University of Nebraska at Omaha

Department of Mathematics

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Mathematics Education at UNO

The national K-12 "math wars" are revving up again, or perhaps winding down, depending on your point of view. The National Council of Teachers of Mathematics, which represents 100,000 educators from prekindergarten through college, has just launched the latest round with a new report, *Curriculum Focal Points for PreKindergarten through Grade 8 Mathematics: A Quest for Coherence.* In the modern era the commotion started when the Soviet Union beat the U.S. into space with Sputnik in 1957. This led to the "new math" of the 1960's which included aspects of set theory, modular arithmetic and symbolic logic. But neither teachers nor parents understood it and so by the early 1970's the new math faded and it was "back to basics". In 1980 the NCTM published *An Agenda for Action* which argued that "an exclusive focus on basics is wrong-headed, and a primary goal of mathematics curricula should be to have students develop problem-solving skills". The 1980's were a period of great ferment in mathematics education. The 1983 report *A Nation at Risk* declared that "the educational foundations of our society are presently being eroded by a rising tide of mediocrity". Several trends were evident. Some state curriculum lists included over 100 distinct items per grade level. Ensuing text books adhering to these lists were targeted as responsible for mathematics curricula being "a mile wide and an inch deep". Public school enrollments increased from 25 million in 1950 to 45 million in 1970 (and then leveled off). In 1989 the National Research Council's *Everybody Counts* declared that "equity for all requires excellence for all; both thrive when expectations are high". In other words, having 50% attrition each year in mathematics from 9th grade on is not acceptable.

Dr. Janice Rech

The NCTM was ready to act again, having established the Commission on Standards in 1986, chaired by Thomas Romberg (BS in Math OU 1955 and former teacher in Omaha). NCTM's *Standards* appeared in 1989 with the purpose of "creating a coherent vision of what it means to be mathematically literate in a rapidly changing world". It stated five general goals for all students: "(1) that they learn to value mathematics, (2) that they become confident in their ability to do mathematics, (3) that they become mathematical problem solvers, (4) that they learn to communicate mathematically, and (5) that they learn to reason mathematically". The three main sections are devoted to defining content and process standards for three grade bands: K-4, 5-8 and 9-12. Consensus among mathematics teachers across the nation took precedence over uniformity. The resulting vagueness allowed different groups to produce very different sets of materials all "in the spirit of the standards". But one of the overall positive effects of *Standards* has been to nudge many teachers away from rote learning and memorization and towards a more active instructional approach with an emphasis on applications and problem solving.

The 2003 Trends in International Mathematics and Science Study found that American eighth grade students ranked just 15th in math skills behind many Asian countries. Singapore came in first place and Singapore Math is now used by about 300 school systems in the U.S. The NCTM's new (Sept 2006) publication, *Curriculum Focal Points*, builds on the 1989 *Standards* by suggesting the three most important topics for each grade, K-12. This is an effort by the NCTM to narrow the gap between traditional and reform approaches to math education.

The UNO Mathematics Department has been responding to all of this activity and excitement in mathematics education by developing new initiatives at several different levels. These initiatives are in line with the *Curriculum Focal Points* as they emphasize both procedural and conceptual knowledge as a foundation of mathematics.

One year ago NU awarded the UNO Colleges of Education and Arts and Sciences a new priority faculty position in Mathematics for Elementary Education. A national search was conducted during 2005-2006 which led to the hiring of Dr. Michael Matthews by the Mathematics Department. One of Michael's assignments is to teach the two new courses, Math 2000, Mathematics for Elementary School Teachers, and Math 2010, Geometry Topics for Elementary Teachers, which were developed by Dr. Janice Rech and inaugurated in Fall 2004. This represents a significant increase in the math requirement for elementary education majors from 3 hours to 9 hours. Enrollments in these two courses are already surpassing 150 students per semester.

