A NATURAL HISTORY OF *GUPPIES*

Virginia Jenkins, E13

The GUPPIES *on* RYE *are a collection of over one hundred computer programs, designed and for the most part written by cryptanalyst programmers, to handle many of the standard cryptanalytic tasks performed daily throughout the Agency. The name "GUPPY" comes from the initials of General Utility Programs. This article tells in brief how general cryptanalytic programs, cryptanalyst programmers and remote-operated computers grew up together at NSA.*

ROGUE, ROB ROY AND RYE

The *GUPPIES* were born (but were not yet named) with ROGUE,[1] NSA's first remote-operated computer system, in 1956.[2] Open-shop programming--programming of their own work by local analysts--started at about the same time. It seems to have been realized rather early that cryptanalysts who could program their own jobs had a valuable tool in their tool boxes, and that the best desk-side aid for any cryptanalyst was a computer program he could run himself from his working area. ROGUE provided both possibilities. It boasted four outstations.

The tradition grew, and so did the number of users, open-shoppers, and programs. The five outstations of ROB ROY,[3] which succeeded ROGUE in 1960, were busy and productive. ROB ROY was popular in spite of long waits for input, one-job-at-a-time processing, and paper tape as the only mode of output.

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1. *Remotely-Operated General Use Equipment. The computer was the* ALWAC IIIE.

2. ROGUE *in fact was one of the first in the country. Monograph #2 in the NSA Technical Literature Series,* HISTORY OF NSA GENERAL-PURPOSE ELECTRONIC DIGITAL COMPUTERS, *by Samuel S. Snyder, tells the story. Some of the information in this article is based on that monograph.*

3. *The computer, originally designed as an editing computer, was named* BOGART *after the city editor of the* New York SUN. *The name* ROB ROY *was not an acronym, but popular ingenuity explained it as one: "Remotely Operated* BOGART--*Remotely Operated by You."*

The outstation looked like a modified government gray desk. Paper tape was output through a hole in the bottom righthand drawer, and hard copy was produced off-line by reading the paper tape through a Flexwriter. I counted about 80 general and special-purpose programs in a ROB ROY manual I came across recently, many of them with familiar names like BAYOU, HUSK, STET, and DIANA.

In 1963, ROB ROY was replaced by RYE.[4] The extent to which analysts had come to depend on doing their cryptanalysis by computer can be measured by the large number of programs--now for the first time called "*GUPPIES*"--programmed for the new remotely-operated system, and by the numerous outstations used. At present, RYE outstations number more than 150. Indeed, the demands for service have at times outweighed RYE's ability to fill them. As a result, many *GUPPY* programs have been rewritten for other computers, notably for DCS,[5] starting in 1966.

From very early, and increasingly as time went on, the cryptanalyst programmers designed their programs to be both "General" and "Utility."

The "Utility" portion of the *GUPPY* name stems from the fact that many of these programs are computerized versions of the day-to-day standard cryptanalytic tasks performed all over the Agency. Some in fact were, and are, versions of pre-computer specialized equipment, like GEEWHIZZER which was originally the name of an Electro-Mechanagrammer. All cryptanalysts, whether they work manual or machine cryptosystems, are generally concerned with substitution, transposition, or some combination of the two. And all cryptanalysts need worksheets, frequency counts, statistics, decrypts, and indexes; they need to drag cribs and to test keys in order to do their jobs. These are like electricity and water "utilities" to the cryptanalysts, and many are handled by the *GUPPY* programs.

Flexible parameters make the *GUPPY* programs "General." One cryptosystem differs from another primarily in the crypto-variables (figures, cipher alphabets, and keys) associated with it, its character set, and the underlying language. Most *GUPPIES* are not limited either in the kind of data they accept or the way they handle it. Almost all of them contain a generalized parameter-handler routine that allows the user to tailor a program to his specific needs.

4. RYE *is not an acronym. Two computers*--UNIVAC 490 *and* UNIVAC 494--*have been used on this system.*

5. *Direct-Coupled System, using* IBM *hardware.*

For example, the *GUPPY* programs will accept a character set 2 through 64 long; data can be prepared on paper tape or cards, or on a variety of equipment (ASR-35, CXCO, FLEX). Options abound for specifying arithmetic (additive, subtractive, minuend, Baudot), widths, graph sizes, sort fields, and data arrangment. Thresholds can often be changed, specialized log weights input, and instructions for formatting of printout given.

