Government 320: Public Opinion and Public Choice

Spring 2005
Tuesday and Thursday 1:25–2:40 (GS KAU)
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- **what is public opinion?**
  - **policy connections**
  - **connections to the public (which is what?)**
    - **atomized or structured?**
    - **classes?**
    - **the bourgeois public sphere and discourse**
    - **elites versus the mass public**
    - **social networks**
    - **political organizations**

- **what is public opinion?**
  - **policy connections (how?)**
    - **“pressure”**
    - **“influence”**
    - **money**
    - **votes**
    - **press**
    - **polls**

- **what is public opinion?**
  - **what is opinion?**
    - **interests: oppositional? false consciousness?**
    - **the attitude theory: cognition plus affect**
    - **values theories**
    - **considerations theories**

- what is public opinion?
  - what is opinion?
    - interests: oppositional? false consciousness?
    - the attitude theory: cognition plus affect
    - values theories
    - considerations theories
  - does context matter?
    - contrast fights over legislative language
    - contrast criminal justice, conviction and sentencing
    - in an election or not?
    - concerning an immediate decision or not

- **relevant opinion**
  - **whose opinion?**
    - **personal opinion or an agent's**
    - **consider lobbyists**
    - **consider representatives (delegate or trustee)**

- **relevant opinion**
  - **whose opinion?**
    - **personal opinion or an agent's**
    - **consider lobbyists**
    - **consider representatives (delegate or trustee)**
  - **why opinions?**
    - **confession?**
    - **coalition signaling and maintenance**
    - **other manipulations**

- **what are opinions?**
  - **attitudes or considerations versus preferences**
    - **transitivity**
    - **completeness**

- **what are opinions?**
  - **attitudes or considerations versus preferences**
    - **transitivity**
    - **completeness**
- **what is collective opinion?**
  - **item by item majorities?**
  - **pluralities?**
  - **agenda-free?**

- **Sophisticated Aggregate Public Opinion: Evaluating the Economy**
  - **prospective versus retrosective evaluations and presidential approval**

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  - **bankers or peasants? (Mackuen, Erikson, Stimson)**

- **Sophisticated Aggregate Public Opinion: Evaluating the Economy**
  - **prospective versus retrosective evaluations and presidential approval**
  - **bankers or peasants? (Mackuen, Erikson, Stimson)**
  - **finding is prospective: future econ conditions predict approval**

- **Ultrasophisticated Public Opinion: NAIRU (Sekhon)**
- **NAIRU: nonaccelerating inflation rate of unemployment (a.k.a. natural rate)**

- **Ultrasophisticated Public Opinion: NAIRU (Sekhon)**
- **NAIRU: nonaccelerating inflation rate of unemployment (a.k.a. natural rate)**
- **the Federal Reserve Board and interest rates (Taylor)**

$$i_t = \sum_{i=0}^{p} \alpha_i (u_{t-i} - u^N_{t-i}) + \sum_{j=0}^{q} \gamma_j (\pi_{t-j} - \pi^*_{t-j}) + r^f + \phi i_{t-1} + \nu_t$$

i_t, **interest rate**

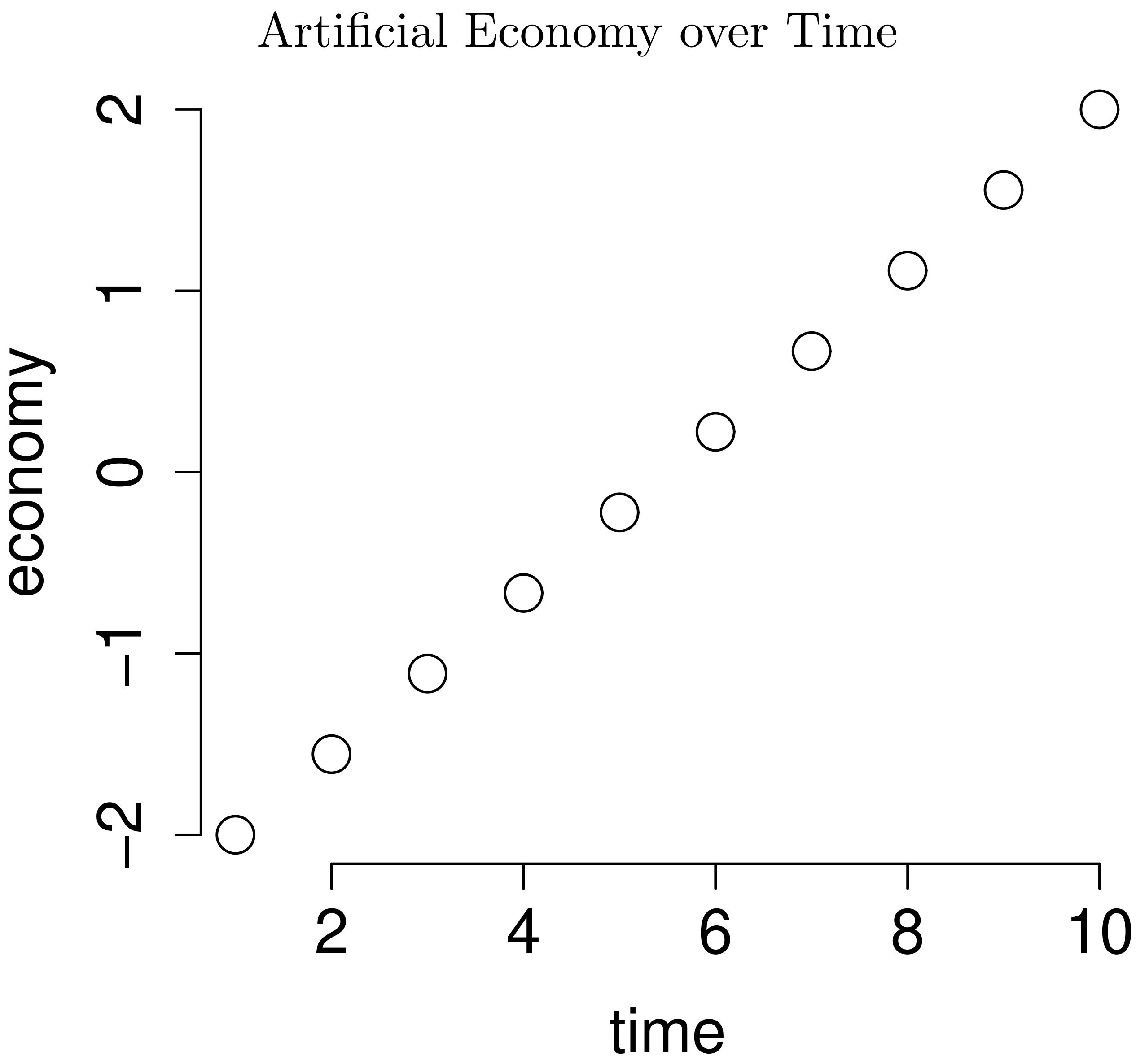
u_t, **unemployment rate**

u^N_t, **NAIRU**

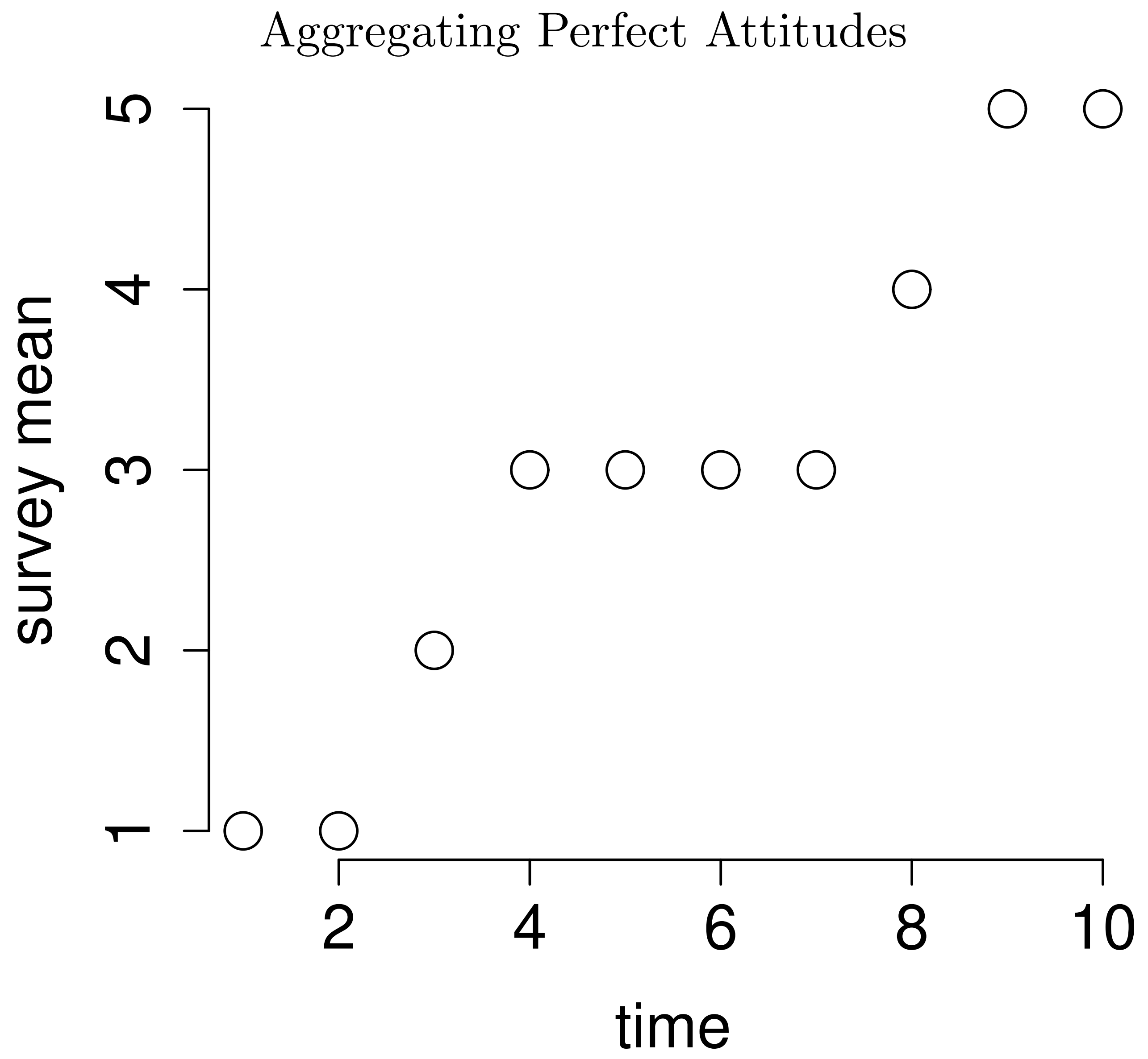
π_t, **inflation rate**

π^*_t, **target inflation rate**

- **Aggregating Opinion**
- **attitudes**
- **attitudes with error**
- **nonattitudes**
- **considerations**


Artificial Economy over Time
economy
time
2
1
0
−1
−2
2
4
6
8
10

- **perfect attitudes**
  - **for J categories of response, there are $J-1$ thresholds, a_j**
  - **choose category $j+1$ if the continuous evaluation is greater than a_j**
  - **the evaluation is exactly the evaluation of the intended object**

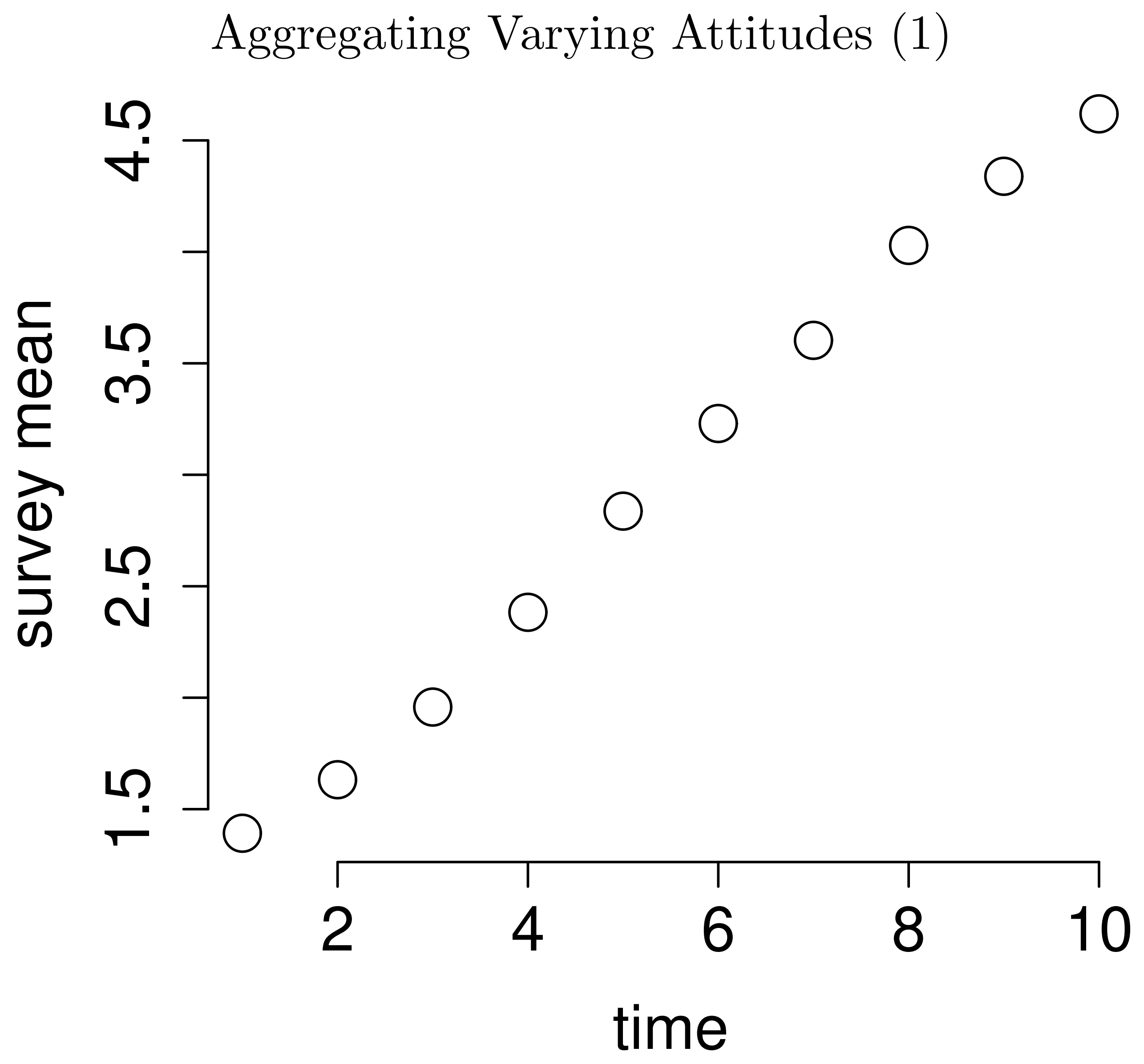

Aggregating Perfect Attitudes
survey mean
1
2
3
4
5
2
4
6
8
10
time

Perfect Attitude Distribution

time

cat.	1	2	3	4	5	6	7	8	9	10
1	1000	1000	0	0	0	0	0	0	0	0
2	0	0	1000	0	0	0	0	0	0	0
3	0	0	0	1000	1000	1000	1000	0	0	0
4	0	0	0	0	0	0	0	1000	0	0
5	0	0	0	0	0	0	0	0	1000	1000

