associated with
 388 each descriptor. Wheels like these are widely used in the flavour and fragrance industries
 389 ([30]; [41]). In addition, odour wheels have been produced to characterise other types of
 390 smells, such as urine in the sixteenth century [12], urban smells [34], and compost and water
 391 [42]. While their use as a documentation tool is popular, the methodology for developing an
 392 odour wheel is not standardised, nor is their function. Cecilia Bembibre [5] identified three
 393 main categories for wheels depending on their approach: (1) focused on sensory aspects, (2)
 394 combining sensory and chemical descriptors and (3) records of a personal olfactory experience.
 395 The wheels in the first category organise olfactory information hierarchically, usually going
 396 with a general (“families”) inner ring which encompass large olfactory traits towards more
 397 detailed subcategories and then odour descriptors. These categories group smells with similar
 398 sensory qualities. The second group is often used in the identification of malodours and
 399 focuses on establishing connections between the chemicals responsible for certain odours
 400 (e.g. acetic acid) and the way they are described sensorily (e.g. sour, vinegary), often also
 401 grouping scents according to sources (e.g. “industrial”). Finally, the third group comprises
 402 examples where an odour wheel is used for documentation purposes only, such as the one
 403 resulting from Rachael Morrison’s sniffing of the book collection in the Museum of Modern
 404 Art (MoMA) Library in New York [16].

405 This diversity of methodological approaches is often seen as a limitation of the wheels as
 406 a documentation and educational tool, especially when coupled with non-transparent choices
 407 such as the criteria for the size of odour categories that can lead to misrepresentations of the
 408 olfactory qualities [15]. Another perceived limitation of the wheels is the fact that the circle
 409 shape might be interpreted as a complete representation and therefore discourage innovation
 410 [31]. However, there is also an effort from many researchers and industry professionals to
 411 present the wheels as a dynamic tool that invites further contribution.

412 We acknowledge the limitations of the wheels but, given the innovative application
 413 proposed in this paper, we estimate it will be a helpful tool. The art historical odour wheel
 414 we propose is not only meant for documentation purposes, but to enable digital scent-based
 415 queries. The wheel is visually and conceptually familiar and open to improvement, while
 416 effectively anchoring the olfactory gaze concept for its unique capacity. Our approach is
 417 quite innovative in yet another way because odour wheels usually apply to singular objects
 418 (books, coffee), domains (foodstuffs) or to complex scentscapes such as cities [28], and rarely
 419 to entire scholarly disciplines.

⁴ <https://pro.europeana.eu/page/search>

⁵ Colour may seem disconnected from context, but certain hues are indicative of industrial developments resulting in new colours, or have symbolic meaning in certain eras, such as the blue pigment ultramarine, indicating “hyperdulia” or sanctity [4, pp. 81–85].

We propose a nose-first art historical odour wheel⁶, which is based on the Odeuropa Olfactory Art History Database, as described before. At this moment, the database consists of 354 entries in 5 classes, with references to Iconclass codes (where possible), and descriptions of the (in)visible odorants. These odorants were categorized into scent families, for which we used: 1) perfume industry odour classifications, 2) the categories “industrial” and “gourmand” from urban scent classifications [28], 3) classifications used in chemistry and food, 4) we added a category “sour/ acid” to classify odorants such as vinegar and vomit. A team of olfactory experts set to work, categorizing for instance frankincense and myrrh as “resinous”, and bread and milk as “gourmand/ food”. Ambergris, civet, musk (animal materials) and horses were grouped into the parent term “animalistic”. Some olfactory sources ended up in two different categories. “Cows” are both “animalistic” and “rural”, a class in which forests and farms find their place.⁷ The nose-first odour wheel (figure 5) starts from the scent families, connected to odorants in the second ring, which leads to the artworks and artefacts and their Iconclass codes. This model reveals surprising similarities and connections between concepts that are quite dissimilar from an ocularcentric point of view. When taking this perspective, we can compute an olfactory distance between seemingly unrelated depictions and, metaphorically speaking, let viewers of digital collections query images with their noses. Since the scent wheel entails information about the olfactory composition of visual smell references, we can decompose every detected phenomenon into its olfactory components. Based on this composition and the associated smell families, an olfactory similarity between two concepts can be quantified. We plan to use this novel concept of an olfactory distance to make the olfactory gaze accessible when looking at digital collections of art. A viewer could for example regard an artwork and get recommendations for artworks that smell similar, or specifically look for artworks that depict objects that smell, for example the countryside (rural). Thinking and searching with an olfactory gaze has led the research team to find formerly overlooked olfactory iconographies such as “Jonah in the whale,” alluding to the animal’s visceral smell, “Descent into Limbo”, evoking the scent of sulphur and cadaverine, and “Napoleon”, who was known for his daily and ample use of Eau de Cologne. In various cases, several scents are connected to one individual story.

