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A MAP Fixed-Point, Packing-Unpacking Routine for the IBM 7094 Computer

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ABSTRACT: Two MAP (Macro Assembly Program) computer routines for packing and unpacking fixed point data are described. Use of these routines with Fortran IV Programs provides speedy access to quantities of data which far exceed the normal storage capacity of IBM 7000-series computers. Many problems that could not be attempted because of the slow access-speed of tape memory can be attacked in this manner.

Computer programers working on problems in the physical sciences are often faced with massive quantities of data. And they must have quick and direct access to these data. Often, the acquisition methods used and computations performed permit accuracy of only two or three significant figures. Further, if the range of the data covers only one or two orders of magnitude, scaling may be used to allow data-items to be carried in fixed-point.

For example, such meteorological data as temperature, humidity, wind direction and speed, and pressure may be expressed in only three digits, if appropriate scaling and coding are applied. Thus, if such data were stored in the conventional manner, about eight digits (octal) would be wasted out of each IBM 7000-series-computer word.

If the data and logic of the problem permit, much storage space can be saved by using packing-and-unpacking routines to use each computer word for the storage of two, three, four, or even six fields of data. By manipulating data, a field may be entered or removed from a computer word without disturbing the other fields.

This note describes two MAP (Macro Assembly Program) packing and unpacking routines, usable with Fortan IV programs, on the IBM 7090 and 7094 computers.

The Routines

The two routines, whose entry points are called PACK and UNPACK, are quite similar. Both use an "internal" routine, called SETUP, to calculate field width, determine the proper amounts of shift necessary to accomplish the packing and unpacking, and check the field specifications for errors.

The calling sequence is similar for both routines:

CALL PACK (No. of Fields, New Data, Pack-Word, Field Position)

(1) No. of Fields — literal integer specifying the defined number of fields in each packed word.

(2) New Data — variable name from which the data-field is to be taken and packed into Pack-Word.

(3) Pack-Word — variable name into which the desired data-field (specified by New Data) is to be packed.

(4) Field Position — variable name containing the field number into which the data are to be packed.

CALL UNPACK (No. of Fields, Data to be recovered, Pack-Word, Field Position)

The arguments have the same significance as in PACK except that

(5) Data to be recovered is the variable name into which a recovered (unpacked) data field is to be placed.

The routines operate on the specified field, removing or inserting the desired data without affecting the other fields within the specified word. The sign of an integer is ignored in this process, so that special handling of negative numbers is necessary.

The details of the machine operations used to accomplish the packing and unpacking are available by writing to the Director, Pacific Southwest Forest and Range Experiment Station, P. O. Box 245, Berkeley, California 94701.

Use

Before these routines can be called, several safeguards must be taken.

- The calling program must include some method that insures that the new data never exceed the field width being used. If negative numbers must be dealt with, a convenient method is the "excess" system. Suppose, for example, that we wished to pack celsius-temperatures, ranging from -50 to +40 degrees. Three digits (octal) could handle this. Octal 777 is decimal 511. We could leave unchanged all positive (and zero) temperatures and make all negative temperatures "excess 50"; that is, -5 would be coded as 55, -20 as 70, etc.
- The calling program must tell the packing routines which word in the packed array is to receive or give up the data.
- The calling program must specify to the packing routines which field in the packed word is to receive or give up the data.

The use of these routines is best illustrated by an example borrowed from a Fortran IV program:

```
      DIMENSION KPACK (5000)
      DO 238 I=1, 20000
      READ (8) LDUM
      IF (LDUM. GE. 0) GO TO 222
219   IF(LDUM. GE. -50) GO TO 221
220   LDUM = -50
221   LDUM = 50 - LDUM
      GO TO 224
222   IF (LDUM. LE. 40) GO TO 224
223   LDUM = 40
224   KW = ((I-1)/4) +1
      IP = 4- ((4*KW) -I)
      CALL PACK (4, LDUM, KPACK(KW), IP)
238   CONTINUE
```

In this example, 20,000 words of data are to be packed into the array KPACK, four fields per packed-word. The quantity KW is the Pack-Word number. Suppose we wanted to pack the seventh data-item. The fixed-point arithmetic above would result in KW being 2, that is, the seventh data-item is in the second Pack-Word. IP is the field position number. Again, if we wanted to pack the seventh data-item, IP would then be 3--the seventh item occupies the third field in the second Pack-Word.

The steps between the tape-reading and the calculation of KW illustrate the checks and manipulations which would be performed if we were packing celsius-temperatures as described above.

Unpacking these data could be done as follows:

```
      DIMENSION KPACK(5000)
      DO 280 I = 1, 20000
      KW = ((I-1)/4) +1
      IP = 4- ((4*KW) -I
      CALL UNPACK (4, LDUM, KPACK (KW), IP)
      IF (LDUM. LT. 50) GO TO 275
273   LDUM = -(LDUM-50)
275   WRITE (8) LDUM
280   CONTINUE
```

Here the steps necessary to recover the proper value of LDUM from the "excess 50" system described above are evident.

The Author

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