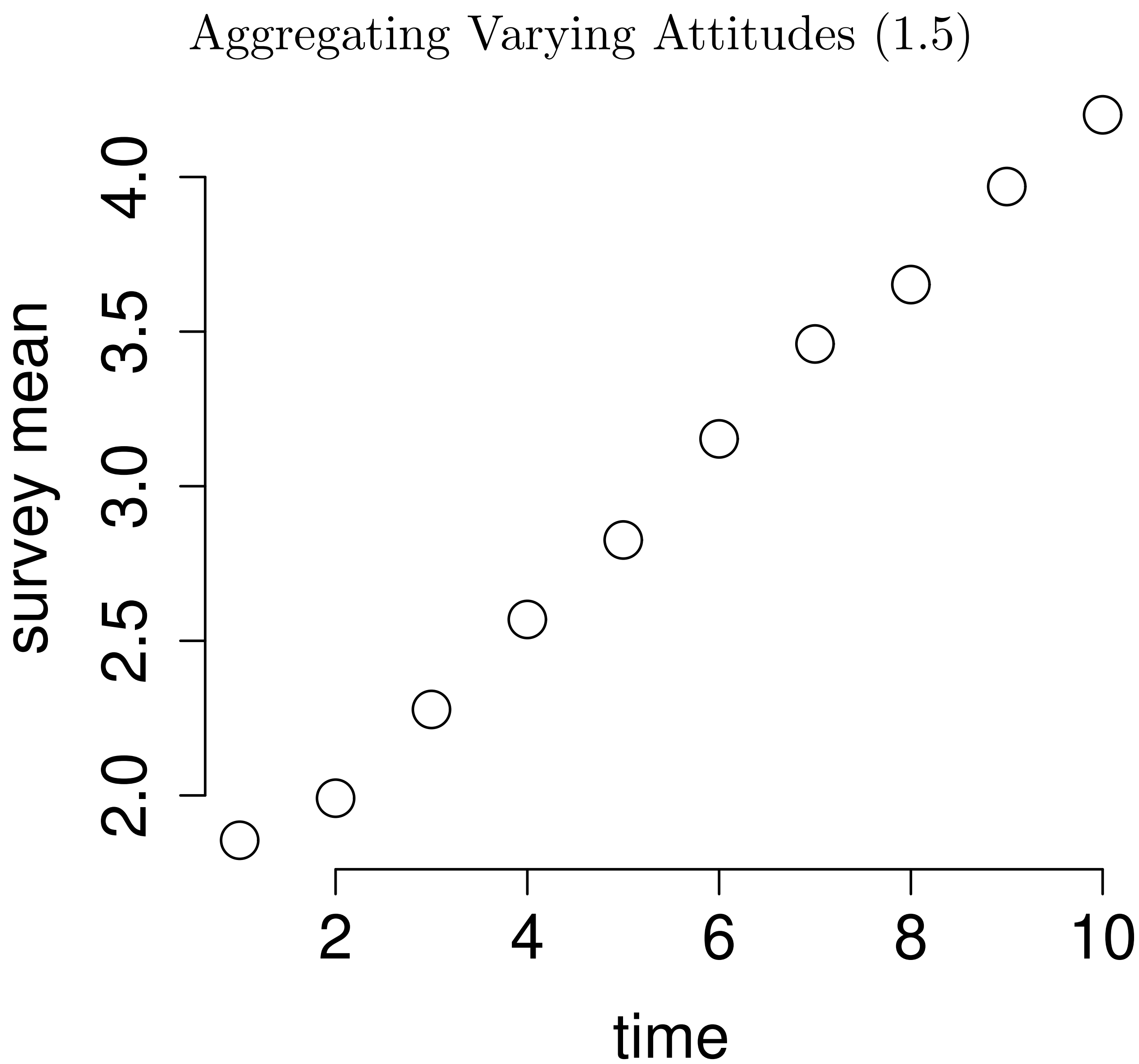
- **varying attitudes**
  - **for** J **categories of response, there are** $J-1$ **thresholds,** a_j
  - **choose category** $j+1$ **if the continuous evaluation is greater than** a_j
  - **the evaluation combines the evaluation of the intended object with random variation**


Aggregating Varying Attitudes (1)
survey mean
1.5
2.5
3.5
4.5
2
4
6
8
10
time

Varying Attitudes Distribution (1)

time

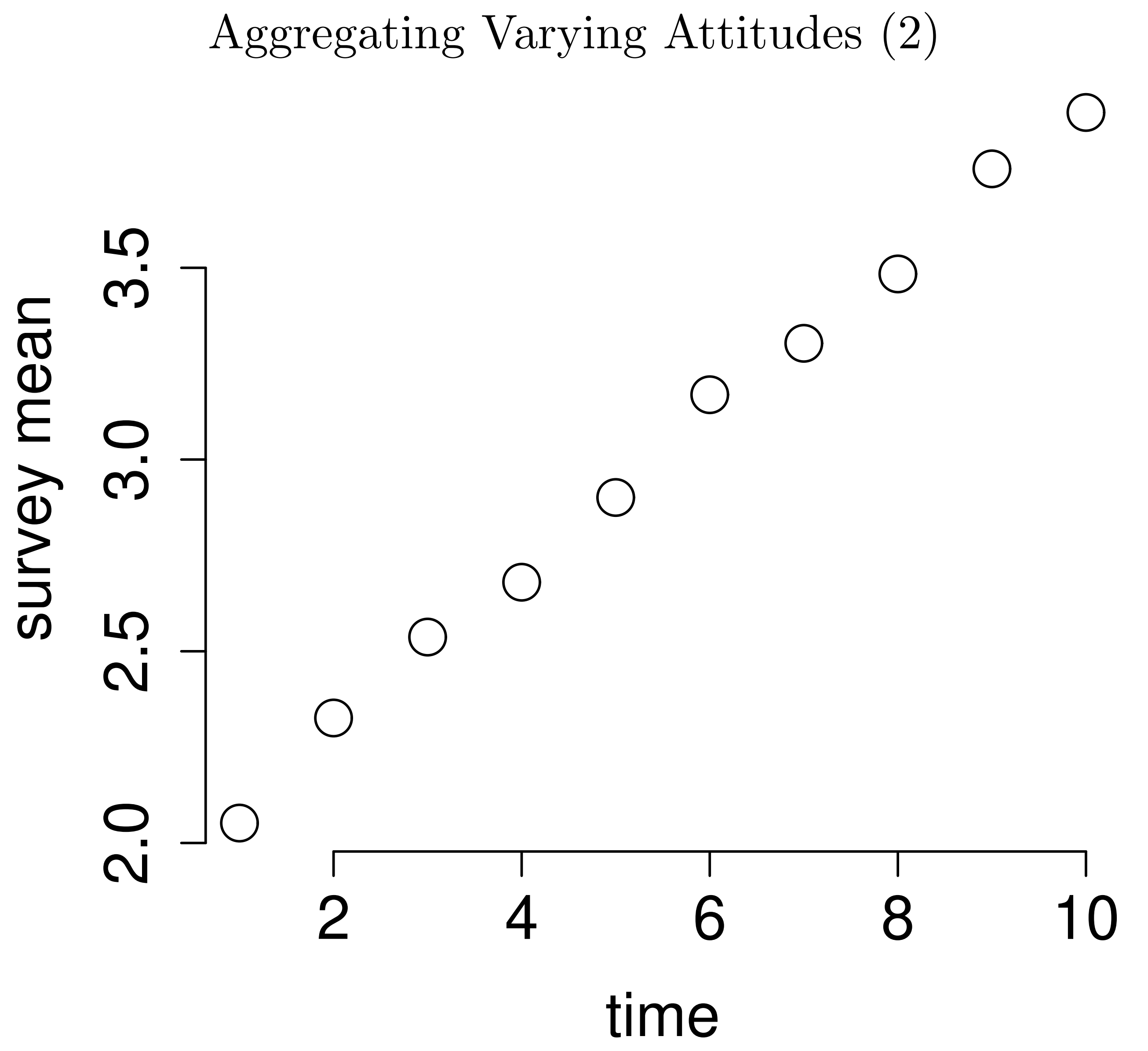
cat.	1	2	3	4	5	6	7	8	9	10
1	714	570	408	230	114	46	27	6	1	0
2	185	238	261	262	176	123	69	32	9	4
3	96	182	303	426	529	512	410	290	195	88
4	5	10	21	59	121	193	262	271	240	193
5	0	0	7	23	60	126	232	401	555	715


Aggregating Varying Attitudes (1.5)
survey mean
2.0
2.5
3.0
3.5
4.0
2
4
6
8
10
time

Varying Attitudes Distribution (1.5)

time

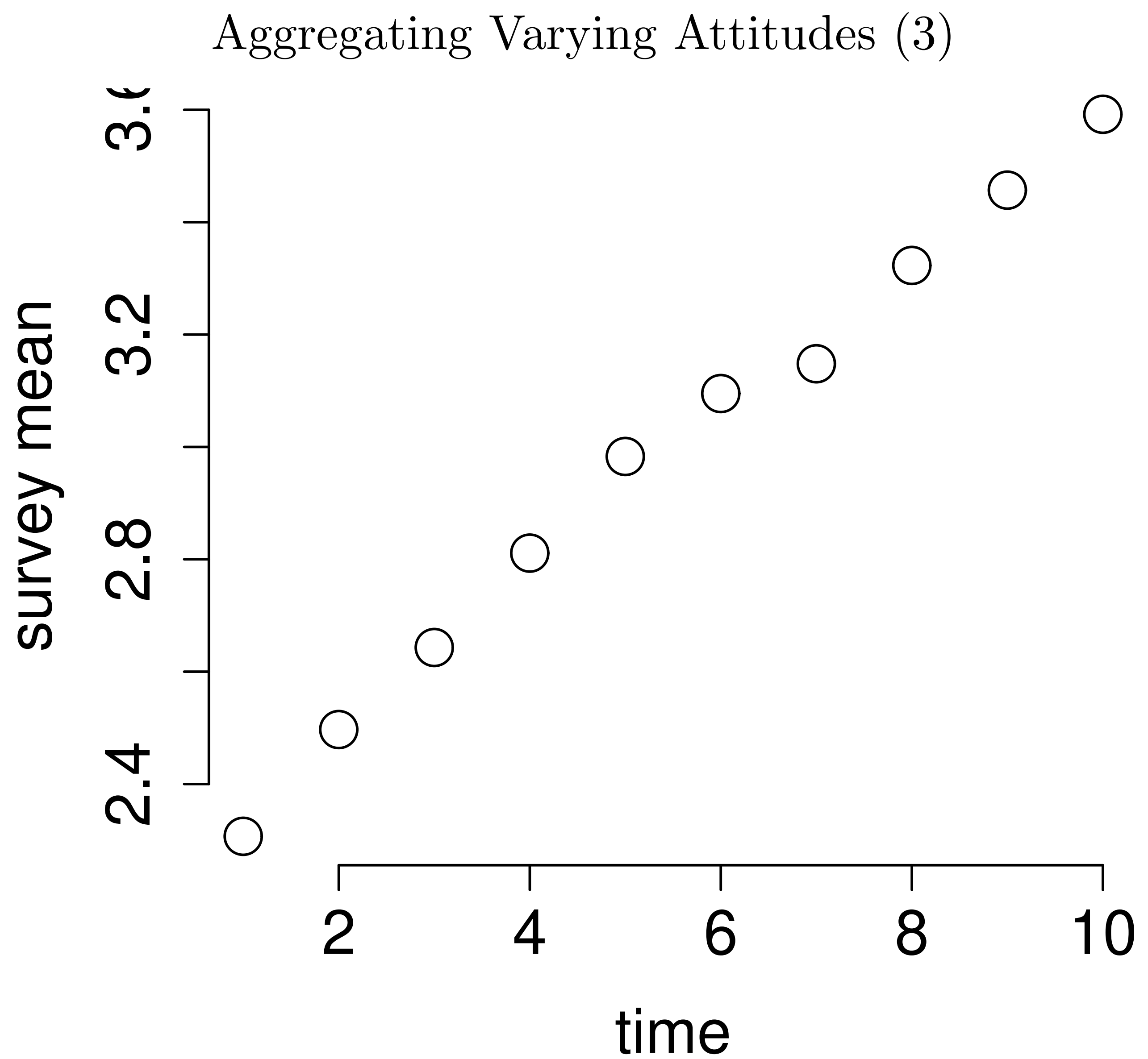
cat.	1	2	3	4	5	6	7	8	9	10
1	1000	1000	0	0	0	0	0	0	0	0
2	0	0	1000	0	0	0	0	0	0	0
3	0	0	0	1000	1000	1000	1000	0	0	0
4	0	0	0	0	0	0	0	1000	0	0
5	0	0	0	0	0	0	0	0	1000	1000


Aggregating Varying Attitudes (2)
survey mean
2.0
2.5
3.0
3.5
2
4
6
8
10
time

Varying Attitudes Distribution (2)

time

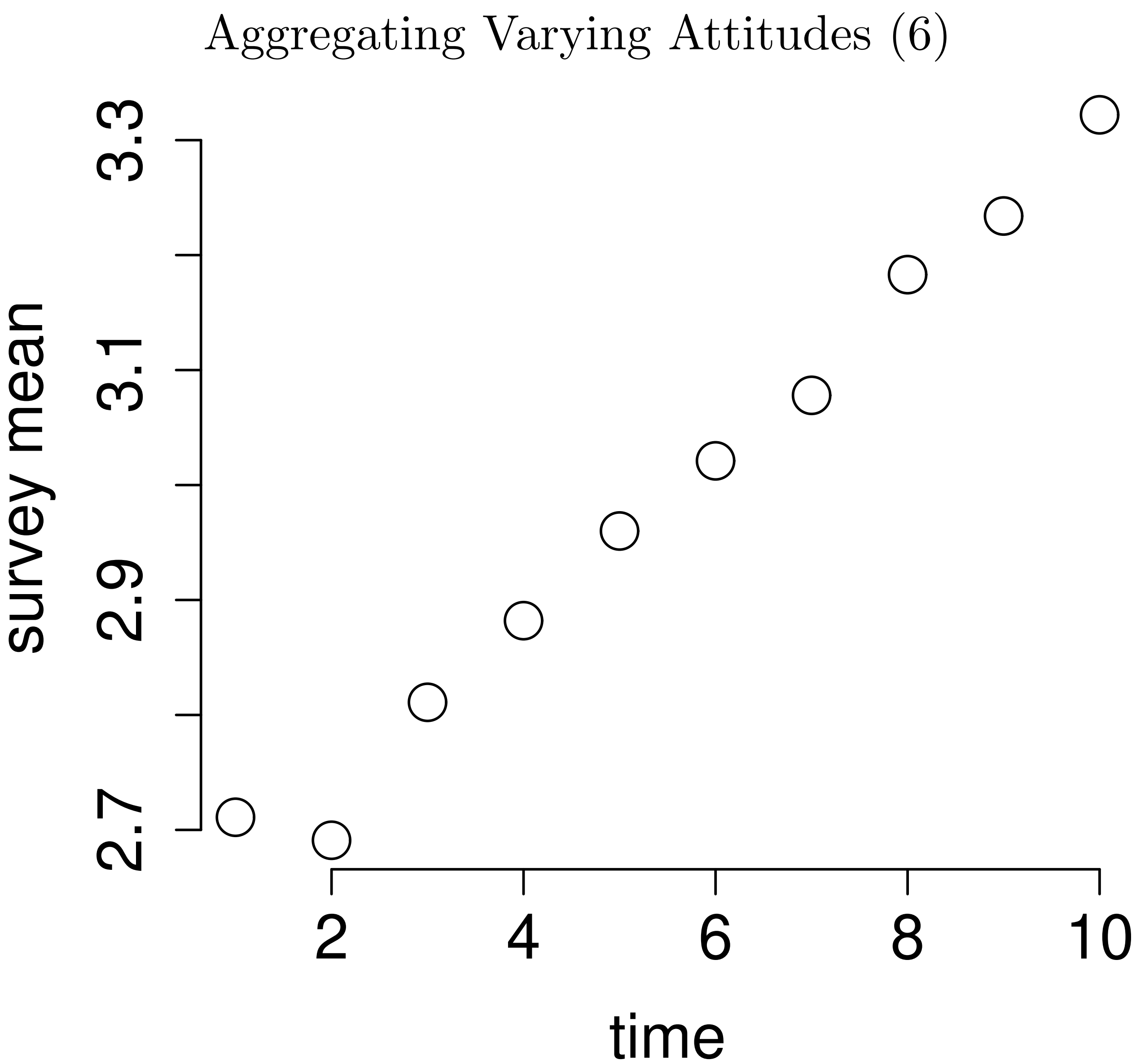
cat.	1	2	3	4	5	6	7	8	9	10
1	357	254	181	141	99	56	40	25	9	7
2	287	257	243	229	182	135	103	94	47	28
3	313	413	465	487	511	510	502	445	393	354
4	33	61	80	95	135	182	224	244	279	275
5	10	15	31	48	73	117	131	192	272	336


