Exporting SAS Datasets to DDI 3 XML files: Data, Metadata, and More Metadata

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SGF Paper 137-2008, Larry Hoyle and Joachim Wackerow

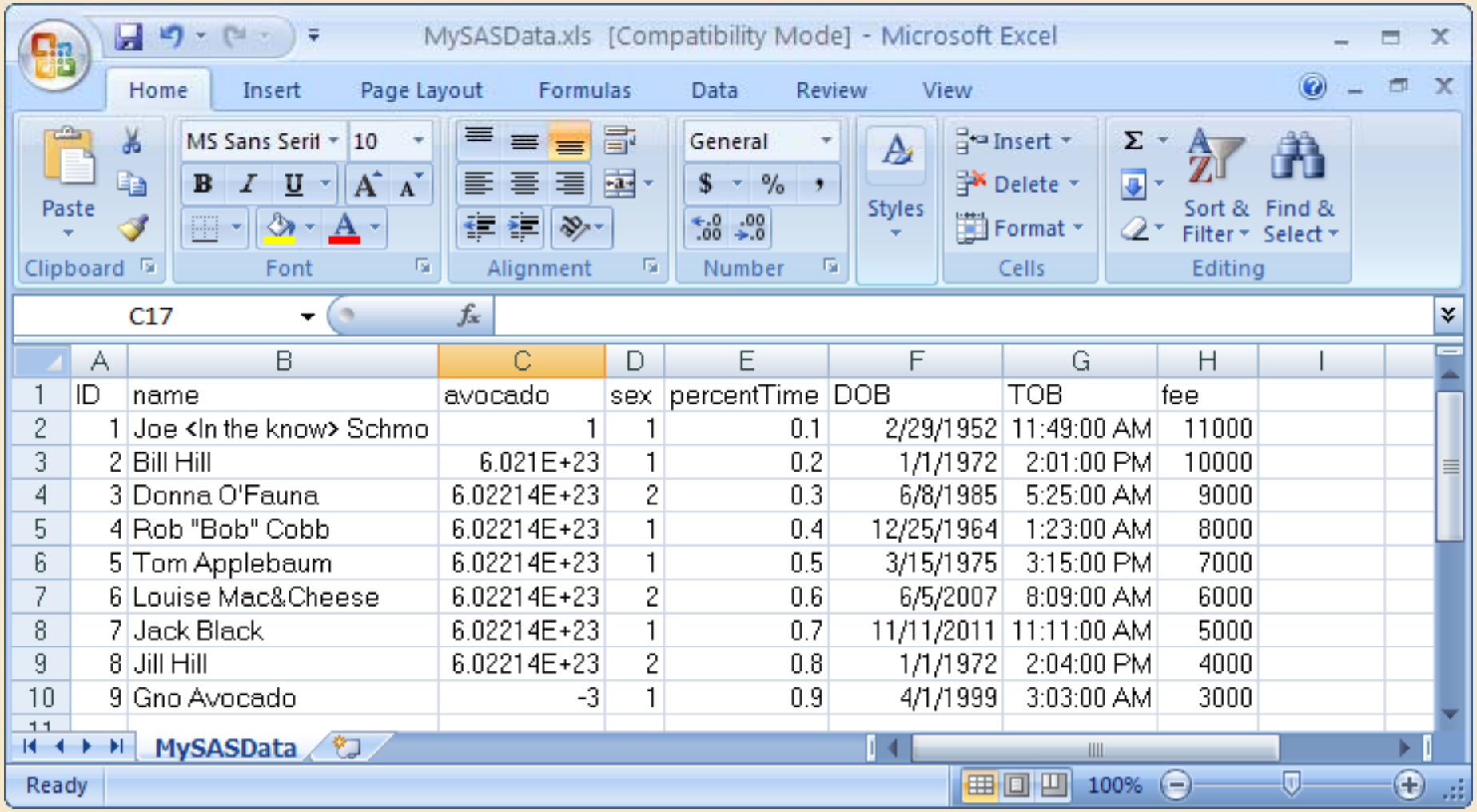
What would you do with these data if this were all you were given?

```
1M1            .11100029feb5211:49Joe <In the know> Schmo
2M6.021e23     .21000001jan7214:01Bill Hill
3F6.02214139e23.30900008jun8505:25Donna O'Fauna
4M6.02214149e23.40800025dec6401:23Rob "Bob" Cobb
5m6.02214159e23.50700015mar7515:15Tom Applebaum
6f6.02214179e23.60600005jun0708:09Louise Mac&Cheese
7m6.02214209e23.70500011nov1111:11Jack Black
8F6.02214219e23.80400001jan7214:04Jill Hill
9m-3           .90300001apr9903:03Gno Avocado
```