Another project, *Teaching for Elementary Achievement in Mathematics,* is being carried out by Dr. Neal Grandgenett and Mr. Peter Smith in COE, Dr. Rech in Mathematics and Mr. Jim Harrington, the Mathematics Supervisor at OPS. TEAM is attempting to provide in-service teachers some of the same material given to pre-service teachers by the two new courses described above. It targets especially grades 4-6 where the need is most urgent because of the gap created in grades 5-8 where mean percentile ranks in OPS basic skill tests typically drop nearly 10 points.

Dr. Neal Grandgenett

Secondary math education is also being addressed by new faculty member Dr. Matthews. He is developing a capstone course for secondary math education majors that will be offered for the first time in Spring 2007, replacing a previously required course in JAVA programming. SED majors take almost as much math as a math major (in fact many of them get a second major in math) and the new course will require them to think more broadly about all of this coursework. It includes a final project using a problem analysis or concept analysis strategy implemented with instructional technology such as software programs Geometer Sketchpad or Maple.

Finally, Dr. Matthews and Dr. Rech are currently in the process of establishing long term measures to evaluate the effectiveness of these new courses and of any further curriculum changes (i.e the effects of switching texts or different emphases). All of these different activities at UNO together represent a significant effort to expand and improve academic training for mathematics teachers in the Omaha area. (Background information for this article was taken from several different newspaper stories as well as "The Math Wars" by Alan H. Schoenfeld in the journal Educational Policy, Volume 18, 2004, p. 253.)

"We are all concerned about the future of American education. But I tell my students, you do not enter the future - - you create the future. The future is created through hard work."

Jamie Escalante, 1930—

News of Recent Graduates

December 2005:

Apisit Amka (BS) – Grad school at UNL or Oklahoma State, or back to Thailand.
Doug Corteville (MS) – Program Chair for Electronic & Manufacturing Engr. Technology at Iowa Western Community College.
Travis Deyle (BS, Comp. Sci. & Math, Summa Cum Laude) – Will continue to intern at Sandia National Laboratory and then go to grad school.
Phillip W. Griess (BS Math & Comp. Sci., Magna Cum Laude) – Grad student in computer science in Texas.
Aaron Harding (BS, Summa Cum Laude) – Working at Best Buy, then go to grad school.
Mary McGee (MS) – Adjunct math instructor/consultant at UNO.
Dee Nguyen (BS)
Stacy Peterson (BA) – Working as Traffic Clerk at Gordman's Distribution Center.
Sarah Stephens (BA) – Director of the Math Center for MCC's Fort Omaha campus.

May 2006:

Misty Allmon (MAT) – Currently staying home to care for new baby.
Louis Bock (MS)
Ryan Bosselman (BS)
Justin Cummins (BS Comp. Sci., Math, Magna Cum Laude)
Megan Gibilisco (BS)
Eric Goeken (BS Comp. Sci., Math) – Working in financial modeling at PKI.
Nicholas Hein (BSED, BS Math)
Ruth Lewis (MAT) – She is a math teacher at St. Alberts in Council Bluffs and also at MCC's Elkhorn campus.
Haley Monk (BS, Magna Cum Laude) – Pursuing a career in PR and event planning.
John O'Dell (BS, Magna Cum Laude) – He is taking a year off before grad school.
Stephanie Schwinghamer (BSED, BS Math) – Pursuing a teaching position in Alaska.
Joshua Tausz (BS Civil Engr., Math, University Honors Program with Thesis)

Todd Munson receiving the *Presidential Early Career Award* at the White House.

August 2006:

Matthew Kinsella (BS) – Will focus on actuarial exams or will work on MBA at UNO.
Sharon Thornhill (BS, Cum Laude Extra Muros) – Considering school in Psychology and will be moving to Okinawa, Japan.
Kodjo Togbey (BS, Physics minor, Cum Laude) – Working as GTA in UNO Math Lab.
Richard Uber (BGS) – He is in the military stationed in Monterey and is pursuing a masters in math at UC Santa Cruz.
Vladimir Ufimtsev (BS, Physics minor, Magna Cum Laude) – He will be working at the AF Research Laboratory in Rome, NY before going to grad school at NE Univ. in Boston.
Ni Yang (BS Math, BA Studio Arts) – Will be attending out of state graduate school.