Aggregating Varying Attitudes (3)
survey mean
2.4
2.8
3.2
3.6
time
2
4
6
8
10

Varying Attitudes Distribution (3)

time

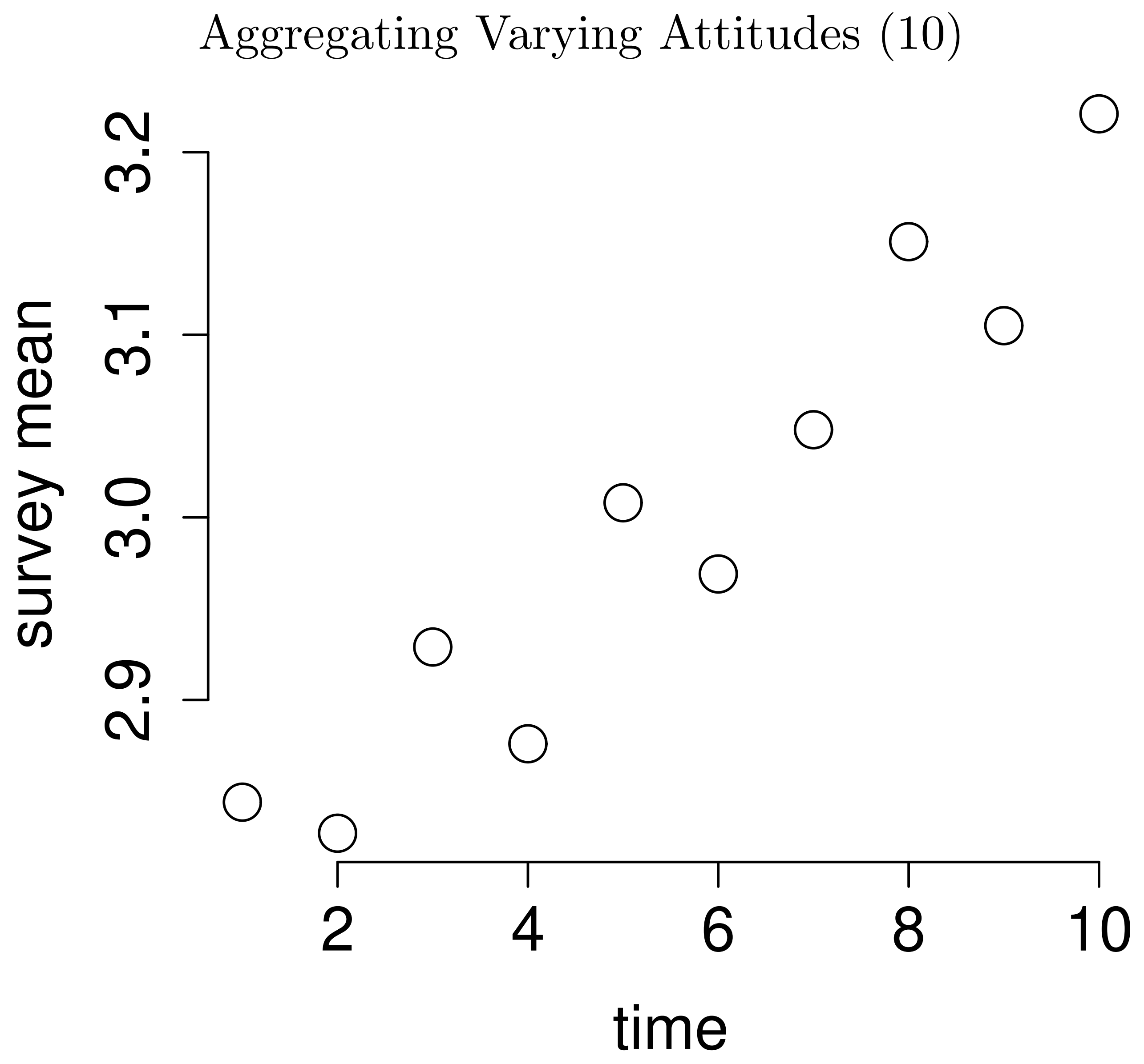
cat.	1	2	3	4	5	6	7	8	9	10
1	270	193	152	141	81	71	62	40	25	16
2	252	253	220	159	173	138	128	120	95	76
3	398	442	499	501	498	512	515	475	462	430
4	61	88	91	146	178	183	190	207	234	256
5	19	24	38	53	70	96	105	158	184	222


Aggregating Varying Attitudes (6)
survey mean
2.7
2.9
3.1
3.3
2
4
6
8
10
time

Varying Attitudes Distribution (6)

time

cat.	1	2	3	4	5	6	7	8	9	10
1	144	150	126	115	92	70	66	52	48	40
2	198	194	183	173	166	164	153	124	114	97
3	499	505	494	495	507	522	499	530	513	508
4	121	117	148	149	160	163	201	177	206	211
5	38	34	49	68	75	81	81	117	119	144

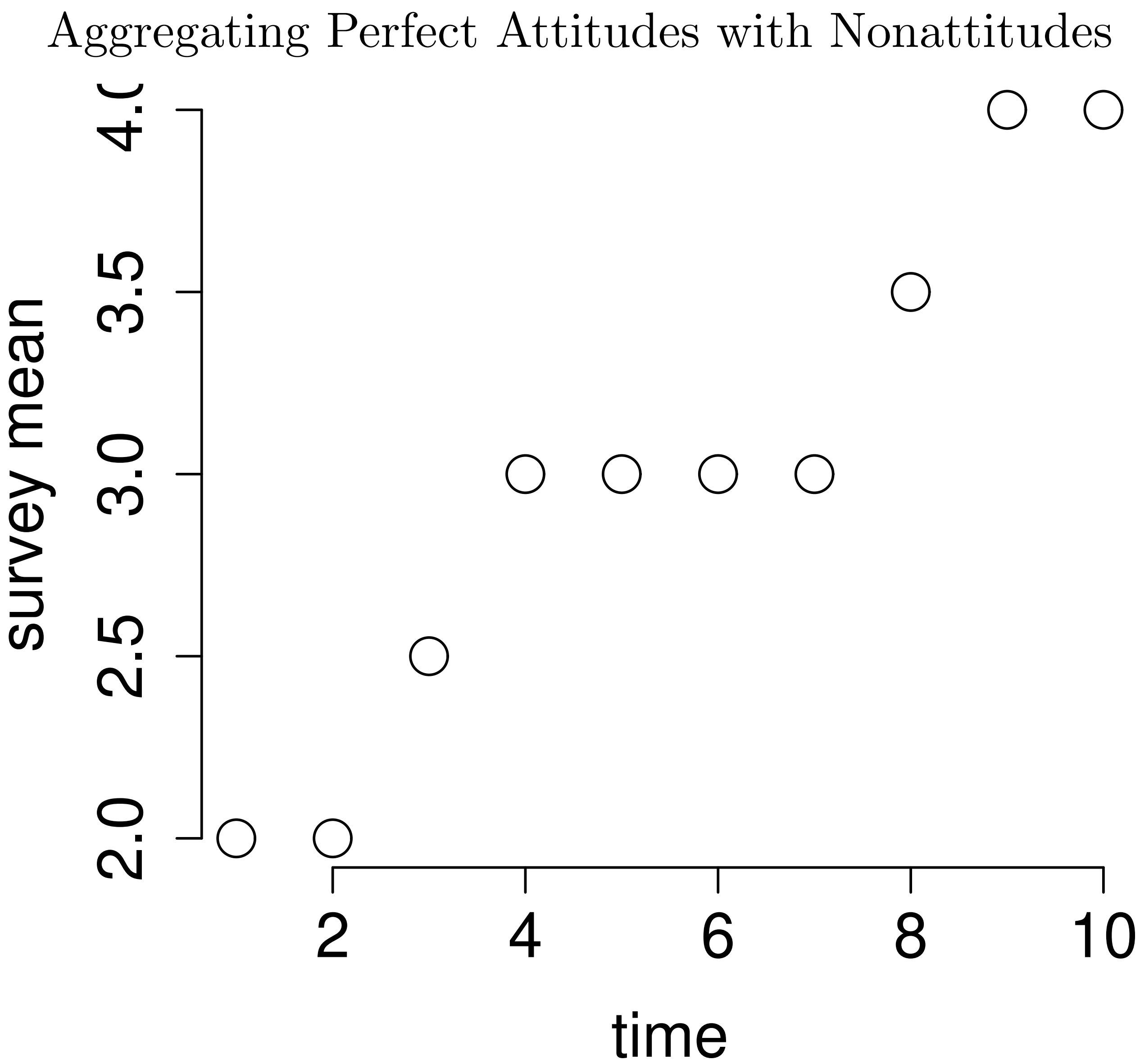

Aggregating Varying Attitudes (10)
survey mean
2.9
3.0
3.1
3.2
time
2
4
6
8
10

Varying Attitudes Distribution (10)

time

cat.	1	2	3	4	5	6	7	8	9	10
1	119	108	91	114	77	75	79	54	61	52
2	162	206	167	173	165	176	159	140	130	132
3	528	495	530	497	503	519	493	505	544	481
4	138	133	146	155	183	165	173	203	173	213
5	53	58	66	61	72	65	96	98	92	122

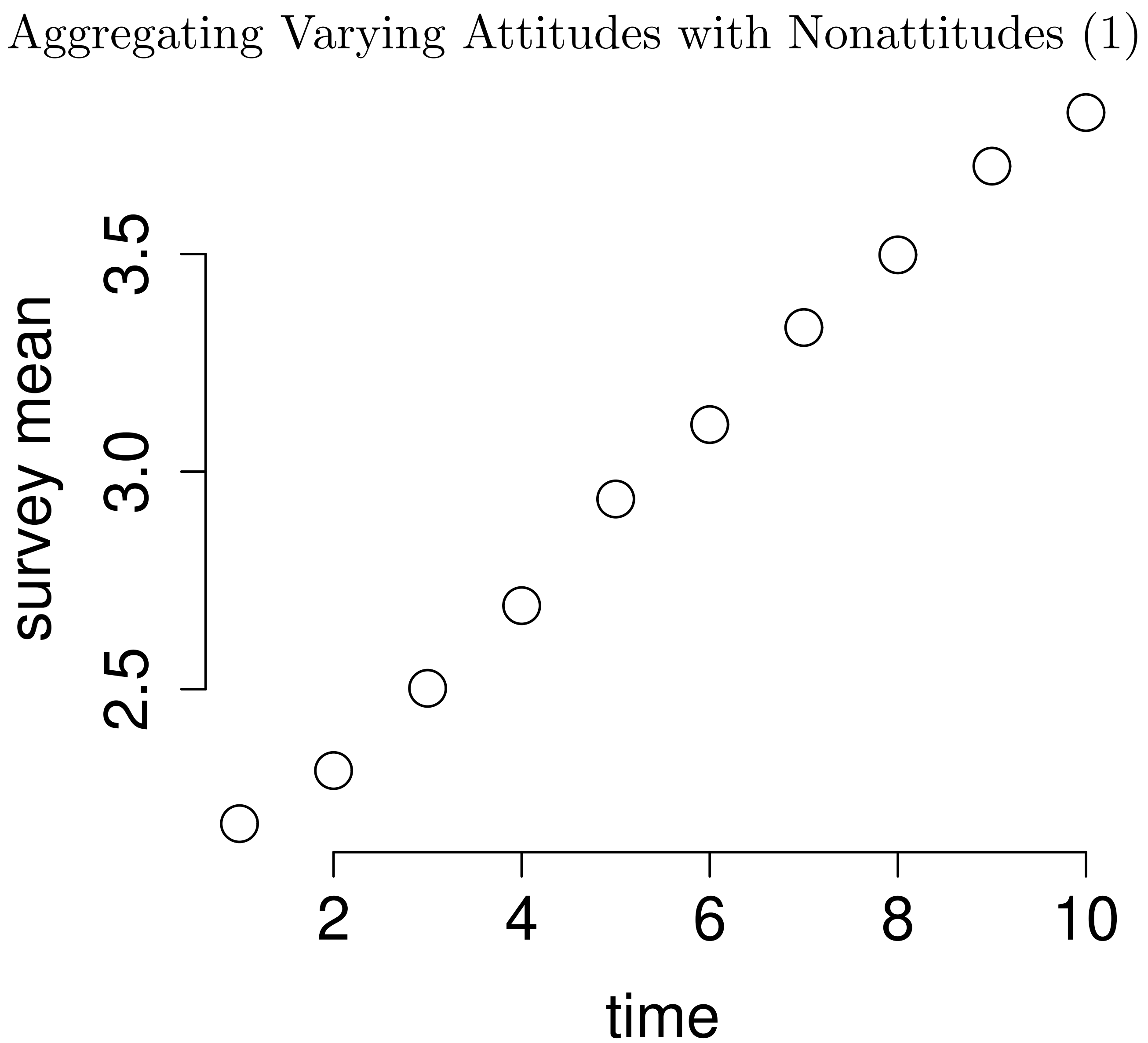
- **varying attitudes with nonattitudes**
  - **for J categories of response, there are $J-1$ thresholds, a_j**
  - **choose category $j+1$ if the continuous evaluation is greater than a_j**
  - **the evaluation combines the evaluation of the intended object with random variation**
  - **a fraction of the respondents pick the middle category**


Aggregating Perfect Attitudes with Nonattitudes
survey mean
4.0
3.5
3.0
2.5
2.0
2
4
6
8
10
time

Perfect Attitudes Distribution with Nonattitudes

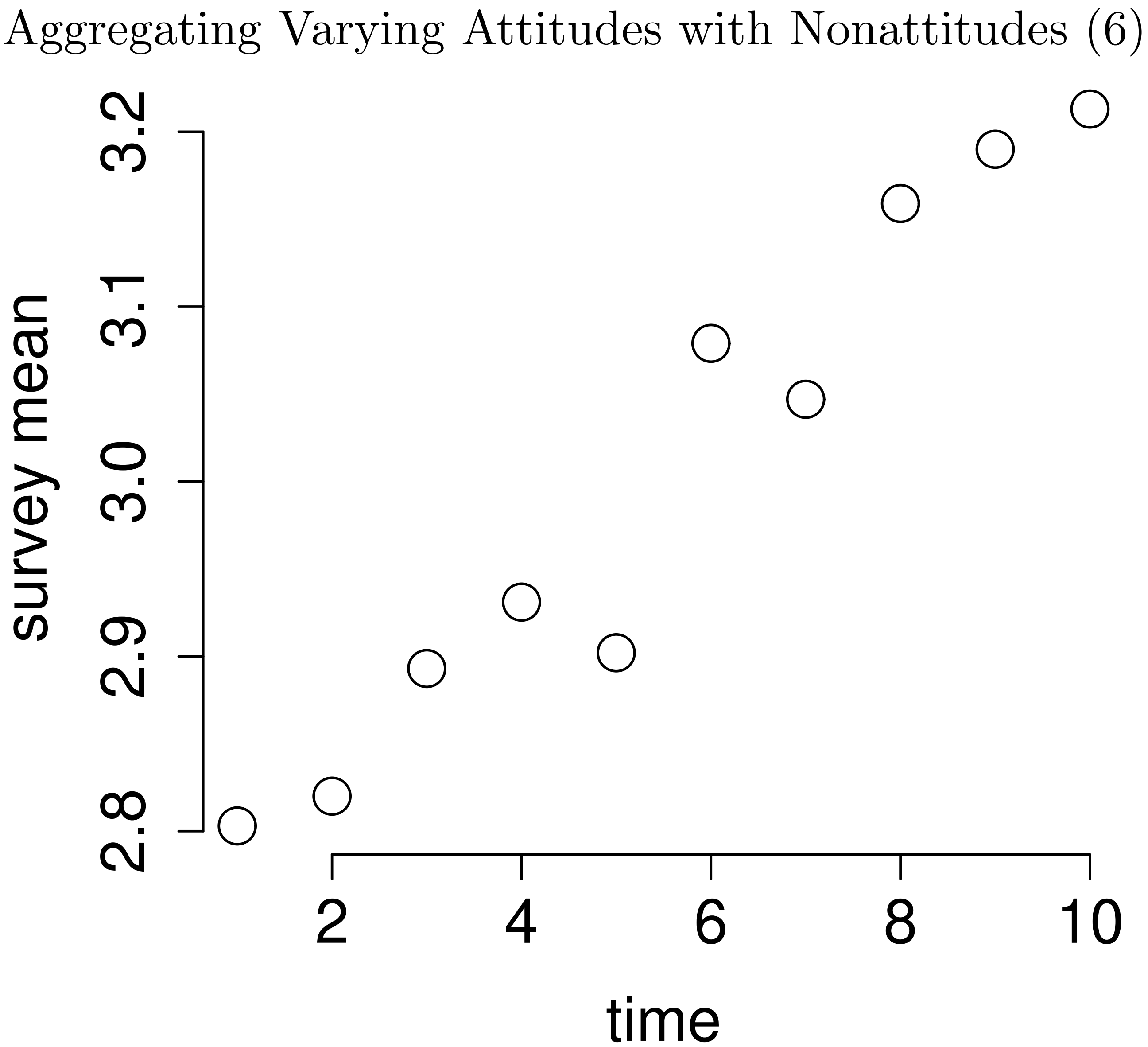
time

cat.	1	2	3	4	5	6	7	8	9	10
1	500	500	0	0	0	0	0	0	0	0
2	0	0	500	0	0	0	0	0	0	0
3	500	500	500	1000	1000	1000	1000	500	500	500
4	0	0	0	0	0	0	0	500	0	0
5	0	0	0	0	0	0	0	0	500	500


Aggregating Varying Attitudes with Nonattitudes (1)
survey mean
2.5
3.0
3.5
time
2
4
6
8
10

Varying Attitudes Distribution with Nonattitudes (1)

	time									
cat.	1	2	3	4	5	6	7	8	9	10
1	358	291	194	114	43	32	6	5	1	0
2	93	110	132	128	101	53	36	22	6	1
3	549	594	654	717	758	749	703	638	589	543
4	0	5	18	34	72	107	131	140	98	86
5	0	0	2	7	26	59	124	195	306	370



