If we have n examples of the type

$$= \begin{matrix} 1001 \\ 1\boxed{0}01 \end{matrix}$$

and n of the type

$$\sim \begin{matrix} 01\boxed{0}1 \\ 1010 \end{matrix}$$

then there are no digrams that will, on the average, be of any value in prediction.

There are, however, 8 trigrams that are of value

$$= \begin{matrix} 1 \\ \square \end{matrix}, \quad = \begin{matrix} 0 \\ \square \end{matrix}, \quad = \begin{matrix} \square \\ \bigcirc \end{matrix}, \quad = \begin{matrix} \square \\ 1 \end{matrix}$$

$$\sim \begin{matrix} 1 \\ \square \end{matrix}, \quad \sim \begin{matrix} 0 \\ \square \end{matrix}, \quad \sim \begin{matrix} \square \\ 0 \end{matrix}, \quad \sim \begin{matrix} \square \\ 1 \end{matrix}.$$

While each of these trigrams is 100% correct in its predictions, there are many examples where none of them can be used — for example

$$\sim \begin{matrix} 1100 \\ 0\square 11 \end{matrix}.$$

In these latter cases, there are two methods that might be used successfully in prediction.

The first involves tetragram frequencies. A few of the useful compact tetragrams are

$$\begin{matrix} 1\,0 \\ 1\,\square \end{matrix}, \quad \begin{matrix} 1\,0 \\ 0\,\square \end{matrix}, \quad \begin{matrix} \square\,0 \\ 0\,0 \end{matrix}, \quad \begin{matrix} 1\,\square \\ 0\,1 \end{matrix}, \quad \begin{matrix} \square\,1 \\ 1\,1 \end{matrix}$$

If one has these tetragrams available it is possible to predict all examples with 100% accuracy without the use of trigrams of the type

$$= \begin{matrix} 1 \\ \square \end{matrix}$$

The second method involves some new ideas. We will evolve a method of constructing ngrams of reasonable probability of usefulness, from entities called "structures" and "n tuples".

We would like to have ngrams of the type

$$\sim \begin{matrix} 1 \\ \square \end{matrix}, \quad \sim \begin{matrix} 1 \\ \square \end{matrix}, \quad \sim \begin{matrix} \square\,\square\,\square \\ \square \end{matrix}, \quad \text{etc.}$$

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We also feel, intuitively, that these ngrams are related to each other in some way — that they are "close" to one another. We have found empirically that the ngram

$$\sim \begin{matrix} 1 \\ \square \end{matrix}$$

is of high ~~apriori~~

usefulness? It would be well if we could derive $\sim \exists\, 1$, $\sim \exists\exists\, 1$, $\sim \exists\exists\exists\, 1$

$\square$ $\square$ $\square$

from it by a simple transformation.) It would also be encouraging if this simple transformation was of use in other applications as well.

In order to generate this sequence of ngrams and facilitate other important operations, we will define "ntuples" and "structures".

The symbol $\exists$ means that this space may be occupied by any digit.

An "ntuple" is an ordered set of n physical objects. An example would be the quadruple (A, 3, α, +).

A 2 dimensional "structure" is an ordered set of 2 dimensional coördinates. Certain of the coördinate pairs may be ommitted, as will be shown.

An example of a 4th order structure is (0,0; 2,-1; 2,1; 3,0)

If a structure operates on an ntuple set of the same order, an ngram will result. This ngram will consist of the elements of the ntuple, placed at the proper coördinates of a 2 dimensional grid.