Would this be better?

```
1  M       1              .1 11000 29feb52 11:49 Joe <In the know> Schmo
2  M       6.021e23       .2 10000 01jan72 14:01 Bill Hill
3  F       6.02214139e23  .3  9000 08jun85 05:25 Donna O'Fauna
4  M       6.02214149e23  .4  8000 25dec64 01:23 Rob "Bob" Cobb
5  m       6.02214159e23  .5  7000 15mar75 15:15 Tom Applebaum
6  f       6.02214179e23  .6  6000 05jun07 08:09 Louise Mac&Cheese
7  m       6.02214209e23  .7  5000 11nov11 11:11 Jack Black
8  F       6.02214219e23  .8  4000 01jan72 14:04 Jill Hill
9  m       -3             .9  3000 01apr99 03:03 Gno Avocado
```

What about this?



	A	B	C	D	E	F	G	H	I
1	ID	name	avocado	sex	percentTime	DOB	TOB	fee	
2	1	Joe <In the know> Schmo	1	1	0.1	2/29/1952	11:49:00 AM	11000	
3	2	Bill Hill	6.021E+23	1	0.2	1/1/1972	2:01:00 PM	10000	
4	3	Donna O'Fauna	6.02214E+23	2	0.3	6/8/1985	5:25:00 AM	9000	
5	4	Rob "Bob" Cobb	6.02214E+23	1	0.4	12/25/1964	1:23:00 AM	8000	
6	5	Tom Applebaum	6.02214E+23	1	0.5	3/15/1975	3:15:00 PM	7000	
7	6	Louise Mac&Cheese	6.02214E+23	2	0.6	6/5/2007	8:09:00 AM	6000	
8	7	Jack Black	6.02214E+23	1	0.7	11/11/2011	11:11:00 AM	5000	
9	8	Jill Hill	6.02214E+23	2	0.8	1/1/1972	2:04:00 PM	4000	
10	9	Gno Avocado	-3	1	0.9	4/1/1999	3:03:00 AM	3000	

Data in these forms leave us with questions

	A	B	C	D	E	F	G	H
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- Technical
  - How is sex coded? How is fee scaled? Is percent a proportion?
- “Business”
  - In what currency is fee? What does avocado mean?
- Discovery
  - Where do the data live? Who created? When? Where? Why?

These questions are addressed by **metadata**

- Data about data
  - Sometimes categorized as “Technical” and “Business”
  - Paper vs electronic
  - Structured vs unstructured

