

Virtualize your data structure

4D Summit 2016



Brent Raymond

Senior Software Architect
Art Institute of Chicago

4DMethod User Group, Organizer
4dmethod.com

Introduction

tl;dr

(too long; didn't read)

Introduction

A Virtual Structure, as defined by this session, is an abstraction layer for data and functionality that contains information that can be accessed by generic code to deliver application specific behavior.

Introduction

- Background
- Description
- Analysis
- Case study
- Example database
- Questions

Introduction

Object Manager

germany Match all (AND)

Object Type is equal to Painting
Collection Status is equal to Permanent Collection

AIC Collection and Long Term Loans

My Essential Art 31 records – 1 selected.

Vasily Kandinsky
French, born Russia, 1866–1944
Improvisation No. 30 (Cannons), 1913
Oil on canvas
43 11/16 x 43 13/16 in. (111.0 x 111.3 cm)
Arthur Jerome Eddy Memorial Collection
1931.511

Gustave Caillebotte
French, 1848–1894
Paris Street; Rainy Day, 1877
Oil on canvas
83 1/2 x 108 3/4 in. (212.2 x 276.2 cm)
Charles H. and Mary F. S. Worcester Collection
1964.336

Georges Seurat
French, 1859–1891
A Sunday on La Grande Jatte — 1884, 1884/86
Oil on canvas
81 3/4 x 121 1/4 in. (207.5 x 308.1 cm)
Helen Birch Bartlett Memorial Collection
1926.224

René Magritte
Belgian, 1898–1967
Time Transfixed, 1938
Oil on canvas
57 7/8 x 38 7/8 in. (147 x 98.7 cm)
Joseph Winterbotham Collection
1970.426

Willem de Kooning
American, born Netherlands, 1904–1997
Excavation, 1950
Oil on canvas
205.7 x 254.6 cm (81 x 100 1/4 in.), without frame

Field Palette: Objects

Quick Search

Record Creation Date
Record Last Modification D...

Attribution

- Artist / Culture
- Artist / Display
- Artist Last Name
- Artist First Name
- Artist Nationality
- Artist Birth Date
- Artist Death Date
- Place
- Places (All)
- SAIC Artist
- SAIC Donor

Object Core Data

- Title
- Title, Date
- Titles (All)
- Display Dates
- Date
- Dates (All)
- Medium Display
- Medium Display, Dimens...
- Dimensions
- Framed Dimensions
- Main Reference Number

Credit Line

- Acquisition Agent
- Acquisition Agents (All)
- Acquisition Method
- Acquisition Notes

Filter: Searchable Viewable

Background

r/history

Background

- In use at Art Institute of Chicago
- Application called CITI for managing art collection
- Strategy leveraged in CITI since early 2000s
- Developed by Stefan Lucke and Michael Blossom
- Heavily influenced by writings of David Adams
- Now Ed Hammond and I develop CITI and extend the virtual structure module (VS)

Description

r/TIL

Today I Learned

Description

- General programming concept, not specific to 4D
- Data Structure (dictionary)
- Tables/ fields do not need to exist in 4D structure
- Can be a formula or combination of other fields
- Access definition (query, retrieval)
- Security/ privacy restrictions
- Appearance
- Controlled value lists
- Relations
- Functionality

Description

- Registry accessed by generic code to handle common tasks
- Application can be extended by changing the VS registry
- New Fields and Tables can be added without modifying the actual 4D database structure
- Single 4Dbase can run in different modes by switching on/ off sections of VS
- New properties are easy to add
- Can become a live documentation of the data and functionality of your application

Analysis

r/ELI5

Explain Like I'm 5

Analysis



Analysis - Strengths

- Naming and data constructs independent from 4D structure
- Easier user navigation of multi-table relation chains
- Limits structure bloat (physical data storage vs. logical)
- Unifies data presentation due to centralized query and retrieval callbacks
- Simplifies data access in the code
- Facilitates access of data from external sources
- Self-documenting for API access
- Centralized data access allows optimizations to have system wide impact

