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SUPPORT SYSTEMS FOR DECISION AND NEGOTIATION PROCESSES

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VOTE: COMPUTER EVALUATION of VOTING TECHNIQUES
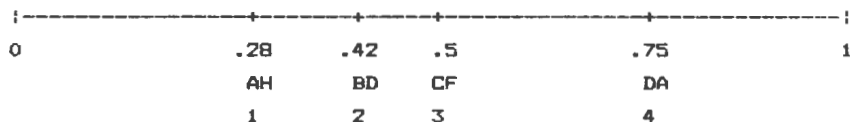
AND CANDIDATES' CHANCES

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Abstract: I designed a computer program for an evaluation of diffe-
rent voting procedures as well as evaluation of a candidate's chan-
ces to win when different information about candidates' positions
and an electorate distribution along one dimension can be obtained.
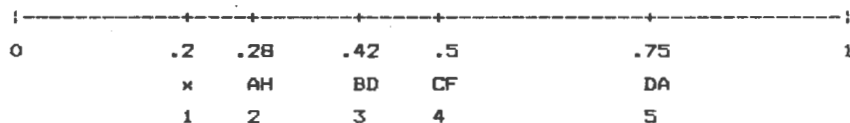
Keywords: Group decision/voting, computer program, evaluation.

The aim of the VOTE program is to evaluate voting techniques
and particular candidates' chances, when the information on the si-
tuation in question is given and when the number of candidates is
greater than 2.

The information about position of "n" candidates is given by
their location along the interval [0,1] called the ideological di-
mension. For instance (if n=4)

```
|------------------+-------+-----+-------------------+---------------|
0                 .28    .42   .5                  .75             1
                  AH     BD    CF                  DA
                  1      2     3                   4
```

Candidates AH, BD, CF and DA (or 1, 2, 3, 4) are placed respec-
tively at points 0.28, 0.42, 0.5 and 0.75 of the interval [0,1].
Their locations (and distances among them) determine for a given vo-
ter the order among the candidates. For instance, if a voter x esta-
blishes his or her position in the interval [0,1] as 0.2

```
|-----------+---+-------+-----+-------------------+---------------|
0           .2  .28    .42   .5                  .75             1
            x   AH     BD    CF                  DA
            1   2      3     4                   5
```

it means that he or she prefers the candidate AH to BD, CF and DA.
If) means a relation of strict preference, the above situation can
be described as AH) BD) CF) DA. Such an ordering is called an
individual profile of a voter x.

    If a voter x establishes his or her position on the interval
[0,1] as 0.46

```
!------------------------+----------+--+--+------------------+------------------!
0                       .28       .42 .46.5                 .75               1

                        AH        BD  x CF                  DA

                        1         2  3 4                    5
```
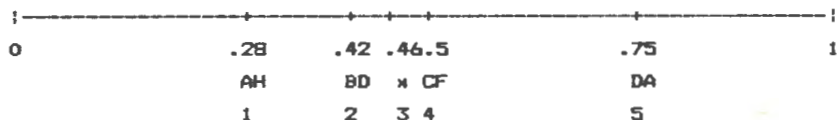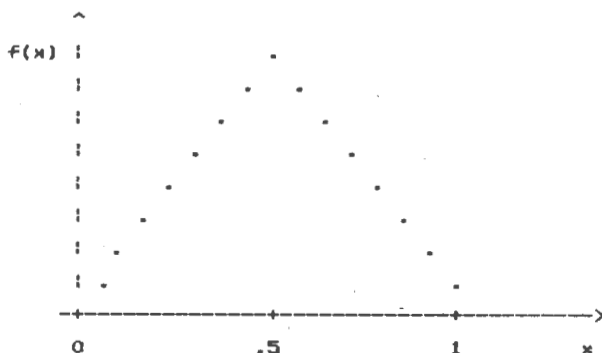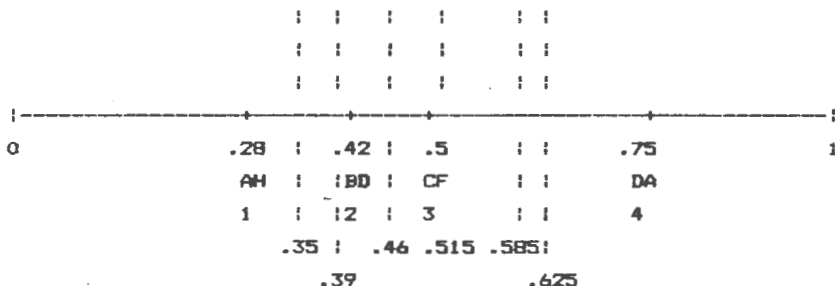
then his or her individual profile looks in the following way: BD)
CF) AH) DA, where) stands for indifference relation.