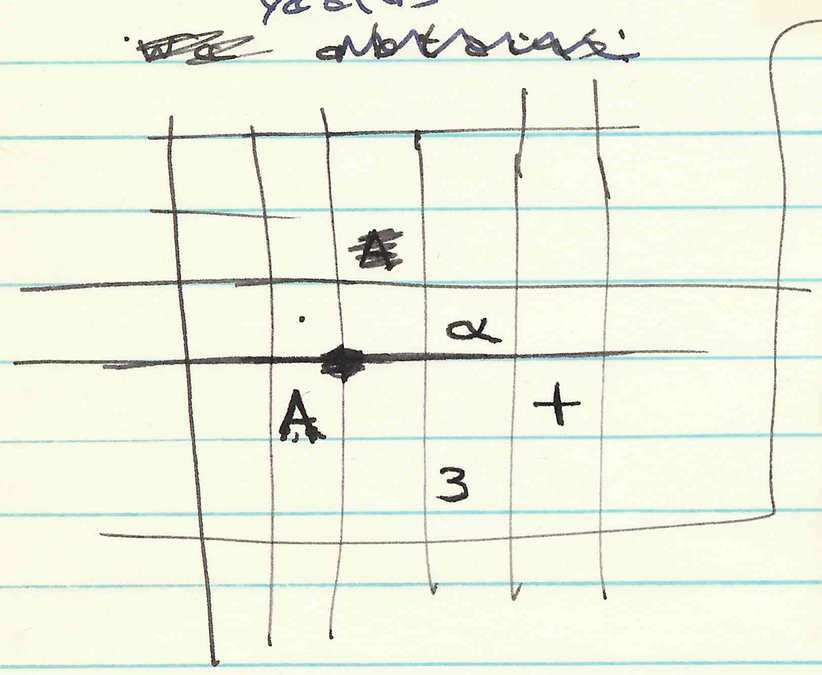
The structure

(0,0; 2,-1; 2,1; 3,0)

operating on the quadruple

(A, 3, α, +)

yields



A structure with ommission would be illustrated by

s ≡ (0,0; 0,1; 1,0; 1,1; —; 2,1)

If s operates on

(=, 1, 3, +, 8, 2)

we obtain

1	+	2
=	3	

Note that we are not interested in the absolute but only the relative positions of objects on the coördinate grid, so if we add the same pair of numbers to each component of a structure we will obtain a structure

equivalent to the original. Structures can become unique if we postulate the first component to be 0, 0 and add suitable values to the other components to obtain this condition.

If some of the individual elements of the ntuple are larger than one coördinate square, there is some ambiguity in operations on this ntuple with a structure. An example, would be the structure

(0, 0; ■, 0) operating on the

pair (~,)

We may interpret this to mean either

	~	

or

	~	

In cases where ambiguity does exist, we will assume that all of the ngrams that are generated by the operation are acceptable. Usually this will cause no difficulty. We may simply consider the operation of a structure upon some ntuples to be a many-valued operation.

If we begin with certain initial structures, we may use them to combine old ngrams that have been found to be useful, into new ngrams of reasonable probability of usefulness.

A simple str. that we may begin with is $S_1 \equiv$ (0 0; 1, 0)

We may obtain a set of ntuples of reasonable apriori probability of usefulness in the following way: Any digit, =, ~, 0, 1 is of reasonable probability of usefulness. The digrams

and have been found to be useful in the past. (The [illegible] they are no longer directly useful in [illegible] prediction)

We will assume that various combinations of objects that have been useful in the past, have a reasonable apriori probability of being useful in the future.

For this, reason the Cartesian product of

□/□, □/□, □/□, □/□, =, ~, 0, 1 with itself

produces a set of pairs, each member of which has a reasonable probability of being useful.

Let us examine the large set of ngrams that we obtain by S_1 operating on this set of pairs. There are 64 such pairs. Due to ambiguity, there are 128 different ngrams. Of these 128, only 32 ever occure, and of the 32, only 24 contain the interrogation square. Of these 24, 8 are of much usefulness in prediction, and 16 are of very little usefulness.

These 8 useful ngrams are:

Since S_1 may be regarded as a basic, simple structure, it is of hy apriori usefulness. The set of digrams which it operated on, to get the 8 useful ngrams, may now be regarded as a ntuple set of hy U.* Let us call this set of pairs, N_1.

[* We will define U to be "usefulness"]

~~Since S_1 is a simple structure, we will examine "neighboring" structures~~

~~This ntuple set may be~~ N_1 may be expressed as the cartesian product of the sets

$A_1 \equiv (=, \sim)$ and $B_1 \equiv$ (□/□, □/□, □/□, □/□)

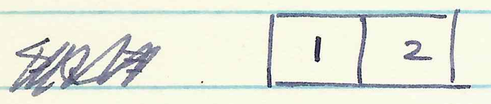
~~These 2 sets of ngrams~~ A_1 and B_1 also aquire some aprip. of U.

Since S_1 is a simple structure, ~~we will~~ that has proved to be of some U, we will examine structures "close" to it, since they will have greater than ordinarily expected U.