Analysis - Weaknesses

- Built-in 4D user facing interfaces such as Query Editor, Quick Report, Labels no longer applicable
- Data retrieval tends toward per field basis leading to some performance cost
- Direct external SQL access to your 4D database also circumvents the Virtual Structure

Analysis - Opportunities

- Run the application in different modes
- Works well with access control system (field and record based privileges per user)
- Enables easier interface exposure of data stored in Object fields
- Encourages generic coding
- Scales well with data requirements
- Use ‘Execute On Server’ method property to handle all data query and retrieval on 64 bit 4D servers
- Inherently better data security due to abstraction of data access

Analysis - Threats

- Additional work to implement and maintain
- Steeper learning curve for new developers
- Can be difficult to explain to those with less systems engineering experience
- Can be a challenge to explain to anyone without some discussion!

Virtual Structure strategy not
right for application...
but has much to offer if
implemented.



Case Study

Art Institute of Chicago



Pics or It Didn't Happen



Case Study



Application named CITI in use at the museum to manage art collection

- Main business is art, so primary table is artwork [Objects]
- Actual table in 4D structure has 63 fields
- Interface and API show that it has 347 fields

Objects	
2	³²
A	¹⁶
2	³²
0.5	
2	³²
0.5	
2	³²
16	

Field Palette: Objects

Quick Search

Record Creation Date
Record Last Modification Date

Attribution

- Artist / Culture
- Artist / Display
- Artist Last Name
- Artist First Name
- Artist Nationality
- Artist Birth Date
- Artist Death Date
- Place
- Places (All)
- SAIC Artist
- SAIC Donor

Object Core Data

- Title
- Title, Date
- Titles (All)
- Display Dates
- Date
- Dates (All)
- Medium Display
- Medium Display, Dimensions
- Dimensions
- Framed Dimensions
- Main Reference Number

Credit Line

- Acquisition Agent
- Acquisition Agents (All)
- Acquisition Method
- Acquisition Notes
- Credit Line
- Credit Line, Main Ref Num
- Proposed Credit Line
- Committee
- Committee Date
- Fund

Descriptions/Conditions

- Physical Description
- Inscriptions
- Subject Description
- Historical Context
- Remarks
- Scholars
- Label For Gallery
- Label For Exhibition
- Condition Description
- Condition Grade
- Condition Status
- Chainline Distance
- Chainline Legibility
- Chainline Orientation
- Watermarks (All)
- Watermarks and Notes (All)
- Frame Information
- Frame Status

