

Standardization of Reporting Digits: Significant Vs. Rounding

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ABSTRACT

In clinical reporting one of the key components to standardize them is to make sure the digits values are presented with outlined formats as per specification documents on digits reporting and the mock shells. In order to achieve this objective various SAS® methodological techniques are incorporated in our reporting algorithms which are dictated by digits rounding rules define in your specification document. As such this paper outlines such rules for significant digits reporting, rounding and further presents various scenarios case by case to differentiate between actual value Vs. transformed value after we apply the specific digits rules for various reporting needs such as Summary Reports and Listings incorporating SAS9 functions and techniques within our programming algorithms to achieve this reporting objective. ROUND function is used to round a numeric variable to the nearest round-off unit. Based on the round-off unit, only the integer or decimal part can be rounded. Round-off unit will be same for all the records of the variable. We would also discuss about how to apply a different rounding (round-off unit) for each record of the same numeric variable when a variable with the rounding (significant) values exist.

INTRODUCTION

Presenting information in a way that's understood by the audience is fundamentally important to anyone's job. Once you collect your data and understand its structure, you need to be able to report and summarize your findings effectively and efficiently. For any submission or reporting event internally to a company or an external regulatory agency, every component of reporting is based on a standard set of rules and procedure to be followed up. One of such components we want to discuss in details in this paper is to establish a standard process of reporting on details reports or listings, summary reports. To achieve this objective first we need to understand on what set of specification rules we need to follow specific to summary results reporting and on the same lines for listing reports. Before we get in details on the reporting process, let's understand on background of rounding and significant digits concepts in general.

Rounding: We always want to keep two things in mind when we round any number. The first is what we are rounding to. The second thing to keep in mind is the method we are using to round by. In your problem that is the nearest method. In the nearest method we look at the digit to the immediate right of the digit we will round to (so for this example we will look at the hundredths digit), and if it is a five or greater (5 through 9) we round up (add 1 to the digit we are rounding and drop all the digits to the right). If the digit to the right of our rounding digit is less than 5 (0 through 4) we round down (drop all digits to the right of digit we are rounding).

Significant Digits: The number of significant figures in a result is simply the number of figures that are known with some degree of reliability. The number 13.2 is said to have 3 significant figures. The number 13.20 is said to have 4 significant figures.

Illustration of Rounding Decimals

First you need to know if you are rounding to tenths, or hundredths, etc. or maybe to "so many decimal places". That tells you how much of the number will be left when you finish.

Examples

3.1416 rounded to hundredths is 3.14 because the next digit (1) is less than 5
 1.2635 rounded to tenths is 1.3 because the next digit (6) is 5 or more
 1.2635 rounded to 3 decimal places is 1.264 because the next digit (5) is 5 or more

Illustration of Rounding Whole Numbers

You may want to round to tens, hundreds, etc, In this case you replace the removed digits with zero.

Examples

134.9 rounded to tens is 130 because the next digit (4) is less than 5
 12,690 rounded to thousands is 13,000 because the next digit (6) is 5 or more
 1.239 rounded to units is 1 because the next digit (2) is less than 5

Illustration of Rounding to Significant Digits

To round "so many" significant digits, just count that many from left to right, and then round off from there. (Note: if there are leading zeros such as 0.009, don't count them because they are only there to show how small the number is).

Examples

1.239 rounded to 3 significant digits is 1.24 because the next digit (9) is 5 or more
 134.9 rounded to 1 significant digit is 100 because the next digit (3) is less than 5
 0.0165 rounded to 2 significant digits is 0.017 because the next digit (5) is 5 or more

REPORTING SPECIFICATION FOR SUMMARY REPORTS AND LISTING

| For Summary Reports | |
|---------------------------------|-----------------------------|
| Statistics | Significant/Rounding Method |
| N: | Actual number |
| Mean: | 3 Significant Digits |
| Median: | 4 Significant Digits |
| Standard Deviation: | 5 Significant Digits |
| Min: | 3 Significant Digits |
| Max: | 3 Significant Digits |
| | |
| For Listings Reports | |
| For Individual Reporting Values | 1 Decimal Place |