Alumni News

Andrew Buchan (MA, 2002) – Andrew is now in his third year as a mathematics teacher at the Buckley School in Sherman Oaks CA. In August he and Kimberly Hager were married in Los Angeles.

Sandra DeLozier Coleman (MAT, 1987) – Sandra is an instructor at the University of Connecticut at Avery Point. She is also the book review editor of the AMATYC Review (American Mathematical Association of Two Year Colleges). In a recent review (2006, v 27, #2) of the book **Fractals, Graphics and Mathematics Education** by Michael Frame and Benoit Mandelbrot, MAA, 2002, Sandra tells how she first became aware of fractals during her several years at UNO in the mid eighties.

Janna Eckhardt (BS 2005) – After continuing for a year as a GTA in the Math Lab, Janna is now an actuarial intern at Mutual of Omaha.

Aaron Friesz (BS in CEEN, Minor in Math, 2003) – Pursuing PhD in Electrical Eng at USC.

Ivan Grabowski (MS, 1998) – Working as an actuary at Zurich Programs in Omaha. He has offered to do advanced tutoring for the department when needed.

Todd Munson (BS in Comp Sci, 1995) – Todd received a PhD in Computer Science from the University of Wisconsin in 2000 and currently is a computational scientist at Argonne National Laboratory. In July he received a Presidential Early Career Award at the White House.

Tom Starkweather (BA, Math and Physics, 1955) – Tom is self-employed and owns two Businesses in El Paso TX.

Zach Voller (BS, 2003) – Zach got a masters degree at Clemson in May 2005 where he did modeling of a flavivirus infection and is now studying computational biology in a PhD program at Iowa State. He also got married in May 2005.

From The Chair

What should a Mathematics Department do to create student interest and attract more majors? This question has been much on my mind since I became chair in August 2000 upon the retirement of Margaret Gessaman. Of course one obvious thing is to hire well qualified faculty who are motivated to teach good courses. And I think that we are doing this. But our faculty are engaged in many other student centered activities as well. Judy Downey supervises two Problem of the Week contests each semester, one for undergraduate students and another for high school students. The High School POW is totally online and is run by undergraduate students who select the problems, post them and then check the solutions submitted. Valentin and Dora Matache have started a Mathematics Awareness Month symposium, held on a Friday morning each April. With the help of UNO Alum (BS, 1973) Pat Kerrigan, we now have about ten students each year working on long term research projects and who then present their final reports at the MAM symposium. For the past several years UNO has fielded a team in the national Putnam competition each December. Each fall a group of students prepares for this exam by practicing on old test questions. Both Griff Elder and Vyacheslav Rykov have supervised this activity. Andrzej Roslanowski is the advisor for the Math Club which sponsors social activities such as having picnics and recognizing Pi Day each March 14. Math Club officers Brett Saunders and Audra Kruse are in the process of preparing a lengthy application to establish a UNO chapter of Pi Mu Epsilon, the undergraduate Mathematics Honor Society. These activities are described in detail on our departmental website at http://www.unomaha.edu/wwwmath.

All of this extracurricular faculty involvement helps to create an exciting atmosphere for students. The department is now graduating an average of ten double majors per year. For example, Engineering, Computer Science, Physics, and Secondary Math Education majors all take lots of mathematics anyway and are being motivated in increasing numbers to pick up a second major in Mathematics. Two years ago the department had the good fortune to receive funding for a new full time staff position of Academic Coordinator. This position, first held by Kelly Johnson and now by Marilyn Liebsch, is critical in helping faculty (and the chair!) keep track of everything going on in a very active department. And finally, this newsletter itself, sent each Fall to the approximately 1000 UNO math alumni of record, has the purpose of letting all of you former UNO students know what we are doing at the present time. Drop by and say hello whenever you're back visiting in Omaha!

