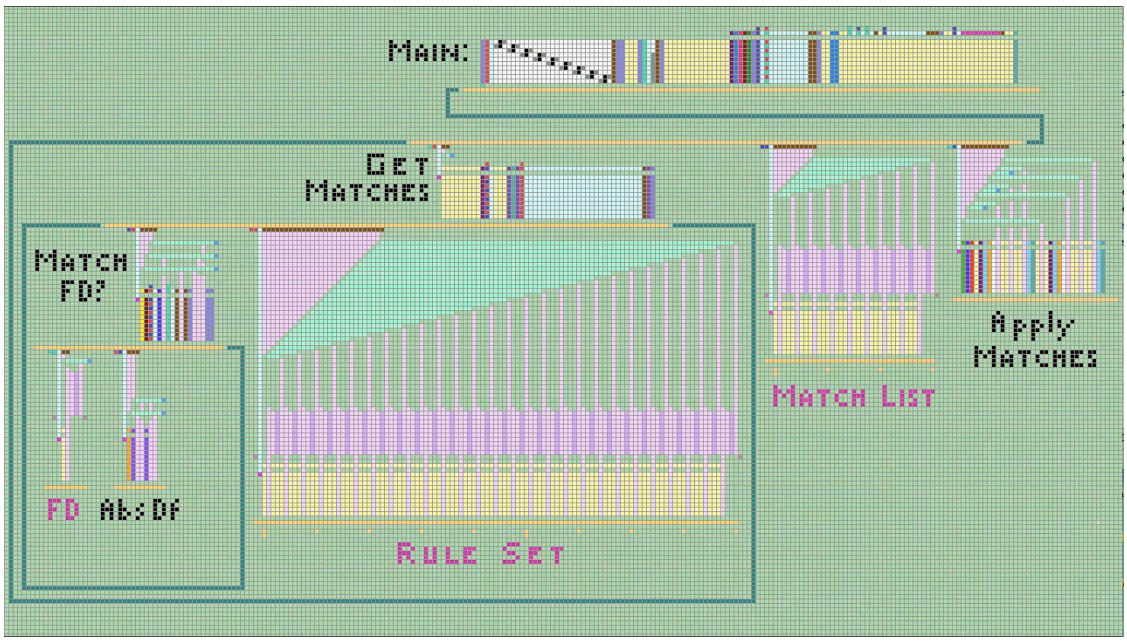
Lisp Glosses for Bitpict-IDR-Bitpict



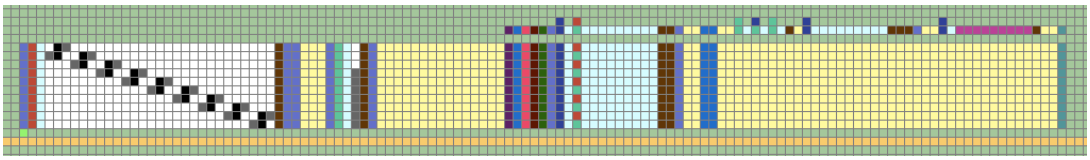
The exercise here was for Bitpict's small pixel rewrites to implement a version of InterDiagrammatic Reasoning (IDR) that was powerful enough to then further a small version of Bitpict itself. More precisely, a 8bit-color-2Dim-Bitpict was used to implement 2Bit-grayscale-1Dim-IDR implementing 2Bit-grayscale-1D-bitpict.

To create a Bitpict version of IDR that can actually do anything serious, it was necessary to create a graphically-represented and graphically-computed high-level language corresponding to the LISP that IDR uses for its conditionals, loops, defuns, etc. The language created is basically a functional programming language, a kind of pseudo-lisp. The videos show various aspects of this machinery in action. The pages here show the "code" in detail, with approximate LISP glosses of the functions used in the Bitpict-IDR-Bitpict implementation.