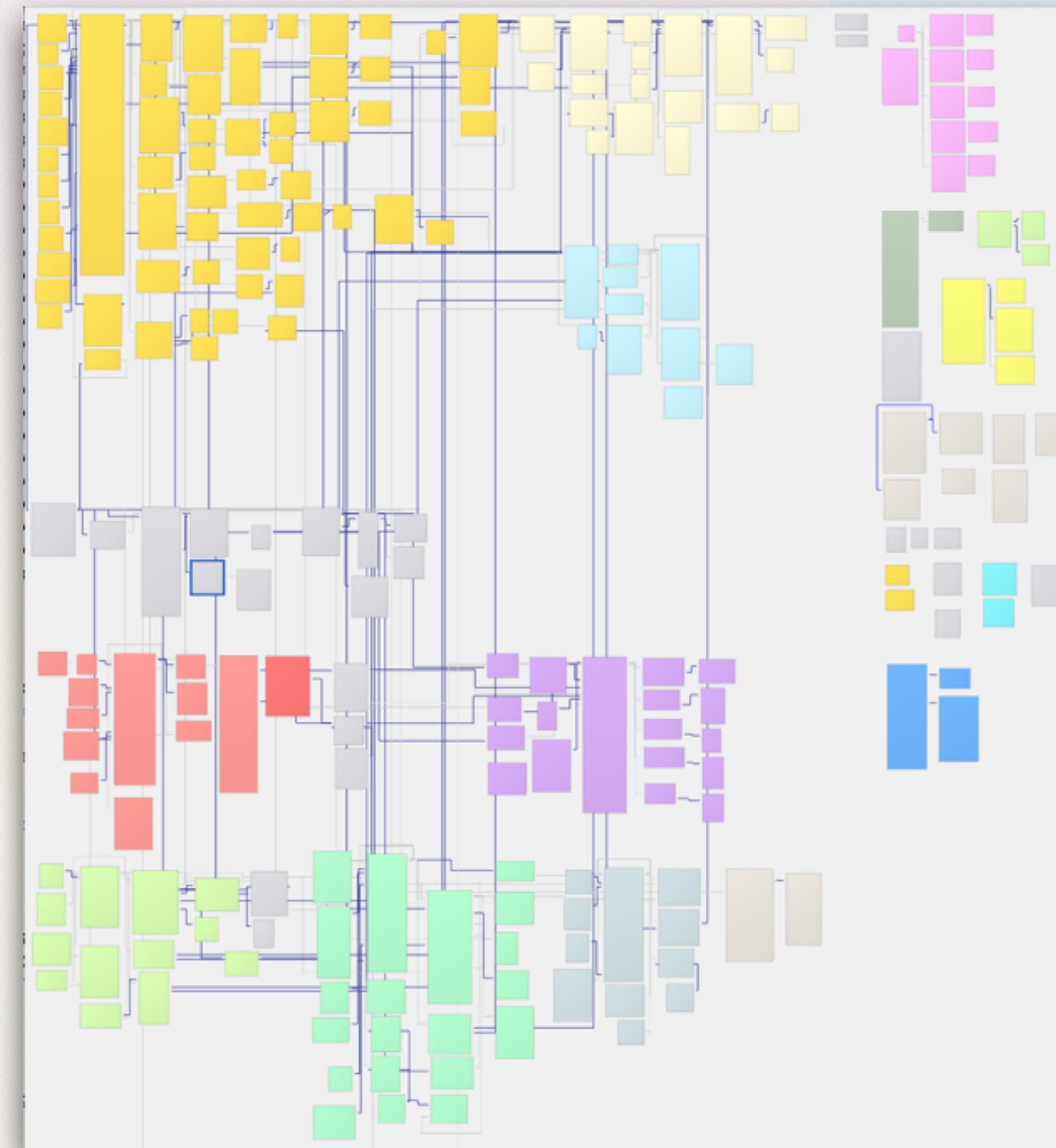
References

- Bibliography
- Publication History

Filter: Searchable Viewable

Case Study

- 231 tables in the 4D structure
- Users are only aware of 9
- Virtual Structure masks the complexity of the data structure
- Keep the glorious yet potentially confounding database design
- Show a human friendly, flat user interface



Case Study

- User defined constants are a must!
- Easy to create with 4D Pop component
- Virtual Structure elements (tables and fields) and their properties all have associated constants
- Combined with a predictable naming convention, gives developer quick access to values

Constants Manager

Module List Category List

Module	Label	Category	Value
Transaction	Tran_kVFIIsNoShipExp	Virtual Field	1220
Agent	Agent_kvFOldMailingAddress	Virtual Table	70
Agent	Agent_kvFBiography	Preference ID	71
Agent	Agent_kvFNatLifeDates	Data Substitution	69
Object	Object_kVPhysicalDesc	DD Slot Type	1
Object	Object_kVInscriptions	Discrete Value	2
Object	Object_kVFDimensions	Input Form Event	3
Object	Object_kVFArtistNatCulture	Integer Field Value	4
Object	Object_kVFPublicationHistory	Label	5
Object	Object_kvFOldExhibitionHistText	Method Switch	6
Object	Object_kVFSubjectDesc	Offset/Range	8
Object	Object_kvFRemarks	Other	9
Object	Object_kVConditionDesc	Popup Choice	10
Object	Object_kVFHistoricalContext	Preference Value	11
Object	Object_kVFDisplayDate	Process Name	12
Object	Object_kVProvenance	Property Number	14
Object	Object_kVChainlineDistance	Property Value	15
Object	Object_kVFCreditLine	Result Code	16
Object	Object_kVFAcqNotes	Semaphore	17
Object	Object_kVProvenanceRemarks	Server Job Code	18
Image Data	ImgData_kVGeneralComments	Set Name	54
Image Data	ImgData_kvFIImgDeptComments	Virtual Field	55
Image Data	ImgData_kVNonObjCaption	Virtual Field	56
Image Data	ImgData_kVFCopyRComments	Virtual Field	57
Image Data	ImgData_kVFCopyROwner	Virtual Field	58
Image Data	ImgData_kVFCopyRContact	Virtual Field	59
Place	Place_kvFPlaceRecPkey	Virtual Field	63
Place	Place_kVFPNRecPkey	Virtual Field	64