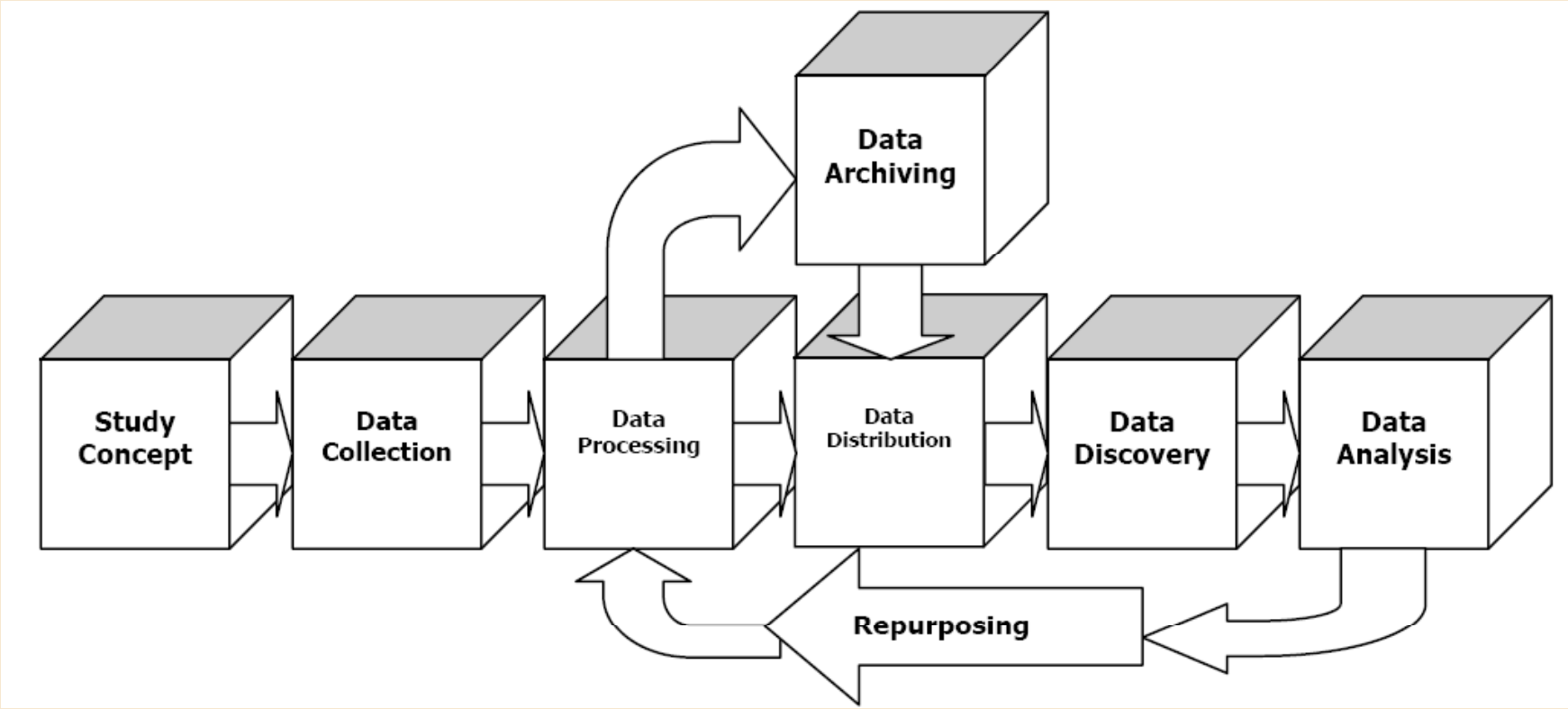
Machine Actionable **Metadata**

- Not just in machine readable format
- In a well defined structure
  - Could be XML or could be properties of objects
  - A program can use this information
  - Metadata can be used in various combinations
    - Presented as a codebook
    - Offered as a Web service

Data Documentation Initiative (DDI)
http://www.ddialliance.org/

- A standard for the compilation, presentation, and exchange of documentation for datasets in the social and behavioral sciences
- XML based
- Begun 1995, first public release 2000
- Version 3 planned for June
- Life-cycle of data - from conception to re-use
- Metadata and data can be included in the same file

Life Cycle of Data



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DDI Features

- Metadata capture from planning and production to dissemination and analysis
- An underlying data model that permits the expression of the model in alternative technologies
- Coverage of more of the data life cycle, with an emphasis on data collection
- Modular design
- Enhanced support for multiple languages
- Support for variable comparison and harmonization
- Structured mechanisms for identification and versioning that enable the creation of registries like question banks
- Core HTML for formatting of unstructured text

More DDI Features

- Elimination of redundancies through a new grouping model and an extensive set of reusable elements
- Grouping of study series for longitudinal and comparative research
- Capturing comparative information for the creation of harmonized data
- ISO/IEC 11179 compliant data registries such as question, variable, and concept banks
- Capability to create "DDI profiles" for specific uses
- Mechanism to carry data inline
- Alignment with other metadata standards, including Dublin Core (cross-domain information resource description), SDMX (time-series data), ISO/IEC 11179 (metadata registry), and FGDC and ISO 19115 (geographic standards)
- Extensibility

Central DDI Modules

Study Unit

- Identification
- Coverage
  - Topical
  - Temporal
  - Spatial
- Conceptual Components
  - Universe
  - Concept
  - Representation (optional replication)
- Purpose, Abstract, Proposal, Funding
- Identification is mapped to Dublin Core and basic Dublin Core is included as an option
- Geographic coverage mapped to FGDC
  - bounding box
  - spatial object
  - polygon description of levels and identifiers
- Universe Scheme, Concept Scheme
  - link of concept, universe, representation through Variable
  - also allows storage as a ISO/IEC 11179 compliant registry

Data Collection

- Methodology
- Question Scheme
  - Question
  - Response domain
- Instrument
- Coding Instructions
  - question to raw data
  - raw data to public file
- Question and Response Domain designed to support Question Banks
  - Question Scheme is a maintainable object
- Organization and flow of questions into Instrument
  - Used to drive CAI systems
- Coding Instructions
  - Reuse by Questions, Variables, and comparison

