

# 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.

```

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.

```

define print_ln(#) ≡
    if verbose then write_ln(output, #)
define print(#) ≡
    if verbose then write(output, #)

```

```

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.)

```

< 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.

```

define abort(#) ≡
    begin verbose ← true; print_ln(#); uexit(1);
end

```

**10\*** 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.

**define** *char*  $\equiv$  0 .. 255

**define** *text\_char*  $\equiv$  *char* { the data type of characters in text files }

**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⟩ + $\equiv$

*text\_file* = **packed file of** *text\_char*;

**30\*** The final algorithm for decoding the run counts based on the above scheme might look like this, assuming a procedure called *pk\_nyb* is available to get the next nybble from the file, and assuming that the global *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.

⟨Packed number procedure 30\*⟩ ≡

```

function 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.

**40\*** 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 '*reset(f,s)*' does this, when *f* is a file variable and *s* is a string variable that specifies the file name. If *eof(f)* is true immediately after *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.

```

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;

```

**41\*** No arbitrary limit on filename length.

⟨ Globals in the outer block 11 ⟩ +≡

*gf\_name, pk\_name*: *c\_string*; { names of input and output files }  
*gf\_loc, pk\_loc*: *integer*; { how many bytes have we sent? }

**42\*** Byte output is handled by a C definition.

```

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 *pk\_file*. There are seven possibilities, each of which is treated as a separate function in order to minimize the overhead for subroutine calls.

```

define pk_byte  $\equiv$  get_byte
define pk_loc  $\equiv$  cur_loc

function get_byte: integer; { returns the next byte, unsigned }
  var b: eight_bits;
  begin if eof(pk_file) then get_byte  $\leftarrow$  0
  else begin read(pk_file, b); incr(cur_loc); get_byte  $\leftarrow$  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  $\leftarrow$  b else signed_byte  $\leftarrow$  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  $\leftarrow$  cur_loc + 2; get_two_bytes  $\leftarrow$  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  $\leftarrow$  cur_loc + 2;
  if a < 128 then signed_pair  $\leftarrow$  a * 256 + b
  else signed_pair  $\leftarrow$  (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  $\leftarrow$  cur_loc + 3;
  get_three_bytes  $\leftarrow$  (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  $\leftarrow$  cur_loc + 3;
  if a < 128 then signed_trio  $\leftarrow$  (a * 256 + b) * 256 + c
  else signed_trio  $\leftarrow$  ((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  $\leftarrow$  cur_loc + 4;
  if a < 128 then signed_quad  $\leftarrow$  ((a * 256 + b) * 256 + c) * 256 + d
  else signed_quad  $\leftarrow$  (((a - 256) * 256 + b) * 256 + c) * 256 + d;
  end;

```

**45\*** We put definitions here to access the `DVItype` functions supplied above. (*signed\_byte* is already taken care of).

```
define get_16  $\equiv$  get_two_bytes
define signed_16  $\equiv$  signed_pair
define get_32  $\equiv$  signed_quad
```

**46\*** 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.

```
procedure gf_16(i : integer);
  begin gf_byte(i div 256); gf_byte(i mod 256);
  end;

procedure gf_24(i : integer);
  begin gf_byte(i div 65536); gf_16(i mod 65536);
  end;

procedure gf_quad(i : integer);
  begin if i  $\geq$  0 then
    begin gf_byte(i div 16777216);
    end
  else begin { i < 0 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. }
    i  $\leftarrow$  i + 1073741824; i  $\leftarrow$  i + 1073741824; gf_byte(128 + (i div 16777216));
    end;
  gf_24(i mod 16777216);
  end;
```

**49\*** 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.