Create Delete All Query Sort Recent Find not tokenized

Case Study

- Constants browser doubles as a Virtual Structure inspector
- Field values and callbacks are double clickable to navigate to related objects in development
- Properties point to pieces of application code that have been made generic

Category Specific: (Virtual Table)

Property	Value
▼ General	
Label (singular)	Object
Label (plural)	Objects
▼ Usage	
Manager	True
Batch Change	True
► Field Properties	
▼ Caption Fields	
Artist / Display	Object_kVFArtistNatCulture
Display Dates	Object_kVFDisplayDate
Medium Display	Object_kVFMedium
Dimensions	Object_kVFDimensions
Credit Line	Object_kVFCreditLine
Title	Object_kVFTitle
Reference Number	Object_kVFRefNum
► Batch Columns	
► Drag and Drop	
► Security Privileges	
▼ Callback Methods	
Keyword Update	Object_UpdateObjPkeyKeyword
Keyword Batch Update	InterPut_BatchUpdateVFKeyword
Field Access Filter	InterGet_GetVFAccessPermission
Display Record Filter	ObjGet_PreProcessDisplay

```
{ "number": 3, "constant": "VT_kObjects", "labelSingle": "Object", "labelPlural": "Objects", "manager": true, "batchChange": true, "primaryKeyFieldNumber": 72, "recordNumberFieldNumber": 73, "thumbnailImageFieldNumber": 80, "internalLargeImageFieldNumber": 20, "preferredImageFkeyFieldNumber": 28, "recordCreatedStampFieldNumber": 873, "recordCreatedUserFkeyFieldNumber": 874, "recordModifiedStampFieldNumber": 875, "recordModifiedUserFkeyFieldNumber": 876, "shortcutFieldNumber": 23, "publishingTaggedFieldNumber": 595, "publishingEnabledFieldNumber": 866, "publishingCategoryNameFkeyFieldNumber": 656, "publishingCategoryFkeyFieldNumber": 1189, "captionFieldNumber": 81, "captionFields": [ 4, 12, 89, 3, 16, 22, 29 ] }
```

Case Study

Category Specific: (Virtual Field)

Property	Value
General	
Label (user env.)	Artist / Display
Table	Objects
Manager	
Category	Attribution
Searchable	True
Viewable	True
Batch Change	True
Input view form	Object_CreatorPlaces
List column width	125
Data	
Type	Text
Field Model	VF_kFldMdlTextRecsSingle
Security	
View	Objects:View Artist/Place Text
Modify	Objects:Modify Artist/Place Text
Callbacks	
Data Retrieval	InterGet_RetrieveCommonVFs
Query	InterGet_QueryCommonVFs
List Sort	ObjMgr_ListViewColumnSort
Batch Save	InterPut_SaveTextRecsData
Search Comparators	
contains all keywords	Search_kCompareContainAllKW