Physical Storage

- Physical Data Structure
  - Links to Data Relationships
  - Links to Variable or NCube Coordinate
  - **Description of physical storage structure**
    - fixed, delimited or proprietary
- Physical Instance
  - One-to-one relationship with a data file
  - Coverage constraints
  - **Variable and category statistics**
- Data set
  - **Inline data items**

Logical Product

- **Category Schemes**
- **Coding Schemes**
- **Variables**
- NCubes
- Variable and NCube Groups
- Data Relationships
- Used as both question response domains and variable representations
- Used as both question response domains and variable representations
- Link representations to concepts and universes through references
- Built from variables (dimensions and attributes)
  - Map directly to SDMX structures
  - More generalized to accommodate legacy data

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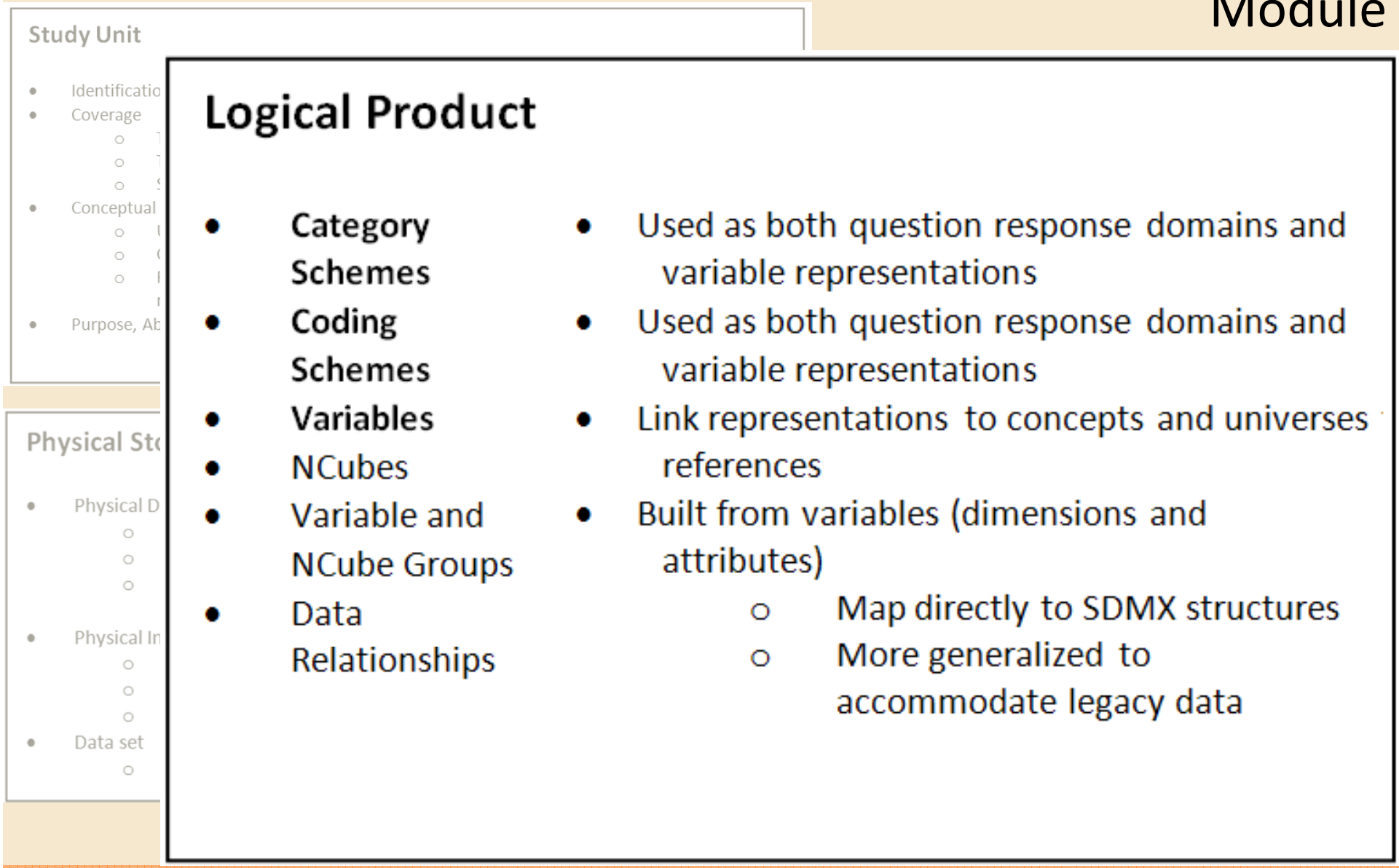
Logical Product Module



