Microsoft

SpreadsheetML Basics

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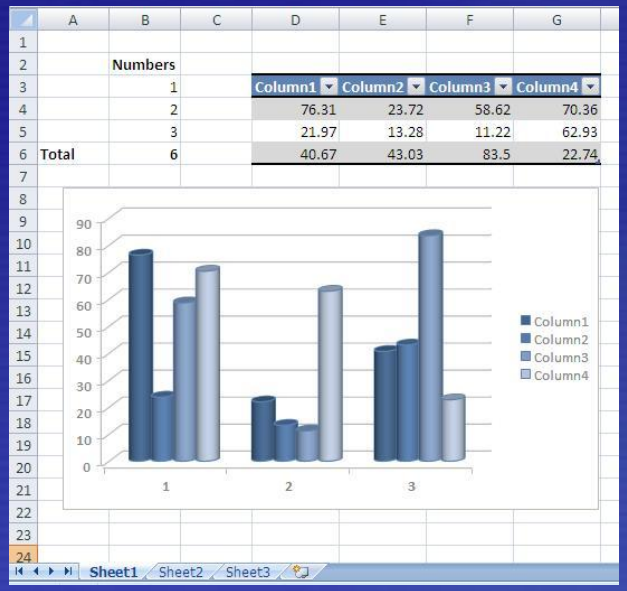
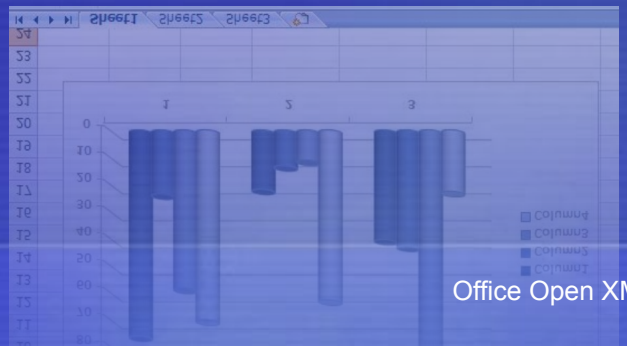
Objectives

- This module covers the core concepts underlying all SpreadsheetML documents:
  - Workbook Architecture
  - Anatomy of an XLSX
  - Rows, columns, values, formulas
  - Strings: inline plain text, rich text, shared strings
  - Formatting Options
  - Calculation Chain

SpreadsheetML





Workbook

- properties
- styles
- sharedStrings
- calcChain
- sheet1..N
  - table
  - chart
    - drawing

SpreadsheetML Design Goal: Performance

SpreadsheetML has been optimized in many ways, based on analysis of real-world spreadsheet usage patterns:

- Small tag size (often a single character)
- Shared strings
- Shared formulas
- Sparse table markup allowed
- Optional r="A1" attribute for faster loading

The minimal XLSX

- Required: **workbook.xml**, the document "start part"
- Required: at least one sheet, **worksheet.xml**
- Required: one relationship part (**.rels**)
  - Must be in a **_rels** folder
- Required: **[Content_Types].xml**
  - Required part for all Open XML documents
  - *Three* content types must be defined:
    - SpreadsheetML main document (for the start part)
    - Worksheet
    - Package relationships (for the required relationships)
- Everything else is optional
  - Worksheet **<sheetdata>** is required, but may be empty

Minimal Workbook/Worksheet

workbook.xml:

```
<workbook>
   <sheets>
    <sheet name="Sheet1" sheetId="1" r:id="rId1"/>
   </sheets>
</workbook>
```