{
 "number": 4,
 "constant": "Object_kVFArtistNatCulture",
 "label": "Artist / Display",
 "tableNumber": 3,
 "tableName": "Objects",
 "categoryNumber": 1,
 "categoryName": "Attribution",
 "searchable": true,
 "viewable": true,
 "batchChange": true,
 "inputViewForm": "Object_CreatorPlaces",
 "columnWidth": 125,
 "dataTypeNumber": 2,
 "dataType": "Text",
 "fieldModelNumber": 3,
 "fieldModelName": "VF_kFldMdlTextRecsSingle",
 "viewPrivilegeNumber": 290,
 "viewPrivilegeLabel": "Objects:View Artist/Place Text",
 "modifyPrivilegeNumber": 291,
 "modifyPrivilegeLabel": "Objects:Modify Artist/Place Text",
 "callbackMethodRetrieval": "InterGet_RetrieveCommonVFs",
 "callbackMethodQuery": "InterGet_QueryCommonVFs",
 "callbackMethodSort": "ObjMgr_ListViewColumnSort",
 "callbackMethodBatchSave": "InterPut_SaveTextRecsData",
 "searchComparators": {
 "values": [
 6,
 7,
 1,
 2,
 3,
 4
]
 }
}

Case Study

- Access control very important with AIC data
- Handled in generic security module
- Allows for different user roles by adjusting over 1100 privileges
- Majority of Security values are referenced only in Virtual Structure registration

Privileges	Quick Search	All	Own Dept.	Workgroups
Privilege				
▶ Administration				
▼ Objects				
Record Access				
Modify Relations	✓	✗	✓	✓
Batch Change Data	✗	✗	✓	✓
Delete Object	✗	✗	✗	✓
View Deleted	✗	✗	✗	✗
Un-delete	✗	✗	✗	✗
Print Reports	✓	✓	✓	✓
View Global Briefcases	✓	✓	✓	✓
Save Global Briefcases	✗			
View Departmental Briefcases			✓	
Save Departmental Briefcases		✓	✓	
View Workgroup Briefcases				✓
Save Workgroup Briefcases				✓
View Own Personal Briefcases		✓		
Save Own Personal Briefcases		✓		
Open Manager				
Manager: Print Data	✓	✓		
Manager: Export Data	✓	✓		
Manager: Conduct a Search	✓	✓		

Case Study

- Lists fields enabled for search
- Checks security for viewing field data
- Gets list of search comparators
- Sets up entry according to field model
- Run registered search callback

A screenshot of a search interface. A dropdown menu is open over a text input field containing "5000 BC". The dropdown menu lists several search comparators: "✓ includes", "includes all of", "is included in", "matches exactly", "is before", and "is after".

A screenshot of a search interface. A dropdown menu is open over a text input field containing "Photograph". The dropdown menu lists several search comparators: "Object Type", "is equal to", and "✓ Photograph". To the right of the input field, a list of object types is shown: "Performance Arts", "✓ Photograph", "Print", "Religious/Ritual Object", and "Sculpture".