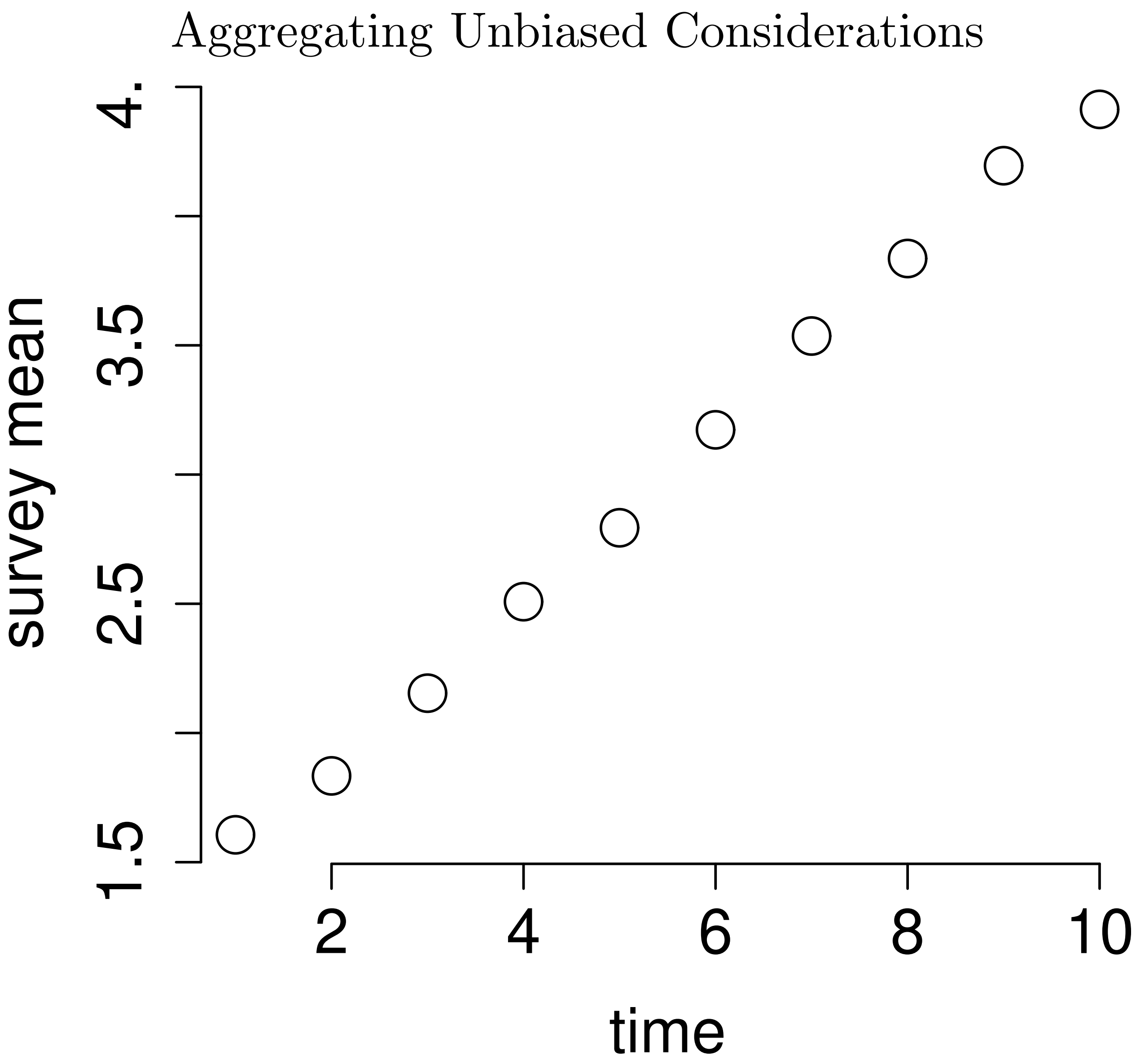
Aggregating Varying Attitudes with Nonattitudes (6)
survey mean
3.2
3.1
3.0
2.9
2.8
2
4
6
8
10
time

Varying Attitudes Distribution with Nonattitudes (6)

	time									
cat.	1	2	3	4	5	6	7	8	9	10
1	243	252	233	208	226	190	195	163	166	161
2	34	19	23	31	34	17	20	18	16	18
3	549	549	543	559	535	544	543	555	538	536
4	25	17	20	26	22	22	27	25	22	17
5	149	163	181	176	183	227	215	239	258	268

- a detour on “don’t know” (DK)
  - not the same as ”same”
  - think Buridan’s Ass: incompleteness

- **varying considerations**
  - **for J categories of response, there are $J-1$ thresholds, a_j**
  - **choose category $j+1$ if the continuous evaluation is greater than a_j**
  - **the evaluation is a random sample of miscellaneous ideas provoked by the poll question**

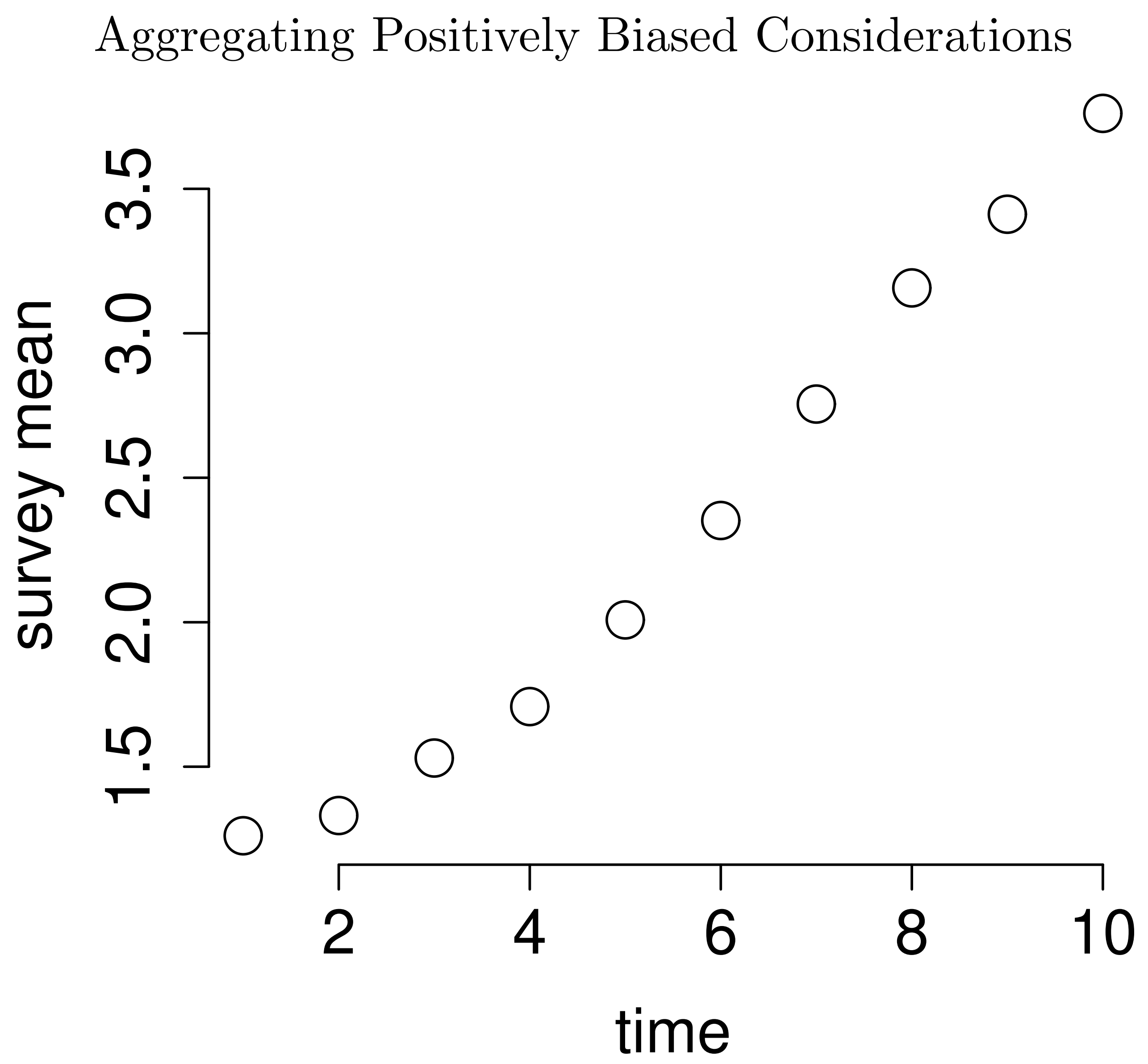

Aggregating Unbiased Considerations
survey mean
1.5
2.5
3.5
4.
2
4
6
8
10
time

Unbiased Considerations Distribution

time

cat.	1	2	3	4	5	6	7	8	9	10
1	642	537	433	310	234	159	105	47	27	14
2	146	184	170	177	148	118	104	70	49	26
3	182	210	261	313	353	343	290	298	195	156
4	24	46	82	95	120	151	152	170	160	141
5	6	23	54	105	145	229	349	415	569	663

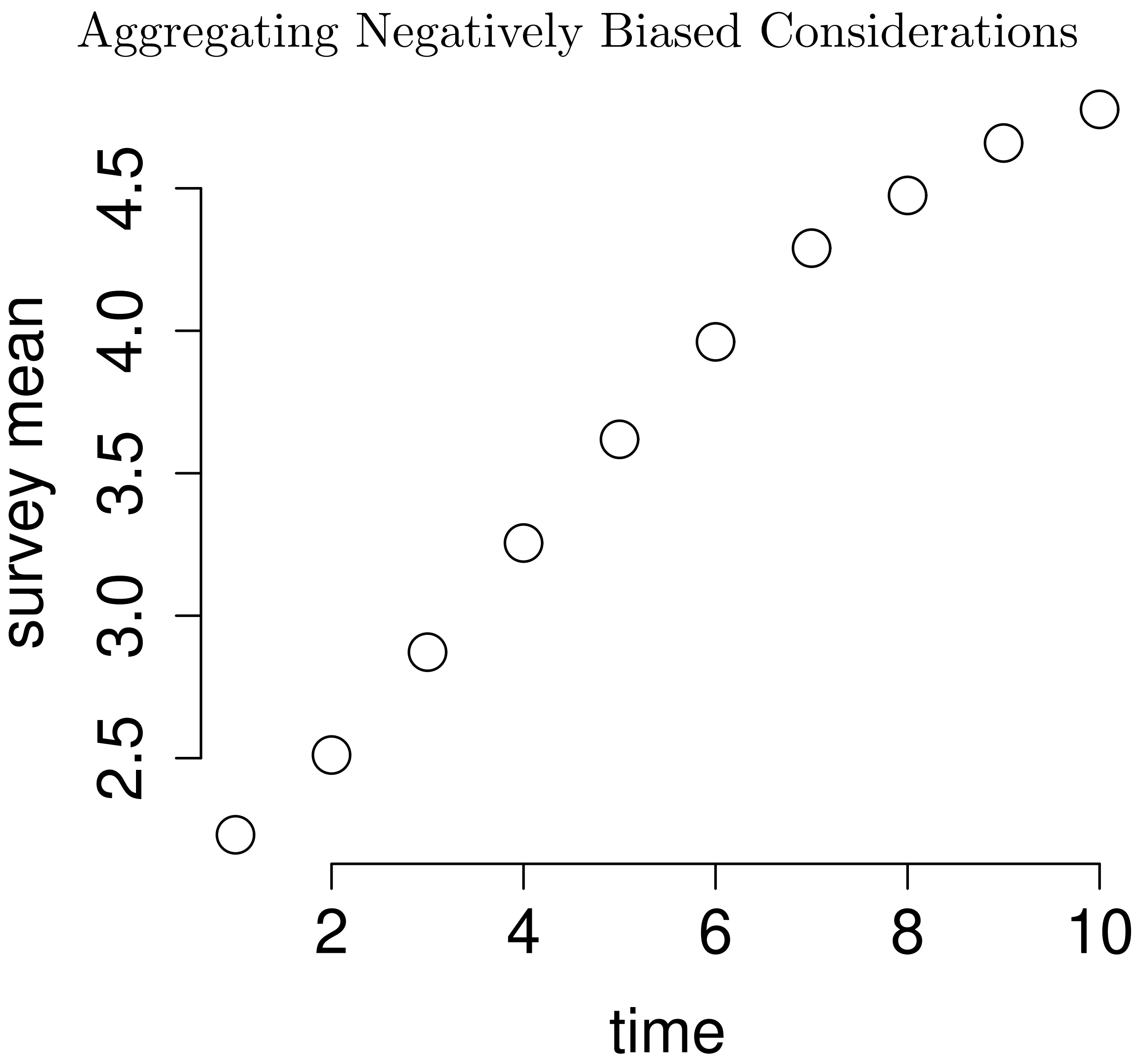
- varying considerations with bias
  - for J categories of response, there are $J-1$ thresholds, a_j
  - choose category $j+1$ if the continuous evaluation is greater than a_j
  - the evaluation is a random sample of miscellaneous ideas provoked by the poll question
  - the mean of the sample is skewed, either in response to something in the question or something extraneous
  - for Zaller (1992), the "extraneous" thing is chiefly the opinions expressed by elites (two-step flow)


Aggregating Positively Biased Considerations
survey mean
1.5
2.0
2.5
3.0
3.5
2
4
6
8
10
time

Positively Biased Considerations Distribution

time

cat.	1	2	3	4	5	6	7	8	9	10
1	829	787	691	594	462	334	233	123	77	43
2	96	111	139	177	195	215	172	166	130	90
3	62	87	131	175	251	294	342	358	363	302
4	11	14	27	35	57	79	113	137	164	193
5	2	1	12	19	35	78	140	216	266	372


Aggregating Negatively Biased Considerations
survey mean
2.5
3.0
3.5
4.0
4.5
2
4
6
8
10
time

Negatively Biased Considerations Distribution

time

cat.	1	2	3	4	5	6	7	8	9	10
1	372	280	220	140	79	35	22	5	2	1
2	182	186	133	119	89	65	35	19	14	7
3	326	354	356	332	290	246	180	157	89	62
4	83	103	137	164	218	212	157	134	113	74
5	37	77	154	245	324	442	606	685	782	856

- considerations as a theory of survey response
  - it's a descriptively accurate but ultimately noncommittal model
  - Zaller uses it to explain responses to salient issues
    * the RAS (receive-accept-sample) model
    * probability of receiving a message increases with political attentiveness
    * probability of accepting the message decreases with political attentiveness
    * hence, middling attentiveness goes with maximum opinion changes
    * considerations are sampled
    * probability of accepting the message increases with the prior credibility of the source (hence, leading elites)

- **considerations and preferences**
  - **transitive and complete individual preference orders**

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  - **von Neumann-Morgenstern utility**
    - **utility is invariant up to an affine transformation:** $v = a + bu$
    - **utility combines linearly with probability, with convexity:** $u(x) > u(y) > u(z)$ **implies there exists some probability** p **such that** $pu(x) + (1-p)u(z) = u(y)$
    - **utility can be determined by ascertaining all choices among lotteries: prefer** $px + (1-p)z$ **or** y **?**

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    - **utility can be determined by ascertaining all choices among lotteries: prefer** $px + (1 - p)z$ **or** y **?**
- **do considerations mean only that the exact description of each choice matters?**

- **axiomatic social choice theory**
  - **state as axioms general properties of any collective choice procedure (or any collective preference procedure)**
  - **derive characteristic properties of any procedure that the axioms describe**
  - **this may include showing that some desirable properties are mutually incompatible**

- **example (and point of departure): Condorcet's paradox (a.k.a. the paradox of voting)**
- **consider three voters with the following preferences:**
  - aP_ibP_ic
  - cP_iaP_ib
  - bP_icP_ia

- **example (and point of departure): Condorcet's paradox (a.k.a. the paradox of voting)**
- **consider three voters with the following preferences:**
  - aP_ibP_ic
  - cP_iaP_ib
  - bP_icP_ia
- **consider majority rule as the collective choice procedure**
- **because majority rule considers only two alternatives at a time, the three alternatives must be considered in some order**
- **the order in which the votes occur is an agenda**

- example: the paradox of voting
- consider three voters with the following preferences:
  - aP_ibP_ic
  - cP_iaP_ib
  - bP_icP_ia
- consider three agendas with pairwise majority votes:
  - a versus b, then winner versus c
  - a versus c, then winner versus b
  - b versus c, then winner versus a

- **example: the paradox of voting**
- **consider three voters with the following preferences:**
  - aP_ibP_ic
  - cP_iaP_ib
  - bP_icP_ia
- **consider three agendas with pairwise majority votes:**
  - a **versus** b**, then winner versus** c
  - a **versus** c**, then winner versus** b
  - b **versus** c**, then winner versus** a
- **the outcome depends on the agenda**

- **consider three voters with the following preferences:**
  - aP_ibP_ic, cP_iaP_ib, bP_icP_ia
- **consider three agendas with pairwise majority votes and sophisticated voting:**
- **with sophisticated voting, each voter looks ahead: the value of the current vote depends on what will happen subsequently**