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From SAS Dataset to DDI File
Two Approaches

- Two approaches
  - DATA steps and PROCS wrapped in macros
  - Tagset for ODS (Output Delivery System)
    - User written
    - ODS with default tagset plus XSLT transformation
- Both need to gather metadata

From SAS Dataset to DDI File
Gathering the Metadata

- A SAS dataset contains data (of course)
- It also contains a mix of technical and business metadata
  - Labels: dataset and variables
  - Formats: **Links** to native and user formats
  - Integrity constraints

Join information from:

- DICTIONARY.COLUMNS
  - Name, length, type, Fmtname, informat, precision, scale, sortedby, idxusage, notnull
- PROC FORMAT, CNTLOUT dataset
  - Information from formats – ranges and labels
- Format documentation dataset (coded in program)
  - Represents e.g. Currency-euros
  - FormatDocumentation e.g. Writes numeric values with a leading euro symbol (E), a comma that separates every three digits, and a period that separates the decimal fraction
- Proc Contents
  - Integrity constraints – type, variables, whereClause, ForeignReference, OnDelete, OnUpdate
- DICTIONARY.CONSTRAINT_COLUMN_USAGE
  - ColumnName
- DICTIONARY.TABLES
  - Memlabel, crdate, modate, nobs, nvar,
- The dataset
  - data

Labels

- Dataset
  - mySASdata(label='Test Data for SAS to DDI 3 program')
- Variable
  - label avocado = 'Number of avacados';
  - label sex = 'Respondant''s Gender';
  - label percentTime = 'Percent of time counting Avacados';
  - label fee = 'Fee in Euros';

Formats – native SAS format

- format percentTime percent8.1;
  - **A proportion to be displayed as a percent**
- format fee EUROX10.2;
  - **Also tells us fee is in Euros**
- format DOB IS8601DA.;
  - **Number of days since January 1, 1960**
- format TOB IS8601TM.;
  - **Seconds since midnight of the current day**

Formats - user

- format avocado avocadoNumber.;

```
value avocadoNumber
 low-<0 = 'avocados owed'
 1 = 'lonley avocado'
 1<-6.02214149e23 = 'too few avocados'
 6.02214149e23-6.02214209e23 = 'guaca mole'
 6.02214209e23<-high = 'a party';
```

Labels ranges of data

(tells us someone likes a bad pun)

Formats – there might also be extraneous user formats

```
value sexAll
  0 = 'Young Male'
  1 = 'Adult Male'
  2 = 'Young Female'
  3 = 'Adult Female'
  ;

  value sex
  0 = 'Male'
  1 = 'Male'
  2 = 'Female'
  3 = 'Female'
  ;
                        /* format BMI is not used and is here to be ignored later */
value BMI
   low-<18.5 =  "Underweight"
   18.5-24.9 =  "Normal weight"
   25-29.9 =  "Overweight"
   30-high =  "Obesity";
```

Integrity Constraints

add constraint prim_key **Primary key**(id)

add constraint DOB_present **Not Null**(DOB)

add constraint id_GT_0 check(**id GT 0**)

gives us information about valid range

add constraint sex_MF check(**sex in (.,1,2)**)

add constraint avocado_unique **Unique**(avocado)

add constraint name_fkey foreign key(name)

references work.RealPeople

valid values come from another table

Data Step Approach

- XML is just text
- Data step can write text to a file
- Static XML structure, known schema
- Content from SAS variables

“Non Technical” Metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<ns1:DDIInstance xmlns:r="ddi:reusable:3_0_CR"      ........>
   <r:MaintainableID>
            <r:ID>testDDIFromSAS</r:ID>
   </r:MaintainableID>
   <r:Citation>
      <r:Title>DDI file from SAS dataset </r:Title>
      <dce:DCElements>
         <dc:title>DDI file from SAS dataset </dc:title>
      </dce:DCElements>
   </r:Citation>

   <s:StudyUnit>
      <r:MaintainableID><r:ID>StudyUnit_001</r:ID>
         <r:Version>1.0</r:Version>
         <r:VersionResponsibility>IPSR - The University of Kansas</r:VersionResponsibility>
      </r:MaintainableID>
```

Can be lots more, including extensive explanatory text

Technical Metadata