Case Study

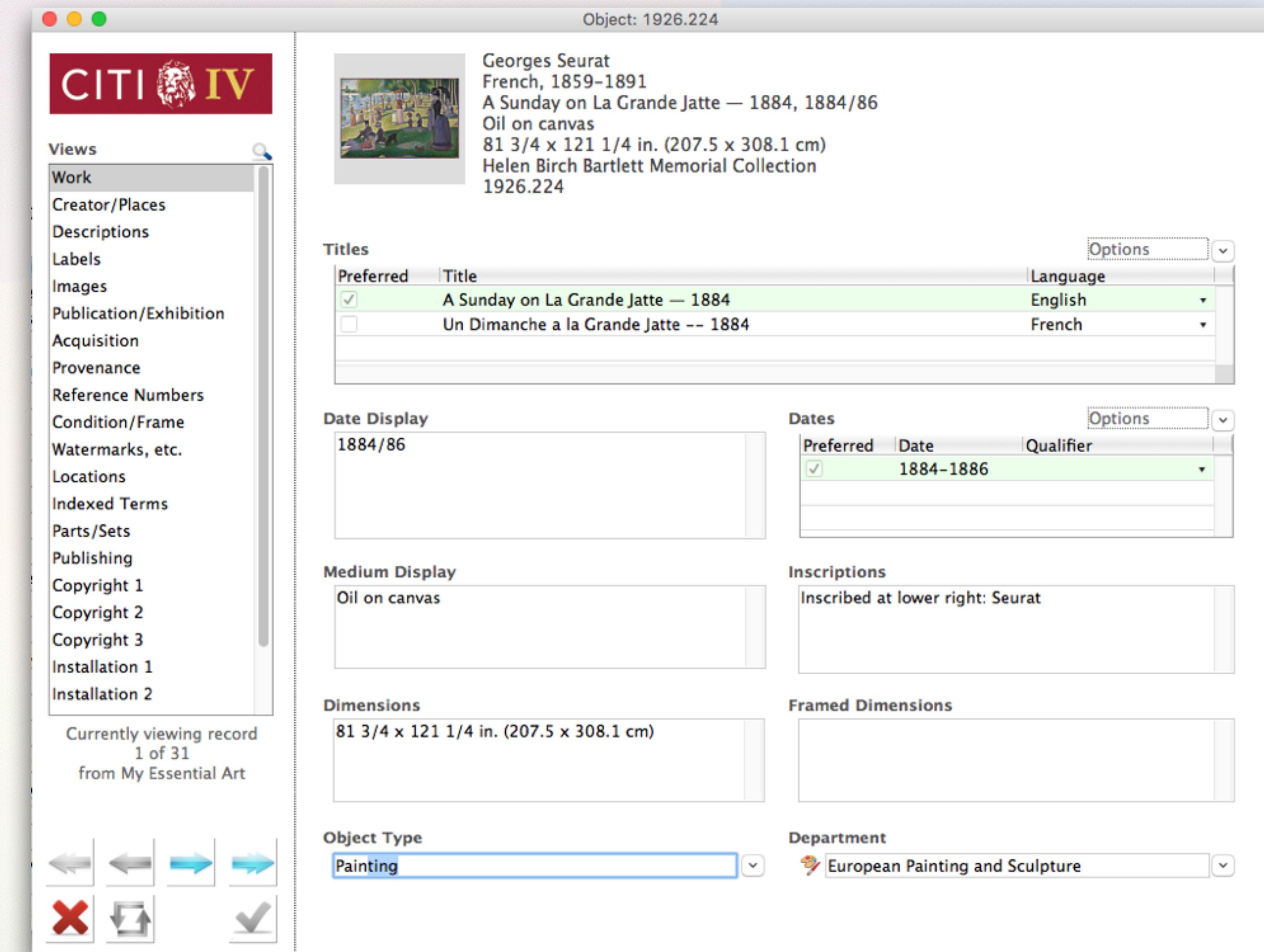
- Check if fields enabled for View
- Set up listbox column width
- Data retrieval callback methods executed for each of the fields
- Set up drag slot types for drag and drop
- Get list of Filter values

Title	Artist / Display	Main Refere...	Object Type
A Sunday on the Island of La Grande Jatte — 1884	Georges Seurat; French, 1859–1891	1926.224	Painting
America Windows	Marc Chagall; French (born Belarus), 1887–1985	1977.938	Painting
American Gothic	Grant Wood; American, 1891–1942	1930.934	Painting
Avery Coonley Playhouse Window	Frank Lloyd Wright; American, 1867–1959	1986.88	Architectural fragment
Burden Basket	Pomo; Northern California, United States	2003.172	Basketry
Cabinet	Herter Brothers; American; New York, New York	1986.26	Furniture
Chicago	Harry Callahan; American, 1912–1999	1983.65	Photograph
Clown Torture	Bruce Nauman; American, born 1941	1997.162	Audio-Video
Corallo Chair	Campana Brothers (Brazilian, founded 1987)	2006.277	Design
Excavation	Willem de Kooning; American, 1904–1997	1952.1	Painting
Georgia O'Keeffe	Alfred Stieglitz; American, 1864–1946	1949.755	Photograph
Half Armor...t the Barriers	Northern Italian, Milan	1982.2172a-o	Armor

- Architectural fragment [1]
- Armor [1]
- Audio-Video [1]
- Basketry [1]
- Decorative Arts [2]
- Design [1]
- Drawing and Watercolor [2]
- Furniture [1]
- Painting [12]**
- Photograph [2]
- Sculpture [4]
- Textile [2]
- Vessel [1]