- **consider three voters with the following preferences:**
  - aP_ibP_ic**,** cP_iaP_ib**,** bP_icP_ia
- **consider three agendas with pairwise majority votes and sophisticated voting:**
- **with sophisticated voting, each voter looks ahead: the value of the current vote depends on what will happen subsequently**
- **this is strategic voting only if one considers each step in the agenda a distinct collective choice process**
- **but it is different in that each voter's vote depends on everyone else's preferences**

- **consider three voters with the following preferences:**
  - aP_ibP_ic, cP_iaP_ib, bP_icP_ia
- **pairwise majority votes and sophisticated voting:**
- **everyone knows everyone votes sincerely in the last stage**
  - a **versus** b**, then winner versus** c
    * **the first vote is really** c **versus** b**, because** cPa
    * **so the winner is** b **(voter 1 votes for** b **not** a**)**

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  - aP_ibP_ic, cP_iaP_ib, bP_icP_ia
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- **everyone knows everyone votes sincerely in the last stage**
  - a **versus** b**, then winner versus** c
    - **the first vote is really** c **versus** b**, because** cPa
    - **so the winner is** b **(voter 1 votes for** b **not** a**)**
  - a **versus** c**, then winner versus** b
    - **the first vote is really** a **versus** b**, because** bPc
    - **so the winner is** a **(voter 2 votes for** a **not** c**)**

- **consider three voters with the following preferences:**
  - aP_ibP_ic, cP_iaP_ib, bP_icP_ia
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- **everyone knows everyone votes sincerely in the last stage**
  - a **versus** b**, then winner versus** c
    * **the first vote is really** c **versus** b**, because** cPa
    * **so the winner is** b **(voter 1 votes for** b **not** a**)**
  - a **versus** c**, then winner versus** b
    * **the first vote is really** a **versus** b**, because** bPc
    * **so the winner is** a **(voter 2 votes for** a **not** c**)**
  - b **versus** c**, then winner versus** a
    * **the first vote is really** c **versus** a**, because** aPb
    * **so the winner is** c **(voter 3 votes for** c **not** b**)**

- **consider three voters with the following preferences:**
  - aP_ibP_ic, cP_iaP_ib, bP_icP_ia
- **pairwise majority votes and sophisticated voting:**
- **everyone knows everyone votes sincerely in the last stage**
  - a **versus** b**, then winner versus** c
    * **the winner is** b
  - a **versus** c**, then winner versus** b
    * **the winner is** a
  - b **versus** c**, then winner versus** a
    * **the winner is** c

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  - aP_ibP_ic, cP_iaP_ib, bP_icP_ia
- **pairwise majority votes and sophisticated voting:**
- **everyone knows everyone votes sincerely in the last stage**
  - a **versus** b**, then winner versus** c
    - **the winner is** b
  - a **versus** c**, then winner versus** b
    - **the winner is** a
  - b **versus** c**, then winner versus** a
    - **the winner is** c
- **the outcome depends on the agenda**

- **axiomatic social choice theory**
  - **how to generalize from such an example? of what is it an example?**
  - **what axioms describe majority rule? (May)**

- **axiomatic social choice theory**
  - **how to generalize from such an example? of what is it an example?**
  - **what axioms describe majority rule? (May)**
    - **Pareto conditions**
      - **unanimity**
      - **weak Pareto (unanimous preferences for a pair)**
      - **strong Pareto (aP_ib for one person without opposition)**
      - **positive responsiveness**

- **axiomatic social choice theory**
  - **how to generalize from such an example? of what is it an example?**
  - **what axioms describe majority rule? (May)**
    - **Pareto conditions**
      - **unanimity**
      - **weak Pareto (unanimous preferences for a pair)**
      - **strong Pareto (aP_ib for one person without opposition)**
      - **positive responsiveness**
    - **pairwise independence**

- **axiomatic social choice theory**
  - **how to generalize from such an example? of what is it an example?**
  - **what axioms describe majority rule? (May)**
    - **Pareto conditions**
      - **unanimity**
      - **weak Pareto (unanimous preferences for a pair)**
      - **strong Pareto (aP_ib for one person without opposition)**
      - **positive responsiveness**
    - **pairwise independence**
    - **anonymity (all voters treated the same)**
    - **symmetry (or neutrality: all alternatives treated the same)**

- **axiomatic social choice theory**
- **other desirable properties**
  - **unrestricted preferences**

- **axiomatic social choice theory**
- **other desirable properties**
  - **unrestricted preferences**
  - **choice from all subsets**

- **axiomatic social choice theory**
- **other desirable properties**
  - **unrestricted preferences**
  - **choice from all subsets**
  - **collective rationality (slightly wrong notation [subscripts])**
    * **RC1: if** $C_i(a,b) = \{a\}$ **and** $C_i(b,c) = \{b\}$ **then** $C_i(a,c) = \{a\}$
    * **RC2: if** $C_i(a,b) = \{a,b\}$ **and** $C_i(b,c) = \{b,c\}$ **then** $C_i(a,c) = \{a,c\}$
    * **RC3: if** a **is in** $C_i(T)$ **and** b **is in** T**, then** a **is in** $C_i(a,b)$
    * **RC4: if** a **is in** $C_i(a,b)$ **and** a **is in** $C_i(T)$**, then** a **is in** $C_(T \cup b)$

- **axiomatic social choice theory**
- **other desirable properties**
  - **unrestricted preferences**
  - **choice from all subsets**
  - **collective rationality (corrected notation)**
    - **RC1: if** $C(a,b) = \{a\}$ **and** $C(b,c) = \{b\}$ **then** $C(a,c) = \{a\}$
    - **RC2: if** $C(a,b) = \{a,b\}$ **and** $C(b,c) = \{b,c\}$ **then** $C(a,c) = \{a,c\}$
    - **RC3: if** a **is in** $C(T)$ **and** b **is in** T**, then** a **is in** $C(a,b)$
    - **RC4: if** a **is in** $C(a,b)$ **and** a **is in** $C(T)$**, then** a **is in** $C_(T \cup b)$

- **axiomatic social choice theory**
- **other desirable properties**
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    * **RC1: if** $C(a, b) = \{a\}$ **and** $C(b, c) = \{b\}$ **then** $C(a, c) = \{a\}$
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    * **RC4: if** a **is in** $C(a, b)$ **and** a **is in** $C(T)$**, then** a **is in** $C_{(}T \cup b)$
- **majority rule fails collective rationality, since it produces voting cycles**

- **axiomatic social choice theory**
- **Arrow's theorem**
- **generalizes the conclusions about majority rule, almost universally**

- **Arrow's theorem (Vickrey variant)**
- **Theorem 3.3: There is a dictator if there are at least three alternatives and the social choice rule satisfies**

  choice from all subsets

  unrestricted preferences

  pairwise independence

  weak Pareto

  and if the social choices satisfy rationality conditions RC1 to RC4

- **Arrow's theorem (Vickrey variant)**
- **proof in two steps**
  1. **epidemic of decisiveness: show that semidecisiveness over any one pair of alternatives implies full decisiveness over all choices from every set of alternatives**
  2. **the dictator: show that the fully decisive set can contain only one individual**

- **epidemic**
- **set D of individuals is semidecisive for a over b if $C(a,b) = \{a\}$ when aP_ib for everyone in D but bP_ia for everyone else**
- **assume D is semidecisive for a over b**

- **epidemic**
- **set D of individuals is semidecisive for a over b if $C(a,b) = \{a\}$ when aP_ib for everyone in D but bP_ia for everyone else**
- **assume D is semidecisive for a over b**
- **preferences demonstrating semidecisiveness epidemic:**

individuals	I	II	III
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **epidemic**
- **set D of individuals is semidecisive for a over b if $C(a,b) = \{a\}$ when aP_ib for everyone in D but bP_ia for everyone else**
- **assume D is semidecisive for a over b**
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individuals	**I**	**II**	**III**
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **unrestricted preferences make all these orders relevant**
- **pairwise independence means these orders can be considered in isolation from the rest of the preference orders, which may vary within each set of individuals**

- **assume D is semidecisive for a over b**
- **preferences demonstrating semidecisiveness epidemic:**

individuals	**I**	**II**	**III**
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **assume D is semidecisive for a over b**
- **preferences demonstrating semidecisiveness epidemic:**

individuals	**I**	**II**	**III**
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **I:** $C(a,b) = \{a\}$ **(semidecisive assumption);** $C(b,c) = \{b\}$ **(weak Pareto);** $C(a,c) = \{a\}$ **(RC1);** D **is semidecisive for** a **over** c **(definition)**

- **assume** D **is semidecisive for** a **over** b
- **preferences demonstrating semidecisiveness epidemic:**

individuals	**I**	**II**	**III**
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **I:** $C(a,b) = \{a\}$ **(semidecisive assumption);** $C(b,c) = \{b\}$ **(weak Pareto);** $C(a,c) = \{a\}$ **(RC1);** D **is semidecisive for** a **over** c **(definition)**
- **II:** $C(a,b) = \{a\}$ **(semidecisive assumption);** $C(d,a) = \{d\}$ **(weak Pareto);** $C(d,b) = \{d\}$ **(RC1);** D **is semidecisive for** d **over** b **(definition)**

- **combining and generalizing examples I and II gives**
- **SD1: if D is semidecisive for a over an alternative y, then D is semidecisive for any other alternative x over y**
- **SD2: if D is semidecisive for an alternative x over b, then D is semidecisive for x over any other alternative y**

- **combining and generalizing examples I and II gives**
- **SD1: if D is semidecisive for a over an alternative y, then D is semidecisive for any other alternative x over y**
- **SD2: if D is semidecisive for an alternative x over b, then D is semidecisive for x over any other alternative y**
- **combining and generalizing examples I and II gives**
- **SD3: if D is semidecisive for a over b, then SD1 implies that D is semidecisive for any alternative x over b**

- **combining and generalizing examples I and II gives**
- **SD1: if** D **is semidecisive for** a **over an alternative** y**, then** D **is semidecisive for any other alternative** x **over** y
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- **combining and generalizing examples I and II gives**
- **SD3: if** D **is semidecisive for** a **over** b**, then SD1 implies that** D **is semidecisive for any alternative** x **over** b
- **SD4: if** D **is semidecisive for** a **over** b**, then SD2 implies that** D **is semidecisive for** a **over any alternative** y

- **combining and generalizing examples I and II gives**
- **SD1: if D is semidecisive for a over an alternative y, then D is semidecisive for any other alternative x over y**
- **SD2: if D is semidecisive for an alternative x over b, then D is semidecisive for x over any other alternative y**
- **combining and generalizing examples I and II gives**
- **SD3: if D is semidecisive for a over b, then SD1 implies that D is semidecisive for any alternative x over b**
- **SD4: if D is semidecisive for a over b, then SD2 implies that D is semidecisive for a over any alternative y**
- **SD5: if D is semidecisive for a over b, then SD3 and SD4 imply that D is semidecisive for any x over any y (except for b over a)**

- **assume** D **is semidecisive for** a **over** b
- **preferences demonstrating semidecisiveness epidemic:**

individuals	I	II	III
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **III:** $C(b,c) = \{b\}$ **(SD5);** $C(a,c) = \{c\}$ **(weak Pareto);** $C(a,b) = \{b\}$ **(RC1);** D **is semidecisive for** b **over** a **(definition)**

- **assume D is semidecisive for a over b**
- **preferences demonstrating semidecisiveness epidemic:**

individuals	**I**	**II**	**III**
in D	aP_ibP_ic	dP_iaP_ib	bP_icP_ia
rest	bP_icP_ia	bP_idP_ia	cP_iaP_ib

- **III:** $C(b,c) = \{b\}$ **(SD5);** $C(a,c) = \{c\}$ **(weak Pareto);** $C(a,b) = \{b\}$ **(RC1);** D **is semidecisive for** b **over** a **(definition)**
- **if D is semidecisive for a over b, then D is semidecisive for any x over any y**

- **semidecisiveness implies decisiveness**

- D **is a decisive set of individuals if for any alternatives** x **and** y**,** $C(x, y) = \{x\}$ **whenever** xP_iy **for everyone in** D **whatever preferences others have**

- **semidecisiveness implies decisiveness**
- **assume** D **is semidecisive (i.e., for any** x **over any** y**)**

- **semidecisiveness implies decisiveness**
- **assume D is semidecisive (i.e., for any x over any y)**
- **preferences demonstrating decisiveness:**

  individuals

in D	dP_ieP_ic
in E	eP_idP_ic
in F	eP_icP_id
rest	eP_icI_id

- $C(d,e) = \{d\}$ **(semidecisiveness);** $C(c,e) = \{e\}$ **(weak Pareto);** $C(c,d) = \{d\}$ **(RC1);** D **is decisive for** d **over** c **(definition)**

- **extension to decisiveness over choices from sets larger than pairs**
- **assume D is a decisive set**
- **assume everyone in D has aP_ib for all $b \in T$**
- **then $C(a, b) = \{a\}$ for all $b \in T$**

- **extension to decisiveness over choices from sets larger than pairs**

- **assume** D **is a decisive set**

- **assume everyone in** D **has** aP_ib **for all** $b \in T$

- **then** $C(a, b) = \{a\}$ **for all** $b \in T$

- **let** $b \neq a$ **and** $b \in T$ **and suppose** $b \in C(T)$**; then** $b \in C(a, b)$ **(RC3), which contradicts** $C(a, b) = \{a\}$**; therefore** $b \notin C(T)$**; therefore** $C(T) = \{a\}$

- **extension to decisiveness over choices from sets larger than pairs**
- **assume** D **is a decisive set**
- **assume everyone in** D **has** aP_ib **for all** $b \in T$
- **then** $C(a,b) = \{a\}$ **for all** $b \in T$
- **let** $b \neq a$ **and** $b \in T$ **and suppose** $b \in C(T)$**; then** $b \in C(a,b)$ **(RC3), which contradicts** $C(a,b) = \{a\}$**; therefore** $b \notin C(T)$**; therefore** $C(T) = \{a\}$
- $C(T) = \{a\}$ **matches the preference of the members of** D

- **extension to decisiveness over choices from sets larger than pairs**

- **assume** D **is a decisive set**

- **assume everyone in** D **has** aP_ib **for all** $b \in T$

- **then** $C(a,b) = \{a\}$ **for all** $b \in T$

- **let** $b \neq a$ **and** $b \in T$ **and suppose** $b \in C(T)$**; then** $b \in C(a,b)$ **(RC3), which contradicts** $C(a,b) = \{a\}$**; therefore** $b \notin C(T)$**; therefore** $C(T) = \{a\}$

- $C(T) = \{a\}$ **matches the preference of the members of** D

- **a set** D **is fully decisive if** D **can ensure that the most preferred alternative of all individuals in** D **is the social choice**

- **Arrow's theorem (Vickrey variant)**
- **proof in two steps**
  1. **epidemic of decisiveness: show that semidecisiveness over any one pair of alternatives implies full decisiveness over all choices from every set of alternatives**
  2. **the dictator: show that the fully decisive set can contain only one individual**

- **the dictator**
- **the collective**

  i. **a collective is the smallest fully decisive set**

  ii. **all sets that include all members of the collective are fully decisive**

  iii. **no set that does not include all members of the collective is fully decisive**

  iv. **there is only one collective**

- **the collective**
- **intersecting fully decisive sets:** D **and** E **are fully decisive sets that have members in common**

in D **and in** E	bP_icP_ia
in D**, not in** E	aP_ibP_ic
in E**, not in** D	cP_iaP_ib
rest	aP_icP_ib

- **the collective**
- **intersecting fully decisive sets:** D **and** E **are fully decisive sets that have members in common**

in D **and in** E	bP_icP_ia
in D**, not in** E	aP_ibP_ic
in E**, not in** D	cP_iaP_ib
rest	aP_icP_ib

- $C(b,c) = \{b\}$ **(**D **decisive);** $C(a,c) = \{c\}$ **(**E **decisive);** $C(a,b) = \{b\}$ **(RC1);** $D \cap E$ **is semidecisive for** b **over** a**; therefore** $D \cap E$ **is a fully decisive set**

- the dictator
- suppose the collective contains two or more members
- let some but not all collective members be in E
- these assumptions lead to a contradiction

  in E $\quad aP_icP_ib$

  rest $\quad cP_ibP_ia$

- $C(a,b) = \{a,b\}$ (neither subset is semidecisive);
  $C(a,c) = \{a,c\}$ (neither subset is semidecisive);
  $C(b,c) = \{b,c\}$ (RC2); but $C(b,c) = \{b,c\}$ violates weak Pareto

- **the dictator**
- **suppose the collective contains two or more members**
- **let some but not all collective members be in** E
- **these assumptions lead to a contradiction**

  in E $\quad aP_icP_ib$

  rest $\quad cP_ibP_ia$
- $C(a,b) = \{a,b\}$ **(neither subset is semidecisive);** $C(a,c) = \{a,c\}$ **(neither subset is semidecisive);** $C(b,c) = \{b,c\}$ **(RC2); but** $C(b,c) = \{b,c\}$ **violates weak Pareto**
- **if only one subset contains the collective, there is no contradiction**
- **the collective is impossible to divide only if has only one member**