An exciting addition would be to expand this wheel with chemical compounds associated with the odour descriptors. This would enable professionals to reconstruct historical scentscapes and to use scents in museums for educational purposes. And finally: the wheel we present here is static. The next improvement is to make it more dynamic, for instance by creating a zoomable wheel, and by linking the wheel categories directly to the relevant scenes in the artworks, by using computer vision techniques.

6 Conclusion

Digital cultural heritage collections present a wealth of information about the sensory world of the past. However, it is currently difficult to extract olfactory information from the metadata of these collections. In this paper, we have described the current situation, and presented a series of solutions to overcome the ocular bias of art collections which would help visitors and researchers to develop an olfactory gaze. Our solution entails the combination of

⁶ The term “nose-first” was popularized by smell mapper Kate Mclean [28].

⁷ We want to emphasize that this classification task is a work in progress, which brings many challenges. For instance, the scent family “malodorous” is problematic since hedonic evaluation is often culturally determined.

461 computer science techniques with expert (art) historical and olfactory heritage knowledge.
 462 The Odeuropa project is developing an Olfactory Art history Database, with a rich taxonomy
 463 of olfactory phenomena, following the structure of the lexical database WordNet. The
 464 database informs the automatic object detection methods employed by the computer vision
 465 team. Furthermore, it informs a nose-first odour wheel (with (in)visible cues to olfaction)
 466 which digital heritage institutes could use to improve discoverability and heighten the impact
 467 of their digital collections.

468 The nose-first odour wheel can inform a broad audience about the olfactory past in a
 469 playful manner and allows users to find unexpected connections between artworks. At the
 470 same time, the collected olfactory metadata enables computer vision experts to teach the
 471 computer how to recognize olfactory scenes and objects, leading to an even more vast and
 472 versatile overview of olfactory history.

473 The act of smelling should not be overlooked as a strategy for knowledge gathering. With
 474 the Odeuropa-team and affiliated partners, we are planning to organize exhibitions and tours
 475 with an olfactory gaze in museums of visual arts. By presenting historically informed scents
 476 for a nose-first approach, visitors can inhale scents while looking at artworks. The nose-first
 477 approach will thus become even more tangible.