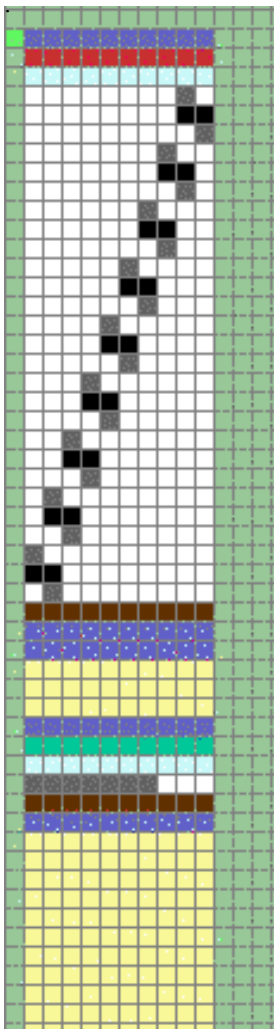
Note that the correspondence to LISP is not exact. For example, built-in operators with a fixed number of arguments do not use any bracketing syntactic markers (where parentheses would appear in LISP). Funcalls do have an *EndBracket*, and Loops have a *Loop-End* marker. Setting a variable is really a function call to a corresponding function. If required, variables can be set to a whole sequence of values; we just present it here as "(Set VarName <values>…)". Also various syntax elements, e.g., for Loops of various kinds, are represented with special colors, which, like the colors for other operators are treated by the language like reserved words. With the exception of the *`divider* marker, they are not quoted in the pseudo-Lisp below. A few columns of color (*'divider* and *emptyspace*) appear in the "code" just for visual separation, to help human visual parsing, much as extra line breaks are used in text-code.

Routine	**Functions Colors**
Main ( )	-
→ GetMatches( )	*Green-Red*
→ Match-FD (*LHS, Mask, RHS*)	*Blue-Red*
→ AbsDiff(*D1,D2*)	*Red-Blue*
→ ApplyMatches(*FD, LHS1, Mask1, RHS1, LHS2, Mask2, RHS2, …)*	*Green-Blue*

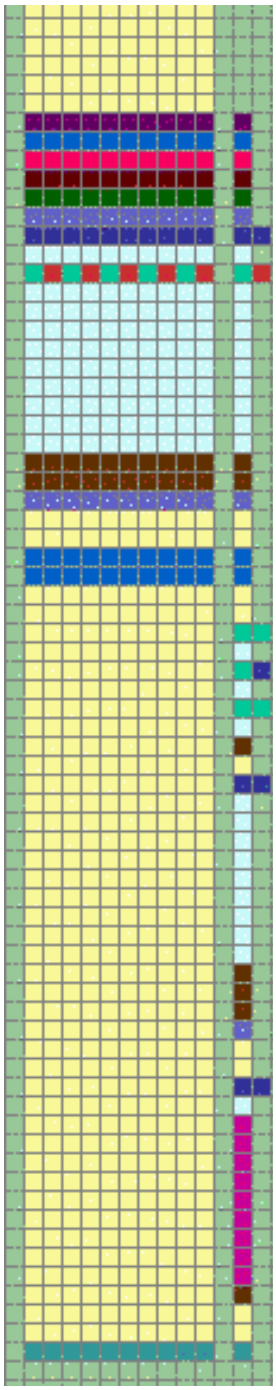
Main ( )



Saves the Ruleset, and the Field Diagram, then iteratively, as long as there are matches, applies those matches to the Field Diagram.



```
('divider   ;;(purely for visual separation)
  (Set RuleSet

     LHS1
     Mask1
     RHS1
     LHS2
     Mask2
     RHS2
     ...









     ...
     LHS9
     Mask9
     RHS9
  )
'divider   ;;(purely for visual separation)
'divider   ;;(purely for visual separation)

           ;;emptyspace (purely for visual separation)

'divider
(Set FD    ;; the Field Diagram

   <the FD>
 )
'divider









           ;; emptyspace
           ;; for results of Loop
```



