# The PKtoGF processor

(Version 1.1, 22 April 2020)

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2* The *banner* string defined here should be changed whenever *PKtoGF* gets modified. You should update the preamble comment as well.

```plaintext
define my_name ≡ 'pktogf'
define banner ≡ 'This is PKtoGF, Version 1.1'  { printed when the program starts }
define preamble_comment ≡ 'PKtoGF 1.1 output'
define comm_length ≡ 17
```

4* Both the input and output come from binary files. On line interaction is handled through Pascal’s standard *input* and *output* files. For C compilation terminal input and output is directed to *stdin* and *stdout*. In this program there is no terminal input. Since the terminal output is really not very interesting, it is produced only when the `-v` command line flag is presented.

```plaintext
define print Ln(#) ≡
if verbose then write Ln(output, #)
define print (#) ≡
if verbose then write(output, #)
```

```plaintext
program PKtoGF(input, output);
const (Constants in the outer block 6*)
type (Types in the outer block 9)
var (Globals in the outer block 11)
  ⟨Define parse_arguments 74*⟩
procedure initialize;  { this procedure gets things started properly }
  var i: integer;  { loop index for initializations }
  begin kpse_set_program_name(argv[0], my_name); kpse_init_prog("PKTOGF", 0, nil, nil);
  parse_arguments; print Ln(banner);
  ⟨Set initial values 12⟩
end;
```

5* This module is deleted, because it is only useful for a non-local goto, which we don’t use in C.

6* These constants determine the maximum length of a file name and the length of the terminal line, as well as the maximum number of run counts allowed per line of the *GF* file. (We need this to implement repeat counts.)

```plaintext
⟨Constants in the outer block 6*⟩≡
MAX_COUNTS = 400;  { initial number of run counts in a raster line }
```

This code is used in section 4*.

8* It is possible that a malformed packed file (heaven forbid!) or some other error might be detected by this program. Such errors might occur in a deeply nested procedure, so we might want to *abort* the program with an error message.

```plaintext
define abort(#) ≡
begin verbose ← true; print Ln(#); uexit(1);
end
```
The original Pascal compiler was designed in the late 60s, when six-bit character sets were common, so it did not make provision for lower case letters. Nowadays, of course, we need to deal with both upper and lower case alphabets in a convenient way, especially in a program like GFtoPK. So we shall assume that the Pascal system being used for GFtoPK has a character set containing at least the standard visible characters of ASCII code ("!" through ";").

Some Pascal compilers use the original name char for the data type associated with the characters in text files, while other Pascals consider char to be a 64-element subrange of a larger data type that has some other name. In order to accommodate this difference, we shall use the name text_char to stand for the data type of the characters in the output file. We shall also assume that text_char consists of the elements chr(first_text_char) through chr(last_text_char), inclusive. The following definitions should be adjusted if necessary.

```plaintext
define char ≡ 0 .. 255  { the data type of characters in text files }
define text_char ≡ char  { ordinal number of the smallest element of text_char }
define first_text_char = 0  { ordinal number of the smallest element of text_char }
define last_text_char = 127 { ordinal number of the largest element of text_char }
⟨Types in the outer block 9⟩ +≡
text_file = packed file of text_char;
```
The final algorithm for decoding the run counts based on the above scheme might look like this, assuming a procedure called \texttt{pk\_nyb} is available to get the next nybble from the file, and assuming that the global \texttt{repeat\_count} indicates whether a row needs to be repeated. Note that this routine is recursive, but since a repeat count can never directly follow another repeat count, it can only be recursive to one level.

\begin{verbatim}
(Packed number procedure 30*) ≡ 
function \texttt{pk\_packed\_num}: integer;
  var i, j: integer;
  begin i ← get\_nyb;
    if i = 0 then
      begin repeat j ← get\_nyb; incr(i);
        until j ≠ 0;
        while i > 0 do
          begin j ← j * 16 + get\_nyb; decr(i);
            end;
          pk\_packed\_num ← j - 15 + (13 - dyn\_f) * 16 + dyn\_f;
        end
    else if i ≤ dyn\_f then pk\_packed\_num ← i
    else if i < 14 then pk\_packed\_num ← (i - dyn\_f - 1) * 16 + get\_nyb + dyn\_f + 1
    else begin if i = 14 then repeat\_count ← pk\_packed\_num
      else repeat\_count ← 1;
      pk\_packed\_num ← pk\_packed\_num;
    end;
  end;

