PG - A Preprocessor Generator

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Libraries and packages of Fortran routines already exist in many areas of scientific computing, however their use demands a familiarity with the details of the routine. The user must allocate storage, determine the proper sequence of routines to call, etc. Therefore considerable time and effort can be spent dealing with problems of Fortran programming. Such libraries can be made much easier to use if a language is provided to describe the problem to be solved in a natural manner. PG is a program designed to generate preprocessors to convert programs written in such languages to Fortran.

PG has been used to write a preprocessor for the ELLPACK language. ELLPACK is a language for solving elliptic partial differential equations. Examples from the ELLPACK preprocessor are used in this report, but knowledge of ELLPACK is not needed to understand them. To implement a problem oriented language, such as ELLPACK, both a grammar for the language and a driver routine for the preprocessor must be supplied. The driver routine is usually fairly short and is needed to initialize the program, open files, etc. A more detailed description of what is needed is given below. The grammar describes the language to be implemented. PG converts the grammar into a set of Fortran subroutines which are called by the user supplied driver routine.

PG is designed around the macro processor, described in Appendix C. The preprocessor contains routines for storing text strings and a template processor. The use of these routines is described below.

1. Introduction to PG Grammars

A preprocessor must perform two basic tasks: parsing the input language, e.g. ELLPACK and generating an output program. Parsing is controlled by grammar rules and generating an output program is done by actions.

In a PG grammar a line beginning with an asterisk is a comment; blank lines are also considered comments. Either type may occur anywhere in the grammar. All lines are assumed to be at most 80 characters long. A statement may be continued
to a new line by ending the current line with an ampersand(&).

We start with a number of simple examples from the ELLPACK language and its preprocessor. A very simple PG grammar, consisting of just one rule is

\[ \text{PROG} \rightarrow \text{OPTION.} \quad \text{NAME} \quad '=' \quad \text{NAME} \quad \text{END.} \]

The name of the rule is PROG; rule name must be valid Fortran names. To the right of the arrow (\(\rightarrow\)) are subrules. Subrules are either character strings to be matched or the name of another rule. PG is not recursive and it is illegal for a rule to use itself as a subrule directly or indirectly, as in rule A using rule B using rule A. There are several built-in rules: NAME is a built-in rule which matches an alphanumeric string without embedded blanks. The last statement in a PG program must be 'END.'. Valid input to the preprocessor generated by the above grammar is

\[ \text{OPTION. WORKSPACE = 5000} \]

It is assumed that blanks in the problem-oriented language, e.g. ELLPACK, are usually not significant, so blanks are skipped automatically after each subrule. The string OPTION. must occur in the first column of the input, but the rest of the line can begin in any column.

The text matched by NAME may not contain any embedded blanks. If it is desired to allow embedded blanks, then the following program can be used

\[ \text{PROG} \rightarrow \text{ALFNUM+} \quad \text{ALFNUM+} \quad \text{END.} \]

ALFNUM is a predefined rule which matches any alphanumeric character, (see Table 1 for a complete list of built-in rules). The '+' is a PG operator and means match one or more occurrences of ALFNUM. Since blanks are skipped after every character matched by ALFNUM embedded blanks are ignored. The '+' may be used with either a rule name, as here, or with a quoted string. The complete set of PG postfix operators is given in Table 2.

In ELLPACK there are two forms for the option statement, e.g.

\[ \text{OPTION. WORKSPACE = 5000} \]

and

\[ \text{OPTION. MEMORY} \]

The PG grammar for the option segment is

\[ \text{PROG} \rightarrow \text{ALFNUM+} \quad '=' \quad \text{ALFNUM+} \quad \text{ALFNUM+} \quad \text{END.} \]

The preprocessor will first try to use the first rule. If it fails, i.e. one of its subrules fails to match the input, then it will try the next alternative, marked by \(\rightarrow\) with no rule name to its left, will be tried. A rule may have any number of alternatives.