PROGRAMMING STEPS

- 1) Compile the summary or listing data to be used for transformation which are outlined in SUMM and LIST datasets outlined below
- 2) Update the MASTER dataset to contain the required rounding or significant methods and their respective rounding values as per the specification of the study used for reporting
- 3) Merge the required SUMM or LIST dataset based on the reporting needs with respect to MASTER dataset and keep the required records, which will output SUMM_COMB or LIST_COMB datasets
- 4) Input the processed dataset SUMM_COMB or LIST_COMB to the transformation macro defined below to apply the significant or rounding rules to the respective actual results to obtain the desired transformed results which have been outlined as SUMM_COMB_OUT or LIST_COMB_OUT datasets below.

Sample Data used for Summary Presentation in its actual form before transformation:

Dataset Name: SUMM

| Report Used For | Lab Test Name | Visit | Visit Number | Statistic Type | Actual Summary Result |
|-----------------|---------------|----------|--------------|----------------|-----------------------|
| REPORT | LAB_TEST | Visit | VISIT_NO | TYPE | ACT_RSLT |
| SUMMARY | CALCIUM | Baseline | 0 | N | 7 |
| SUMMARY | CALCIUM | Baseline | 0 | MEAN | 12.25142857 |
| SUMMARY | CALCIUM | Baseline | 0 | MEDIAN | 8.36 |
| SUMMARY | CALCIUM | Baseline | 0 | STD | 10.86596434 |
| SUMMARY | CALCIUM | Baseline | 0 | MIN | 5.92 |
| SUMMARY | CALCIUM | Baseline | 0 | MAX | 36.76 |
| SUMMARY | CALCIUM | Day 1 | 1 | N | 8 |
| SUMMARY | CALCIUM | Day 1 | 1 | MEAN | 12.6125 |
| SUMMARY | CALCIUM | Day 1 | 1 | MEDIAN | 9.26 |
| SUMMARY | CALCIUM | Day 1 | 1 | STD | 10.14943735 |
| SUMMARY | CALCIUM | Day 1 | 1 | MIN | 7.8 |
| SUMMARY | CALCIUM | Day 1 | 1 | MAX | 37.64 |
| SUMMARY | CALCIUM | Day 7 | 2 | N | 5 |
| SUMMARY | CALCIUM | Day 7 | 2 | MEAN | 14.524 |
| SUMMARY | CALCIUM | Day 7 | 2 | MEDIAN | 9.2 |
| SUMMARY | CALCIUM | Day 7 | 2 | STD | 12.37292528 |
| SUMMARY | CALCIUM | Day 7 | 2 | MIN | 8.48 |
| SUMMARY | CALCIUM | Day 7 | 2 | MAX | 36.64 |

Master Dataset which will be used for transformation for Significant Digits and Rounding of Actual Results either for summary reporting or listing

Dataset Name: MASTER

| Lab Test Name | Report Used For | Report Used For Numeric | Statistic Type | Statistic Type Numeric | Significant/Round Method | Significant/Rounding Value |
|---------------|-----------------|-------------------------|----------------|------------------------|--------------------------|----------------------------|
| LAB_TEST | REPORT | REPORTN | TYPE | TYPEN | METHOD | VALUE |
| CALCIUM | SUMMARY | 1 | N | 0 | NONE | |
| CALCIUM | SUMMARY | 1 | MEAN | 1 | SIG | 3 |
| CALCIUM | SUMMARY | 1 | MEDIAN | 2 | SIG | 4 |
| CALCIUM | SUMMARY | 1 | STD | 3 | SIG | 5 |
| CALCIUM | SUMMARY | 1 | MIN | 4 | SIG | 3 |
| CALCIUM | SUMMARY | 1 | MAX | 5 | SIG | 3 |
| CALCIUM | LISTING | 2 | ACTUAL | 9 | RND | 1 |