Jack Heidel, Chair

New Faculty & Staff

2006-2007 Faculty and Staff

Mary Dennison, *Director-Math Lab*
Judith M. Downey, *Lecturer*
J. Scott Downing, *Professor*
Jerome Drakeford, *Instructor*
Dean Ann Edwards, *Special Projects*
G. Griff Elder, *Associate Professor*
Jenny Farrar, *Instructor*
Steve From, *Professor*
Margaret Gessaman, *Professor Emeritus*
Jack Heidel, *Chair and Professor*
Betty Hickman, *Associate Professor*
John Konvalina, *Professor*
Marilyn Liebsch, *Academic Coordinator*
Yi-Hsin Liu, *Professor Emeritus*
Margaret Mainelli, *Staff Assistant*
John Maloney, *Professor*
Dora Matache, *Assistant Professor*
Valentin Matache, *Associate Professor*
Michael Matthews, *Assistant Professor*
Janice Rech, *Associate Professor*
Jim Rogers, *Assistant Professor*
Andrzej Roslanowski, *Associate Professor*
Vyacheslav V. Rykov, *Professor*
Larry Stephens, *Professor*
Andrew Swift, *Assistant Professor*
Cindy Teller, *Staff Assistant-Math Lab*
Kathy Vranicar, *Instructor*
Kristin Wolesensky, *Instructor*
Zhenyuan Wang, *Professor*

Michael Matthews, Assistant Professor

Michael Matthews

Michael holds a new NU priority position in Mathematics for Elementary Education. He received his PhD in Mathematics Education from the University of Iowa in May 2006 (as well as an MS in Mathematics) and a BA in Mathematics from Brigham Young University in 1997. From 1997-2003 he was a mathematics teacher at the Rite of Passage Charter High School in Yerington, Nevada, which is a school for adjudicated youth. One of his assignments at UNO is to teach two new courses, Math 2000, Mathematics for Elementary School Teachers and Math 2010, Geometry Topics for Elementary Teachers. Michael is also developing a capstone course for secondary math ed majors and may also teach an occasional methods course in the College of Education.

Andrew Swift

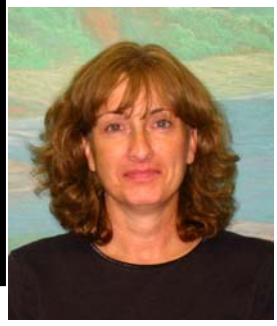
Andrew Swift, Assistant Professor

Andrew received the DSc degree from George Washington University in 2001 in the areas of Operations Research and Statistics with prior MA and BA degrees in Mathematics from the University of Oxford in England. From 2001-2006 he was a Visiting Assistant Professor at Worcester Polytechnic Institute where he taught a variety of courses in both statistics and applied mathematics. In his first semester at UNO he is teaching Stat 3000, Statistical Methods I and Stat 3800, Applied Engineering Probability and Statistics. In Spring 2007 he will be teaching a topics course in Time Series as well as a new version of Math 4310, Operations Research II, concentrating on stochastic OR.

Kristin Wolesensky

Kristin Wolesensky, Instructor

Kristin received an MS in Applied Mathematics from UNL in 1990 and a BA in Mathematics from Doane College in 1988. Since then she has served as an Adjunct Mathematics Instructor at both Metropolitan Community College and the College of Saint Mary. She also has much experience tutoring both high school and college students in mathematics. Her teaching assignment at UNO is Calculus and pre-Calculus.