The grammar and its rules define the input language and
the actions associated with these define the output. The actions 
are executed when the associated alternative is matched. Most 
actions are to set or reset variables in the template processor 
or to write Fortran statements. For example, the action statement 
\[ $(TPVNAME) = 'ASTRING' \]
sets the template variable TPVNAME to ASTRING. Template variable 
names must begin with a letter and contain only letters and 
digits; there is no limit on their length. A reference to a 
template variable is indicated by $ preceding the template variable 
name. The PG grammar used by ELLPACK to set a template variable 
via the OPTION segment is 
\[
PROG \rightarrow 'OPTION.' \ ALFNUM+ \ '=' \ ALFNUM+
\] 
\[ $(2) = \$4 \]
\[
\rightarrow 'OPTION.' \ ALFNUM+
\] 
\[ $(2) = '.TRUE.' \]
END.

The dollar notation (adopted from YACC) is as follows: each 
element in a rule or alternative is numbered in order of its 
ocurrence and what it matches is referenced by its number preceded 
by $. In the first rule above, $1 is OPTION., $2 is whatever 
is matched by the first ALFNUM+, $3 is =, and $4 is whatever 
is matched by the second ALFNUM+.

Thus, if the input is 
\[
OPTION. -> WORKSPACE = 5000
\]
then $2 is WORKSPACE and $4 is 5000. When this line is read 
by the ELLPACK preprocessor generated using this grammar the 
template variable WORKSPACE is set to the string 5000. If the 
input is 

\[
OPTION. MEMORY
\]
then the template variable MEMORY is set to .TRUE.. Note that 
this approach allows one to associate language keywords, (e.g. 
WORKSPACE and MEMORY), with template variables.

While all template variables contain text strings, special 
provision is made for two special classes. A logical template 
variable is one that contains either the text string .TRUE. or 
.FALSE.. An integer template variable is one that contains 
a character string representing an integer. A logical template 
variable can be set using the action 
\[ $L(TPVNAME) = <LOGICAL EXPRESSION> \]
and an integer template variable can be set using 
\[ $I(TPVNAME) = <INTEGER EXPRESSION> \]
In addition, both $L(TPVNAME) and $I(TPVNAME) can be used in 
expressions as if they were Fortran function calls of the corre­ 
sponding type. The use of these features is illustrated by the 
following grammar.

\[
PROG \rightarrow 'OPTION.' \ ALFNUM+ \ '=' \ ALFNUM+
\] 
\[ $(2) = \$4 \]
\[ $I(TOTAL) = $I(TOTAL) + $I(\$2) \]
\[ $L(TOOG) = $I(\$2) .GT. 10000 \]

Using the same input as before will result in WORKSPACE being
set to 5000, adding 5000 to the variable TOTAL and setting TOOBIG to .FALSE..
In addition to the above PG utilities which act like functions there are PG procedures which act like subroutine calls. The grammar

\[
\text{PROG} \rightarrow \ 'OPTION.' \ \text{ALFNUM}+ \ '='$ \ \text{ALFNUM}+ \\
\quad \text{WRITE(''} \quad / / \quad $2 \quad / / \quad $3 \quad / / \quad $4) \\
\quad \rightarrow \ 'OPTION.' \ \text{ANY}+ \\
\quad \text{ERROR(''ILLEGAL OPTION - ''} \quad / / \quad $2)
\]

END.

Given the input

OPTNAM. \ \text{LEVEL} = 3

the statement

\text{LEVEL=3}

will be written to the program file. If it is given the input

OPTNAM. \ \text{MEMORY}

then it will write the error message

\text{ILLEGAL OPTION - MEMORY}

to the listing file and set a flag indicating that an error has occurred. The complete list of PG procedures is given in Table 3.

The following grammar which shows how to allow several options separated by dollar signs, to occur on the same line introduces several new features.

\[
\text{PROG} \rightarrow \ 'OPTION.' \ \text{OPTEXP} ++ \ '$' \\
\text{OPTEXP} \rightarrow \ \text{OPTNAM} \ '='$ \ \text{ALFNUM}+ \\
\quad $$($1) = $3 \quad \text{CLEAR}
\]

The rule PROG is defined in terms of the subrules OPTEXP and OPTNAM. Given the input

\text{OPTION. \ \text{LEVEL} = 3 \quad $ \ \text{WORKSPACE} = 5000}

this rule and its actions sets the template variable LEVEL to 3 and sets WORKSPACE to 5000. The infix operator ++ as in

\text{<SUBRULE1> ++ <SUBRULE2>}

matches a list of <SUBRULE1> type objects separated by objects of matching <SUBRULE2>. Here we want a list of options separated by dollar signs. The text matched by ALFNUM+ on the right side of the OPTNAM rule is passed back to the OPTEXP rule.