Case Study

- Check all security privileges including view and modify
- Loading and updating designated caption field
- Loading and validating choice lists in drop-downs/ type ahead functionality
- Business rules and more
- Generic ‘Go to field’ function



Case Study

Objects Load From Briefcase: Options

Access	Main Reference Number	Artist / Culture	Title	Dimensions
1926.224	Seurat, Georges	A Sunday o...tte — 1884	81 3/4 x 121 1/4 in. (207.5 x 308.1 cm)	
1977.938	Chagall, Marc	America Windows	96 x 385 in. (244 x 978 cm) (overall)	
1930.934	Wood, Grant	American Gothic	78 x 65.3 cm (30 3/4 x 25 3/4 in.)	
1986.88	Wright, Frank Lloyd	Avery Coo...ych Window	Center panel: 35 1/4 x 43 in. (89.5 x...s: 36 x 7 3/4 in. (91.4 x 19.7 cm) (each)	
2003.172	Pomo	Burden Basket	53.3 x 61 cm (21 x 24 in.)	
1986.26	Herter Brothers	Cabinet	134.6 x 180.3 x 40.6 cm (53 x 71 x 16 in.)	
1983.65	Callahan, Harry	Chicago	19.2 x 24.2 cm (image/paper); 20.2 x 25.3 cm (mount)	
1997.162	Nauman, Bruce	Clown Torture	Tape I/Reel A: "Clown Taking a Shit" (...peat" (color and sound – 60 minutes)	
2006.277	Campana Brothers	Corallo Chair	90.2 x 139.7 x 99.9 cm (35 1/2 x 55 1/8 x 39 1/3 in.)	
1952.1	de Kooning, Willem	Excavation	205.7 x 254.6 cm (81 x 100 1/4 in.), without frame	

Field: Dimensions Action

Current: 81 3/4 x 121 1/4 in. (207.5 x 308.1 cm)

Modified: 81 3/4 x 121 1/4 in. (207.5 x 308.1 cm)

Find & Replace Replace Entire

Replaces all occurrences of the find text with the replace text.

Find: Seurat

Replace with: El Brento

Set Written By/ Date

Written By: Raymond, Brent

Written on Date: 01/06/2016

Select Places to attach or to remove from Objects:

Set	Place	Preferred
-	Andhra Pradesh	-
-	Asia	-
-	Beauvais	-
-	Belgium	-
-	California	-
✓	Chicago	✓
-	France	-
-	Gabon	-
-	Germany	-
-	Holland	-
-	Italy, northern	-
-	Iznik	-

Additional fields:

<input checked="" type="checkbox"/> Qualifier	Object made in:
<input type="checkbox"/> Current	False
<input type="checkbox"/> Historical	False
<input type="checkbox"/> Topographical	False

Cancel OK

Case Study

Application Modes

- Production
- Mirror
- Internal API
- Web Publishing
- Developer
- Test
- Maintenance
- Crash Recovery

Create a custom API for your
application that generically
references your Virtual Structure

Case Study

See demo videos of CITI at
<http://4dmethod.com/demos/4d-at-the-art-institute-of-chicago/>