Sample Data used for Listing Presentation in its actual form before transformation:

Dataset Name: LIST

| Subject ID | Lab Test Name | Visit Number | Visit | Actual Result | Report Used For | Statistic Type |
|------------|---------------|--------------|----------|---------------|-----------------|----------------|
| ID | lab_test | visit_no | visit | ACT_RSLT | Report | type |
| 1 | CALCIUM | 0 | Baseline | 9.6 | LISTING | ACTUAL |
| 1 | CALCIUM | 1 | DAY 7 | 10 | LISTING | ACTUAL |
| 1 | CALCIUM | 2 | DAY 14 | 9.2 | LISTING | ACTUAL |
| 2 | CALCIUM | 0 | Baseline | 8 | LISTING | ACTUAL |
| 2 | CALCIUM | 1 | DAY 7 | 10.3 | LISTING | ACTUAL |
| 2 | CALCIUM | 2 | DAY 14 | 9.7 | LISTING | ACTUAL |
| 3 | CALCIUM | 0 | Baseline | 8.84 | LISTING | ACTUAL |
| 3 | CALCIUM | 1 | DAY 7 | 9.12 | LISTING | ACTUAL |
| 4 | CALCIUM | 0 | Baseline | 8.36 | LISTING | ACTUAL |
| 4 | CALCIUM | 1 | DAY 7 | 8.32 | LISTING | ACTUAL |
| 4 | CALCIUM | 2 | DAY 14 | 8.48 | LISTING | ACTUAL |
| 5 | CALCIUM | 0 | Baseline | 5.92 | LISTING | ACTUAL |
| 5 | CALCIUM | 1 | DAY 7 | 7.8 | LISTING | ACTUAL |
| 6 | CALCIUM | 0 | Baseline | 8.28 | LISTING | ACTUAL |
| 6 | CALCIUM | 1 | DAY 7 | 8.32 | LISTING | ACTUAL |
| 7 | CALCIUM | 0 | Baseline | 36.76 | LISTING | ACTUAL |
| 7 | CALCIUM | 1 | DAY 7 | 37.64 | LISTING | ACTUAL |
| 7 | CALCIUM | 2 | DAY 14 | 36.64 | LISTING | ACTUAL |
| 8 | CALCIUM | 1 | DAY 7 | 9.4 | LISTING | ACTUAL |
| 8 | CALCIUM | 2 | DAY 14 | 8.6 | LISTING | ACTUAL |

TRANSFORMATION MACRO

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/*****
%MACRO TRANSFORM(INDSN =, OUTDSN =);

DATA &OUTDSN.;
SET &INDSN.;
IF REPORT = "SUMMARY" THEN DO;
  IF METHOD = "NONE" THEN DO;
    TFM_RSLT = ACT_RSLT;
  END;
  IF METHOD = "SIG" THEN DO;
    IF INT(ACT_RSLT) NE 0 THEN DO;
      TFM_RSLT=ROUND(ACT_RSLT,10**(INT(LOG10(ABS(ACT_RSLT)))-(VALUE -1)));
    END;
  ELSE DO;
    TFM_RSLT=ROUND(ACT_RSLT,10**(-1*(ABS(INT(LOG10(ABS(ACT_RSLT))))+VALUE)));
  END;
END;

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    END;
  END;
  IF REPORT = "LISTING" THEN DO;
    IF METHOD = "RND" THEN DO;
      TFM_RSLT = ROUND(ACT_RSLT, 1/10**VALUE);
    END;
  END;
  RUN;

%MEND;
/***** SUMMARY STATISTICS REPORTING PROCESS *****/

PROC SORT DATA = SUMM;
  BY LAB_TEST TYPE;
  RUN;

PROC SORT DATA = MASTER;
  BY LAB_TEST TYPE;
  RUN;