Marilyn Liebsch

Marilyn Liebsch, Academic Coordinator

Marilyn joined the department in January. She has a BS in 1979 from Friends University in Wichita and lots of experience in tutoring high school mathematics. Her duties in the department are many and varied. She coordinates academic advising by making sure that math majors have a faculty advisor and that they are making progress towards their degree. She also works with advisors in other colleges concerning math requirements. During registration she helps students who are having trouble getting into the courses they want. She notifies students about employment and internship opportunities. She supervises the Walk-in Tutor Room, open 9:00-2:00 M-F. She works with high school dual enrollment teachers. She maintains the departments constantly growing website. There is rarely a dull moment in the Math Office!

In Memory, Barbara Buchalter

Barbara Buchalter

Dr. Barbara D. Buchalter, age 76, died in Tempe, Arizona on Saturday, November 26, 2005, following a prolonged illness. She was born on April 13, 1929, in Greensburg, Pennsylvania. She graduated from Seton Hill College magna cum laude and was married to Dr. Leonard Buchalter in 1949 until his death in 1970. In 1955, Leonard and Barbara moved to Tucson, Arizona where they opened a pharmacy and they received their doctorates from the University of Arizona. Barbara taught mathematics in the Tucson public schools during this period. They moved to Omaha, Nebraska in 1968, where she was a mathematics professor at UNOmaha, until her retirement in 1993.

When Barbara joined the Mathematics and Computer Science Department in 1968, there were twelve fulltime faculty members. In 1975 she served as an A&S rotating Assistant Dean for one year. During this year she helped VC Garfinkel develop guidelines for a Distinguished Scholars Program. She then worked with Dean Newton to set up an A&S Honors Program which was implemented by Rosalie Saltzman in 1976. Also in 1975 she was awarded an NSF grant to create a Mathematics Laboratory for independent instruction in Algebra, Precalculus Algebra and Trigonometry. It began with 400 students per semester. In 1990 when Barbara turned the Math Lab over to Janice Rech, it had 1000 students per semester in just Algebra and Precalculus Algebra. When Barbara retired in 1993 the Department had thirty fulltime faculty equally divided between Mathematics and Computer Science. Upon her retirement, Dr. Buchalter moved back to Tucson, Arizona. She was active with the American Association of University Women, Brandeis University National Women's Committee, and Delta Kappa Gamma (an international education honorary). (For more detailed information see Reflections in Time (video recording): Barbara Buchalter, UNOmaha Library).

Solving Nonlinear Optimization Problems that have a Nondifferentiable Objective Function by Using a Pseudo Gradient Search

UNO Masters Thesis by Marie Spilde (winner of Kerrigan Award for Excellence in Mathematical Writing, 2004-2005)

Marie Spilde, Great Wall at Juyongguan, China, 2005.

INTRODUCTION

No algorithm exists that will solve every nonlinear optimization problem. One approach to solving a nonlinear optimization problem is to apply a gradient search procedure. As an example of how the gradient search procedure works, consider the simplest case which is when the nonlinear function is concave, differentiable, and the solution space is two dimensional (see figure 1). The gradient search applied to this simple case amounts to taking the derivative of the function and then evaluating the derivative at a particular value of *x*. If the derivative at *x* is positive, then the x^* solution, , must lie to the right of *x*. If the derivative at *x* is negative, then the solution lies to the left of *x*. Once a left and right bound are identified, the value of the derivative at the midpoint between the two bounds can be used in further tests. The search ends when the value of the derivative at *x* equals zero or when the distance between the left and right bounds is smaller than a given tolerance. When multiple variables are involved, there are countless possible directions in which to In the event that the objective function is not differentiable, the traditional gradient search procedure cannot be applied. A new optimization technique must be determined.

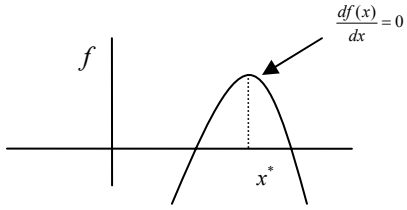


Figure 1. Example of a concave function that has an optimal solution at x*.