478 ————— References —————

- 479 1 William S. Anderson et al. *Ovid's Metamorphoses*. University of Oklahoma Press, 1997.
- 480 2 Taylor Arnold and Lauren Tilton. Distant viewing: analyzing large visual corpora. *Digital*
 481 *Scholarship in the Humanities*, 34(Supplement_1):i3–i16, 2019.
- 482 3 David S. Barnes. *The great stink of Paris and the nineteenth-century struggle against filth and*
 483 *germs*. JHU Press, 2006.
- 484 4 Michael Baxandall et al. *Painting and experience in fifteenth century Italy: a primer in the*
 485 *social history of pictorial style*. Oxford University Press, USA, 1988.
- 486 5 Cecilia Bembibre Jacobo. *Smell of Heritage*. PhD thesis, UCL (University College London),
 487 2020.
- 488 6 Christina Rain Bradstreet. 'wicked with roses': floral femininity and the erotics of scent.
 489 *Nineteenth-Century Art Worldwide*, 6(1):20–37, 2007.
- 490 7 Christina Rain Bradstreet. *Scented visions: the nineteenth-century olfactory imagination*. PhD
 491 thesis, Birkbeck (University of London), 2008.
- 492 8 Hans Brandhorst. Revising iconclass section 32b human races, peoples; nationalities, 2021.
 493 Accessed: 29 April 2021. URL: <http://iconclass.org/Updating32B.pdf>.
- 494 9 Marie Clapot. Insights from an educator crafting scent-based experiences in museum galleries.
 495 In *Bridging Communities through Socially Engaged Art*, pages 34–37. Routledge, 2019.
- 496 10 Constance Classen. *The museum of the senses: Experiencing art and collections*. Bloomsbury
 497 Publishing, 2017.
- 498 11 Alain Corbin. *Le miasme et la jonquille: L'odorat et l'imagination social, XVIIe-XIXe siècles*.
 499 Flammarion, 1982.
- 500 12 Johannes De Ketham. *Fasciculus Medicinae*. 1500.
- 501 13 Holly Dugan. Scent of a woman: Performing the politics of smell in late medieval and early
 502 modern england. *Journal of Medieval and Early Modern Studies*, 38(2):229–252, 2008.
- 503 14 Holly Dugan. Seeing smell. In *The senses in early modern England, 1558–1660*. Manchester
 504 University Press, 2020.
- 505 15 Avery Gilbert. Spinning one's wheels. Accessed: 29 April 2021. URL: <https://www.firstnerve.com/2017/10/spinning-ones-wheels.html>.
- 507 16 Anna Jane Grossmann. Because we're home to not only the publishing industry but also to a
 508 woman who spends her days smelling books. *New York Magazine*, 2010. Accessed: 29 April
 509 2021. URL: <http://nymag.com/news/articles/reasonstoloveny/2010/70078/>.