```
<l:Variable>
        <r:IdentifiableID><r:ID>ID</r:ID><r:Name>ID</r:Name></r:IdentifiableID>
            <r:Label>Identification Number</r:Label>
            <l:VariableDefinition> SAS varnum: 1
                                   SAS idxusage SIMPLE
                                   SAS transcode: yes
                                   SAS Integrity Constraints: Check(Where ID>0)
                                   Primary Key(Variables ID) </l:VariableDefinition>
            <l:ConceptReference><r:Reference><r:ID>ID</r:ID></r:Reference>
           </l:ConceptReference>
            <l:Representation >
                <l:NumericRepresentation type="Double"></l:NumericRepresentation>
            </l:Representation>
 </l:Variable>
```

This identifier complexity allows for generating a URN which can be referenced in a global metadata structure

Metadata – implied from format

```
<l:Variable>
    <r:IdentifiableID><r:ID>fee</r:ID><r:Name>fee</r:Name></r:IdentifiableID>
    <r:Label>Fee in Euros</r:Label>
    <l:VariableDefinition> SAS varnum: 9
                           SAS format: EUROX10.2
                           SAS transcode: yes </l:VariableDefinition>
   <l:ConceptReference><r:Reference><r:ID>fee</r:ID></r:Reference>
    </l:ConceptReference>

    <l:Representation measurementUnit="Currency-euros" >
        <l:Role> SAS format indicates: Writes numeric values with a
                 leading euro symbol (E), a period that separates
                 every three digits, and a comma that separates
                 the decimal fraction</l:Role>
        <l:NumericRepresentation type="Double"></l:NumericRepresentation>
   </l:Representation>
</l:Variable>
```

Data can be written in the XML too

```
<ds:ItemValue>
    <ds:VariableReference>
        <r:Reference>
            <r:ID>fee</r:ID>
        </r:Reference>
    </ds:VariableReference>
    <ds:Value>9000 </ds:Value>
</ds:ItemValue>
```

User Written Tagset

- Extension of Output Delivery System (ODS) by user-defined tagsets
- Output in ODS as a stream of events
- Capture of events, triggering of specific action
- User-defined tagset defines template definitions for a target format
- User-defined tagsets can be added to existing SAS ODS tagsets

Tagset – SAS Events can trigger user events

```
define event doc ;
        start:
                trigger _parameter ;
                trigger _head ;
                trigger _DDIInstance start ;
        finish:
                trigger _DDIInstance finish ;
                putlog '      DDI file written: ' BODY_NAME ;
 end ;
```

Tagset - User Defined Events

```
define event _DDIInstance ;
    start:
        put '<ddi:DDIInstance';
        put ' xsi:schemaLocation="ddi:instance:' $ddi_version ' instance.xsd"' ;

