

## Quick Tips and Tricks: Perl Regular Expressions in SAS®

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### ABSTRACT

Programming with text strings or patterns in SAS® can be complicated without the knowledge of Perl regular expressions. Just knowing the basics of regular expressions (PRX functions) will sharpen anyone's programming skills. Having attended a few SAS conferences lately, we have noticed that there are few presentations on this topic and many programmers tend to avoid learning and applying the regular expressions. Also, many of them are not aware of the capabilities of these functions in SAS. In this presentation, we present quick tips on these expressions with various applications which will enable anyone learn this topic with ease.

### INTRODUCTION

SAS has numerous character (string) functions which are very useful in manipulating character fields. Every SAS programmer is generally familiar with basic character functions such as SUBSTR, SCAN, STRIP, INDEX, UPCASE, LOWCASE, CAT, ANY, NOT, COMPARE, COMPBL, COMPRESS, FIND, TRANSLATE, TRANWRD etc. Though these common functions are very handy for simple string manipulations, they are not built for complex pattern matching and search-and-replace operations.

Regular expressions (RegEx) are both flexible and powerful and are widely used in popular programming languages such as Perl, Python, JavaScript, PHP, .NET and many more for pattern matching and translating character strings. Regular expressions skills can be easily ported to other languages like SQL., However, unlike SQL, RegEx itself is not a programming language, but simply defines a search pattern that describes text.

Learning regular expressions starts with understanding of character classes and metacharacters. Becoming skillful on this topic is not hard but RegEx can be intimidating at first as it is based on a system of symbols (metacharacters) to describe a text pattern to read text, and this can be an obvious reason for anyone to put it off.

|   |   |  |
|---|---|--|
| Regular Expression<br>(Matching Text)<br><small>/search-string/source-string/</small>               | prxmatch( '/^[BDGKMNSTZ]{1}(OO)[0-9]{3}-\d{2}s*\$/', id);<br>→ B00003-39  |  |
|   | a) Metacharacter ^ = Start<br>b) One of BDGKMNSTZ chars<br>c) {1} = quantifier 1 char<br>d) Followed by char group (OO)<br>e) [0-9]{3} char class 3 times | f) Followed by –<br>g) Followed by \d{2} 2 digits<br>h) \$ End with #7 above or space \s 1 or more times * |
| Regular Expression<br>(Find and Replace)<br><small>s/regular-expression/replacement-string/</small> | prxchange('s/\d//',-1, 0001000254698ABCD)<br>→ ABCD   |  |
|   | a) s/ Substitution operator<br>b)   Alternation matching  | c) \ escape character<br>d) -1 1 time -  |

## CHARACTERS AND METACHARACTERS

Regular expressions are built up from metacharacters and their power comes from the use of these metacharacters, which allow the matching of types of text and sequences through systemic searches. There are different sets of characters and metacharacters used in Perl regular expressions as listed below.

|   |  |                                     |
|---|--|-------------------------------------|
| Literal characters  | This works the same way as normal find and replace without the use of symbols; more like SAS TRANWRD function. This is simple but inflexible.  |                                     |
| Character classes (sets and ranges)   | [abc]  | a, b, or c                          |
|   | [^abc]   | any but not a, b, or c              |
|   | [a-zA-Z]   | character between a to z            |
|   | [0-9]  | any digits                          |
| Predefined Character classes<br>(Shorthand Character Sets)  | .  | any character                       |
|   | \w, \d, \s   | Word [0-9 a-z _], digit, whitespace |
|   | \W, \D, \S   | not word, digit, whitespace         |
| Character sets (groups and look around)   | This allows for a series of characters within a range defined by starting and ending characters.   |                                     |
|   | () (abc)   | capture everything enclosed         |
|   | (?:abc)  | non-capturing group                 |
|   | (?=abc)  | positive lookahead                  |
|   | (?!abc)  | negative lookahead                  |
|   | \1, \2   | back reference to group #1, #2      |
| Positional metacharacters<br>(anchors/boundaries)   | ^abc\$   | start / end of the string           |
|   | \b\B   | word, not-word boundary             |
| Quantifiers metacharacters<br>(Wildcards/Repetitions/Multipliers)   | a* a+ a?   | 0 or more, 1 or more, 0 or 1        |
|   | a{5} a{2,}   | exactly five, two or more           |
|   | a{1,3}   | between one & three                 |
|   | a+? a{2,}?   | match as few as possible            |
|   | ab cd  | alternative matching ab or cd       |
|   | (July Jul)   | July or Jul equivalent to July?     |
| Escaping Metacharacters<br>(Metacharacters -> Literal Meaning)  | When a metacharacter(s) itself is in the text, then the metacharacter needs to "escape" from its metacharacter meanings. This is done by putting a backslash in front of it for its literal meaning.<br><br>\. \? \* \+ \[ \] \\\ ( \) \{ \} \\$ \% \^ \\\ |                                     |
| Note: The '^' has a different meaning in character class [^abc] vs (^abc). Similarly, '-' has different meaning within [-a-z]. A character can have different meanings depending on where it is being used. For example, escaped metacharacters are not metacharacters. |  |                                     |