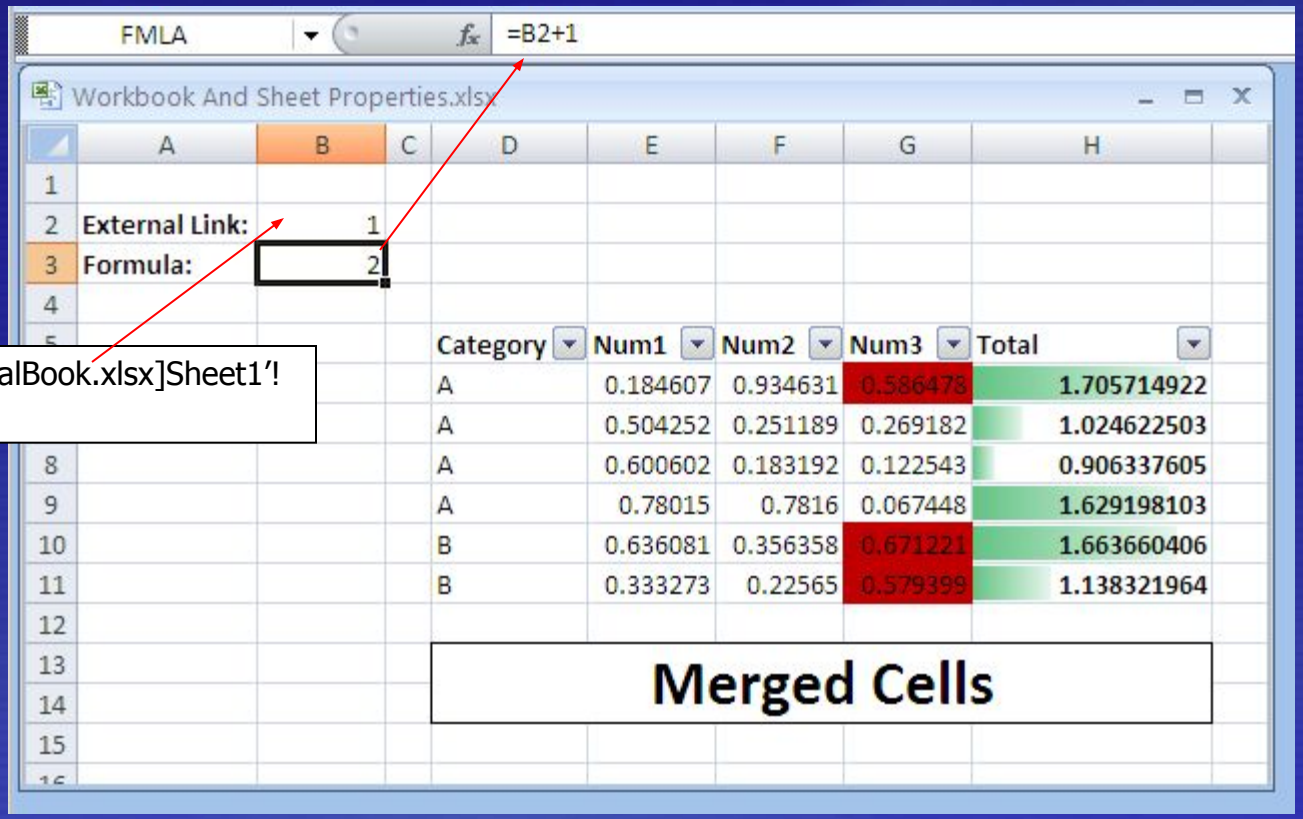
sheet1.xml:


```
<worksheet>
   <sheetData/>
</worksheet>
```

DEMO

SHEETS

Sample Sheet



Worksheet Part – Main Sections

1. Sheet properties (everything before sheetData)
   - Viewing: selected tab, active cell, etc.
   - Print options: orientation, resolution, page margins, etc.
   - Miscellaneous: default row height, sheet protection, etc.

2. The cell table (sheetData, empty if not a worksheet)
   - Row, cells, values, strings (shared-strings indexes), formulas

Sheet Properties

```
<worksheet>
    <sheetPr filterMode="1"/>
    <dimension ref="A2:H14"/>
    <sheetViews>
        <sheetView tabSelected="1" workbookViewId="0">
            <selection activeCell="B3" sqref="B3"/>
        </sheetView>
    </sheetViews>
    <sheetFormatPr defaultRowHeight="15"/>
    <cols>
        <col min="1" max="1" width="12.85546875" bestFit="1" customWidth="1"/>
        <col min="3" max="3" width="3.28515625" customWidth="1"/>
        <col min="4" max="4" width="11.140625" bestFit="1" customWidth="1"/>
        <col min="8" max="8" width="17.140625" style="1" customWidth="1"/>
    </cols>
    <sheetData/>
    <sheetProtection objects="0" scenarios="0"/>
    <printOptions/>
    <pageMargins left="0.7" right="0.7" top="0.75" bottom="0.75" header="0.3"
footer="0.3"/>
    <pageSetup orientation="portrait" horizontalDpi="300" verticalDpi="300"/>
    <headerFooter/>
</worksheet>
```