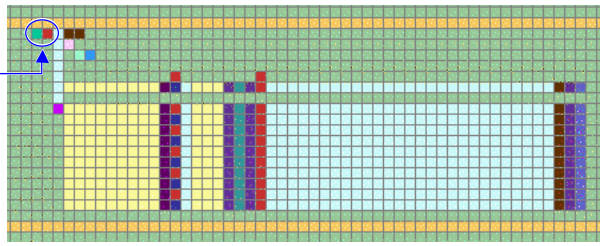
```
          ;; emptyspace
          ;; for results of Loop


(LOOP-BEGIN
  WHILE                   ;;;;Loop while there are matches:
  (BNot                   ;; BooleanNOT (T->F; F->T)
    (NULL-P               ;;
     (EmptyGroupToNull    ;; Built-in returns 0-diag iff nothing btw dividers
     `divider             ;; to begin Group for EmptyGroupToNull
     (Set MatchList
        (GetVariable Matches



                          ;; space for return values from GetMatches



         )                ;; end GetVariable-Matches
     )                    ;; end Set Matchlist
    `divider )))          ;; to end Group for EmptyGroupToNull


    DO                    ;;;;; apply the matches, and reset the match list:


    (SetVariable FD
       (ApplyMatches
          (GetVariable - FD
           )
          (GetVariable - MatchList



                          ;; space for returned MatchList values



          )               ;; end Get Matchlist
       )  ;; end ApplyMatches
    )  ;;end Set
    `divider          ;; for visual separation of successive FD results

    (Set MatchList    ;; resets (unsets) Matchlist


         ...

      <special `reset value>

         ...


    ) ;; end Set (unset) - returns nothing

 LOOP-END)) ;; also end of MAIN
```

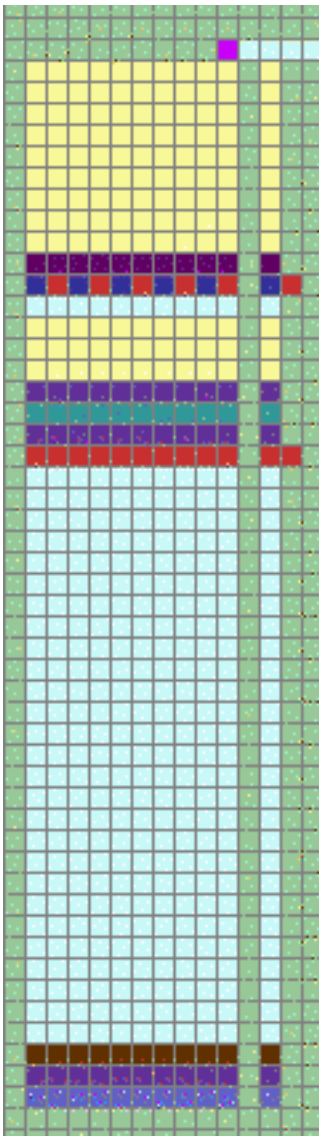
Note that the part of the WHILE loop that comes after the “DO” is refilled whenever the WHILE condition evaluates to TRUE, using the same basic mechanisms used to restore Defuns after they have been executed. That is, rewrite rules use the small color marks (1-2 pixels) to construct the appropriate operator columns (here, rows, because everything is rotated for commenting). Two-pixel marks are needed for what will become function calls (including Get/Set of variables), since user-defined functions are labeled by color pairs.

GetMatches( ) *;;Function Colors: Green-Red*

Takes no arguments.

Returns a sequence containing all the rules that match the Field Diagram.