- **Arrow's theorem (as proven)**
- **Theorem 3.7: There is a dictator if there are at least three alternatives and the social choice rule satisfies**

  choice from all subsets

  unrestricted preferences

  pairwise independence

  weak Pareto

  and if the social choices satisfy rationality conditions RC1, RC2 and RC3

- **manipulation**

- **manipulation**
- **a social choice rule is open to manipulation if an individual can obtain a more preferred collective choice by having the rule use preferences other than his own while using everyone else's true preferences**

- **manipulation**
- **a social choice rule is open to manipulation if an individual can obtain a more preferred collective choice by having the rule use preferences other than his own while using everyone else's true preferences**
- **a rule is non-manipulable if it is not open to manipulation by any individual on any set of alternatives**

- **Gibbard-Satterthwaite theorem (variant)**
- **Theorem 5.4: There is a dictator if there are at least three alternatives and the social choice rule satisfies**

  choice from all subsets

  unrestricted preferences

  weak Pareto

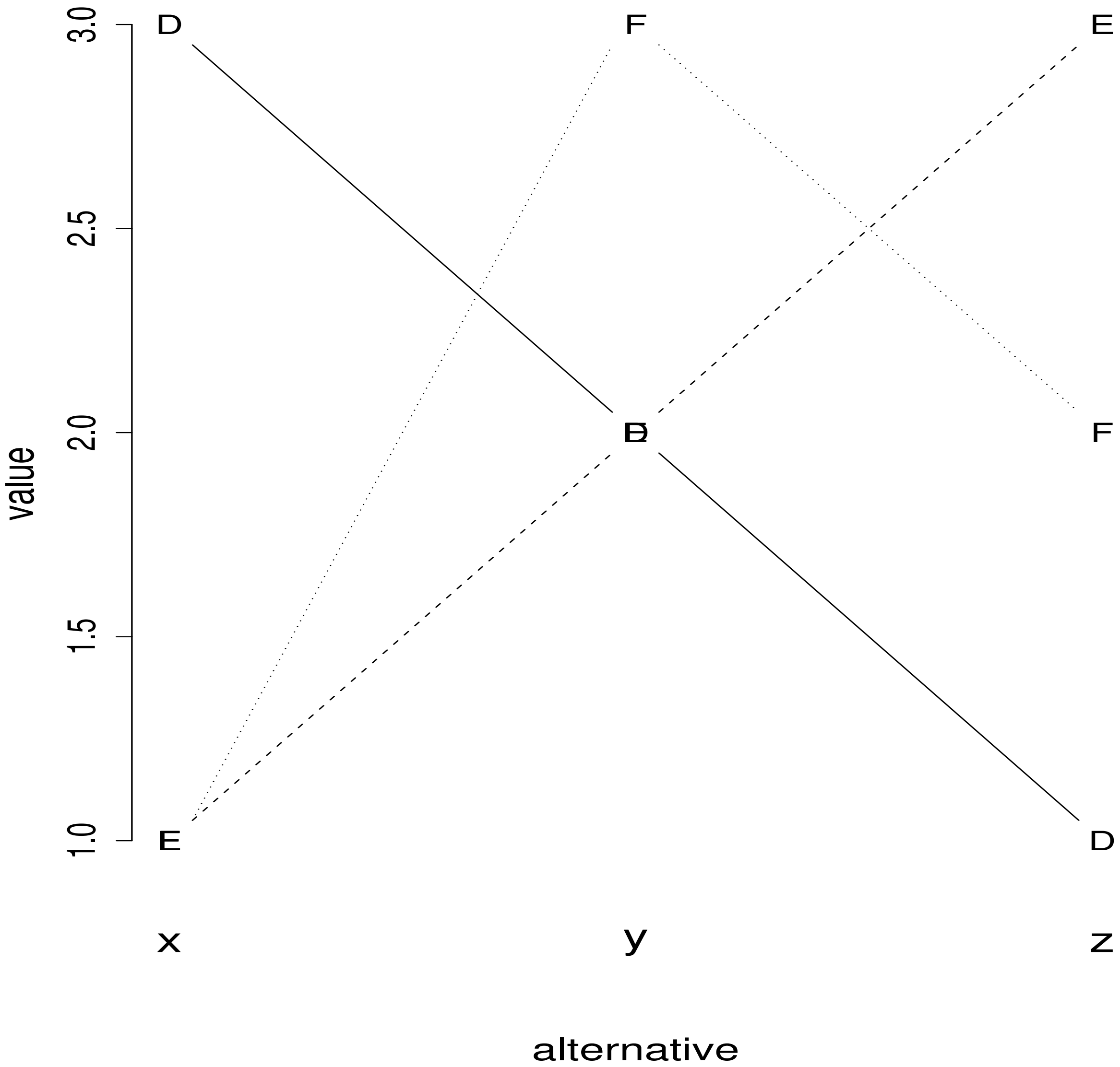
  non-manipulability

  and if the social choices satisfy rationality conditions RC1 to RC4

- **the spatial model**
  - **are preferences single peaked?**
  - **example: YES**

- **the spatial model**
  - **are preferences single peaked?**
  - **example: YES**
  - **preferences:**
    - **person D:** xP_iyP_iz
    - **person E:** zP_iyP_ix
    - **person F:** yP_izP_ix

- **the spatial model**
  - **are preferences single peaked?**
  - **example: YES**
  - **preferences:**
    - **person D:** xP_iyP_iz
    - **person E:** zP_iyP_ix
    - **person F:** yP_izP_ix
  - **each person has an IDEAL POINT**



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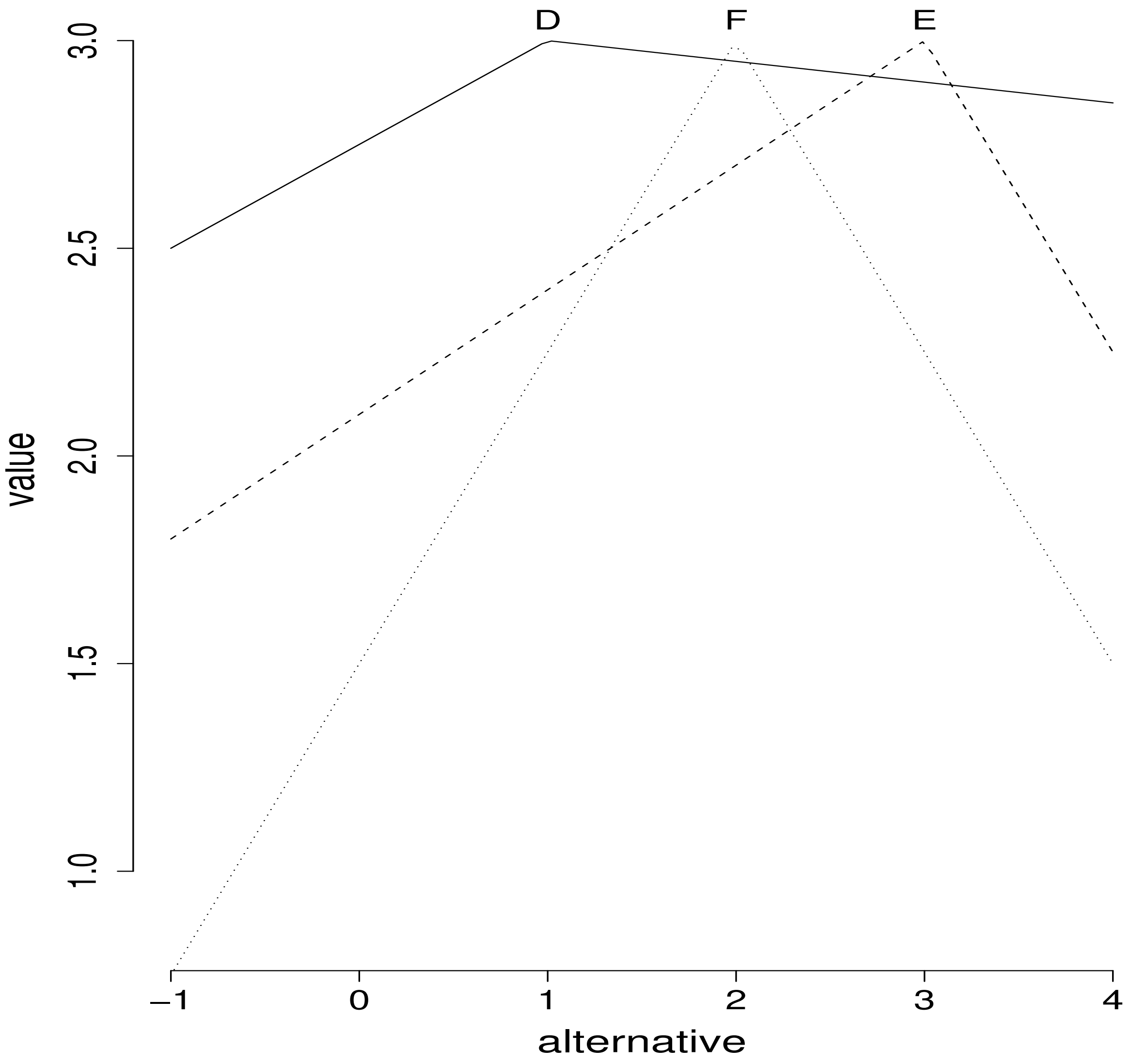
- **the spatial model**
- **single-peaked preferences**

- **the spatial model**
- **single-peaked preferences**
- **which alternative wins in a series of pairwise votes?**



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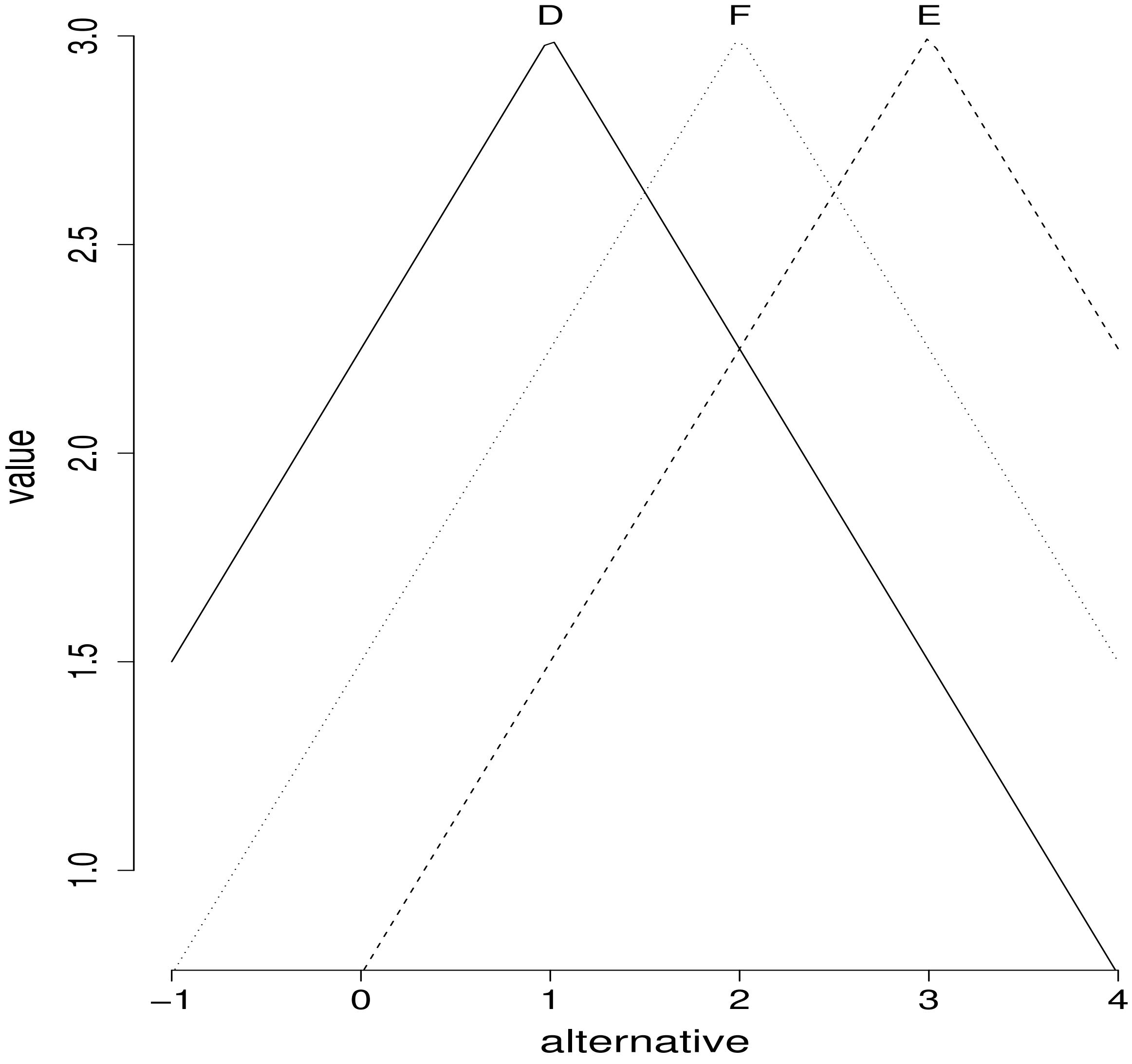
- **the spatial model**
- **single-peaked preferences**
- **which alternative wins in a series of pairwise votes?**
- **with single-peaked preferences, the median is the Condorcet winner**

- **the spatial model**
- **single-peaked preferences and measures of distance**
  - **example with symmetry and same distances for different people**
  - **tent metrics:** $u_{ik} = -b|x_k - x_i|$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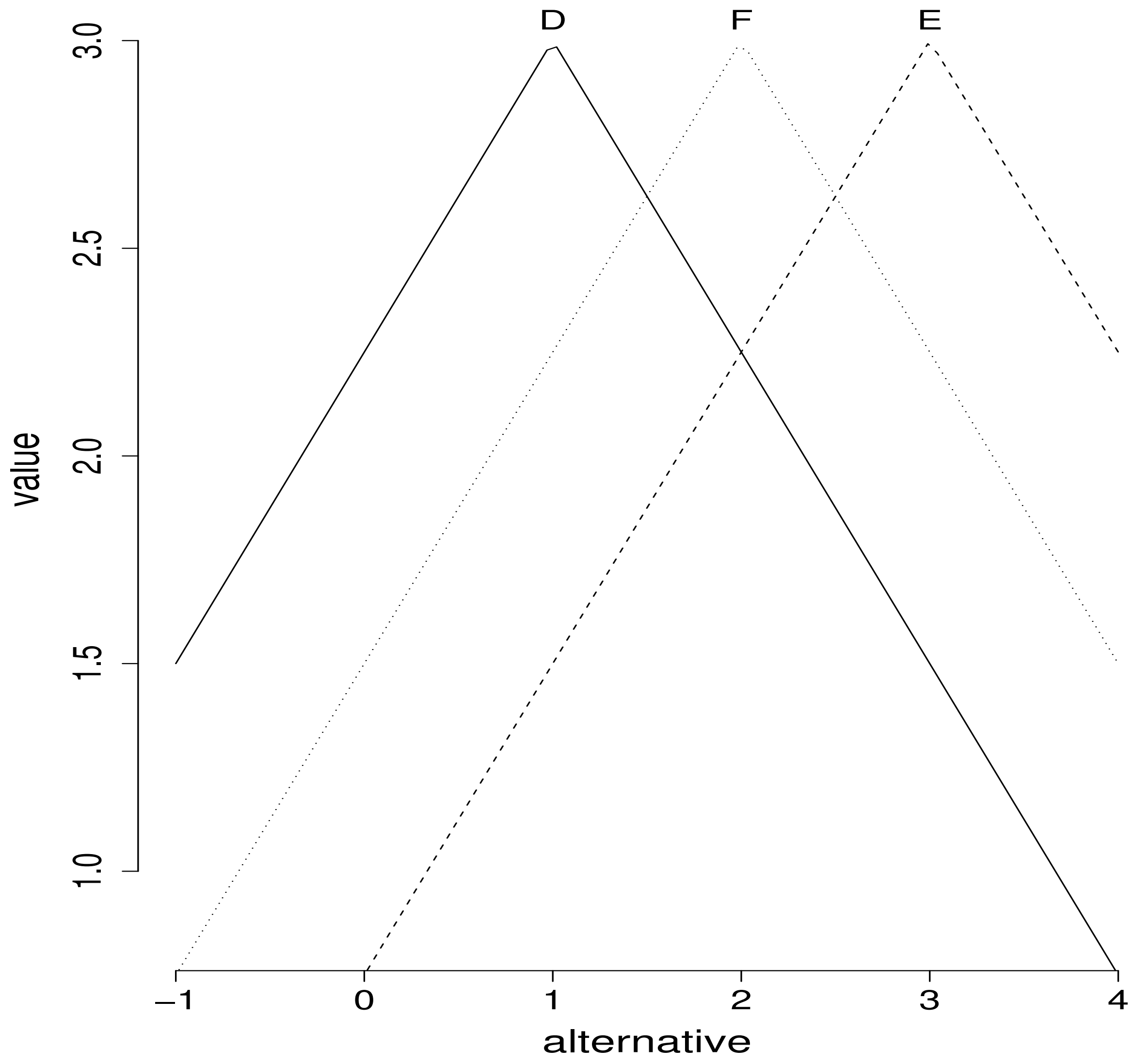
- **the spatial model**
- **single-peaked preferences and measures of distance**
  - **example with symmetry and same distances for different people**
  - **tent metrics:** $u_{ik} = -b|x_k - x_i|$
  - **apply an affine transformation:** $y_i = a + cx_i$