Descriptions of the *GUPPY* programs are published in the *GUPPY* Manuel available from Mrs. Linda Sweeney, C4, phone 3829s. This publication is available to any interested cryptanalyst. In addition, the use of RYE and of the *GUPPY* programs is taught in three courses conducted by the Cryptanalysis Department of the NCSch. They are: General Cryptanalysis (CA-100), Practical Diagnosis (CA-260), and Rye Operations for Cryptanalytic Applications (CA-090). The latter course is a new one; the pilot class was held in March 1973.

In G Group, Mr. J. D. Tankersley is always available to give assistance on RYE both to cryptanalysts and to open-shoppers. In his office, 3A111 (phone 4727s), he maintains a file of all the *GUPPY* program assemblies and a library of punched paper tapes of plain text and weights for some of the G Group languages. He also serves as *GUPPY* trouble shooter and is the person to call if a program seems to be in trouble.

Instructors in the Cryptanalysis Department are also glad to assist cryptanalysts in using RYE in any way they can. The phone number of 8025/36; the room number in FANX II is A2A32B.

* * * *

TRANSLATION, PLEASE?

SAVILLE DER DAGO
TOUSEND BUZES IN ARO
NOCHOE DEM IST TROUXS
SUMMIT COUZIN
SUMMIT DOUXS

Vince Las Casas, B6

(See answer on page 28)

An Alphabetical Guide to the GUPPIES

* [PROGRAMS WHICH PUNCH TAPES AS WELL AS PRINT ARE MARKED WITH AN ASTERISK.] *

\+ [BAUDOT PROGRAMS OR ONES WITH BAUDOT OPTIONS ARE MARKED WITH A PLUS SIGN.] +

ASKIT: Predicts or evaluates results of polyalphabetic depth search based on Kappa test.

+BALK: Prints worksheet, 3 to 100 characters per line.

*BAYOU: Prints monographic and digraphic frequency counts, log and category weights for chained, disjointed or transposition digraphs.

+*BDELT: Makes Baudot horizontal or intermessage difference streams.

+BEE: Prints binary 5-level differences and statistics.

BIGSTET: Standard diagnostic STET tests on option, some with thresholds, but handles more data, widths, intervals and prints columnar counts.

BISEC: Key recovery and decryption via generatrices and scores, for monoalphabetic in fixed-length-section cipher.

BREN: Route and grille transposition decrypt, span < 450.

+BUNK: Key drag and difference stream, Baudot arithmetic.

CALC: Desk calculator functions: +,-,x,÷, exponentiation, square root, number base change.

CASANOVA: Periodic polyalphabetic intermessage depth search, individual or all monographic column pairs on a width.

CHICKADEE: Diagnoses and exploits stagger bust.

CØLLEEN: Mono-, di-, and trigraphic columnar counts and statistics on a width.

COPPERHEAD: Polyalphabetic polygraphic depth search.

CRAZYQUILT: Transposition bust exploitation.

CROSSUM: Cross-product sums and repeat rates at all slides for all pairs of N frequency distributions.

DELPHI: Key recovery and decryption, periodic polyalphabetic, related or unrelated alphabets.

+*DELT: Horizontal or intermessage differences or sums, modular or Baudot arithmetic.

+*DELTBDELT: [redacted]

DIANA: Digraphic counts and statistics.

*DØBE: Uniliteral (1 for 1) substitution decrypt or conversion.

*DØBE2: Biliteral (2 for 1) substitution decrypt or conversion.

DOODLE: Formatted worksheets, specified hits underlined. Hat and crenelated diagrams.

+DOPESHEET: Probabilistic worksheet for polyalphabetic depth reading.

EPICTETUS: Enciphered indicator search.

+FINKSBURG: Diagnostics on levels of 5-level streams.

FLUSH: Aperiodic polyalphabetic depth search.

FREQWIDTH: Prints formatted worksheet, with count below each group.

GEEWHIZZER: Anagrams columnar and grille transposition.

+*GEORGE: General purpose encipher/decripher of transposition, monoalphabetic and polyalphabetic substitution and Hagelin. Related or unrelated alphabets.

+*GIMP: Polyalphabetic crib drag.