Text would be passed back to the PROG rule except for the CLEAR procedure. If text were always passed back to the PROG rule the system would retain the entire input. This would be very wasteful of space since there is no need to keep the input text once it has been parsed and the relevant actions performed. The CLEAR statement tells PG that all the text matched so far can be thrown away.

2. PG Rule Syntax
The basic PG grammar rules are quoted strings and a set of built-in rules. (A quoted string may be thought of as a special kind of built-in rule).

Table 1

The built-in rules of the PG system. Blanks are automatically skipped after each rule, except for rules marked (NS).

<table>
<thead>
<tr>
<th>Rule Name</th>
<th>Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>'TEST'</td>
<td>quoted text, used ' ' to quote a quote</td>
</tr>
<tr>
<td>ALFNUM</td>
<td>a letter or a digit</td>
</tr>
<tr>
<td>ANY</td>
<td>anything but an end-of-line</td>
</tr>
<tr>
<td>BLANKS</td>
<td>any number of blanks</td>
</tr>
<tr>
<td>CHAR</td>
<td>anything but an end-of-line (NS)</td>
</tr>
<tr>
<td>DIGIT</td>
<td>a digit</td>
</tr>
<tr>
<td>EOL</td>
<td>end-of-line (NS)</td>
</tr>
<tr>
<td>FEXPR</td>
<td>Fortran expression</td>
</tr>
<tr>
<td>FNAME</td>
<td>Fortran-type name</td>
</tr>
<tr>
<td>LETTER</td>
<td>a letter</td>
</tr>
<tr>
<td>LINE</td>
<td>everything up to an end-of-line name (alphanumeric string without embedded blanks)</td>
</tr>
<tr>
<td>NAME</td>
<td></td>
</tr>
</tbody>
</table>

A basic rule may have a postfix operator applied to it. The postfix operators are given in Table 2.

Table 2

The postfix operators in PG.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>RULE *</td>
<td>match zero or more occurrences of RULE</td>
</tr>
<tr>
<td>RULE +</td>
<td>match one or more occurrences of RULE</td>
</tr>
<tr>
<td>RULE ?</td>
<td>match zero or one occurrences of RULE</td>
</tr>
<tr>
<td>RULE -</td>
<td>match rule, but otherwise ignore matched text, do not pass the text back up</td>
</tr>
<tr>
<td>RULE ** N</td>
<td>match exactly N (&gt;0) occurrences of RULE</td>
</tr>
<tr>
<td>RULE ** 0</td>
<td>match rule, but then back up the input so that the text is not considered matched</td>
</tr>
<tr>
<td>RULE ?* N</td>
<td>match up to N (&gt;0) occurrences of RULE</td>
</tr>
<tr>
<td>RULE ?-</td>
<td>match zero or one occurrence of RULE, but ignore matched text</td>
</tr>
</tbody>
</table>

The list operator, RULE1 ++ RULE2, matches a list of RULE1 type objects separated by RULE2 type objects. For example, FEXPR ++ ',' matches a list of Fortran expressions separated by commas.
3. PG Actions

In a PG action a **basic string variable** is either $<\text{INTEGER}>$, or a quoted string. If the quoted string contains only letters and digits the quotes may be omitted. A quote may be included in a quoted string by using two quotes. A **string variable** is either a basic string variable, the value of a template variable or a combination of these concatenated using the concatenation operator `//`. A template variable is referenced by $\langle<SV>\rangle$, where $<SV>$ is a string variable. Recall the definition that $1$ refers to the text matched by the first subrule, $2$ to the text matched by the second subrule, etc. Examples of string variables are

- '\text{X+3.6}*Y'\`
- '\text{ISN'T}''
- '\text{TEXT}$\langle\text{TEMPLATE}\rangle$
- $3$
- 'ABC $\langle$\langle\langle\langle\text{VARIABLE}$\rangle$\rangle$\rangle$ $\langle$\langle\langle\langle\text{DEF}$\rangle$\rangle$ $\langle$\langle\langle\langle\text{XYZ}$\rangle$\rangle$ $\langle$\langle\langle\langle\text{R12}$\rangle$\rangle$

Text matched with an ignore operator attached ('-' or '?!') cannot be accessed with $<\text{N}>$.