This code is used in section 62.
\end{verbatim}
To prepare these files for input, we reset them. An extension of Pascal is needed in the case of gf_file, since we want to associate it with external files whose names are specified dynamically (i.e., not known at compile time). The following code assumes that \( \text{reset}(f, s) \) does this, when \( f \) is a file variable and \( s \) is a string variable that specifies the file name. If \( \text{eof}(f) \) is true immediately after \( \text{reset}(f, s) \) has acted, we assume that no file named \( s \) is accessible.

In C, we do path searching based on the user’s environment or the default path, via the Kpathsea library.

```plaintext
procedure open_pk_file;  \{ prepares to read packed bytes in pk_file \}
begin
  \{ Don't use kpse_find_pk; we want the exact file or nothing. \}
  pk_name ← cmdline(optind); pk_file ← kpse_open_file(cmdline(optind), kpse_pk_format);
  if pk_file then
    begin cur_loc ← 0; end;
end;

procedure open_gf_file;  \{ prepares to write packed bytes in gf_file \}
begin
  \{ If an explicit output filename isn't given, we construct it from pk_name. \}
  if optind + 1 = argc then
    begin gf_name ← basename_change_suffix(pk_name, `pk`, `gf`); end
  else begin gf_name ← cmdline(optind + 1); end;
  rewritebin(gf_file, gf_name); gf_loc ← 0;
end;
```

No arbitrary limit on filename length.

\[ \langle \text{Globals in the outer block} \rangle +≡ \]
\[ 
gf_name, pk_name: \text{c-string}; \{ \text{names of input and output files} \} 

gf_loc, pk_loc: \text{integer}; \{ \text{how many bytes have we sent?} \} 
\]

Byte output is handled by a C definition.

```plaintext
define gf_byte(#) ≡
  begin put_byte(#, gf_file); incr(gf_loc) end
```
43* We shall use a set of simple functions to read the next byte or bytes from \textit{pk\_file}. There are seven possibilities, each of which is treated as a separate function in order to minimize the overhead for subroutine calls.

\begin{verbatim}
define pk_byte ≡ get_byte
define pk_loc ≡ cur_loc

function get_byte: integer;  \{ returns the next byte, unsigned \}
  var b: eight_bits;
  begin if eof (pk_file) then get_byte ← 0
    else begin read(pk_file, b); incr(cur_loc); get_byte ← b;
    end;
  end;

function signed_byte: integer;  \{ returns the next byte, signed \}
  var b: eight_bits;
  begin read(pk_file, b); incr(cur_loc);
    if b < 128 then signed_byte ← b else signed_byte ← b − 256;
  end;

function get_two_bytes: integer;  \{ returns the next two bytes, unsigned \}
  var a, b: eight_bits;
  begin read(pk_file, a); read(pk_file, b); cur_loc ← cur_loc + 2;
    get_two_bytes ← a * 256 + b;
  end;

function signed_pair: integer;  \{ returns the next two bytes, signed \}
  var a, b: eight_bits;
  begin read(pk_file, a); read(pk_file, b); cur_loc ← cur_loc + 2;
    if a < 128 then signed_pair ← a * 256 + b
      else signed_pair ← (a − 256) * 256 + b;
  end;

function get_three_bytes: integer;  \{ returns the next three bytes, unsigned \}
  var a, b, c: eight_bits;
  begin read(pk_file, a); read(pk_file, b); read(pk_file, c);
    cur_loc ← cur_loc + 3;
    get_three_bytes ← (a * 256 + b) * 256 + c;
  end;