GROUPDATA: Prints formatted worksheets.

+HUSHPUPPY: Polyalphabetic crib and key drag. Monographic log weights.

INDEX: Index and frequency counts, user-specified sort order.

ISOM: Locates isomorphs.

JEZEBEL: Decrypts biliteral substitution. Coordinates may be summed, with variants, or appear nonconsecutively in cipher.

KRAKUP: Tests for cyclic phenomena in nonhomogeneous material.

KYOTO: Tests and exploits stagger bust situation in polyalphabetics.

*LACER: Interlaces 2 data streams to user specification.

LAMBRØS: Key recovery and decryption via generatrices and scores for periodic polyalphabetic.

LILINDEX: Index and frequency counts, user-specified sort order, limited amount of data.

+LOGDIFF: Computes monographic plain and theoretical difference log weights.

MARTEE: Recovers key length for monoalphabetic-in-fixed-length encipherment.

+*MASK: Deletes characters or levels on cycling basis.

MODIRA: Coordinate recovery for monomedinome.

MONDIN: Prints monome-dinome worksheets and decrypts.

+MONDITRI: Mono-, di-, and trigraphic frequency counts of selected levels and level combinations.

MONOSEC: Replaces MARTEE (same options).

MYSTARS: Sorts 2-5 character groups from 1 stream; differences and sorts differences from 2 streams.

*NEPTUNE: Decrypts transposition within span of 100.

OVERLAP:

PASDEDEUX:

+PICKWICK: Theoretical cipher distribution and log weights for polyalphabetics.

PØLLY: Lists overall and oncut polygraphic repeats. Statistics.

PROFILE: Displays triliteral frequency distribution a la MC-I, pg. 72.

PUSHUP: Tests polyalphabetic depths and prints depth reader's worksheet.

QUIKROB: Polyalphabetic depth test, modified Kappa scoring on limited data.

QUIKSTET: STET on limited data.

QUIKTWIST: TWIST on limited data.

QUIKWHIZ: GEEWHIZZER on limited data.

QUIKXIBAR: XIBAR on limited data. No frequency counts option.

RITWIDTH: General purpose worksheet preparation, user specifications.

ROBIN: Polyalphabetic depth search.

ROLLFAST: Generatrices for 1 stream or pairs of 2 or 3 streams, formatted output.

RUMDUM: Sorts message identification streams prepared for INDEX.

SALLY: Prints monome-dinome frequency count.

+SCØØT: Polyalphabetic crib and key drag. Tetragraphic weights and cribs from TAPIR.

SHADOW: Profile monographic frequency count on data and on horizontal delta. Statistics.

SMARTSET: STET plus chi-square; threshold option.

STET: Prints standard diagnostic statistics and counts.

STUBBY: Remainder test.

+SUMDIF: [redacted]

SYLLABLE: General purpose matrix decrypt (up to 36x36), plain and cipher unit sizes 1-5.

SYNDROME: Coordinate recovery, worksheets, frequency counts and decryption for monome-dinome.

TABLES: Tailor-made mathematical tables: chi-square and binomial probabilities; prime factors and numbers; combinations N things r at time; transposition column factors and matrix widths.

TAPECON: Produces hard copy from paper tape, acting on functions.

+*TAPIR: Alphabetic, inverse frequency lists and log weights for 3, 4, 5 character groups.

TASKAN: Single, double transposition key test.

THUD: Makes depth reader's worksheet.

TREES: General purpose book-breaker's package: counts, indexes, WMP's, codebooks, et al.

TWIST: Single, double transposition decrypt.

UNICORN: Stripped-down version of SHADOW.

*UNLACER: Creates 2 data streams from 1 according to user specifications.

+*VIGORO: Creates streams of X's and O's from 5 or 6 level tape.

+WARP: Difference or decrypt polyalphabetic substitution.

+WENDY: Prints binary worksheet (X's and O's) from 5 level characters.

WIDTH: Prints frequency counts and statistics for columns of width write-out.

XIBAR: Makes frequency counts overall on individual messages or on columns of width and subdivides them into homogeneous sets.

*XPAN: Creates data stream expanded positionally by specified characters.