- 510 17 James Hall. *Dictionary of subjects and symbols in art*. Routledge, 2007.
- 511 18 Susan Ashbrook Harvey. *Scenting salvation: Ancient Christianity and the olfactory imagination*,
512 volume 42. Univ of California Press, 2006.
- 513 19 David Howes. Charting the sensorial revolution. *The Senses and Society*, pages 113–128, 2006.
- 514 20 David Howes. *Empire of the senses: The sensual culture reader*. Routledge, 2021.
- 515 21 David Howes and Constance Classen. *Ways of sensing: Understanding the senses in society*.
516 Routledge, 2013.
- 517 22 Leonardo Impett and Sabine Süsstrunk. Pose and pathosformel in aby warburg's bilderatlas.
518 In *European Conference on Computer Vision*, pages 888–902. Springer, 2016.
- 519 23 Longlong Jing and Yingli Tian. Self-supervised visual feature learning with deep neural
520 networks: A survey. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2020.
- 521 24 Andrew Kettler. *The Smell of Slavery: Olfactory Racism and the Atlantic World*. Cambridge
522 University Press, 2020.
- 523 25 Nina Levent and Alvaro Pascual-Leone. *The multisensory museum: Cross-disciplinary per-
524 spectives on touch, sound, smell, memory, and space*. Rowman & Littlefield, 2014.
- 525 26 Prathmesh Madhu, Ronak Kosti, Lara Mührenberg, Peter Bell, Andreas Maier, and Vincent
526 Christlein. Recognizing characters in art history using deep learning. In *Proceedings of the 1st
527 Workshop on Structuring and Understanding of Multimedia heritAge Contents*, pages 15–22,
528 2019.
- 529 27 Lizzie Marx. Perfume and books of secret. *Fleeting - Scents in Colour, exh. cat. Mauritshuis,
530 The Hague*, 2021.
- 531 28 Katherine Jane McLean. *Nose-first: practices of smellwalking and smellscape mapping*. Royal
532 College of Art (United Kingdom), 2019.
- 533 29 George A Miller. Wordnet: a lexical database for english. *Communications of the ACM*,
534 38(11):39–41, 1995.
- 535 30 Ann C. Noble, Rich A. Arnold, John Buechsenstein, Jane E. Leach, Janice O. Schmidt, and
536 Peter M. Stern. Modification of a standardized system of wine aroma terminology. *American
537 journal of enology and viticulture*, 38(2):143–146, 1987.
- 538 31 Claus Noppeneij. Smelly wheels: in search of alternatives. *blog Scent Culture Institute,
539 Smelling in Culture*, 2017. Accessed: 29 April 2021. URL: <https://scentculture.institute/smelly-wheels-in-search-of-alternatives/>.
- 541 32 Sinno Jialin Pan and Qiang Yang. A survey on transfer learning. *IEEE Transactions on
542 knowledge and data engineering*, 22(10):1345–1359, 2009.
- 543 33 Joy Parr. *Sensing changes: technologies, environments, and the everyday, 1953-2003*. ubc
544 Press, 2010.
- 545 34 Daniele Quercia, Rossano Schifanella, Luca Maria Aiello, and Kate McLean. Smelly maps:
546 the digital life of urban smellscapes. In *Proceedings of the International AAAI Conference on
547 Web and Social Media*, volume 9:1, 2015.
- 548 35 François Quiviger. *The Sensory World of Italian Renaissance Art*. Reaktion Books, 2010.
- 549 36 Joseph Redmon and Ali Farhadi. Yolo9000: better, faster, stronger. In *Proceedings of the
550 IEEE conference on computer vision and pattern recognition*, pages 7263–7271, 2017.
- 551 37 Tal Ridnik, Emanuel Ben-Baruch, Asaf Noy, and Lihi Zelnik-Manor. Imagenet-21k pretraining
552 for the masses. *arXiv preprint arXiv:2104.10972*, 2021.
- 553 38 Pavel Rojtberg, Thomas Pöllabauer, and Arjan Kuijper. Style-transfer gans for bridging the
554 domain gap in synthetic pose estimator training. In *2020 IEEE International Conference on
555 Artificial Intelligence and Virtual Reality (AIVR)*, pages 188–195. IEEE, 2020.
- 556 39 Olga Russakovsky, Jia Deng, Hao Su, Jonathan Krause, Sanjeev Satheesh, Sean Ma, Zhiheng
557 Huang, Andrej Karpathy, Aditya Khosla, Michael Bernstein, et al. Imagenet large scale visual
558 recognition challenge. *International journal of computer vision*, 115(3):211–252, 2015.
- 559 40 Mark Michael Smith et al. *Sensing the past: seeing, hearing, smelling, tasting, and touching
560 in history*. Univ of California Press, 2007.

23:16 Nose-First. Towards an Olfactory Gaze for Digital Art History

- 561 **41** Molly Spencer, Emma Sage, Martin Velez, and Jean-Xavier Guinard. Using single free sorting
562 and multivariate exploratory methods to design a new coffee taster's flavor wheel. *Journal of*
563 *food science*, 81(12):S2997–S3005, 2016.
- 564 **42** IH Suffet and P Rosenfeld. The anatomy of odour wheels for odours of drinking water,
565 wastewater, compost and the urban environment. *Water Science and Technology*, 55(5):335–
566 344, 2007.
- 567 **43** William Tullett. The macaroni's 'ambrosial essences': Perfume, identity and public space in
568 eighteenth-century england. *Journal for Eighteenth-Century Studies*, 38(2):163–180, 2015.
- 569 **44** William Tullett. Grease and sweat: race and smell in eighteenth-century english culture.
570 *Cultural and Social History*, 13(3):307–322, 2016.
- 571 **45** William Tullett. *Smell in Eighteenth-Century England: A Social Sense*. Oxford University
572 Press, 2019.
- 573 **46** Henri van de Waal. Système de classification iconographique "iconclass" et la collection de
574 reproductions d.i.a.l. (decimal index of the art of the low countries). A summary of the lecture
575 was published in the series "Colloques Internationaux du Centre National de la Recherche
576 Scientifique – Bibliographie d'Histoire de l'Art" Paris, March 25– 26, 1969.
- 577 **47** Ariane van Suchtelen. *Fleeting - Scents in Colour, exh. cat. Mauritshuis, The Hague*. Waanders
578 Publishers Zwolle, 2021.
- 579 **48** Caro Verbeek. *Ruiken aan de tijd - de olfactorische dimensie van het Futurisme (1909-1942)*
580 (*Smelling Time - The Olfactory Dimension of Futurism (1909-1942)*). PhD thesis, 2020.
581 forthcoming.
- 582 **49** Érika Wicky. Les parfums de l'ancien régime: Persistance et représentations au xixe siècle,
583 2019.