- **the spatial model**
- **single-peaked preferences and measures of distance**
  - **example with symmetry and same distances for different people**
  - **tent metrics:** $u_{ik} = -b|x_k - x_i|$
  - **apply an affine transformation:** $y_i = a + cx_i$

$$
\begin{aligned}
u_{ik} &= -b|y_k - y_i| \\
&= -b|a + cx_k - (a + cx_i)| \\
&= -bc|x_k - x_i|
\end{aligned}
$$

  - **the transformation changes the distance measure but not the shape of the indifference curves: intensity doesn't matter**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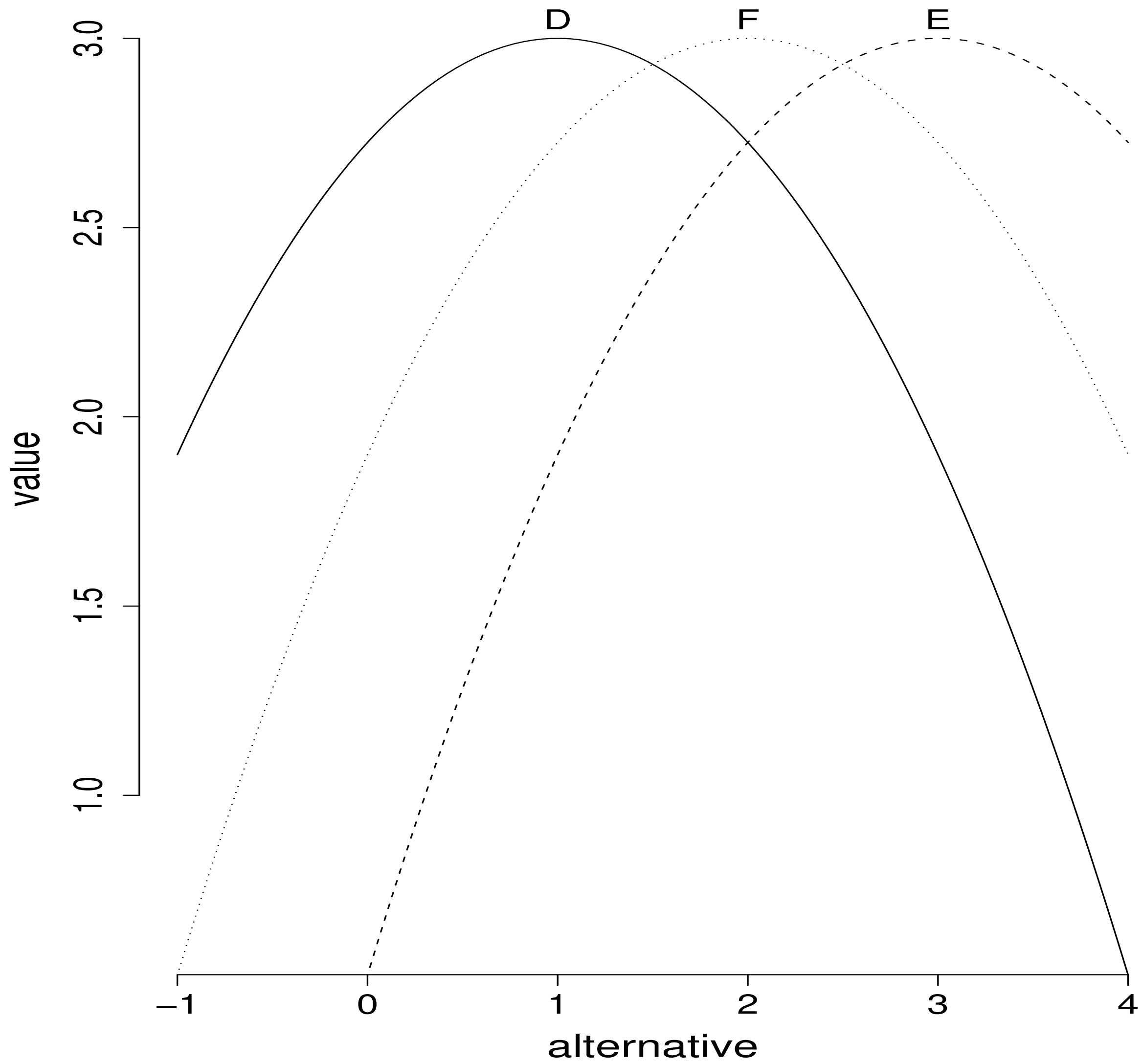
- **the spatial model**
- **single-peaked preferences and measures of distance**
  - **euclidean metrics:** $u_{ik} = -b[(x_k - x_i)^2]^{1/2}$
  - **symmetry**
- **the median remains the Condorcet winner**



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- **the spatial model**
- **single-peaked preferences and measures of distance**
  - **euclidean metrics:** $u_{ik} = -b[(x_k - x_i)^2]^{1/2}$
  - **symmetry**

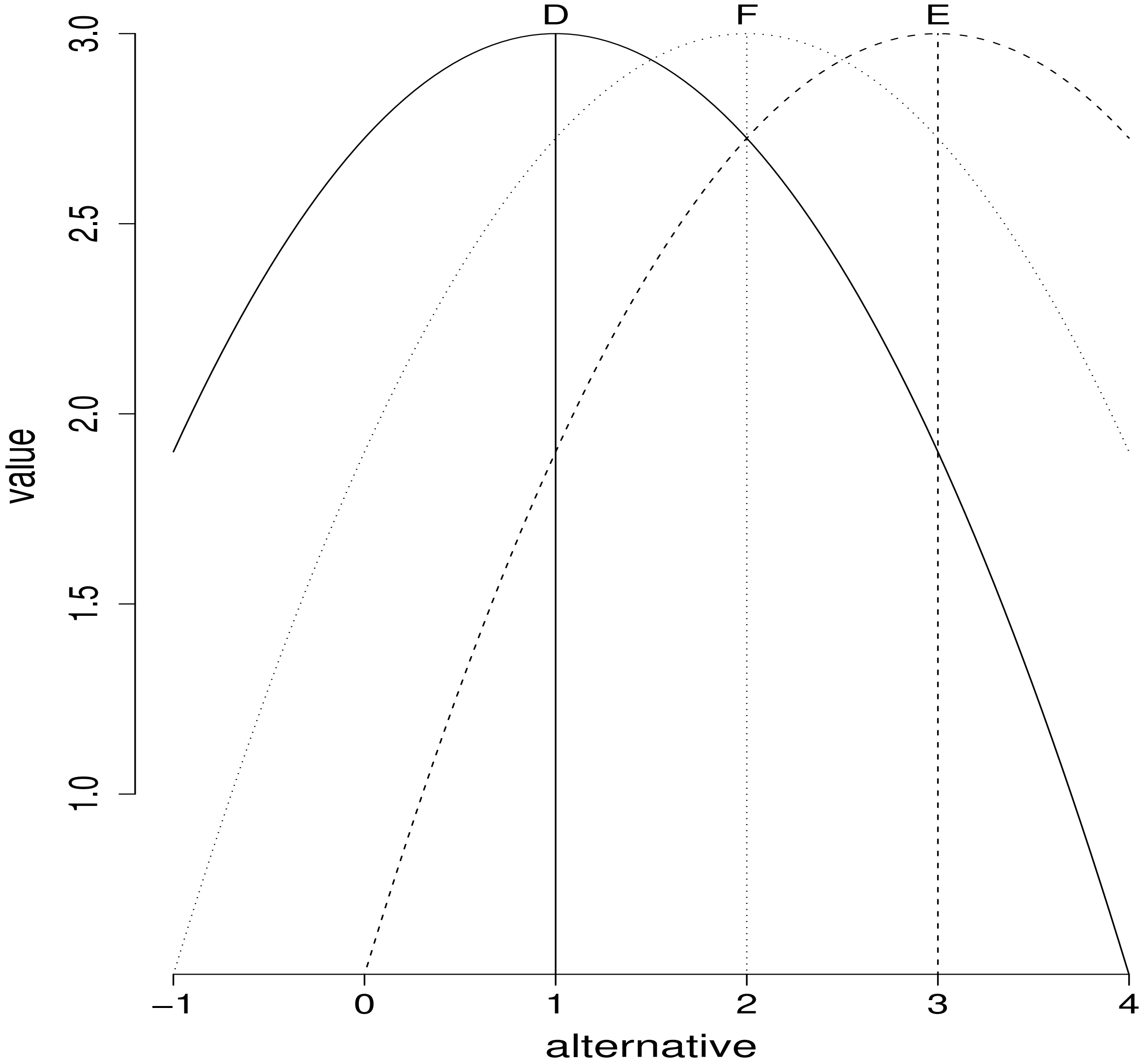
- **the spatial model**
- **single-peaked preferences and measures of distance**
  - **euclidean metrics:** $u_{ik} = -b[(x_k - x_i)^2]^{1/2}$
  - **symmetry**
  - **apply an affine transformation:** $y_i = a + cx_i$**:**

$$\begin{aligned} u_{ik} &= -b[(y_k - y_i)^2]^{1/2} \\ &= -b[(a + cx_k - (a + cx_i))^2]^{1/2} \\ &= -bc[(x_k - x_i)^2]^{1/2} \end{aligned}$$

  - **the transformation changes the distance measure but not the shape of the indifference curves**

- **the spatial model**
- **with symmetric single-peaked preferences**
- **which is to say, in a pure one-dimensional spatial model...**

- **the spatial model**
- **with symmetric single-peaked preferences**
- **which is to say, in a pure one-dimensional spatial model...**
- **all information about the chooser's preferences that is relevant for choice behavior is summarized by the chooser's ideal point**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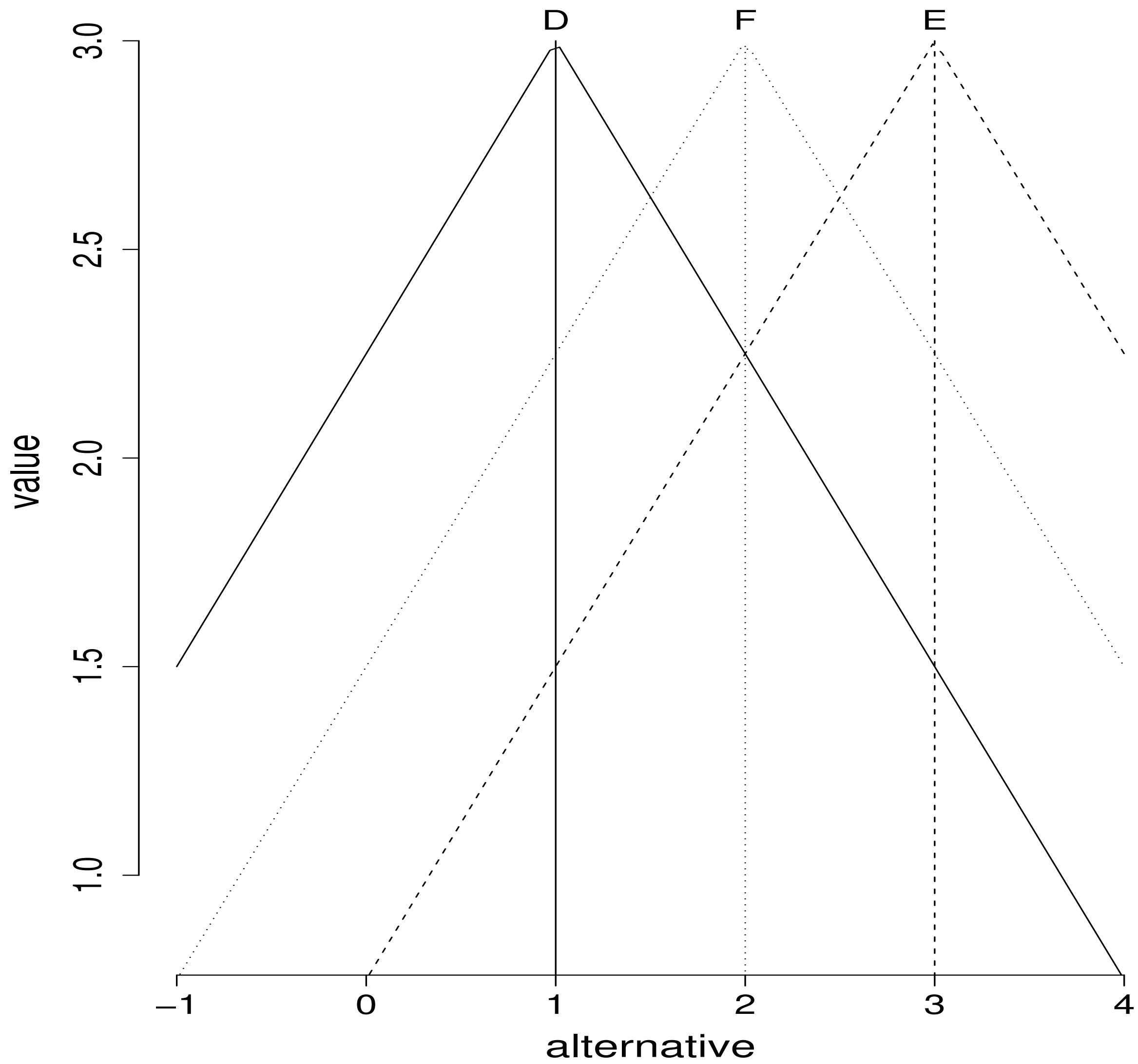
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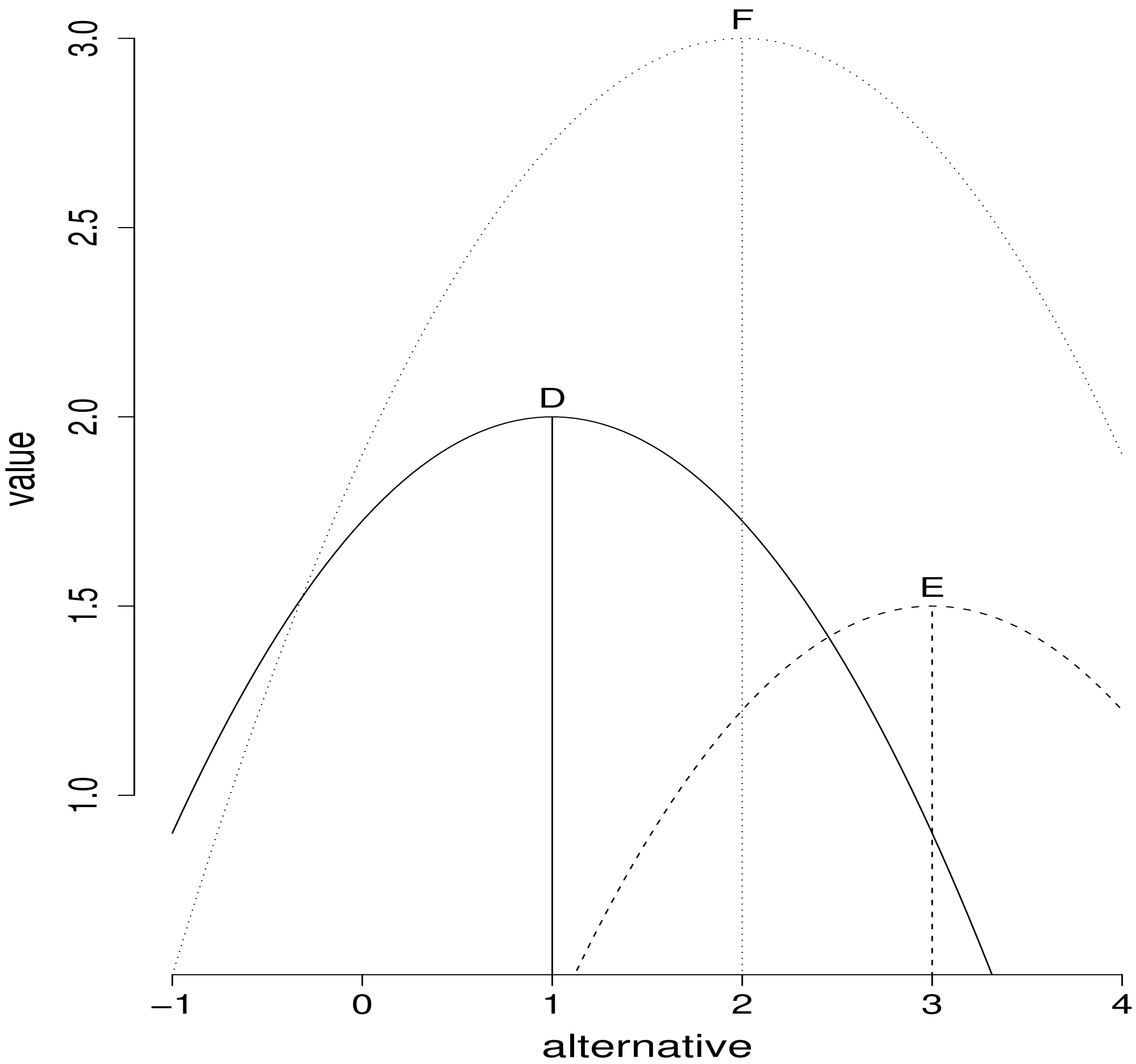