function signed_trio: integer;  \{ returns the next three bytes, signed \}
  var a, b, c: eight_bits;
  begin read(pk_file, a); read(pk_file, b); read(pk_file, c);
    cur_loc ← cur_loc + 3;
    if a < 128 then signed_trio ← (a * 256 + b) * 256 + c
      else signed_trio ← ((a − 256) * 256 + b) * 256 + c;
  end;

function signed_quad: integer;  \{ returns the next four bytes, signed \}
  var a, b, c, d: eight_bits;
  begin read(pk_file, a); read(pk_file, b); read(pk_file, c);
    read(pk_file, d); cur_loc ← cur_loc + 4;
    if a < 128 then signed_quad ← ((a * 256 + b) * 256 + c) * 256 + d
      else signed_quad ← (((a − 256) * 256 + b) * 256 + c) * 256 + d;
  end;
\end{verbatim}
We put definitions here to access the DVItype functions supplied above. (*signed_byte* is already taken care of).

\[
\begin{align*}
\text{define } & \text{get}_{16} \equiv \text{get\_two\_bytes} \\
\text{define } & \text{signed}_{16} \equiv \text{signed\_pair} \\
\text{define } & \text{get}_{32} \equiv \text{signed\_quad}
\end{align*}
\]

As we are writing the GF file, we often need to write signed and unsigned, one, two, three, and four-byte values. These routines give us that capability.

\[
\begin{align*}
\text{procedure } & \text{gf}_{16}(i : \text{integer}); \\
\text{begin } & \text{gf\_byte}(i \div 256); \text{gf\_byte}(i \mod 256); \\
\text{end}
\end{align*}
\]

\[
\begin{align*}
\text{procedure } & \text{gf}_{24}(i : \text{integer}); \\
\text{begin } & \text{gf\_byte}(i \div 65536); \text{gf}_{16}(i \mod 65536); \\
\text{end}
\end{align*}
\]

\[
\begin{align*}
\text{procedure } & \text{gf\_quad}(i : \text{integer}); \\
\text{begin } & \text{if } i \geq 0 \text{ then} \\
\text{begin } & \text{gf\_byte}(i \div 16777216); \\
\text{end } & \text{else begin } \{ i < 0 \text{ at this point, but a compiler is permitted to rearrange the order of the additions, which would cause wrong results in the unlikely event of a non-2’s-complement representation. } \} \\
\text{begin } & i \leftarrow i + 1073741824; \ i \leftarrow i + 1073741824; \ \text{gf\_byte}(128 + (i \div 16777216)); \\
\text{end } & \text{gf}_{24}(i \mod 16777216); \\
\text{end}
\end{align*}
\]
Now we read and check the preamble of the PK file. In the preamble, we find the \( hppp \), \( design\_size \), \( checksum \). We write the relevant parameters to the GF file, including the preamble comment.

\[
\text{(Read preamble 49*)} \equiv \\
\text{if } pk\_byte \neq pk\_pre \text{ then } \text{abort(‘Bad pk file! pre command missing.’);} \\
\text{gf\_byte(pre);} \\
\text{if } pk\_byte \neq pk\_id \text{ then } \text{abort(‘Wrong version of packed file!’);} \\
\text{gf\_byte(gf\_id\_byte);} \\
\text{for } i \leftarrow 1 \text{ to } j \\
\text{begin } hppp \leftarrow pk\_byte; \text{ gf\_byte(hppp); print(xchr[xord[hppp]]);} \\
\text{end;} \\
\text{print\_ln(‘{’);} \\
\text{end;} \\
\text{design\_size \leftarrow get\_32; checksum \leftarrow get\_32; hppp \leftarrow get\_32; vppp \leftarrow get\_32;} \\
\text{if } hppp \neq vppp \text{ then } \text{print\_ln(‘Warning: aspect ratio not 1:1!’);} \\
\text{magnification \leftarrow round(hppp * 72.27 * 5/65536); last\_eoc \leftarrow gf\_loc}
\]

This code is used in section 73*.

\[
\text{(Set initial values 12* +)} \\
\text{row\_counts \leftarrow xmalloc\_array(integer, MAX\_COUNTS); max\_counts \leftarrow MAX\_COUNTS} \\
\]