A Categorical Guide to the GUPPIES

Anagram

GEEWHIZZER
QUIKWHIZ

Baudot

BALK
BDELT
BEE
BUNK
DELTBDELT
DOPESHEET
FINKSBURG
GEORGE
GIMP
HUSHPUPPY
LOGDIFF
MASK
MONDITRI
PICKWICK
SCOOT
SUMDIF
TAPIR
VIGORO
WARP
WENDY

Binary

BEE
FINKSBURG
MASK
MONDITRI
VIGORO
WENDY

Binomial

TABLES

Bookbreaking

FREQWIDTH
GOUPDATA
INDEX
LILINDEX
POLLY
RITWIDTH
TAPIR
TREES

Bust Exploitation

CHICKADEE
CRAZYQUILT
KYOTO

Chi-Square

FINKSBURG
SMARTSTET
TABLES

Conversion

See Decryption

Crenelated Diagram

DOODLE

Crib/Key Drag

BUNK
GIMP
HUSHPUPPY
SCØØT

Data Processing

BALK
LACER
MASK
ROLLFAST
TAPECON
UNLACER
VIGORO
XPAN

(Cont'd in next column)

Decryption for Substitution

BISEC
DELPHI
DELT
DELTBDELT
DOBE
DOBE2
GEORGE
JEZEBEL
LAMBROS
MONDIN
SYLLABLE
TREES
WARP

Decryption for Transposition

BREN
GEORGE
NEPTUNE
QUIKTWIST
TWIST

Depth Test

ASKIT
CASANOVA
COPPERHEAD
CROSSUM
FLUSH
PUSHUP
QUIKROB
ROBIN

Desk Calculator

CALC

Differences

BDELT
BEE
BUNK
DELT
DELTBDELT
MYSTARS
OVERLAP
ROLLFAST
SHADOW
SUMDIF
WARP

Frequency Counts

BAYOU
BIGSTET
COLLEEN
DIANA
FREQWIDTH
INDEX
LILINDEX
MONDIN
MONDITRI
PROFILE
QUIKSTET
QUIKZIBAR
SALLY
SHADOW
SYNDROME
TAPIR
UNICORN
WIDTH
XIBAR

Frequency Profiles

PROFILE
SHADOW
UNICORN

Generatrices

BISEC
LAMBROX
ROLLFAST

Hat Diagram

DOODLE

Homogeneity

BIGSTET
QUIKSTET
QUIKXIBAR
STET
XIBAR

I.C. and/or Sigmage

ASKIT
BEE
BIGSTET
CASANOVA
COLLEEN
CROSSUM
DELT
DELTBDELT
DIANA
EPICTETUS
GDELT
KRAKUP
MARTEE
MONOSEC
MYSTARS
PASDEDEUX
POLLY
PUSHUP
QUIKSTET
QUIKXIBAR
SHADOW
SMARTSTET
STET
TAPIR
UNICORN
WIDTH
XIBAR

Index

INDEX
LILINDEX

Indicators

EPICTETUS
INDEX
MYSTARS
RUMDUM
SUMDIF

Inverse Frequency

TAPIR
TREES

Isomorphs

ISOM

Key/Alphabet Test

BISEC
DELPHI
DOPESHEET
LAMBRØS
TASKAN

Local Roughness

BIGSTET
MARTEE
MONOSEC
QUIKSTET
SMARTSTET
STET

Log Weights

BAYOU
LOGDIFF
PICKWICK
TAPIR

Math Tables

TABLES

Matrix Factors/ Dimensions

TABLES

[redacted]

DELTBDELT
OVERLAP
SUMDIF

Monome-To-Dinome Ratio

MODIRA

Polygraphic Repeats

BIGSTET
COLLEEN
COPPERHEAD
DOODLE
INDEX
LILINDEX
MYSTARS
OVERLAP
POLLY
QUIKSTET
STET
SUMDIF
TAPIR

Prime Factors/ Numbers

TABLES

Probability Tables

TABLES

Remainder Test

STUBBY

Repeat Rate

COLLEEN
CROSSUM
DIANA
KRAKUP
SYNDROME
TAPIR
UNICORN

Sorts

INDEX
LILINDEX
MYSTARS
OVERLAP
SUMDIF
TAPIR

Statistics

See Chi-Square, I.C. Sigmage, Log Weights Repeat Rate

Stub Test

STUBBY

Theoretical Cipher

LOGDIFF
PICKWICK

Variants

BIGSTET
GEORGE
INDEX
QUIKSTET
STET
SYLLABLE

Widths

BIGSTET
CASANOVA
COLLEEN
CROSSUM
DOODLE
KRAKUP
LAMBROS
OVERLAP
PASDEDEUX
QUIKSTET
SMARTSTET
STET
WIDTH
XIBAR

Worksheets

DOODLE
FREQWIDTH
GROUPDATA
MONDIN
PUSHUP
RITWIDTH
SYNDROME
THUD
WENDY

Cryptosystem Guide to the GUPPIES

Following is a list of the cryptosystems covered in this Guide:

1. MONOALPHABETIC SUBSTITUTION -
Uniliteral; biliteral; monome-dinome; matrix (bipartite, digraphic); code.

2. PERIODIC POLYALPHABETIC AND CYCLIC ADDITIVE SUBSTITUTION.

3. APERIODIC POLYALPHABETIC AND NONCYCLIC ADDITIVE SUBSTITUTION -
General; Baudot; binary; ciphertext autokey; Hagelin; monoalphabetic in fixed-length section; progressive.

4. TRANSPOSITION -
General; bisection, railfence; columnar (single, double); grille, local, route; transposed code.

5. PLAINTEXT PROCESSING

UNILITERAL

CHI-SQUARE
- SMARTSET
- TABLES

DECRYPTION
- DOBE
- GEORGE
- LAMBROS

DIAGNOSIS
- STETs

DIFFERENCES
- DELT
- DELTBDELT
- ROLLFAST
- SHADOW

FREQUENCY PROFILES
- FREQWIDTH
- INDEX
- LILINDEX
- QUIKXIBAR
- STETs
- XIBAR

HOMOGENEITY
- CROSSUM
- QUIKXIBAR
- STETs
- XIBAR

I.C.
- DELT
- DELTBDELT
- POLLY
- PUSHUP
- QUIKXIBAR
- SHADOW
- STETs
- UNICORN
- XIBAR

INDEX,SORTS
- INDEX
- LILINDEX

KEY/ALPHABET TEST
- LAMBROS

NULLS, MASKS
- GEORGE
- MASK

POLYGRAPHIC REPEATS
- DOODLE
- INDEX
- LILINDEX
- POLLY
- STETs

REPEAT RATE
- CROSSUM
- UNICORN

VARIANTS
- DOBE
- GEORGE
- INDEX

WEIGHTS
- BAYOU
- LOGDIFF

WORKSHEETS
- DOODLE
- FREQWIDTH
- GROUPDATA
- PUSHUP
- RITWIDTH
- THUD

BILITERAL

DECRYPTION
- DOBE2
- JEZEBEL
- SYLLABLE

DIAGNOSIS
- STETs

DIFFERENCES
- DELT
- DELTBDELT
- MYSTARS

FREQUENCY COUNTS
- BAYOU
- COLLEEN
- DIANA
- FREQWIDTH
- INDEX
- LILINDEX

HOMOGENEITY
- DIANA
- QUIKXIBAR
- STETs
- XIBAR

I.C.
- BAYOU
- COLLEEN
- DIANA
- MYSTARS
- STETs

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- BAYOU
- LOGDIFF

WORKSHEETS
- DOODLE
- FREQWIDTH
- GROUPDATA
- RITWIDTH

MONOME-DINOME

COORDINATE RECOVERY
- MODIRA
- SYNDROME

DECRYPTION
- MONDIN
- SYNDROME

DIAGNOSIS
- STETs
- SYNDROME

DIFFERENCES
- DELT
- DELTBDELT

FREQUENCY COUNTS
- MONDIN
- SALLY
- SYNDROME

HOMOGENEITY
- STETs
- SYNDROME

I.C.
- BAYOU
- DELT
- DELTBDELT
- POLLY
- STETs

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MONOME-TO-DINOME RATIO
- MODIRA

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- STETs

REPEAT RATE
- SYNDROME

VARIANTS
- INDEX
- MONDIN
- SYNDROME

WEIGHTS
- BAYOU
- LOGDIFF

WORKSHEETS
- MONDIN
- SYNDROME

MATRIX: *BIPARTITE DIGRAPHIC*

DECRYPTION
- DOBE2
- JEZEBEL
- SYLLABLE

DIAGNOSIS
- DIANA
- STETs
- TAPIR

DIFFERENCES
- DELT
- DELTBDELT
- MYSTARS

FREQUENCY COUNTS
- BAYOU
- DIANA
- FREQWIDTH
- INDEX
- LILINDEX
- TAPIR

HOMOGENEITY
- DIANA
- STETs

I.C.
- BAYOU
- CASANOVA
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- DIANA
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- TAPIR