## SAS PRX Functions

|  |   |
|--|---|
| <p><u>Find using PRXMATCH:</u></p> <p>PRXMATCH function can match the location of the search strings in the source strings. It has two parameters: the first is regular expression id (search string) and second parameter is character string to be searched (source string).</p> <p>Syntax:<br/>PRXMATCH(/regular-expression/, source)</p> <p>Ex.<br/>prxmatch('/world/', 'Hello world!');</p> <p>The above example uses the PRXMATCH function to find the position (=7) of the search-string (world) in the source-string (Hello World)</p> | <p><u>Find and Replace using PRXCHANGE:</u></p> <p>PRXCHANGE is not only used to find strings but also to replace it using specified rules. PRXCHANGE expressions allow the programmer to choose part of text to replace and rest to keep. SAS has a simple function named TRANWRD which is very handy for a search-and-replace string, but TRANWRD works only with literal characters or words.</p> <p>Syntax:<br/>PRXCHANGE(s/regular-expression/replacement-string/, source)</p> <p>Ex.<br/>prxchange('s/world/planet/', 1, 'Hello world!');</p> <p>The above example uses the PRXCHANGE function to replace 'world' in 'Hello world' with 'planet,' resulting in 'Hello planet'</p> |
|--|---|

## APPLICATION 1: SIMPLE SEARCH

| <pre>%let ptlist1=%str(HIVE? HEPATITIS TREPONEMA PALLIDUM HTLV CYCLOSPORA); data app1a;   text="HIV Positive";   grade='GR3'; output; run; data app1;   set app1a;   if prxmatch("/(&amp;ptlist1)/", text) then flag1='X'; /*check ptlist against text*/   if prxmatch("/(GR3 SEVERE)/", grade) then flag2='X'; /*GR3 or SEVERE*/ run;</pre> |      |              |   |       |     |   |       |   |   |       |   |
|--|------|--------------|---|-------|-----|---|-------|---|---|-------|---|
| <table border="1"> <thead> <tr> <th>text</th> </tr> </thead> <tbody> <tr> <td>HIV Positive</td> </tr> </tbody> </table>  | text | HIV Positive | <table border="1"> <thead> <tr> <th>grade</th> </tr> </thead> <tbody> <tr> <td>GR3</td> </tr> </tbody> </table> | grade | GR3 | <table border="1"> <thead> <tr> <th>flag1</th> </tr> </thead> <tbody> <tr> <td>X</td> </tr> </tbody> </table> | flag1 | X | <table border="1"> <thead> <tr> <th>flag2</th> </tr> </thead> <tbody> <tr> <td>X</td> </tr> </tbody> </table> | flag2 | X |
| text   |      |              |   |       |     |   |       |   |   |       |   |
| HIV Positive   |      |              |   |       |     |   |       |   |   |       |   |
| grade  |      |              |   |       |     |   |       |   |   |       |   |
| GR3  |      |              |   |       |     |   |       |   |   |       |   |
| flag1  |      |              |   |       |     |   |       |   |   |       |   |
| X  |      |              |   |       |     |   |       |   |   |       |   |
| flag2  |      |              |   |       |     |   |       |   |   |       |   |
| X  |      |              |   |       |     |   |       |   |   |       |   |