Now, the globals to help communication between these procedures, and a buffer for the raster row counts.

\[
\text{(Globals in the outer block 11* +)} \\
\text{input\_byte: eight\_bits; } \{ \text{the byte we are currently decimating} \} \\
\text{bit\_weight: eight\_bits; } \{ \text{weight of the current bit} \} \\
\text{max\_counts: integer;} \\
\text{row\_counts: integer; } \{ \text{where the row is constructed} \} \\
\text{rcp: integer; } \{ \text{the row counts pointer} \} 
\]
§65* And the main procedure.

\[(\text{Read and translate raster description } 65^*) \equiv\]
\[
\text{if } (c_{\text{width}} > 0) \land (c_{\text{height}} > 0) \text{ then}
\]
\[
\begin{align*}
\text{begin} & \quad \text{bit\_weight} \leftarrow 0; \quad \text{count\_down} \leftarrow c_{\text{height}} \times c_{\text{width}} - 1; \\
\text{if } & \quad \text{dyn\_f} = 14 \text{ then } \text{turn\_on} \leftarrow \text{get\_bit}; \\
\text{repeat\_count} & \leftarrow 0; \quad x_{\text{to\_go}} \leftarrow c_{\text{width}}; \quad y_{\text{to\_go}} \leftarrow c_{\text{height}}; \quad \text{cur\_n} \leftarrow c_{\text{height}}; \quad \text{count} \leftarrow 0; \\
\text{first\_on} & \leftarrow \text{turn\_on}; \quad \text{turn\_on} \leftarrow \neg \text{turn\_on}; \quad rcp \leftarrow 0; \\
\text{while } & \quad y_{\text{to\_go}} > 0 \text{ do} \\
\text{begin } & \quad \text{if } \text{count} = 0 \text{ then } \langle \text{Get next count value into count } 64 \rangle; \\
\text{if } & \quad \text{rcp} = 0 \text{ then } \text{first\_on} \leftarrow \text{turn\_on}; \\
\text{while } & \quad \text{count} \geq x_{\text{to\_go}} \text{ do} \\
\text{begin } & \quad \text{row\_counts}[rcp] \leftarrow x_{\text{to\_go}}; \quad \text{count} \leftarrow \text{count} - x_{\text{to\_go}}; \\
\text{for } & \quad i \leftarrow 0 \text{ to repeat\_count} \text{ do} \\
\text{begin } & \quad \langle \text{Output row } 66 \rangle; \\
\text{y_{to\_go}} & \leftarrow y_{\text{to\_go}} - 1; \\
\text{end}; \\
\text{repeat\_count} & \leftarrow 0; \quad x_{\text{to\_go}} \leftarrow c_{\text{width}}; \quad rcp \leftarrow 0; \\
\text{if } & \quad (\text{count} > 0) \text{ then } \text{first\_on} \leftarrow \text{turn\_on}; \\
\text{end}; \\
\text{if } & \quad \text{count} > 0 \text{ then} \\
\text{begin } & \quad \text{row\_counts}[rcp] \leftarrow \text{count}; \\
\text{if } & \quad \text{rcp} = 0 \text{ then } \text{first\_on} \leftarrow \text{turn\_on}; \\
\text{rcp} & \leftarrow \text{rcp} + 1; \\
\text{if } & \quad \text{rcp} > \text{max\_counts} \text{ then} \\
\text{begin } & \quad \text{println}(\text{`Reallocated\_row\_counts\_array\_to\_\text{array}`}, (\text{max\_counts} + \text{MAX\_COUNTS}) : 1, \\
\text{`\items_{\text{item}} from \text{item}`}, \text{max\_counts} : 1, \text{`\text{item}`}); \quad \text{max\_counts} \leftarrow \text{max\_counts} + \text{MAX\_COUNTS}; \\
\text{row\_counts} & \leftarrow \text{xrealloc\_array}(\text{row\_counts}, \text{integer}, \text{max\_counts}); \\
\text{end}; \\
\text{x_{to\_go}} & \leftarrow x_{\text{to\_go}} - \text{count}; \quad \text{count} \leftarrow 0; \\
\text{end}; \\
\text{end}; \\
\text{end}\]