PROC SQL;
  CREATE TABLE SUMM_COMB AS
  SELECT *
  FROM SUMM A, MASTER B
  WHERE A.LAB_TEST = B.LAB_TEST AND A.TYPE = B.TYPE;
  QUIT;
%TRANSFORM(INDSN = SUMM_COMB, OUTDSN = SUMM_COMB_OUT);

/***** LISTING REPORTING PROCESS *****/

PROC SORT DATA = LIST;
  BY LAB_TEST TYPE;
  RUN;

PROC SORT DATA = MASTER;
  BY LAB_TEST TYPE;
  RUN;

PROC SQL;
  CREATE TABLE LIST_COMB AS
  SELECT *
  FROM LIST A, MASTER B
  WHERE A.LAB_TEST = B.LAB_TEST AND A.TYPE = B.TYPE;
  QUIT;
%TRANSFORM(INDSN = LIST_COMB, OUTDSN = LIST_COMB_OUT);

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Sample Data used for Summary Presentation after transformation:

Dataset Name: SUMM_COMB_OUT

| Report Used For | Report Used For Numeric | Lab Test Name | Visit Number | Visit | Statistic Type | Statistic Type Numeric | Rounding/Significant Method | Rounding/Significant Value | Actual Result | Transformed Result |
|-----------------|-------------------------|---------------|--------------|----------|----------------|------------------------|-----------------------------|----------------------------|---------------|--------------------|
| REPORT | REPORTN | LAB_TEST | VISIT_NO | Visit | TYPE | TYPEN | METHOD | VALUE | ACT_RSLT | TFM_RSLT |
| SUMMARY | 1 | CALCIUM | 0 | Baseline | N | 0 | NONE | | 7 | 7 |
| SUMMARY | 1 | CALCIUM | 0 | Baseline | MEAN | 1 | SIG | 3 | 12.25142857 | 12.3 |
| SUMMARY | 1 | CALCIUM | 0 | Baseline | MEDIAN | 2 | SIG | 4 | 8.36 | 8.36 |
| SUMMARY | 1 | CALCIUM | 0 | Baseline | STD | 3 | SIG | 5 | 10.86596434 | 10.866 |
| SUMMARY | 1 | CALCIUM | 0 | Baseline | MIN | 4 | SIG | 3 | 5.92 | 5.92 |
| SUMMARY | 1 | CALCIUM | 0 | Baseline | MAX | 5 | SIG | 3 | 36.76 | 36.8 |
| SUMMARY | 1 | CALCIUM | 1 | Day 1 | N | 0 | NONE | | 8 | 8 |
| SUMMARY | 1 | CALCIUM | 1 | Day 1 | MEAN | 1 | SIG | 3 | 12.6125 | 12.6 |
| SUMMARY | 1 | CALCIUM | 1 | Day 1 | MEDIAN | 2 | SIG | 4 | 9.26 | 9.26 |
| SUMMARY | 1 | CALCIUM | 1 | Day 1 | STD | 3 | SIG | 5 | 10.14943735 | 10.149 |
| SUMMARY | 1 | CALCIUM | 1 | Day 1 | MIN | 4 | SIG | 3 | 7.8 | 7.8 |
| SUMMARY | 1 | CALCIUM | 1 | Day 1 | MAX | 5 | SIG | 3 | 37.64 | 37.6 |
| SUMMARY | 1 | CALCIUM | 2 | Day 2 | N | 0 | NONE | | 5 | 5 |
| SUMMARY | 1 | CALCIUM | 2 | Day 2 | MEAN | 1 | SIG | 3 | 14.524 | 14.5 |
| SUMMARY | 1 | CALCIUM | 2 | Day 2 | MEDIAN | 2 | SIG | 4 | 9.2 | 9.2 |
| SUMMARY | 1 | CALCIUM | 2 | Day 2 | STD | 3 | SIG | 5 | 12.37292528 | 12.373 |
| SUMMARY | 1 | CALCIUM | 2 | Day 2 | MIN | 4 | SIG | 3 | 8.48 | 8.48 |
| SUMMARY | 1 | CALCIUM | 2 | Day 2 | MAX | 5 | SIG | 3 | 36.64 | 36.6 |