## APPLICATION 2: MULTIPLE SEARCHES

```

data app2;
  set sashelp.class;
  if prxmatch ("/^A/", name) then flag1='X'; /*start with A*/
  if prxmatch ("/d$/", strip(name)) then flag2='X'; /*end with d*/
  if prxmatch ("/d\s*$/", name) then flag3='X'; /*end with d or space*/
  if prxmatch ("/^Jw+y\s*$/i", name) then flag4='X'; /*start with J and end with y*/
  if prxmatch("/^w{2}(e|s)\s*$/i", name) then flag5='X'; /*end with e or s*/
  if prxmatch("/^w{2,4}(e|s)\s*$/i", name) then flag6='X'; /*flag5 but 2 to 4 char)
  if prxmatch ("/^Janet?/", name) then flag7='X'; /*ending t is optional*/
  if prxmatch("/(\S)1/", name ) then flag8='X'; /*2 continious white space*/
  if prxmatch("/[^Janet]/i", strip(name)) then flag9='X';/*Except J|a|n|e|t*/
  if prxmatch("/^[Janet]/i", strip(name)) then flag10='X'; /*start with J|a|n|e|t*/
run;

```

| Name    | flag1 | flag2 | flag3 | flag4 | flag5 | flag6 | flag7 | flag8 | flag9 | flag10 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Alfred  | X     | X     | X     |       |       |       |       |       | X     | X      |
| Alice   | X     |       |       |       | X     | X     |       |       | X     | X      |
| Barbara |       |       |       |       |       |       |       |       | X     |        |
| Carol   |       |       |       |       |       |       |       |       | X     |        |
| Henry   |       |       |       |       |       |       |       |       | X     |        |
| James   |       |       |       |       | X     | X     |       |       | X     | X      |
| Jane    |       |       |       |       | X     | X     | X     |       |       | X      |
| Janet   |       |       |       |       |       |       | X     |       |       | X      |
| Jeffrey |       |       |       | X     |       |       |       | X     | X     | X      |
| John    |       |       |       |       |       |       |       |       | X     | X      |
| Joyce   |       |       |       |       | X     | X     |       |       | X     | X      |
| Judy    |       |       |       | X     |       |       |       |       | X     | X      |
| Louise  |       |       |       |       | X     |       |       |       | X     |        |
| Mary    |       |       |       |       |       |       |       |       | X     |        |
| Philip  |       |       |       |       |       |       |       |       | X     |        |
| Robert  |       |       |       |       |       |       |       |       | X     |        |
| Ronald  |       | X     | X     |       |       |       |       |       | X     |        |
| Thomas  |       |       |       |       | X     |       |       |       | X     | X      |
| William |       |       |       |       |       |       |       | X     | X     |        |

### APPLICATION 3: IN PROC SQL

```
/*search start with H|M|J and with y or space*/  
proc sql;  
  select *  
    from sashelp.class  
    where prxmatch('/^(h|m|j).*y\s*$/i', name);  
quit;
```

| Name    | Sex | Age | Height | Weight |
|---------|-----|-----|--------|--------|
| Henry   | M   | 14  | 63.5   | 102.5  |
| Jeffrey | M   | 13  | 62.5   | 84     |
| Judy    | F   | 14  | 64.3   | 90     |
| Mary    | F   | 15  | 66.5   | 112    |

### APPLICATION 4: BOUNDARY

```
/*boundary before and after 4dr*/  
data app4;  
  set sashelp.cars (obs=4 keep=make model type);  
  if prxmatch("\b4dr\b/i", model) then flag3='X';  
run;
```

| Make  | Model          | Type  | flag1 |
|-------|----------------|-------|-------|
| Acura | MDX            | SUV   |       |
| Acura | RSX Type S 2dr | Sedan |       |
| Acura | TSX 4dr        | Sedan | X     |
| Acura | TL 4dr         | Sedan | X     |