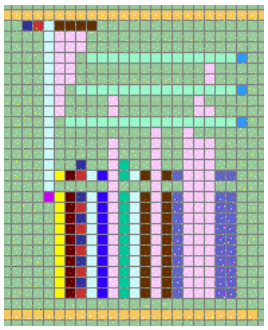




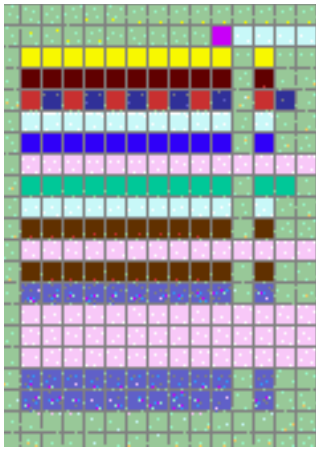
```
;; (Return Data pathway)

;; emptyspace for accumulating results

(LOOP-BEGIN          ;; MAPk passes args, k-at-a-time, to a function
   Match-FD          ;; The function - which takes three args

                     ;; k=3 lines of emptyspace
                     ;;    for MAPk to fill in repeatedly from
                     ;;    the sequence of diagrams that follow
   MAPk-divider      ;; This pattern of three layers marks the end of
   LOOP-divider      ;;    the input arg space for Match-FD and the
   MAPk-divider      ;;    beginning of the sequence to be MAPped over
   (Get RuleSet      ;; GetVariable (special funcall)
                     ;; -- its value (a list of rules, each comprising
                     ;;    three diagrams) will be fed, one rule at a time
                     ;;    (3 diagrams at a time) to Match-FD

                     ;; Space for returned data from
                     ;; Get RuleSet variable

         )           ;; End Get Ruleset
   MAPk-divider      ;;
   LOOP-END))        ;; End of Loop
```

The MAPk loop feeds k diagrams at a time to the specified function. Its syntax is based on a generic LOOP construct that consists of a LOOP-BEGIN, a LOOP-divider, and a LOOP-end. This generic structure invokes rewrites that do generic loop things – like restoring the body of the loop for each iteration, and cleaning up afterwards. The specific behavior of the MAPk loop is invoked by surrounding the LOOP-divider, and preceding the LOOP-end, with a special MAPk-divider color. Then the correct local rewrite rules can be triggered to produce the MAPk behavior.

Match-FD (LHS, Mask, RHS) *;; Function Colors: Blue-Red*



Compares the Field Diagram, masked by the mask, to the LHS of the rule:
If they match, it returns the rule (i.e., the triple: LHS, Mask, RHS).
Otherwise, it returns nothing.



```
                        ;; (Return Data pathway)
(IF-G                   ;; IF/THEN construct working on groups of diagrams
   (NULL-P              ;; Returns TRUE iff following diagram is null diagram
     (AbsDiff           ;; Returns null diagrams iff its two argument
                        ;;    diagrams are equal
         (AND           ;; Built-in IDR AND operator
            Arg2        ;; ← Mask
            (Get FD     ;; GetVariable (special funcall)
                        ;;
          ))            ;; (end Get FD)(end AND)
          Arg1          ;; ← LHS
    ))                  ;; (end AbsDiff) (end NULL-P)
   `divider             ;; Marks beginning of THEN
    Arg1                ;; ← LHS
    Arg2                ;; ← Mask
    Arg3                ;; ← RHS
   `divider             ;; Marks beginning of ELSE
   `divider  )          ;; Marks end of IF, also is end of Match-FD
```

This uses the IF-G (IF for Groups) construct. Its syntax is:

```
IF-G color (a particular yellow)
Predicate  (must evaluate to T/F)
`divider
 Group_of_Diagrams_1
`divider
 Group_of_Diagrams_2
`divider
```

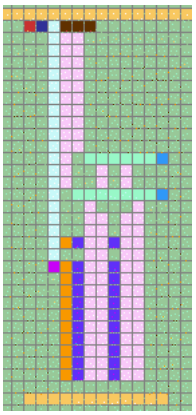
If the predicate evaluates to TRUE, it evaluates to the first group, otherwise it evaluates to the second group. Either group may be just a literal sequence of diagrams, or somehow computed.

FYI: It is a more complicated version of the simple IF:

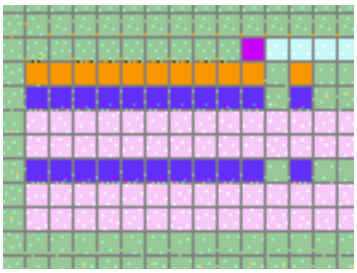
```
IF color  (a slightly different yellow)
Predicate (must evaluate to T/F)
Diagram1
Diagram2
```

The simple IF returns Diagram1 if the predicate is TRUE, and Diagram2 otherwise.