    Establishing positions of given candidates along the interval
[0,1] allows for determination of the so-called elementary supports.
They are subsets of [0,1] determining positions of potential candi-
dates, which for fixed positions of candidates, always generate the
same individual profile.

```
                        :  :   :   :      : :
                        :  :   :   :      : :
                        :  :   :   :    . : :
!------------------------+-----+-----+------------------+------------------!
0                       .28 :  .42 :  .5      : :      .75               1

                        AH  :  :BD :  CF      : :      DA

                        1   :  :2  :  3       : :      4

                        .35 :    .46 .515 .585:
                            .39                  .625
```

```
           ^
   f(x)  :                    .
         :                .       .
         :            .               .
         :        .                       .
         :    .                               .
         :  .                                     .
         :  .                                        .
         : .                                            .
         --+----------------+------------------+---------->
           0               .5                 1        x
```

For instance, an individual profile AH > BD > CF > DA is iden-
tical for any position of a voter from [0,0.35) intèrval, but an in-
dividual profile CF > DA > BD > AH is restricted to positions of vo-
ters from (0.585, 0.625) interval.

An information of the electorate is given by its distribution
f(x) along the interval [0,1]. An example is shown above.

Knowing the candidates' positions (and elementary supports)
means that the electoral distribution is de facto given by presen-
ting the cardinality of elementary supports, i.e. the number of vo-
ters, whose positions fall into a given support. For instance, in
the previously given situation of placing 4 candidates AH, BD, CF
and DA and a symmetric triangular distribution f(x) of a one-hundred
electorate, its distribution is presented as follows:

| support		cardinality
0 — 0.35	:	24
0.35 — 0.39	:	6
0.39 — 0.46	:	12
0.46 — 0.515	:	10
0.515 — 0.585	:	13
0.585 — 0.625	:	6
0.625 — 1	:	29

Having the information about candidates' positions and the ele-
ctorate distribution allows for evaluating winning chances for each
candidate when the voting technique is established. For instance, if
every voter gives one vote for each candidate (it is assumed that
he or she is sincere and the candidate is the first one in his or
her individual profile) and the candidate who gets the most votes
wins (the so-called plurality voting); then in the given example
particular candidates obtain: AH: 24 votes, BD: 18 votes, CF: 29
votes, and DA: 29 votes, and there is no winner in this voting, but
a tie between CF and DA.

The proposed program VOTE allows also for evaluation of so-
called power indices: Shapley—Shubik and Banzhaf ones.

An example.