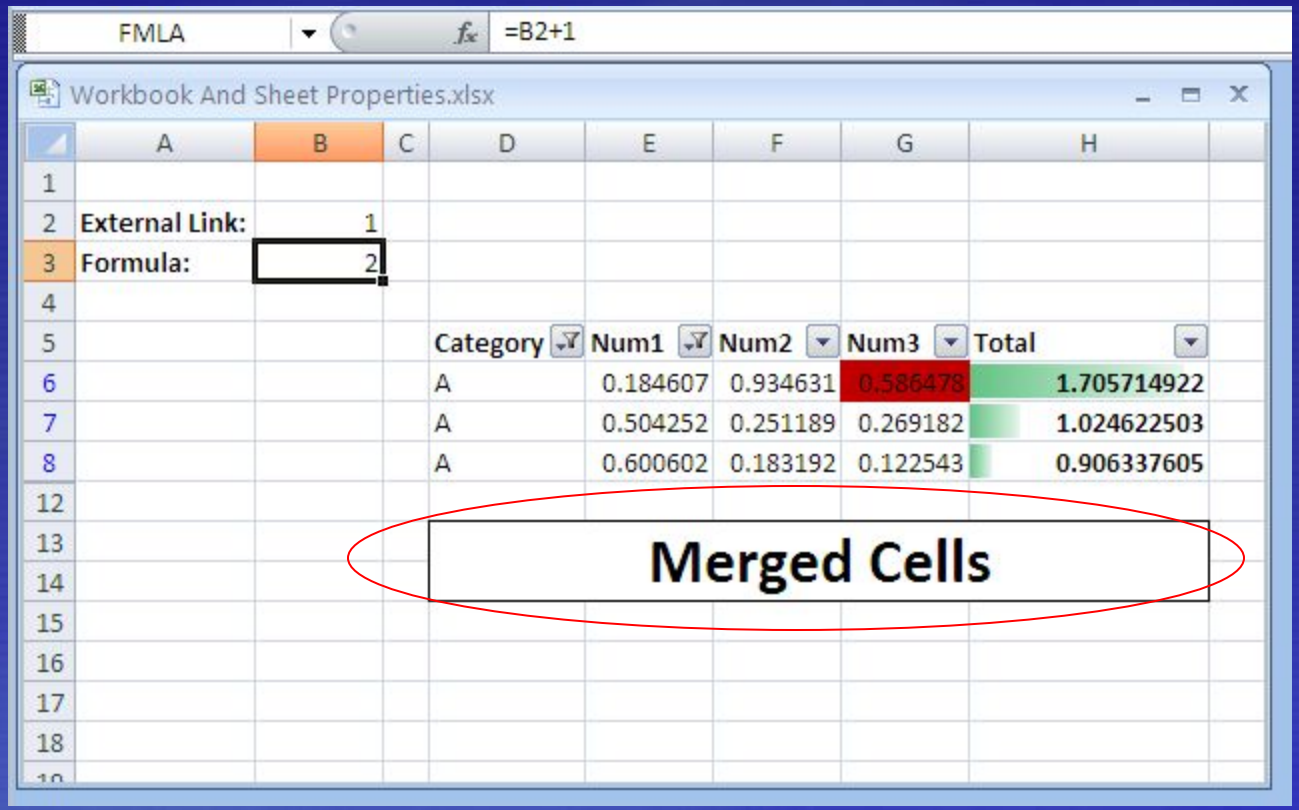
Cell Table: <sheetData> element

```
<row r="7" spans="4:8">
    <c r="D7" t="s">
        <v>2</v>
    </c>
    <c r="E7">
        <v>0.50425224796279555</v>
    </c>
    <c r="F7">
        <v>0.25118866081991786</v>
    </c>
    <c r="G7">
        <v>0.26918159410869791</v>
    </c>
    <c r="H7" s="1">
        <f t="shared" ref="H7:H11" ce="1" si="0">SUM(
        <v>1.0246225028914113</v>
    </c>
```

```
<row r="8" spans="4:8">
    <c r="D8" t="s">
        <v>2</v>
    </c>
    <c r="E8">
        <v>0.6006019062877066</v>
    </c>
    <c r="F8">
        <v>0.18319235857964333</v>
    </c>
    <c r="G8">
        <v>0.12254334000604317</v>
    </c>
    <c r="H8" s="1">
        <f t="shared" ce="1" si="0">SUM(E8:G8)</f>
        <v>0.9063376048733931</v>
    </c>
```

mergeCells

```
<worksheet>
    <sheetData/>
        <mergeCells>
            <mergeCell ref="D13:H14"/>
        </mergeCells>
```