Example Database

r/Programming

Example Database

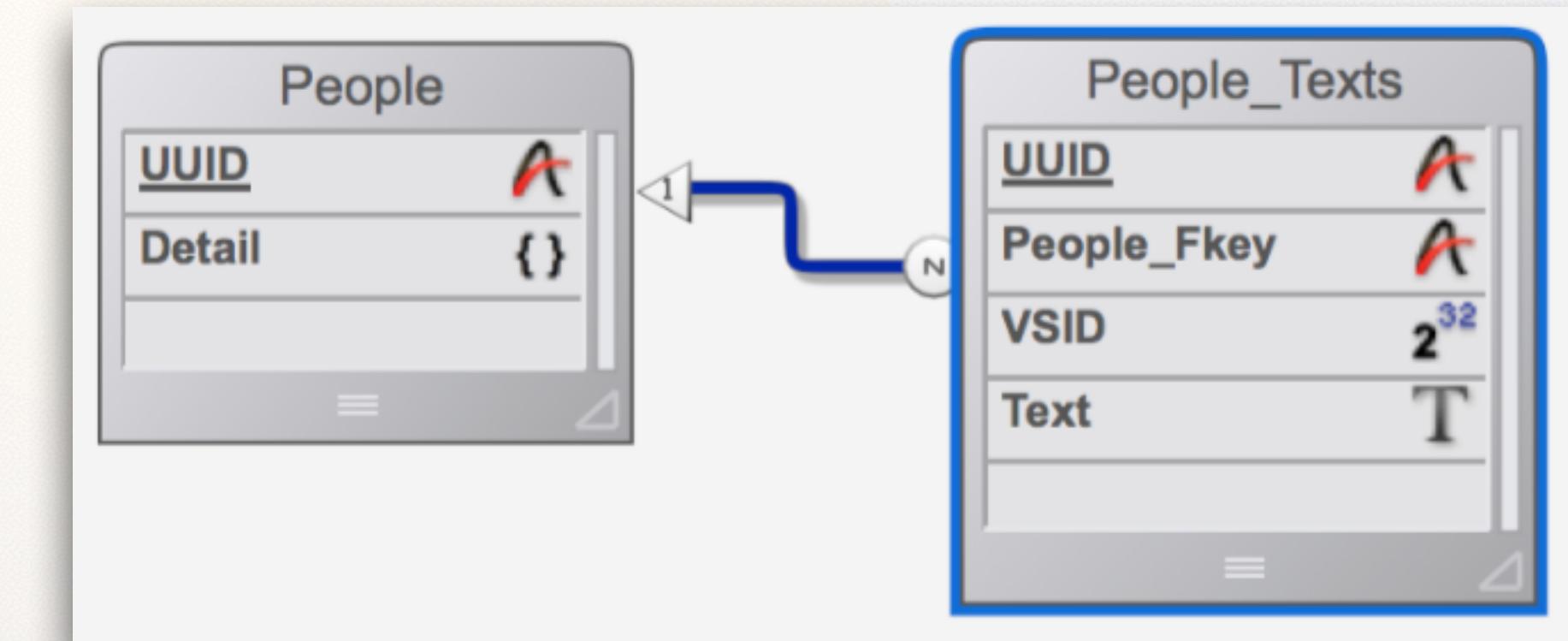
- VS – All methods for initializing the Virtual Structure and generic data access

```
OB SET($oField;VS_kPropID;Person_kVSFirstName)
OB SET($oField;VS_kPropLabelSingular;"First Name")
OB SET($oField;VS_kPropIsField;True)
OB SET($oField;VS_kPropTableID;Person_kvSTable)
OB SET($oField;VS_kPropDataType;Is_text)
OB SET($oField;VS_kPropFieldModel;VS_kFldMdlTextRecsSingle)
OB SET($oField;VS_kPropCBDataRetrieval;"VS_DataGet")
OB SET($oField;VS_kPropCBQuery;"VS_DataQuery")
OB SET($oField;VS_kPropCBSave;"VS_DataSave")
OB SET($oField;VS_kPropCanModify;True)
OB SET($oField;VS_kPropCanSearch;True)
```

- Manager – Offers a generic interface for viewing table data, search and saving

Table: People				
Person ID	First Name	Last Name	Country	Full Name
2E9E706...530A55F	John	Doe	Germany	John Doe

- Person – A sample main table module that owns the data and non generic data access



Demonstration

Questions

r/AMA

I am A ..., Ask Me Anything



Upvote!



[r/4DApps](#)

A subreddit for 4D related topics

Thank you!

For more information about the CITI application at the Art Institute of Chicago, go to
<http://4dmETHOD.com/demos/4d-at-the-art-institute-of-chicago/>

Brent Raymond

LinkedIn
www.linkedin.com/in/linkbrent

Art Institute of Chicago
www.artic.edu

4DMethod 4D & Wakanda User Group
4dmETHOD.com