This code is used in section 47.
Terminal communication. Since this program runs entirely on command-line arguments, there is no terminal communication.

pktogf.web has a dialog procedure here.
73* The main program. Now that we have all the pieces written, let us put them together.

```
begin initialize; (Open files 44);
(Read preamble 49*)
skip_specials;
while flag_byte ≠ pk_post do
  begin (Unpack and write character 47);
    skip_specials;
  end;
while ¬eof (pk_file) do i ← pk_byte;
(Write GF postamble 68);
print_ln(pk_loc : 1,"bytes unpacked to",gf_loc : 1,"bytes.");
end.
```
74* System-dependent changes. Parse a Unix-style command line.

```plaintext
define argument_is(#) ≡ (strcmp(long_options[option_index].name, #) = 0)
(Define parse_arguments 74*)
procedure parse_arguments;
  const n_options = 3; {Pascal won't count array lengths for us.}
  var long_options: array [0..n_options] of getopt_struct;
    getopt_return_val: integer; option_index: c_int_type; current_option: 0..n_options;
begin (Initialize the option variables 79*);
  (Define the option table 75*);
repeat getopt_return_val ← getopt_long_only(argc, argv, ``, long_options, address_of(option_index));
  if getopt_return_val = −1 then
    begin do nothing; {End of arguments; we exit the loop below.}
  end
else if getopt_return_val = `?` then
  begin usage(my_name);
  end
else if argument_is(`help`) then
  begin usage_help(PKTOGFHELP, nil);
  end
else if argument_is(`version`) then
  begin print_version_and_exit(banner nil, `TomasRokicki`, nil);
  end; { Else it was a flag; getopt has already done the assignment.}
until getopt_return_val = −1; {Now optind is the index of first non-option on the command line. We
  must have one or two remaining arguments.}
if (optind + 1 ≠ argc) ∧ (optind + 2 ≠ argc) then
  begin write_line(err, my_name, `::Need_one_or_two_file_arguments.`); usage(my_name);
  end;
end;
This code is used in section 4*.
```

75* Here are the options we allow. The first is one of the standard GNU options.

```
(Define the option table 75*)
  current_option ← 0; long_options[current_option].name ← `help``;
  long_options[current_option].has_arg ← 0; long_options[current_option].flag ← 0;
  long_options[current_option].val ← 0; incr(current_option);
See also sections 76*, 77*, and 80*.
This code is used in section 74*.
```

76* Another of the standard options.

```
(Define the option table 75*) +≡
  long_options[current_option].name ← `version``; long_options[current_option].has_arg ← 0;
  long_options[current_option].flag ← 0; long_options[current_option].val ← 0; incr(current_option);
```

77* Print progress information?

```
(Define the option table 75*) +≡
  long_options[current_option].name ← `verbose``; long_options[current_option].has_arg ← 0;
  long_options[current_option].flag ← address_of(verbos); long_options[current_option].val ← 1;
  incr(current_option);
```

78* (Globals in the outer block 11) +≡
  verbose: c_int_type;
```
§79  PK to GF changes for C

§79*  (Initialize the option variables $79^*$) $\equiv$
\[
\text{verbose} \leftarrow \text{false};
\]
This code is used in section 74*.

80*  An element with all zeros always ends the list.

(Define the option table $75^*$) $\equiv$
\[
\begin{align*}
\text{long_options} & [\text{current_option}].\text{name} \leftarrow 0; \\
\text{long_options} & [\text{current_option}].\text{has_arg} \leftarrow 0; \\
\text{long_options} & [\text{current_option}].\text{flag} \leftarrow 0; \\
\text{long_options} & [\text{current_option}].\text{val} \leftarrow 0;
\end{align*}
\]
The following sections were changed by the change file: 2, 4, 5, 6, 8, 10, 30, 40, 41, 42, 43, 45, 46, 49, 51, 53, 65, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81.

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