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INVERSE FREQUENCY
- TAPIR

KEY/COORDINATE TEST
- CASANOVA
- CROSSUM

NULLS, MASKS
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- GROUPDATA
- RITWIDTH

CODE

CODE BOOK
- TREES

DECRYPTION
- SYLLABLE
- TREES

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- TAPIR

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- TREES

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- CASANOVA
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- TAPIR

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- TAPIR
- TREES
  - (BY CODE GP., MEANING, VALIDITY, ANY SPECIFIED GROUPS)

INVERSE FREQUENCY
- TAPIR
- TREES

NULLS, MASKS
- MASK

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POSITIONAL ROUGHNESS
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- SYLLABLE

VMP
- TREES

WEIGHTS
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WORKSHEETS
- ~~FREQWIDTH~~
- GROUPDATA
- RITWIDTH

PERIODIC POLYALPHABETIC AND CYCLIC ADDITIVE

BUST EXPLOITATION
- CHICKADEE
- KYOTO

CHI-SQUARE
- ~~SMARTSET~~
- TABLES

CRIB/KEY DRAG
- GIMP
- HUSHPUPPY
- SCOOT

DECRYPTION
- DELPHI
- GEORGE
- LAMBROS
- WARP

DEPTH TESTS
- CASANOVA
- CROSSUM
- FLUSH
- PUSHUP
- XIBAR
- QUIKXIBAR

DIAGNOSIS
- STETs

DIFFERENCES
- DELT
- DELTBDELT
- MYSTARS
- OVERLAP
- ROLLFAST
- SUMDIF
- WARP

FREQUENCY COUNTS
- BIGSTET
- COLLEEN
- QUIKXIBAR
- WIDTH
- XIBAR

GENERATRICES
- LAMBROS
- ROLLFAST

I.C.
- CASANOVA
- COLLEEN
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- WIDTH
- XIBAR

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- ISOM

KEY/ALPHABET TEST
- DELPHI
- LAMBROS

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- TABLES

[redacted]
- DELTBDELT
- OVERLAP
- SUMDIF

POLYGRAPHIC REPEATS
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- OVERLAP
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- SUMDIF
- TAPIR

REMAINDER/STUB TEST
- STUBBY

REPEAT RATE
- COLLEEN
- CROSSUM
- TAPIR

UNRELATED CIPHER ALPHABETS
- CASANOVA
- DELPHI
- GEORGE

WEIGHTS
- BAYOU
- LOGDIFF
- TAPIR

WORKSHEETS
- DOODLE
- GROUPDATA
- OVERLAP
- PUSHUP
- RITWIDTH
- THUD

APERIODIC POLYALPHABETIC AND NONCYCLIC ADDITIVE

BUST EXPLOITATION
- CHICKADEE
- KYOTO

CHI-SQUARE
- SMARTSTET
- TABLES

CRIB-KEY DRAG
- GIMP
- HUSHPUPPY
- SCOTT

DECRYPTION
- DELPHI
- DELT
- DELTBDELT
- GEORGE

DEPTH TESTS
- ASKIT
- COPPERHEAD
- CROSSUM
- FLUSH
- PUSHUP
- QUIKROB
- ROBIN

DIAGNOSIS
- STETs

DIFFERENCES
- DELT
- DELTBDELT
- MYSTARS
- OVERLAP
- ROLLFAST
- SUMDIF
- WARP

FREQUENCY COUNTS
- COLLEEN
- XIBAR

GENERATRICES
- ROLLFAST

I.C.
- ASKIT
- BAYOU
- DELT
- DELTBDELT
- MYSTARS
- POLLY
- PUSHUP
- QUIKXIBAR
- STETs
- TAPIR
- XIBAR

INDEX, SORTS
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- MYSTARS
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- SUMDIF

INDICATORS
- EPICTETUS

ISOMORPHS
- ISOM

KEY/ALPHABET TEST
- DOPESHEET

LOCAL ROUGHNESS
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