        • • •      '>' ;
        ndent ;
        putl '<r:MaintainableID>' ;
        ndent ;
        putl '<r:ID>XX</r:ID>' ;
        xdent ;
        putl '</r:MaintainableID>' ;
        trigger _StudyUnit start ;
    finish:
        trigger _StudyUnit finish ;
        xdent ;
        putl '</ddi:DDIInstance>' ;
     end ;
```

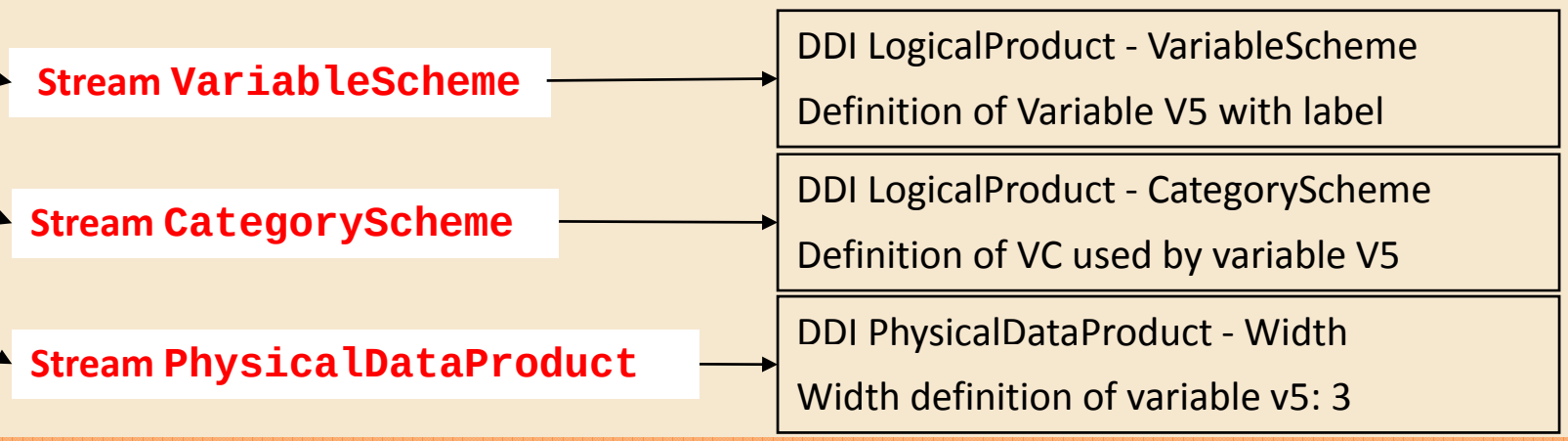
```
<ddi:DDIInstance
xsi:schemaLocation="ddi:instance:3_0_CR
instance.xsd" xmlns:a=
                ....
>
 <r:MaintainableID>
  <r:ID>XX</r:ID>
 </r:MaintainableID>
 <s:StudyUnit>
  <r:MaintainableID>
   <r:ID>XX</r:ID>
  </r:MaintainableID>
```

Tagset Streams

The CONTENTS Procedure

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
1	V1	Num	4		ZA Study Number
2	V2	Num	6		Respondent Number
3	V3	Num	3	VA.	Country
4	V4	Num	3	VB.	Good citizen: Always vote in elections
	event row				
5	**V5**	**Num**	**3**	**VC.**	**Good citizen: Never try to evade taxes**



Row event triggers a cascade of events writing to multiple streams

```
define event row ;
        start:
           break / if ^cmp( section, 'body' ) ;
           do /if cmp( $proc, 'Contents' ) ;
              do / if cmp( $leaf, 'Attributes' ) ;
            break ;
                 ndent ;
                 putl '<OneAttribute>' ;
              else / if cmp( $leaf, 'EngineHost' ) ;
            break ;
                 ndent ;
                 putl '<OneEngineHost>' ;
              else / if cmp( $leaf, 'Variables' ) ;
                        trigger _master_variable start ;
              done ;
           else ;
              break ;
           done ;
```

```
define event _master_variable ;
    start:
            trigger _Concept start ;
            trigger _Variable start ;
```

Here the <l:Variable> element is written

```
define event _Variable ;
    start:
        flush ;
        open LogicalProduct ;
        putl '<l:Variable>' ;
        flush ;
        close ;
    finish:
        flush ;
        open LogicalProduct ;
        ndent ;
        putl '<r:IdentifiableID>' ;
        ndent ;
        put '<r:ID>Variable_' ;
        put $variable_name ;
        putl '</r:ID>' ;
        put '<r:Name>' ;
        put $variable_name ;
        putl '</r:Name>' ;
        xdent ;
        putl '</r:IdentifiableID>' ;
        put '<r:Label>' ;
        put $variable_label ;
        putl '</r:Label>' ;
        putl '<l:ConceptReference>' ;
        ndent ;
        putl '<r:Reference>' ;
        ndent ;
        put '<r:ID>Concept_' ;
        put $variable_name ;
        putl '</r:ID>' ;
        xdent ;
        putl '</r:Reference>' ;
        xdent ;
        putl '</l:ConceptReference>' ;
        xdent ;
        putl '</l:Variable>' ;
        flush ;
        close ;
end;
```