The Sheet-Level Pieces

- Comments
- Formulas & References & Defined Names
- Tables
- AutoFilter
- External Links
  - General
  - Special Directory Relationships
- PivotTable
  - PivotTable
  - PivotCache
- QueryTable
- Metadata

WORKBOOK PROPERTIES

Workbook Properties: Elements

- <fileVersion>
- <workbookPr>
- <calcPr>
- <bookViews>
- <sheets>

```
<workbook>
    <fileVersion lastEdited="4" lowestEdited="4" rupBuild="3814"/>
    <workbookPr backupFile="1" saveExternalLinkValues="0" updateLinks="never"/>
    <calcPr calcId="122211" calcMode="manual" iterate="1"/>
    <bookViews>
        <workbookView showHorizontalScroll="0" showVerticalScroll="0"
showSheetTabs="0" xWindow="45" yWindow="15" windowWidth="9420"
windowHeight="5460" tabRatio="701"/>
    </bookViews>
    <sheets>
        <sheet name="Sheet1" sheetId="1" sh:id="rId1"/>
        <sheet name="Sheet2" sheetId="2" sh:id="rId2"/>
        <sheet name="Sheet3" sheetId="3" sh:id="rId3"/>
    </sheets>
</workbook>
```

STRINGS

Strings in SpreadsheetML

Two ways a string can be stored:

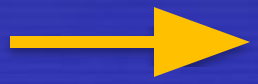
1. Inline strings
   - Provided for ease of translation/conversion
   - Useful in XSLT scenarios
   - Excel and other consumers may convert to shared strings
2. An entry in the shared-strings table
   - May be either a simple string or formatted text

- These approaches may be mixed/combined

Inline Strings

- Inline string support provides a very simple mechanism for programmatically populating a worksheet
- Especially useful in XSLT scenarios
- Excel 2007 converts to shared strings on save
  - If you're consuming Open XML documents, you must handle both cases: inline strings and/or shared strings
- To convert our shared-strings example to inline strings, just replace sheetdata:

```
<sheetData>
  <row><c t="inlineStr"><is><t>Paris</t></is></c></row>
  <row><c t="inlineStr"><is><t>Seattle</t></is></c></row>
  <row><c t="inlineStr"><is><t>London</t></is></c></row>
  <row><c t="inlineStr"><is><t>Copenhagen</t></is></c></row>
  <row><c t="inlineStr"><is><t>Paris</t></is></c></row>
  <row><c t="inlineStr"><is><t>London</t></is></c></row>
</sheetData>
```



	A
1	Paris
2	Seattle
3	London
4	Copenhagen
5	Paris
6	London

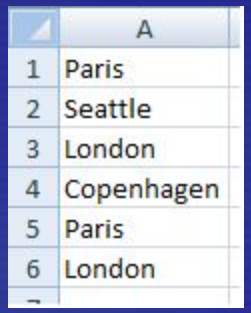
Shared Strings

- By default, strings are stored in a shared-strings part:
  - Each unique string is stored once
  - Cells store the index (0-based) of the string
- This design is based on analysis of typical spreadsheet contents: highly repetitive strings are very common

- Benefits:
  - Users: reduced file size, improved performance
  - Developers: all strings are in one part, simplifying search, localization, and other common string-handling objectives

Shared Strings: example

Worksheet contents:



	A
1	Paris
2	Seattle
3	London
4	Copenhagen
5	Paris
6	London

sharedStrings.xml contents:

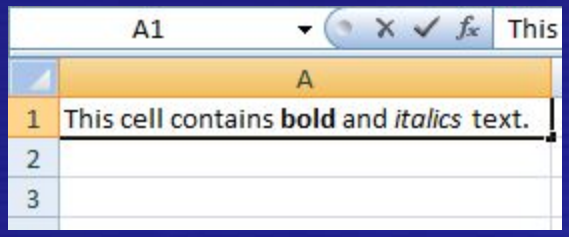
```
<sst xmlns="..." count="6" uniqueCount="4">
  <si>
    <t>Paris</t>
  </si>
  <si>
    <t>Seattle</t>
  </si>
  <si>
    <t>London</t>
  </si>
  <si>
    <t>Copenhagen</t>
  </si>
</sst>
```