A reasonable replacement for the gradient search is a pseudo gradient search. Differences instead of differentials are applied, which avoids the problem of nondifferentiability. Iteration is necessary to progress through a series of trial solutions to reach the optimal solution. The quick convergence rate that accompanies a neural network makes it well suited to carry out the pseudo gradient search; however a neural network suffers from the problem of potentially converging to a local solution rather than a global solution. A genetic algorithm is another viable approach to the problem. It would provide a global solution, but at a cost of an undesirably slow convergence rate. This work will exploit the advantages of both the genetic algorithm and the neural network approaches. A genetic algorithm will be used to converge towards the global solution, but for a limited number of generations. Then a pseudo gradient search algorithm based on a neural network model will be initialized with the results from the genetic algorithm in order to quickly fine-tune the results and converge to the presumed global solution.

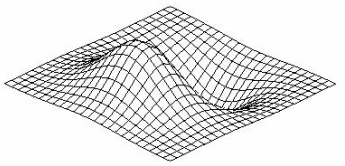


Figure 2. Example of a function that has multiple search directions at any point.

GENETIC ALGORITHM

Overview. Genetic algorithms are designed to search for and propagate good solutions to a problem. A genetic algorithm flows in the manner presented in figure 3. Each individual in the population is a solution to the problem and is one chromosome. Each chromosome is composed of genes which are represented as binary numbers.

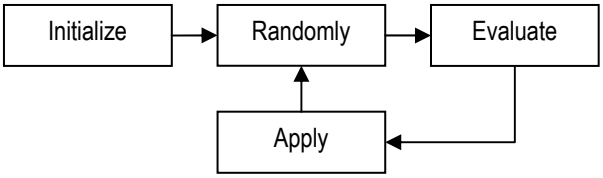


Figure 3. Flow of a genetic algorithm [4].

A hallmark of genetic algorithms is the mating step where two individuals in the current population are used to produce new offspring. During processing, the bits in the chromosomes are swapped, reversed, and changed to form new individuals in hopes of creating an offspring that is more valuable than its parents.

> *Consider a herd of antelope and suppose one of them has long feet, allowing it to escape a predator easier than could the other members of the herd, while another has exceptionally good sight, allowing it to find food easier than the others. Now when the two antelope mate, a crossover takes place and the chromosomes of their progeny will consist of pieces of the chromosomes of each parent. This in turn will lead to inheritance of parental traits by their progeny, and chances are that at least one of them will inherit both the long feet from one of the parents and the good sight from the other. Clearly, that young antelope will be superior to either of its parents.*

The genetic operators that cause the genetic variation are three-bit mutation, two-point crossover, and two-point realignment (see figures 5, 6, and 7). **A different approach: the pseudo gradient search.** Neural network ideas are useful in designing an alternative algorithm. The predictive attributes represent the input, the objective attribute is the output, the connections are feed-forward, and the *a* and *b* vectors are updated in each iteration so the overall error is reduced. The new concept is to apply differences instead of differentials to compose a change vector that will be used to update the *a* and *b* vectors.

Marie Spilde Thesis Synopsis, Cont.

EXAMPLE

The statistics division of the United Nations keeps track of several databases of information. The UN allows unrestricted access to certain databases which it has compiled into readable formats referred to as yearbooks. One of the yearbooks is the *Demographic Yearbook 2001* which contains demographic statistics such as population trends, birth rates, mortality rates, marriage rates, and divorce rates for over 230 countries in the world. One of the tables in the yearbook is titled "Vital statistics summary and expectation of life at birth: 1997-2001". The table presents the following vital statistics for the many countries listed: number of live births, crude birth rate, number of deaths, crude death rate, rate of natural increase, number of infant deaths, infant mortality rate, life expectancy by gender, and fertility rate.