## APPLICATION 5: MATCH ENDING CHAR

```
/*match ending char*/
data app5;
  set bb.vismap;
  if prxmatch('/^01[A-B]{1}\s*$\s/i', visno) then flag='X';
run;
```

| VISNO | DAYS | CALC_PROC | ISACTIVE | CAL_PROC                                | flag |
|-------|------|-----------|----------|---|------|
| 00A   | -22  |           | 1        | Screening (Days -22 to -2)              |      |
| 00B   | -1   |           | 1        | Admission (Day -1)                      |      |
| 01    | 1    |           | 1        | Day 1 Dosing                            |      |
| 01A   | 1    |           | 1        | Day 1 - 1 Hour Post Dose: PK Sampling   | X    |
| 01B   | 1    |           | 1        | Day 1 - 2 Hours Post Dose: PK Sampling  | X    |
| 01C   | 1    |           | 1        | Day 1 - 4 Hours Post Dose: PK Sampling  |      |
| 01D   | 1    |           | 1        | Day 1 - 5 Hours Post Dose: PK Sampling  |      |
| 01E   | 1    |           | 1        | Day 1 - 6 Hours Post Dose: PK Sampling  |      |
| 01F   | 1    |           | 1        | Day 1 - 8 Hours Post Dose: PK Sampling  |      |
| 01G   | 1    |           | 1        | Day 1 - 12 Hours Post Dose: PK Sampling |      |
| 01H   | 1    |           | 1        | Day 1 - 16 Hours Post Dose: PK Sampling |      |
| 01I   | 2    |           | 1        | Day 2 - 24 Hours Post Dose: PK Sampling |      |
| 01J   | 2    |           | 1        | Day 2 - 36 Hours Post Dose: PK Sampling |      |
| 02    | 3    |           | 1        | Day 3 - 48 Hours Post Dose Clinic Visit |      |
| 03    | 4    |           | 1        | Day 4 - 72 Hours Post Dose Clinic Visit |      |
| 04    | 5    |           | 1        | Day 5 - 96 Hours Post Dose Clinic Visit |      |
| 05    | 12   |           | 1        | Day 12 Clinic Visit                     |      |

## APPLICATION 6: WITH ALTERNATION (|)

```
/*check of any of ids exist in text*/
%let idtext=%str(Z07IW001|Z07IW002|Z07IW003|Z07IW004|Z07IW005|Z07IW094);
%let text=%str(Continue from If Other, specify: was not obtained prior tension notice and contacted ZZZZ. Potentially affected are: Z07IW098, Z07IW094);

data app6;
  if prxmatch("/(&idtext)/", "&text") then flag=1;
run;
```

flag

1

## APPLICATION 7: ID PATTERN

```

data app7a;
  input id $1-50;
  datalines;
MOCK-EXTRACT
G00011-39R
S00081-34
S00081-IS
T-11642-39
S00171 -42
G001054A
ZOO1054A
ZO1054A
B00003-39
;
run;

data app7;
  set app7a;
  if prxmatch( '/^( |KHANISILYE||MOCK-EXTRACT|MOCK23APR12|0|Z00722-6A-61)\s*$', id) then flag1=1;
  else if prxmatch( '/^[BDGKMNSTZ]{1}[0-9]{5}-(\d{2}[R]{1})\s*$', id) then flag2=1; *G00011-39R -delete*;
  else if prxmatch( '/^[TN]{1}[0]{2}[0-9]{3}-(\d{1}C|M)(\d{1}|A)\s*$', id) then flag3=1; *T00011-42*;
  else if prxmatch( '/^[BDGKMNSTZ]{1}[0-9]{5}-(\d{1}C|M)(\d{1}|A)\s*$', id) then flag4=1; *S00081-34 *;
  else if prxmatch( '/^[BDGKMNSTZ]{1}[0-9]{5}-(\d{2}[\.]{1})|VTM|IS)\s*$', id) then flag5=1; *S00081-IS K00081-VT*;
  else if prxmatch( '/^[BDGKMNSTZ]{1}(|-)[0-9]{5}-\d{2}\s*$', id) then flag6=1; *T-11642-39*;
  else if prxmatch( '/^[BDGKMNSTZ]{1}[0-9]{5} -\d{2}\s*$', id) then flag7=1; *S00171 -42*;
  else if prxmatch( '/^[BDGKMNSTZ]{1}[0-9]{5}(\d{1}C)(\d{1}|A)\s*$', id) then flag8=1; *G001054A G0000538**;
  else if prxmatch( '/^[BDGKMNSTZ]{1}[0-9]{5}-\d{3}\s*$', id) then flag9=1; *G001054A G0000538**;
  else if prxmatch( '/^[BDGKMNSTZ]{1}(O)[0-9]{4}-\d{2}\s*$', id) then flag10=1; *ZO*;
  else if prxmatch( '/^[BDGKMNSTZ]{1}(OO)[0-9]{3}-\d{2}\s*$', id) then flag11=1; *ZOO*;
  else if prxmatch( '/(PLEA SE|H2O|NPVOP IN|SWAB|INTULI|SAMPLE|ACADEMIC)/', id) then flag12=1;
run;