6 string references,
4 unique strings

Paris = string 0

```
<row r="1" spans="1:1">
  <c r="A1" t="s">
    <v>0</v>
  </c>
</row>
```

Rich Text Strings



- Stored in sharedStrings.xml
- *One* entry for the entire cell
- Note run properties **<rPr>**

- Cell refers to string 0:

```
<row r="1" spans="1:1">
  <c r="A1" t="s">
    <v>0</v>
  </c>
</row>
```

```
<sst xmlns="..." count="1" uniqueCount="1">
 <si>
  <r>
   <t xml:space="preserve">This cell contains </t>
  </r>
  <r>
   <rPr>
    <b/>
    <sz val="11"/>
    <color theme="1"/>
    <rFont val="Calibri"/>
    <family val="2"/>
    <scheme val="minor"/>
   </rPr>
   <t>bold</t>
  </r>
  <r>
   <t xml:space="preserve"> and </t>
  </r>
  <r>
   <rPr>
    <i/>
    <sz val="11"/><color theme="1"/>
    <rFont val="Calibri"/>
    <family val="2"/>
    <scheme val="minor"/>
   </rPr>
   <t>italics</t>
  </r>
  <r>
   <t xml:space="preserve"> text.</t>
  </r>
 </si>
</sst>
```

FORMATTING

SpreadsheetML Formatting Options

- Direct Cell Formatting (XF)
  - Fonts
  - Fills
  - Borders
  - Numeric Formatting
- Cell Styles
- Table Styles
- PivotTable Styles

Direct Formatting

```
<styleSheet>
    <fonts count="2">
        <font>
            <sz val="11"/>
            <color theme="1"/>
            <name val="Calibri"/>
            <scheme val="minor"/>
        </font>
        <font>
            <b/>
            <sz val="11"/>
            <color theme="1"/>
            <name val="Calibri"/>
            <family val="2"/>
        </font>
    </fonts>
    <fills count="2">
        <fill>
            <patternFill patternType="none"/>
        </fill>
        <fill>
            <patternFill patternType="gray125"/>
        </fill>
    </fills>
    <borders count="1">
        <border>
            <left/>
            <right/>
            <top/>
            <bottom/>
            <diagonal/>
        </border>
    </borders>
    <cellStyleXfs count="1">
        <xf numFmtId="0" fontId="0" fillId="0" borderId="0"/>
    </cellStyleXfs>
    <cellXfs count="2">
        <xf numFmtId="0" fontId="0" fillId="0" borderId="0" xfId="0"/>
        <xf numFmtId="0" fontId="1" fillId="0" borderId="0" xfId="0" applyFont="1"/>
    </cellXfs>
    <cellStyles count="1">
        <cellStyle name="Normal" xfId="0" builtinId="0"/>
    </cellStyles>
</styleSheet>
```

	A	B
1		Numbers
2		1
3		2
4		3
5	Total	6

```
<sheetData>
    <row r="1" spans="1:2">
        <c r="B1" s="1" t="s">
            <v>0</v>
        </c>
    </row>
    <row r="2" spans="1:2">
        <c r="B2">
            <v>1</v>
        </c>
    </row>
    <row r="3" spans="1:2">
        <c r="B3">
            <v>2</v>
        </c>
    </row>
    <row r="4" spans="1:2">
        <c r="B4">
            <v>3</v>
        </c>
    </row>
    <row r="5" spans="1:2">
        <c r="A5" s="1" t="s">
            <v>1</v>
        </c>
        <c r="B5">
            <f>SUM(B2:B4)</f>
            <v>6</v>
        </c>
    </row>
</sheetData>
```

DEMO

Applying Cell, Table, PivotTable Styles

- Referenced by Name
- Explicit formatting is described using formatting records (xf)

FORMULAS AND CALC CHAIN

Formulas, References, Defined Names

- Excel saves out exactly what you see in the cell at runtime.
- Implication: Excel re-parses the formula on load, and serializes it on save

- Formula links to external workbooks:
  - Abstract file path to relationships part
  - Excel caches snapshot of external workbook structure (sheets & cell tables)

Formulas: example

```
<row>
  <c>
    <v>1</v>
  </c>
</row>
<row>
  <c>
    <v>2</v>
  </c>
</row>
<row>
  <c>
    <v>3</v>
  </c>
</row>
<row>
  <c>
    <f>SUM(A1:A3)</f>
  </c>
</row>
```

DEMO

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