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Art Historical Odour Wheel & Taxonomy Visualizations

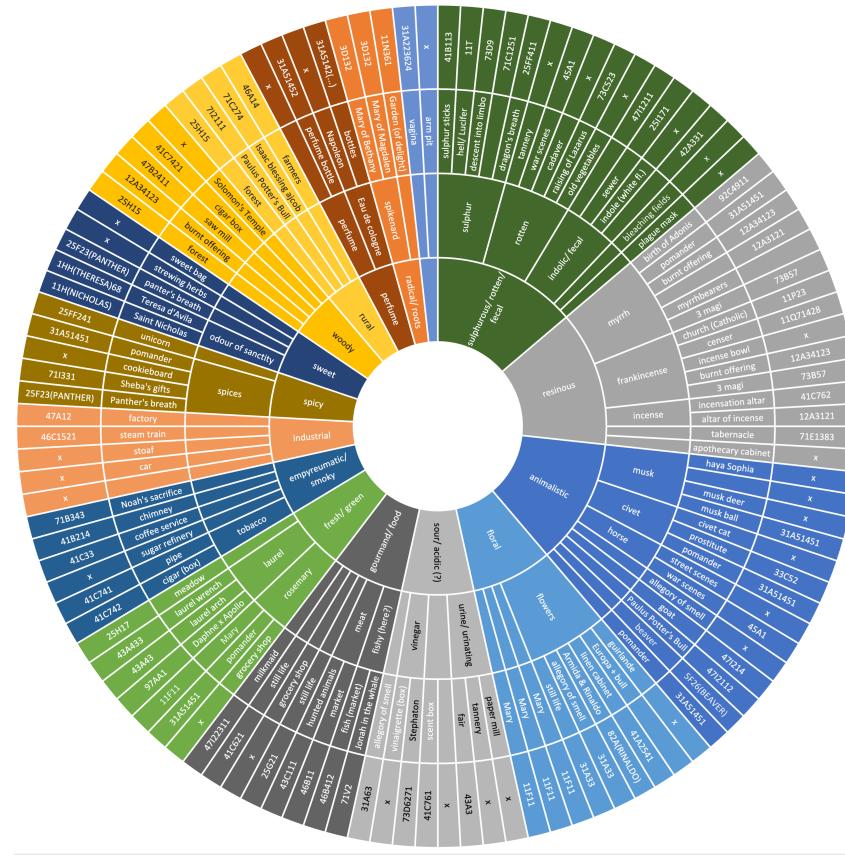
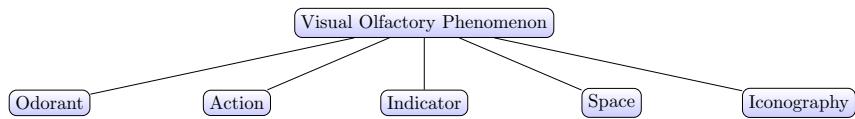


Figure 5 The Odeuropa “Nose-first art historical odour wheel” starting from scent families in the first ring, connected to odorants in the second ring, and then to artworks and artefacts around that, ending with an outer ring with Iconclass codes. Please note that the colours of the wheel are not specifically related to the content.



■ **Figure 6** Top level categories for a pragmatic taxonomy for computer vision extraction of olfactory information from digital art collections (draft).