```

| id           | flag1 | flag2 | flag3 | flag4 | flag5 | flag6 | flag7 | flag8 | flag9 | flag10 | flag11 | flag12 |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|
| MOCK-EXTRACT | 1     | .     | .     | .     | .     | .     | .     | .     | .     | .      | .      | .      |
| G00011-39R   | .     | 1     | .     | .     | .     | .     | .     | .     | .     | .      | .      | .      |
| S00081-34    | .     | .     | .     | 1     | .     | .     | .     | .     | .     | .      | .      | .      |
| S00081-IS    | .     | .     | .     | .     | 1     | .     | .     | .     | .     | .      | .      | .      |
| T-11642-39   | .     | .     | .     | .     | .     | 1     | .     | .     | .     | .      | .      | .      |
| S00171 -42   | .     | .     | .     | .     | .     | .     | 1     | .     | .     | .      | .      | .      |
| G001054A     | .     | .     | .     | .     | .     | .     | .     | 1     | .     | .      | .      | .      |
| ZOO1054A     | .     | .     | .     | .     | .     | .     | .     | .     | .     | .      | .      | .      |
| ZO1054A      | .     | .     | .     | .     | .     | .     | .     | .     | .     | .      | .      | .      |
| B00003-39    | .     | .     | .     | 1     | .     | .     | .     | .     | .     | .      | .      | .      |

## APPLICATION 8: SIMPLE REPLACE

```
data app8;  
  set sashelp.class (obs=3);  
  name2=prxchange("s/(Alfred)/Alex/i",-1,name); /*replace Akfred with Alex*/  
run;
```

| Name    | Sex | Age | Height | Weight | name2   |
|---------|-----|-----|--------|--------|---------|
| Alfred  | M   | 14  | 69.0   | 112.5  | Alex    |
| Alice   | F   | 13  | 56.5   | 84.0   | Alice   |
| Barbara | F   | 13  | 65.3   | 98.0   | Barbara |

## APPLICATION 9: INTERCHANGE WORDS

```
data app9;  
  set names;  
  fullname2=prxchange('s/(\w+) (\w+)/$2, $1/', -1, fullname);  
run;
```

| fullname1        | fullname2         |
|------------------|-------------------|
| Reyansh Bass     | Bass, Reyansh     |
| Madelyn Martins  | Martins, Madelyn  |
| Jacqueline Wills | Wills, Jacqueline |
| Antony Dunne     | Dunne, Antony     |
| Eden Macdonald   | Macdonald, Eden   |
| Morris Beltran   | Beltran, Morris   |
| Dario Hollis     | Hollis, Dario     |
| Ophelia Rudd     | Rudd, Ophelia     |
| Gracey Cline     | Cline, Gracey     |
| Mira Barnett     | Barnett, Mira     |



## APPLICATION 10: REPLACE WITH CHAR CLASS

```

data app10;
  set sashelp.class;
  name2=prxchange("s/([aeiou])/$1$1/i", -1, name);
  name3=prxchange("s/([^\aeiou])//i", -1, name);
run;