A **PG action statement** may assign a value to a template variable. The action statement

\[\$<SV1>$ \langle$<SV2>$\langle\langle\langle\langle\text{VARIABLE}$\rangle$\rangle$\rangle$ $\langle$\langle\langle\langle\text{DEF}$\rangle$\rangle$ $\langle$\langle\langle\langle\text{XYZ}$\rangle$\rangle$ $\langle$\langle\langle\langle\text{R12}$\rangle$\rangle$

assigns the string $<SV2>$ to the template variable $<SV1>$. To append the string $<SV2>$ to $<SV1>$ the action statement

\[\$(<SV1>) <- (SV2)$\]

is used.

If the value to be assigned to a template variable is either logical ('.TRUE.' or '.FALSE.') or an integer (an optional '+' or '-', followed string of digits) then the special assignment statements

- \[\$L( <SV> ) = \text{LOGICAL-EXPRESSION} \]
- \[\$I( <SV> ) = \text{INTEGER-EXPRESSION} \]

may be used. The logical and integer expressions follow the usual Fortran rules augmented by the logical and integer valued functions

- \[\$L( <SV> )\]
- \[\$I( <SV> )\]

For example,

\[\$I(\text{COUNT}) = \$I(\text{COUNT}) + 1\]

takes the digits in the string named by COUNT, converts them to an integer, adds one to the value; the new value is then converted back to a digit string and assigned to COUNT.

PG action statements may also involve ordinary Fortran statements with template variables. These statements are local to the set of actions associated with a rule and do not, in
general, affect the action statements of other rules (but see the GLOBAL statement below). Fortran variables in these statements have their types determined by the usual Fortran rules. The following example shows how one can access Fortran facilities in a PG action statement using Fortran statements.

```fortran
IWORK = $I(WORKSPACE) / 2 + 10
SCALE = ALOG10( FLOAT(MAXO(IWORK,100)) ) + 1
$I(WORKSPACE) = 10**SCALE + $I(WORKSPACE)
```

The built-in action procedures are given in Table 3. They each have one of the forms:

- `<NAME>`
- `<NAME>`( `<SV>` )
- `<NAME>`( `<SV1>`, `<SV2>` )

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERROR( <code>&lt;SV&gt;</code> )</td>
<td>Prints <code>&lt;SV&gt;</code> as an error message on the listing file and sets an error flag.</td>
</tr>
<tr>
<td>WRITE( <code>&lt;SV&gt;</code> )</td>
<td>Prints <code>&lt;SV&gt;</code> on the normal output file.</td>
</tr>
<tr>
<td>PWRITE( <code>&lt;SV&gt;</code> )</td>
<td>Prints <code>&lt;SV&gt;</code> on the output file, using the Fortran continuation convention if the line is longer than 72 characters.</td>
</tr>
<tr>
<td>DONE</td>
<td>Sets a flag indicating normal completion.</td>
</tr>
<tr>
<td>CLEAR</td>
<td>Resets PG so that all text matched so far is deleted. This must be done, usually after each input program segment is finished, to keep the amount of text stored by PG within set limits.</td>
</tr>
<tr>
<td>IGNORE</td>
<td>The text matched by the current rule is cleared. When control returns to the rule for which the current rule is a subrule, it will appear that the subrule succeeded but the corresponding string <code>$&lt;N&gt;</code> is null.</td>
</tr>
<tr>
<td>REPLACE( <code>&lt;SV&gt;</code> )</td>
<td>The text matched by the current rule is replaced by <code>&lt;SV&gt;</code>. <code>&lt;SV&gt;</code> may contain text matched in the current rule. This command allows the text to be rearranged. For the rest of the action in with this command appears only <code>$1</code> is defined and it refers to <code>&lt;SV&gt;</code>. When control returns to the calling rule the corresponding <code>$&lt;N&gt;</code> will have the value <code>&lt;SV&gt;</code>.</td>
</tr>
</tbody>
</table>
FAIL Causes the current rule to fail and control to return to the calling rule without trying any more alternatives of the current rule. This can be used, for example, to write a rule which matches anything but a '$' or an end-of-line marker:

```
NOTDOL  ->  '$'
FAIL    ->  ANY
```

Conditional execution of action statements is possible using IF-ELSE-ENDIF. It has the form

```
IF ( <LOGICAL-EXPRESSION> )
    any number of action statements
ELSE
    any number of action statements
ENDIF
```

The ELSE clause may be omitted. IF-ELSE-ENDIF statements may be nested.