Sample Data used for Listing Presentation after transformation:

Dataset Name: LIST_COMB_OUT

| Report Used For | Report Used For Numeric | Subject ID | Lab Test Name | Visit Number | Visit | Statistic Type | Statistic Type Numeric | Rounding/Significant Method | Rounding/Significant Value | Actual Result | Transformed Result |
|-----------------|-------------------------|------------|---------------|--------------|----------|----------------|------------------------|-----------------------------|----------------------------|---------------|--------------------|
| Report | REPORTN | ID | lab_test | visit_no | visit | type | TYPEN | METHOD | VALUE | ACT_RSLT | TFM_RSLT |
| LISTING | 2 | 1 | CALCIUM | 0 | Baseline | ACTUAL | 9 | RND | 1 | 9.6 | 9.6 |
| LISTING | 2 | 1 | CALCIUM | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 10 | 10 |
| LISTING | 2 | 1 | CALCIUM | 2 | DAY 14 | ACTUAL | 9 | RND | 1 | 9.2 | 9.2 |
| LISTING | 2 | 2 | CALCIUM | 0 | Base | ACTUAL | 9 | RND | 1 | 8 | 8 |

| | | | | | | | | | | | |
|---------|---|---|-------------|---|--------------|--------|---|-----|---|-------|------|
| | | | M | | line | | | | | | |
| LISTING | 2 | 2 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 10.3 | 10.3 |
| LISTING | 2 | 2 | CALCIU M | 2 | DAY 14 | ACTUAL | 9 | RND | 1 | 9.7 | 9.7 |
| LISTING | 2 | 3 | CALCIU M | 0 | Base line | ACTUAL | 9 | RND | 1 | 8.84 | 8.8 |
| LISTING | 2 | 3 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 9.12 | 9.1 |
| LISTING | 2 | 4 | CALCIU M | 0 | Base line | ACTUAL | 9 | RND | 1 | 8.36 | 8.4 |
| LISTING | 2 | 4 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 8.32 | 8.3 |
| LISTING | 2 | 4 | CALCIU M | 2 | DAY 14 | ACTUAL | 9 | RND | 1 | 8.48 | 8.5 |
| LISTING | 2 | 5 | CALCIU M | 0 | Base line | ACTUAL | 9 | RND | 1 | 5.92 | 5.9 |
| LISTING | 2 | 5 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 7.8 | 7.8 |
| LISTING | 2 | 6 | CALCIU M | 0 | Base line | ACTUAL | 9 | RND | 1 | 8.28 | 8.3 |
| LISTING | 2 | 6 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 8.32 | 8.3 |
| LISTING | 2 | 7 | CALCIU M | 0 | Base line | ACTUAL | 9 | RND | 1 | 36.76 | 36.8 |
| LISTING | 2 | 7 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 37.64 | 37.6 |
| LISTING | 2 | 7 | CALCIU M | 2 | DAY 14 | ACTUAL | 9 | RND | 1 | 36.64 | 36.6 |
| LISTING | 2 | 8 | CALCIU M | 1 | DAY 7 | ACTUAL | 9 | RND | 1 | 9.4 | 9.4 |
| LISTING | 2 | 8 | CALCIU M | 2 | DAY 14 | ACTUAL | 9 | RND | 1 | 8.6 | 8.6 |

CONCLUSIONS

With this approach outlined we can standardize the reporting process in a dynamic manner which can be adapted to various domain data type across based on the need in a efficient manner. With the above process of standardization to Significant digits or rounding which is a basic, it paves an opportunity to evolve into a sophisticated system on reporting with incorporation of other functionality around it.

REFERENCES

SAS 9.2 Online Documentation
<http://support.sas.com/kb/24/728.html>

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