Let's consider the following real-life example of Polish situation of early september '91 (before fall general election). On fig. 1 one may see the interlocation of Polish major parties (according to *Rzeczpospolita* after *Gazeta Wyborcza* of August 29) transferred into two possible one-dimensional cases. Using VOTE program one may answer to the fundamental question in any elections: who will be the winner (also when different voting techniques are in use).
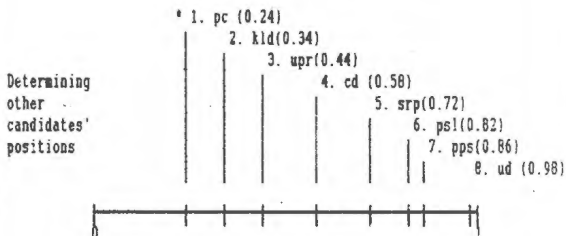
The corresponding results are presented on the following computer prints. The reader knowing the results of real ·election may evaluate himself or herself the accuracy of such attempt. There is also possibility to make an experiment and to change voting regulation, what sometimes gives extra information.
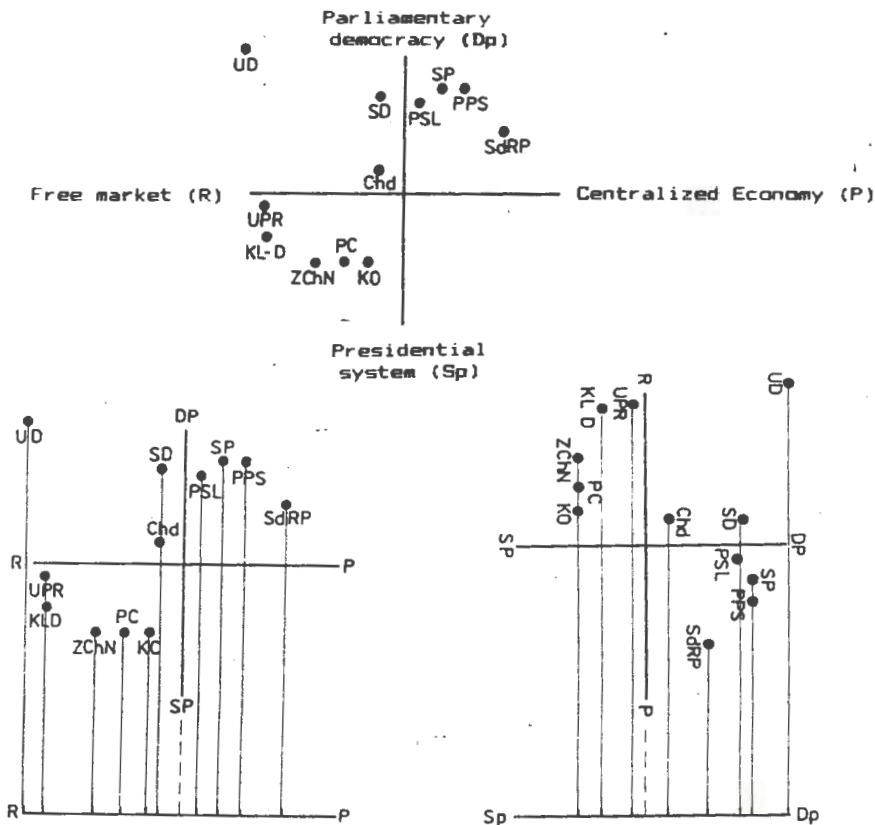
```
═══════════════════════════ VOTE ═══════════════════════════
Type of electorate distribution is known, all candidate's positions•are known

  Determining voting parameters    : - the number of candidates    :  8
                                     - size of electorate  : 210


                        * 1. pc (0.24)
                        |    2. kld(0.34)
                        |    |   3. upr(0.44)
  Determining          |    |   |      4. cd (0.58)
  other    ·           |    |   |      |      5. srp(0.72)
  candidates'          |    |   |      |      |   6. ps!(0.82)
  positions            |    |   |      |      |   |  7. pps(0.86)
                       |    |   |      |      |   |  |    8. ud (0.98)
                       |    |   |      |      |   |  |    |
              ┌────┼────┼───┼──────┼──────┼───┼──┼────┐
              0                                          1

          PRESS << ENTER >> TO DETERMINE ELECTORATE DISTRIBUTION
(*)-Our candidate

  F1 - Help
```

```
═══════════════════════════ VOTE ═══════════════════════════
Type of electorate distribution is known, all candidate's positions are known

  Determining voting parameters    : - the number of candidates    :  8
                                     - size of electorate  : 210

  1.(0.24)*
  2.(0.34)
  3.(0.44)
  4.(0.58) .
  5.(0.72)
  6.(0.82)
  7.(0.86)
  8.(0.98)
```

| Name of vote | Chosen Cand. | Votes of the rest of candidates | | | | | | | |
technique	No/votes	1	2	3	4	5	6	7	8
Condorcet	OUR ONE LOST	-	··	-	-	··	-	-	-
Borda	4 / 989	621	847	982	989	839	627	425	158
Plurality	4 / 46	35	28	43	46	26	9	7	2
Approval	3 / 138	84	116	138	137	117	91	62	19

```
═══════════════ Press ENTER ═══════════════
```

393

```
========================= VOTE =========================
Type of electorate distribution is known, all candidate's positions are known

  Determining voting parameters   : - the number of candidates   : 10
                                     - size of electorate  : 210
              . * 1. ud (0.02)
               *|  2. upr(0.06)
               *|    |  3. zcn(0.22)
               *|    |    4. pc (0.30)
               *|    |     |  5. ko (0.40)
  Determining* |    |     |  6. sd (0.42)
  other      * |    |     |     7. psl(0.54)
  candidates'* |    |     |      8. sp (0.60)
  positions  * |    |     |       9. pps(0.68)
             * |    |     |         10. srp(0.80)

            |+|--+----+--++--+---+---+---+------------|
            0                                        1 .


        PRESS << ENTER >> TO DETERMINE ELECTORATE DISTRIBUTION
(*)-Our candidate

F1 - Help
```

```
========================= VOTE =========================
Type of electorate distribution is known, all candidate's positions are known

  Determining voting parameters   : - the number of candidates   : 10
 1.(0.02)*                           - size of electorate  : 210
 2.(0.06)
 3.(0.22)
 4.(0.30)
 5.(0.40)
 6.(0.42)
 7.(0.54)
 8.(0.60)
 9.(0.68)
10.(0.80)
```

Name of vote	Chosen Cand.	Votes of the rest of candidates									
technique	No/votes	1	2	3	4	5	6	7	8	9	10
Condorcet	OUR ONE LOST	.	-	-	-	-	-	-	-	-	-
Borda	7 / 1188	202	417	723	930	1100	1179	1188	1110	947	664
Plurality	7 / 33	0	7	15	19	17	23	33	22	24	28
Approval	7 / 135	27	49	73	98	114	131	135	120	106	71

```
                        Press ENTER
```