AbsDiff(D1,D2) *;; Function Colors: Red-Blue*

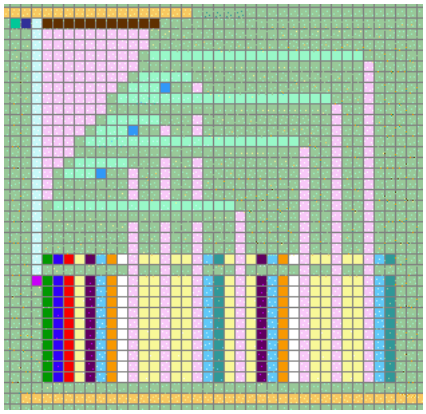


Computes the pixel-by-pixel absolute difference between two diagrams.
The result is the null (0) diagram, iff the two are equal.



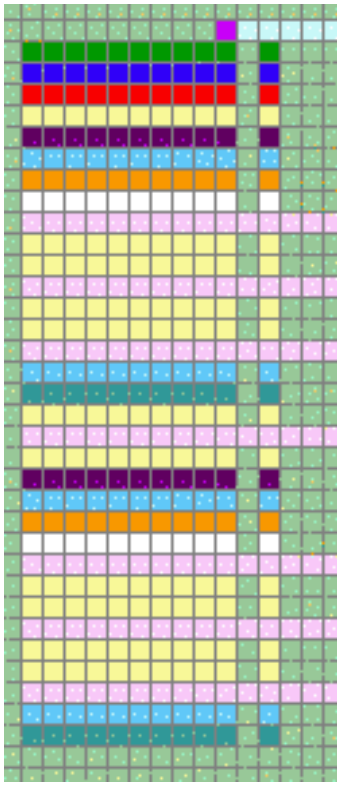
```
                    ;; (Return Data pathway)
(OVELAY             ;; Built-in IDR OVERLAY operator
  (PEEL             ;; Built-in IDR PEEL operator
     Arg1           ;; ← LHS
     Arg2           ;; ← Mask
  (PEEL             ;; Built-in IDR PEEL operator
     Arg2           ;; ← LHS
     Arg1))         ;; ← Mask
```

The arguments are placed correctly by the cross-bar switch, seen in the diagram upper right.



ApplyMatches(FD, LHS1, Mask1, RHS1, LHS2, Mask2, RHS2, …)
Function Colors: Green-Blue

Applies up to three matched rules to the Field Diagram, FD.
Returns the new Field Diagram.



```
                    ;; (Return Data pathway)
(OR                 ;; Built-in IDR OR operator
   (AND             ;; Built-in IDR AND operator
     (NOT           ;; Built-in IDR NOT operator

       (LOOP-BEGIN  ;; This layer and the next mark the beginning
        ACCUM-Loop  ;;   of an Accumulate loop
         OVERLAY    ;;
         0-diagram  ;;
         Arg3       ;;  ← Mask1
                    ;;          empty space required by geometry of
                    ;;          crossbar arg distrib mechanism
         Arg6       ;; ← Mask2
                    ;;          empty space required for crossbar

         Arg9       ;; ← Mask3
        ACCUM-Loop  ;; This and the next together specify the end of
       LOOP-END)    ;;   an Accumulate loop

          Arg1      ;; ← FD

       (LOOP-BEGIN  ;; This layer and the next mark the beginning
        ACCUM-Loop  ;;   of an Accumulate loop
         OVERLAY    ;;
         0-diagram  ;;
         Arg4       ;; ← RHS1
                    ;;          empty space reqd for crossbar

         Arg7       ;; ← RHS2
                    ;;          empty space reqd for crossbar

         Arg10      ;; ← RHS3
        ACCUM-Loop  ;; This and the next together mark the end of
       LOOP-END))))) ;;   an Accumulate loop;
```

This function uses the new Accumulate loop. This is a different implementation of Accumulate than that shown in Anderson&Furnas (2010), in that it uses much of the general-purpose loop machinery, instead of the one-off mechanism in the paper.

*One other difference from the paper is that Accumulate here is done on an OVERLAY operator not an OR. The result is the same under the assumed condition of disjoint matches after conflict resolution.