```

| Name    | Sex | Age | Height | Weight | name2      | name3 |
|---------|-----|-----|--------|--------|------------|-------|
| Alfred  | M   | 14  | 69.0   | 112.5  | AAlfred    | Ae    |
| Alice   | F   | 13  | 56.5   | 84.0   | AAlicee    | Aie   |
| Barbara | F   | 13  | 65.3   | 98.0   | Baarbaaraa | aaa   |
| Carol   | F   | 14  | 62.8   | 102.5  | Caarool    | ao    |
| Henry   | M   | 14  | 63.5   | 102.5  | Heenry     | e     |
| James   | M   | 12  | 57.3   | 83.0   | Jaamees    | ae    |
| Jane    | F   | 12  | 59.8   | 84.5   | Jaanee     | ae    |
| Janet   | F   | 15  | 62.5   | 112.5  | Jaaneet    | ae    |
| Jeffrey | M   | 13  | 62.5   | 84.0   | Jeefreey   | ee    |
| John    | M   | 12  | 59.0   | 99.5   | Joohn      | o     |
| Joyce   | F   | 11  | 51.3   | 50.5   | Jooycee    | oe    |
| Judy    | F   | 14  | 64.3   | 90.0   | Juudy      | u     |
| Louise  | F   | 12  | 56.3   | 77.0   | Loouuisee  | ouie  |
| Mary    | F   | 15  | 66.5   | 112.0  | Maary      | a     |
| Phillip | M   | 16  | 72.0   | 150.0  | Phillip    | ii    |
| Robert  | M   | 12  | 64.8   | 128.0  | Roobeert   | oe    |
| Ronald  | M   | 15  | 67.0   | 133.0  | Roonaald   | oa    |
| Thomas  | M   | 11  | 57.5   | 85.0   | Thoomaas   | oa    |
| William | M   | 15  | 66.5   | 112.0  | Williaam   | iia   |

## APPLICATION 11: REMOVE CHAR

```
data app11;  
  set ex3a;  
  if prxmatch('/[ST]\s*$/'i, visno) then flag='X';  
  visno2=prxchange('s/[ST]\s*$/'i,-1, visno);  
run;
```

| VISNO | flag | visno2 |
|-------|------|--------|
| 00    |      | 00     |
| 00S   | X    | 00     |
| 01    |      | 01     |
| 05    |      | 05     |
| 06    |      | 06     |
| 06S   | X    | 06     |
| 07    |      | 07     |
| 10    |      | 10     |
| 10S   | X    | 10     |
| 11    |      | 11     |
| 12    |      | 12     |
| 12S   | X    | 12     |
| 12T   | X    | 12     |
| 14    |      | 14     |
| 14S   | X    | 14     |
| 15    |      | 15     |

## APPLICATION 12: REMOVE DIGITS OR ALPHABETS

```
data app12;  
  text="0001000254698ABCD";  
  alpha=prxchange('s/d/',-1, text); /*remove digits*/  
  num=prxchange('s/[a-z]/'i,-1, text); /*remove alphabets*/  
run;
```

| text              | alpha | num           |
|-------------------|-------|---------------|
| 0001000254698ABCD | ABCD  | 0001000254698 |

## APPLICATION 13: REMOVE LEADING ZEROS

```
data app13a;  
  x='000asd1234'; output;  
  x='123AA'; output;  
  x='0009876A0'; output;  
run;  
  
data app13;
```

```

set app13a;
L0 =prxchange('s/^0+//',-1,x);
run;

```

| x          | L0      |
|------------|---------|
| 000asd1234 | asd1234 |
| 123AA      | 123AA   |
| 0009876A0  | 9876A0  |

### APPLICATION 15: REMOVE DUPLICATES

```

data app15;
clist = "ALEX ALEX Aaa B C D E F E G H B I Aaa Bb D J K TIM TIM";
do i=1 to countw(clist);
Nondups=prxchange('s/(\b\w+?\b)(.*?)(?=\b\1{1,}\b)(.?)$2$3/i',-1,compbl(clist));
end;
run;

```

| clist  | i  | Nondups                                  |
|--|----|--|
| ALEXALEXAaa B C D E F E G H B I Aaa Bb D J K TIM TIM | 21 | ALEXB C D E F E G H B I Aaa Bb D J K TIM |

## CONCLUSION

In this paper, we stated that learning regular expressions requires understanding of various types of metacharacters and presented some simple examples, ranging from finding simple literals to finding complex string patterns and replacing them as well. The examples presented in this paper show regular expressions are powerful and convenient, which makes it worth learning.

Learning RegEx requires mastering the use of metacharacters, which requires a trial and error approach. Further fine-tuning can be performed by practicing the use of a free text editor like Atom in an interactive mode by placing source-string in the text buffer and search-string in the find buffer respectively.

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## RECOMMENDED READING

- <https://www.lexjansen.com/>
- [https://support.sas.com/rnd/base/datastep/perl\\_regex/regex-tip-sheet.pdf](https://support.sas.com/rnd/base/datastep/perl_regex/regex-tip-sheet.pdf)

## CONTACT INFORMATION

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