```

⟨Read preamble 49*⟩ ≡
  if pk_byte ≠ pk_pre then abort(˘Bad_pk_file!_pre_command_missing.˘);
  gf_byte(pre);
  if pk_byte ≠ pk_id then abort(˘Wrong_version_of_packed_file!.˘);
  gf_byte(gf_id_byte); j ← pk_byte; gf_byte(j); print(˘{˘);
  for i ← 1 to j do
    begin hppp ← pk_byte; gf_byte(hppp); print(xchr[xord[hppp]]);
    end;
  print_ln(˘}˘); design_size ← get_32; checksum ← get_32; hppp ← get_32; vppp ← get_32;
  if hppp ≠ vppp then print_ln(˘Warning:_aspect_ratio_not_1:1!˘);
  magnification ← round(hppp * 72.27 * 5/65536); last_eoc ← gf_loc

```

This code is used in section 73\*.

```

51* ⟨Set initial values 12⟩ +≡
  row_counts ← xmalloc_array(integer, MAX_COUNTS); max_counts ← MAX_COUNTS;

```

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

```

⟨Globals in the outer block 11⟩ +≡
input_byte: eight_bits; { the byte we are currently decimating }
bit_weight: eight_bits; { weight of the current bit }
max_counts: integer;
row_counts: ↑integer; { where the row is constructed }
rcp: integer; { the row counts pointer }

```



**65\*** And the main procedure.

⟨Read and translate raster description 65\*⟩ ≡

```

if (c_width > 0) ∧ (c_height > 0) then
  begin bit_weight ← 0; count_down ← c_height * c_width - 1;
  if dyn_f = 14 then turn_on ← get_bit;
  repeat_count ← 0; x_to_go ← c_width; y_to_go ← c_height; cur_n ← c_height; count ← 0;
  first_on ← turn_on; turn_on ← ¬turn_on; rcp ← 0;
  while y_to_go > 0 do
    begin if count = 0 then ⟨Get next count value into count 64⟩;
    if rcp = 0 then first_on ← turn_on;
    while count ≥ x_to_go do
      begin row_counts[rcp] ← x_to_go; count ← count - x_to_go;
      for i ← 0 to repeat_count do
        begin ⟨Output row 66⟩;
        y_to_go ← y_to_go - 1;
        end;
      repeat_count ← 0; x_to_go ← c_width; rcp ← 0;
      if (count > 0) then first_on ← turn_on;
      end;
    if count > 0 then
      begin row_counts[rcp] ← count;
      if rcp = 0 then first_on ← turn_on;
      rcp ← rcp + 1;
      if rcp > max_counts then
        begin print_ln(‘Reallocated_row_counts_array_to_’, (max_counts + MAX_COUNTS) : 1,
          ‘_items_from_’, max_counts : 1, ‘.’); max_counts ← max_counts + MAX_COUNTS;
          row_counts ← xrealloc_array(row_counts, integer, max_counts);
          end;
        x_to_go ← x_to_go - count; count ← 0;
        end;
      end;
    end;
  end

```

This code is used in section 47.

**71\* Terminal communication.** Since this program runs entirely on command-line arguments, there is no terminal communication.

**72\*** `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.

```

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(PKTOGF_HELP, nil);
        end
    else if argument_is(`version`) then
        begin print_version_and_exit(banner, nil, `Tomas_Rokicki`, 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_ln(stderr, 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(verbose); long_options[current_option].val ← 1;
    incr(current_option);

```

**78\*** ⟨Globals in the outer block 11⟩ +≡

```

verbose: c_int_type;

```

**79\***  $\langle$  Initialize the option variables 79\*  $\rangle \equiv$   
*verbose*  $\leftarrow$  *false*;

This code is used in section 74\*.

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

$\langle$  Define the option table 75\*  $\rangle + \equiv$   
*long\_options*[*current\_option*].*name*  $\leftarrow$  0; *long\_options*[*current\_option*].*has\_arg*  $\leftarrow$  0;  
*long\_options*[*current\_option*].*flag*  $\leftarrow$  0; *long\_options*[*current\_option*].*val*  $\leftarrow$  0;

**81\* Index.** Pointers to error messages appear here together with the section numbers where each identifier is used.

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