The criterion for "closeness" of structures that will be used at this point, is a very simple direct geometric one. We will assume that the structures (0,0 ; ■,1), (0,0 ; ■,-1), (0,0 ; ●,■), (0,0 ; 0,-1) (0,0; 2,1)(0,0; 2,0)(0,0; 2,-1) are all "close" to the structure (0,0; 1,0)

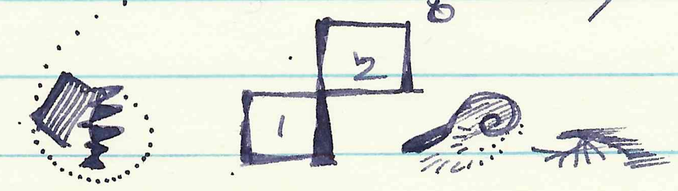
We may visualize structures rather well by plotting ~~the squares that are~~ on graph paper the squares that represent the various components.

For instance $S_1 \equiv (0,0;1,0)$ is represented by



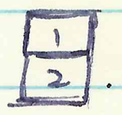
The "1" represents the ~~position~~ coördinates of the first component, the "2" the ~~position~~ coördinates of the second component.

Similarly we may pair our other structures and representations in the following way:

$S_2 \equiv (0,0;1,1) \longleftrightarrow$ 

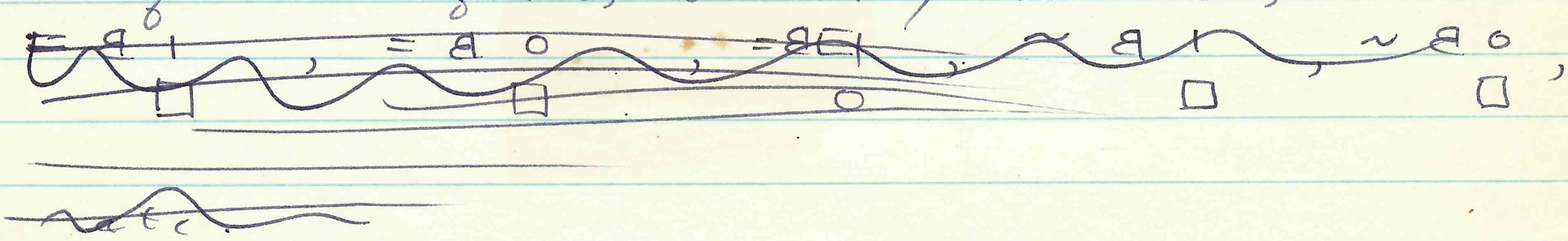
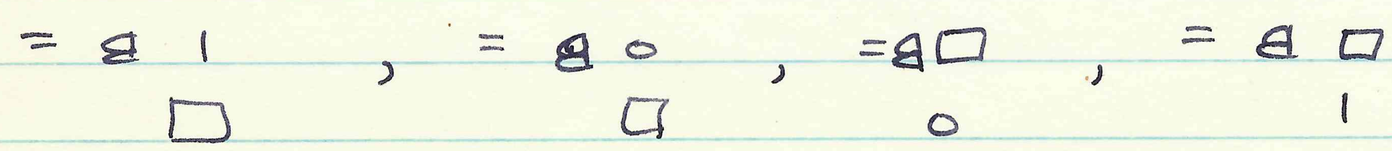
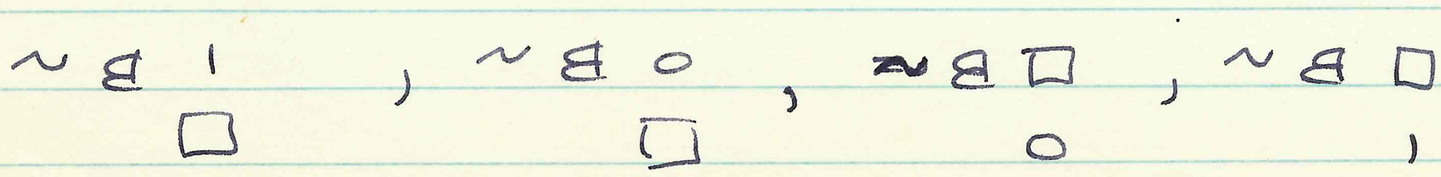
$S_3 \equiv (0,0;1,-1) \longleftrightarrow$

$S_4 \equiv (0,0;0,1) \longleftrightarrow$

$S_5 \equiv (0,0;0,-1) \longleftrightarrow$ 

$S_6 \equiv (0,0;2,1) \longleftrightarrow$

$S_7 \equiv (0,0;2,0) \longleftrightarrow$

$S_8 \equiv (0,0;2,-1) \longleftrightarrow$

If we operate upon the set of pairs, N, with most of these structures, we will obtain ngrams of small U. The structures S_6, S_7 and S_8, however, yield, among other ngrams, the very useful trigram set,