PG also has a DO-loop construct. It has the form

```
DO <I> = <FEXPR1>, <FEXPR2>, <FEXPR3>
    any number of action statements
ENDDO
```

<I> is a Fortran integer variable and the <FEXPRn> are Fortran integer expressions. As in Fortran <FEXPR3> may be omitted; it defaults to one. DO loops may be nested and may include IF statements.

There are several Fortran routines provided for use in PG action statements. In all cases their arguments are string variables. They are summarized in table 4.

<table>
<thead>
<tr>
<th>Routine Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQN01( &lt;SV&gt; )</td>
<td>Integer function returning -1, 0, or 1 if &lt;SV&gt; is a Fortran expression equal to -1, 0, 1, respectively; otherwise, it returns 2.</td>
</tr>
<tr>
<td>IQIVAL( &lt;SV&gt; )</td>
<td>Integer function returning the value of the string &lt;SV&gt; (as an integer).</td>
</tr>
<tr>
<td>LQMTCH( &lt;SV1&gt;, &lt;SV2&gt; )</td>
<td>Logical function whose value is .TRUE. if &lt;SV1&gt; is identical to &lt;SV2&gt;.</td>
</tr>
<tr>
<td>QQADLS( &lt;SV1&gt;, &lt;SV2&gt; )</td>
<td>Subroutine which adds the Fortran name &lt;SV2&gt; to a comma separated list of names in &lt;SV1&gt;, if &lt;SV2&gt; is not already on the list. This is intended for maintaining a lists of variables to</td>
</tr>
</tbody>
</table>
be used in a Fortran declarations.

4. Special Segments

A PG grammar must include several special segments. The first of these is the (optional) GLOBAL segment in which Fortran declaration statements may be included. If it is used it must be the first segment in a PG grammar. Each PG grammar rule corresponds to a Fortran subroutine. The declarations in the GLOBAL segment are included in all of these subroutines. Variables which are referenced in actions associated with different rules must be in a COMMON block. It is also possible to declare the types of variables and arrays. If arrays are declared they should be in a COMMON block, or else, since they will be declared for each rule, an excessive amount of memory may be needed.

The GLOBAL segment is also used to set the sizes of various arrays used by PG to other than their default values. The list of these arrays, and the template variables controlling their sizes, is given in Table 5.

<table>
<thead>
<tr>
<th>Name</th>
<th>Default</th>
<th>Size of</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQSPMX</td>
<td>1000</td>
<td>CQSTCK (the primary stack)</td>
</tr>
<tr>
<td>IQMXIN</td>
<td>2000</td>
<td>CQBFIN (the input buffer)</td>
</tr>
<tr>
<td>ICRDIM</td>
<td>1500</td>
<td>input buffer</td>
</tr>
<tr>
<td>ICSDIM</td>
<td>1000</td>
<td>character storage array</td>
</tr>
<tr>
<td>IHADIM</td>
<td>401</td>
<td>hash table (must be prime)</td>
</tr>
<tr>
<td>ISTDIM</td>
<td>6000</td>
<td>integer pointer pool (must be divisible by 3)</td>
</tr>
</tbody>
</table>

An example of a GLOBAL segment is

GLOBAL.
COMMON /ABC/ X, Y, Z
INTEGER Y
REAL Z(10)
$(IQSPMX) = 2000$

The second special segment is MAIN. It is a required segment. It contains actions which are executed in the generated main routine. Usually it includes statements to initialize template variables and a call to a (separately compiled) Fortran routine to open files, etc.

To execute a grammar rule from the actions under MAIN or from a Fortran subprogram use
CALL <RULE>
The ELLPACK grammar (and the PG sample grammars in this document) use the rule PROG as the base rule, which causes all of the other rules to be executed. Hence exactly one CALL PROG statement is needed to cause an entire program to be parsed.