```
<l:Variable>
  <r:IdentifiableID>
    <r:ID>Variable_V3</r:ID>
    <r:Name>V3</r:Name>
  </r:IdentifiableID>
  <r:Label>Country</r:Label>
  <l:ConceptReference>
    <r:Reference>
      <r:ID>Concept_V3</r:ID>
    </r:Reference>
  </l:ConceptReference>
</l:Variable>
```

Outputting the Streams

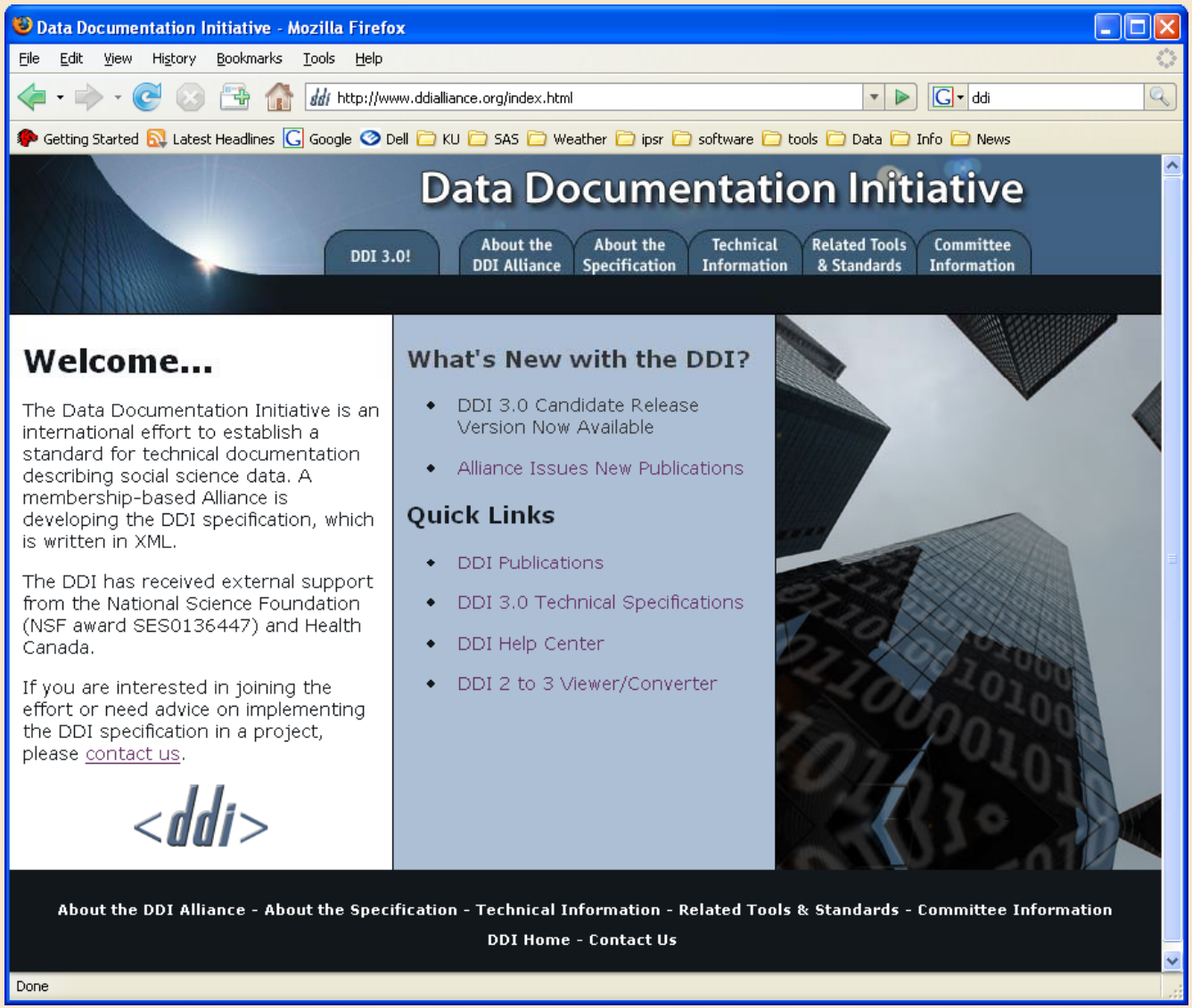
```
define event _StudyUnit ;
        …
            finish:
                    trigger _ConceptualComponent finish ;
                    putstream ConceptualComponent ;
                    delstream ConceptualComponent ;
                    trigger _LogicalProduct finish ;
                    putstream LogicalProduct ;
                    delstream LogicalProduct ;
      xdent ;
                    putl '</s:StudyUnit>' ;
    end;
```

Using the Tagset

```
/* specifiying the DDI tagset as ODS destination and opening a file */
ods tagsets.DDI file='ddi.xml' encoding='utf-8';

proc contents data=library.mySASdata;
run;
proc report data=userFormats;
run;
proc freq data=library.mySASdata;
run;
/* closing the ODS destination for DDI */
ods tagsets.DDI close;
```

http://www.ddialliance.org/index.html



Questions?

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- Germany
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- www.gesis.org