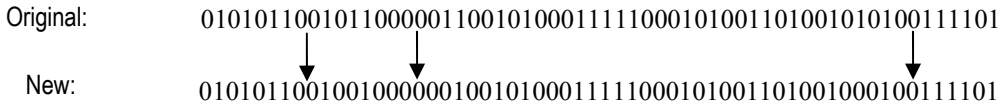


Figure 5. Example of three-bit mutation. The bits are flipped in positions 12, 19, and 50.

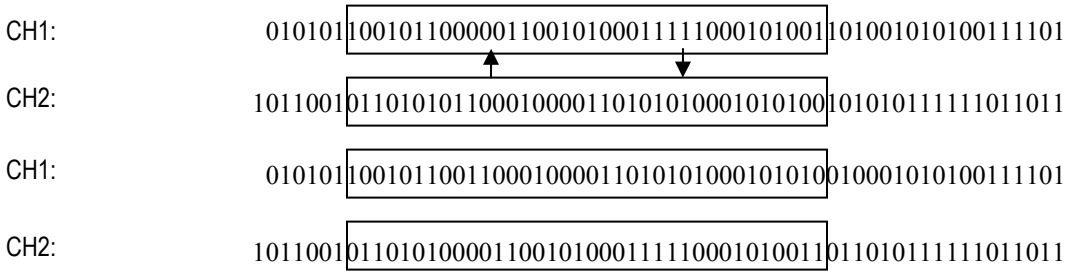


Figure 6. Example of two-point crossover. The two chromosomes are split at positions 15 and 45. The middle positions are then swapped to produce two new chromosomes.

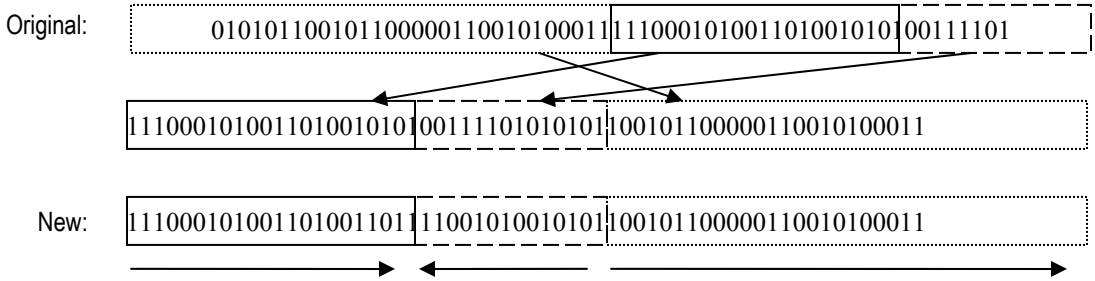


Figure 7. Example of two-point realignment. The chromosome is split at positions 30 and 48. The three pieces are then randomly swapped. Finally, the three pieces are randomly reversed.

The attributes of crude birth rate, infant death rate, and the rate of natural increase were chosen as the predictive attributes and the life expectancy of males at birth was chosen as the objective attribute. Any country that did not have complete data for each of those attributes was removed. Forty-two countries remained. Eighty percent of the countries (34) were used as a training set and twenty percent of the countries (8) were used as a validation set. Each country was numbered from one to forty-two and a computer program randomly generated eight distinct numbers in that range. The eight countries were then used as the validation set.

The validation set was used to see how well the results generalize. As table eight demonstrates, the validation set had excellent results. The maximum change from the estimated objective attribute is 4.22 years and the average change was 1.42 years.

Objective Attribute from Data Set (years)	Estimated Objective Attribute (years)
62.74	62.70
75.45	76.39
74.86	74.10
75.31	71.37
74.29	73.95
77.19	76.26
73.6	73.35
58.0	62.22

Table 8. Comparing the estimated objective attribute of the validation set against the true objective attribute from the data set.

This is a synopsis of Marie's thesis.
For the full version: mariespilde@hotmail.com

Tanya Stupar, Math Honors student, 2005-2006, double major, Math and German.

"The purpose of computing is insight, not numbers."

R.W. Hamming, 1915-1998

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