In the separately compiled Fortran routine, to open the input file set IQINPF in the common block CQCINT (see section 5) to the Fortran unit number and OPEN the file. Similarly, the listing file unit number is given by IQLSTF and the file for the generated code by IQOUTF. The template processor is invoked by the call

```
CALL TPDRV ( IN, ILIST, IOUT )
```

where IN, ILIST, IOUT are the Fortran unit numbers of the input, listing and output files, respectively.

The last segment must be END. It has no values and no actions.

A complete example of a simple PG grammar is:

```
GLOBAL.
  COMMON /ABC/ X, Y, Z
  INTEGER Y
  REAL Z(10)
  $(IQSPMX) = 2000
MAIN.
  $(I(COUNT)) = 0
  CALL PPINIT
  CALL PROG
PROG -> 'OPTION.' ALFNUM+ '=' ALFNUM+
     $(S2) = $4
     $(I(COUNT)) = $(I(COUNT)) + 1
     -> 'OPTION.' ALFNUM+
     $L(S2) = .TRUE.
     $(I(COUNT)) = $(I(COUNT)) + 1
END.
```

5. PG Internals

In this section we give a description of the data structures used by PG generated programs.

Most PG routines manipulate a character stack stored in CQSTCK. Character strings are pushed onto the stack using the routine QQPUSH. Strings are removed from the stack by resetting the pointer IQSP. if the rule fails. The action CLEAR resets the pointer to 1.

```
/QQCSTK/ IQSP     pointer to next free location in CQSTCK
IQSPMX     dimensioned size of CQSTCK
```
/QQCCST/  CQSTCK         matched characters

All PG routines get their input through the routine QQGTCH. It maintains a circular buffer of the characters read. The data structures for this buffer are

/QQCINP/  IQBFLG     for use by input routine
         IQNXIN     pointer to next character in CQBFIN to be returned
         IQINB1     pointer to first valid character in CQSTCK
         IQINB2     pointer to last valid character in CQSTCK
         IQMNIN     dimensioned size of CQBFIN
/QQCBIN/  CQBFIN     input characters

The pointer IQINB1 is moved only the the CLEAR action. The characters between IQINB1 and IQNXIN have been tentatively matched; they can be put back into the input queue by adjusting IQNXIN. PG built-in and generated rules save the pointer IQNXIN on entry. If the rule fails then IQNXIN is reset to its initial value.

When IQNXIN reaches IQINB2 the routine QQINPT is called to input the next line. It calls QQREAD to get the next line, prints the line, skips lines beginning with a comment character and adds the end-of-line marker if the previous line did not end with the continuation character. QQREAD calls UTIORD to get the line and strips trailing blanks. All input for PG programs (including input for the template processor) is done through UTIORD. The data structures used by these routines are

/CQCINT/  IQLEVEL     output listing level
         IQINFF     input file unit number
         IQOUTF     output file unit number
         IQLSTF     listing file unit number
         IQCEOL     number of characters used by end-of-line marker
/CQCCHR/  CQCEOL     end-of-line marker
/CQCCIN/  CQCOMT     comment character
/CQCNTN/  CQCNIN     continuation character
/QQCLOG/  LQERR       .TRUE. if the current rule has failed
         LQEOL       .TRUE. if current character is an end-of-line
         LQFATL      .TRUE. if a fatal error is flagged by the ERROR() action statement

6. Installing PG

The PG distribution tape contains the following files:
1  CSD-TR 405
2  PGLIB1.F
3  PGLIB2.F
4  PGDRIV.F
The files PGLIB1.F and PGLIB2.F together are a library of Fortran routines needed by PG and by the programs generated by PG. They should be compiled and made into a single object module library called PGLIB.

The file PGDRIV.F contains the OPEN statements needed by PG. It may need to be changed on some systems. The file PG.F contains the main PG routines and was itself generated by PG. PGDRIV.F and PG.F should be compiled and link-edited with PGLIB to produce the executable file PG.

The file SYMBOLS is used by PG when it executes. (An OPEN statement in PGDRIV.F refers to it). The file PG.G is the grammar that was used to produce PG.F. Executing PG with PG.G as input should produce PG.F as output.

References:

J. Brophy, PG - A preprocessor generator. Computer Science Dept., Purdue University, CSD-TR405, 1982.

J. Rice and W. Ward, A simple macro processor, Computer Science Dept., Purdue University, CSD-TR400, 1982.