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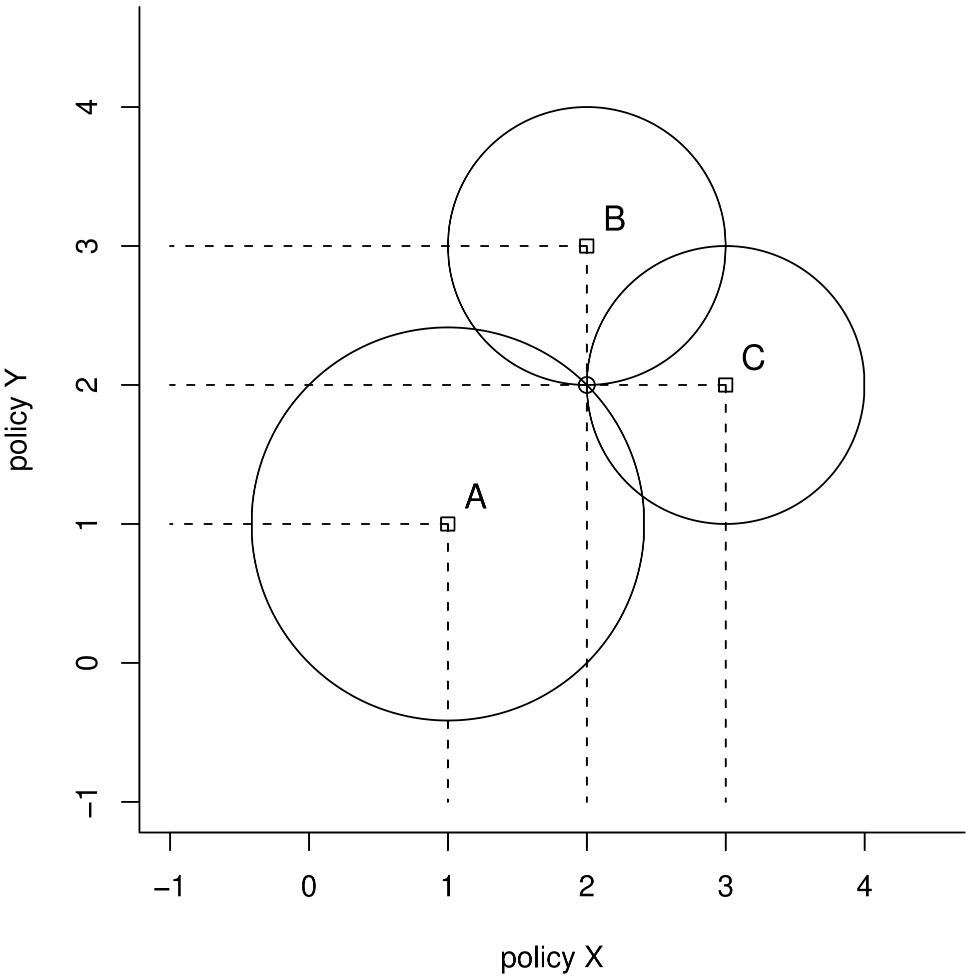
alternative

- **a two-dimensional spatial model**
- **two-dimensional separable euclidean preferences:**

  $u_{ik} = [(x_k - x_i)^2 + (y_k - y_i)^2]^{1/2}$

- **an example with three voters**

Three Voters with Separable Euclidean Preferences



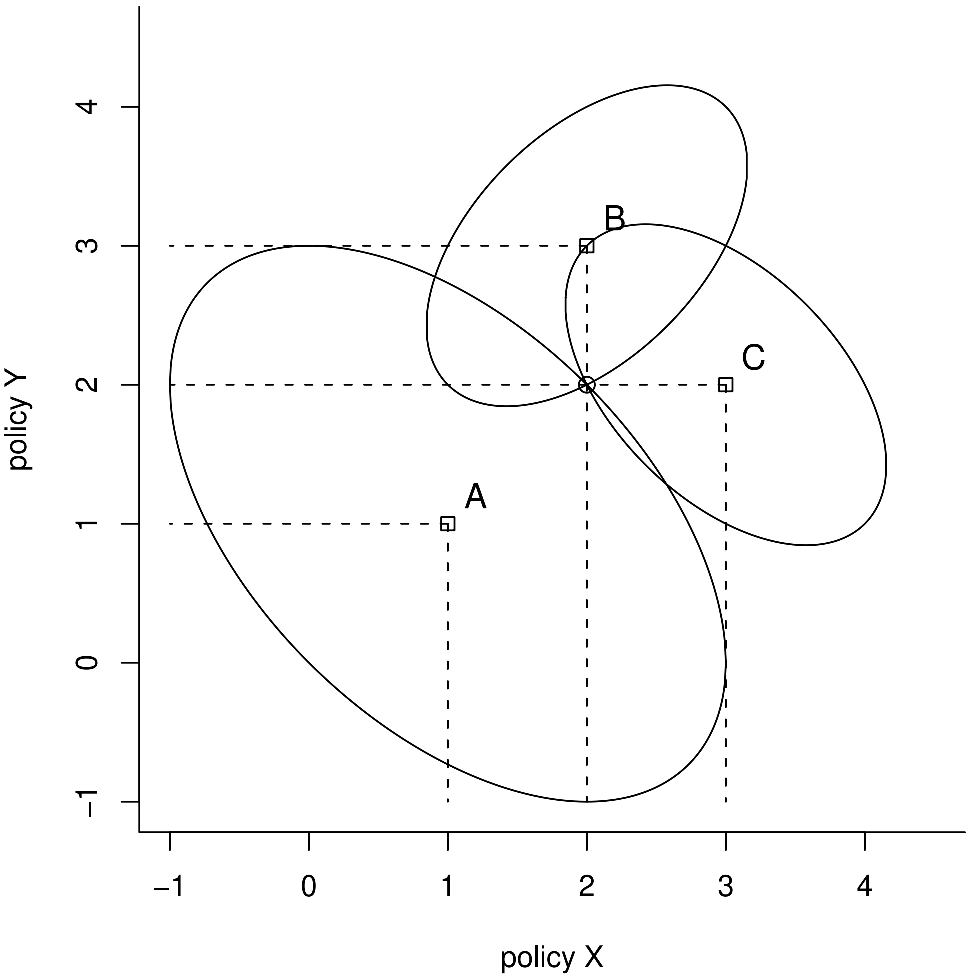
- **a two-dimensional spatial model**
- **two-dimensional separable euclidean preferences:**

  $u_{ik} = [(x_k - x_i)^2 + (y_k - y_i)^2]^{1/2}$
- **with two-dimensional spatial preferences, in general the winset of any point x is not empty**
- **with separable preferences, the median on one dimension can be defeated by alternatives that shift along both dimensions**
- **with nonseparable preferences, a one-dimensional median is even more unstable**

- **two-dimensional nonseparable euclidean preferences:**

  $$u_{ik} = [(x_k - x_i)^2 + (y_k - y_i)^2 + b(x_k - x_i)(y_k - y_i)]^{1/2}$$

Three Voters with Nonseparable Euclidean Preferences



- **two-dimensional nonseparable euclidean preferences:**

$$u_{ik} = [(x_k - x_i)^2 + (y_k - y_i)^2 + b(x_k - x_i)(y_k - y_i)]^{1/2}$$

- **with two-dimensional spatial preferences, whether separable or nonseparable, in general the winset of any point x is not empty**
- **with nonseparable preferences, the median on one dimension can be defeated even by alternatives that shift along the same dimension**

- **instability with multidimensional spatial preferences**
- **the chaos theorems**

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  - **there is a finite path of pairwise majority votes from any alternative to any other alternative, and back**
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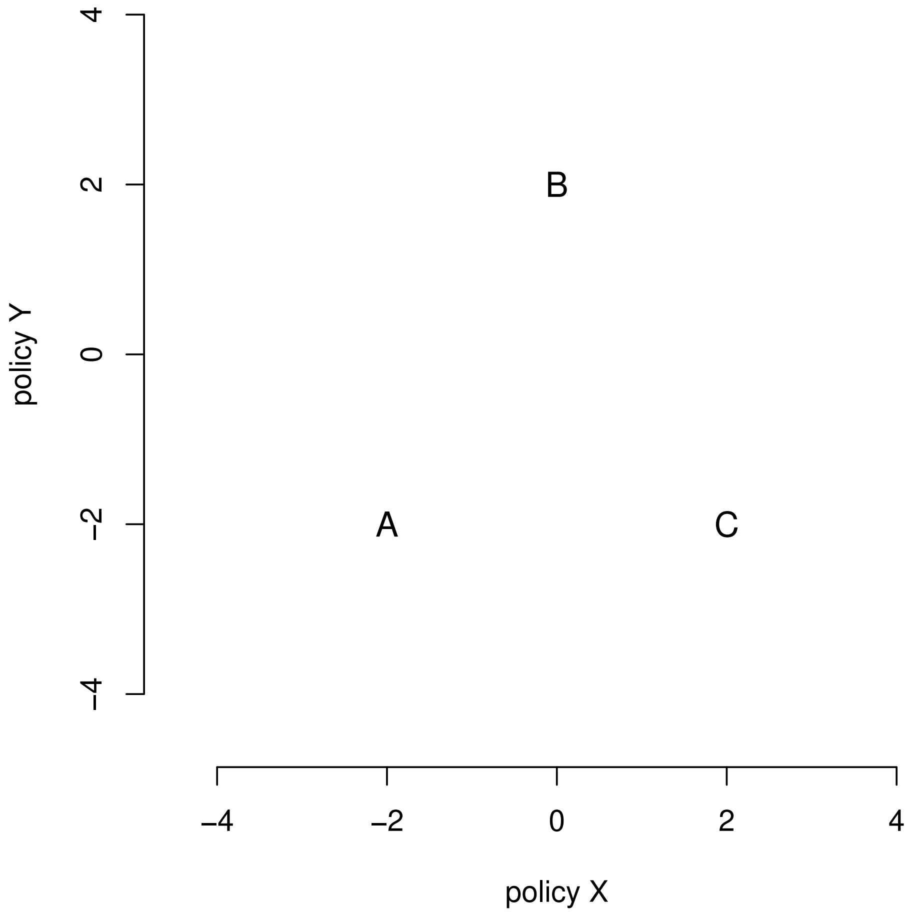
  - **power of the agenda setter given sincere voters**
- **an example with three voters**

Three Voters



- **Pareto set:**
  - **the set of all points that are not unanimously inferior to any other point**
- **each point in the Pareto set**
  1. **is not unanimously inferior to any other point**
  2. **is unanimously superior to at least one other point**

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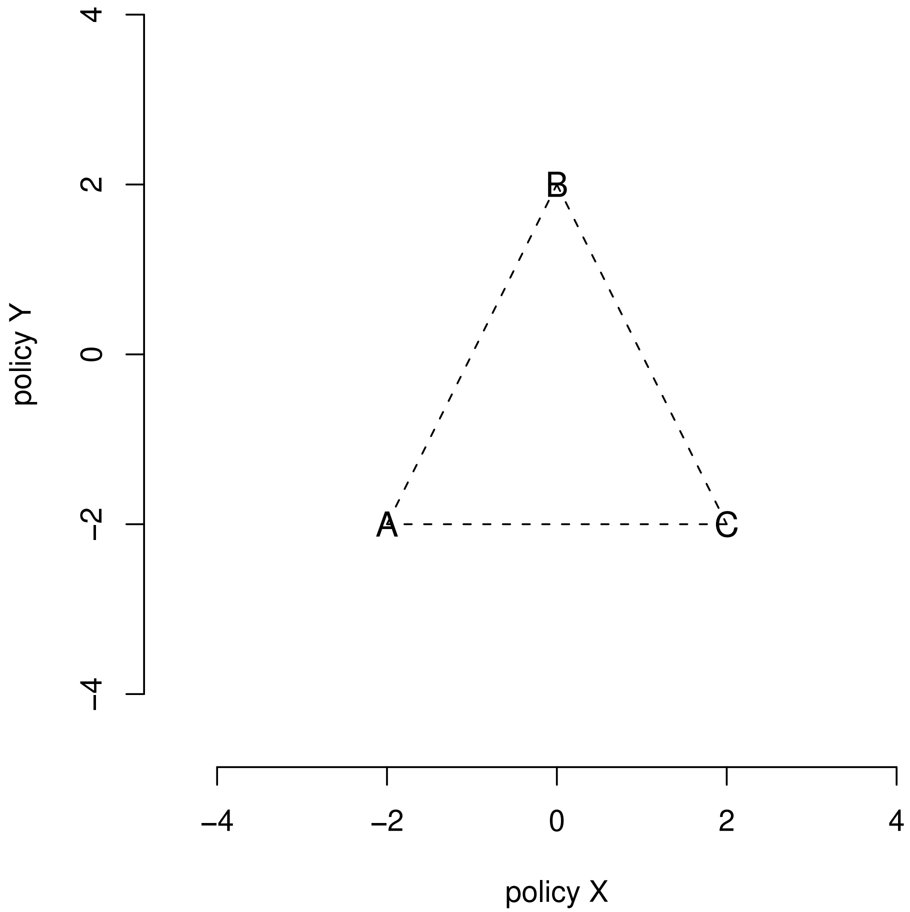
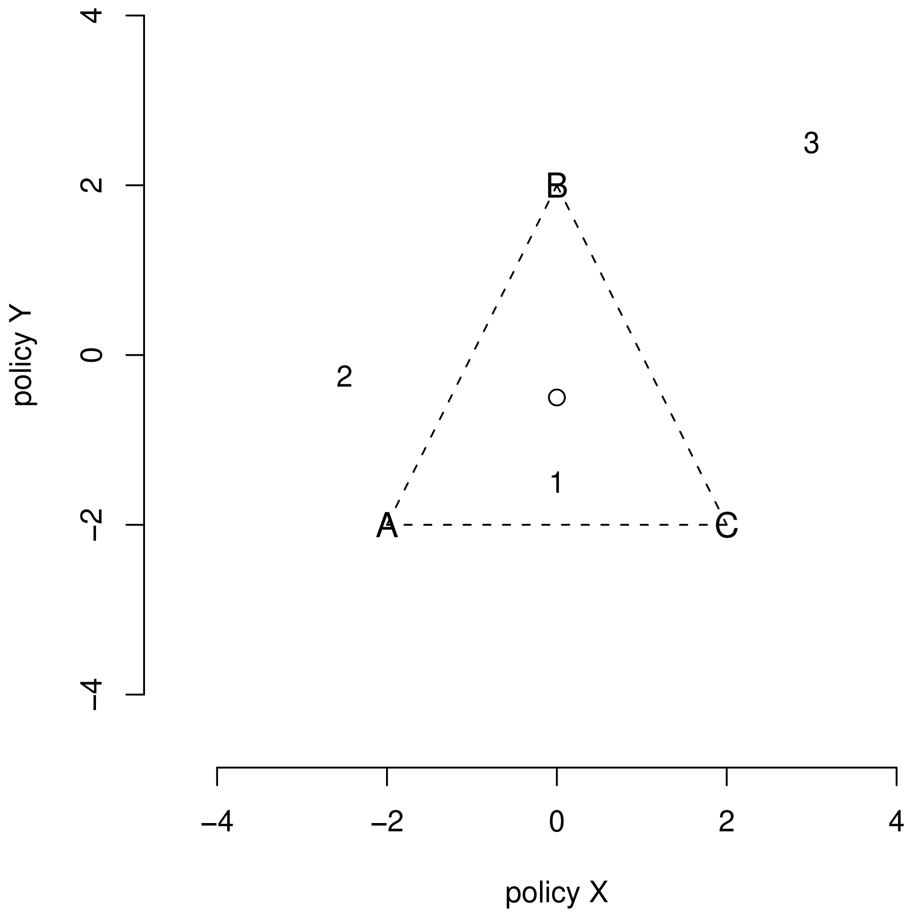
- **each point in the Pareto set**
  1. **is not unanimously inferior to any other point**
  2. **is unanimously superior to at least one other point**
- **with three voters, the boundaries of the Pareto set coincide with the median lines**

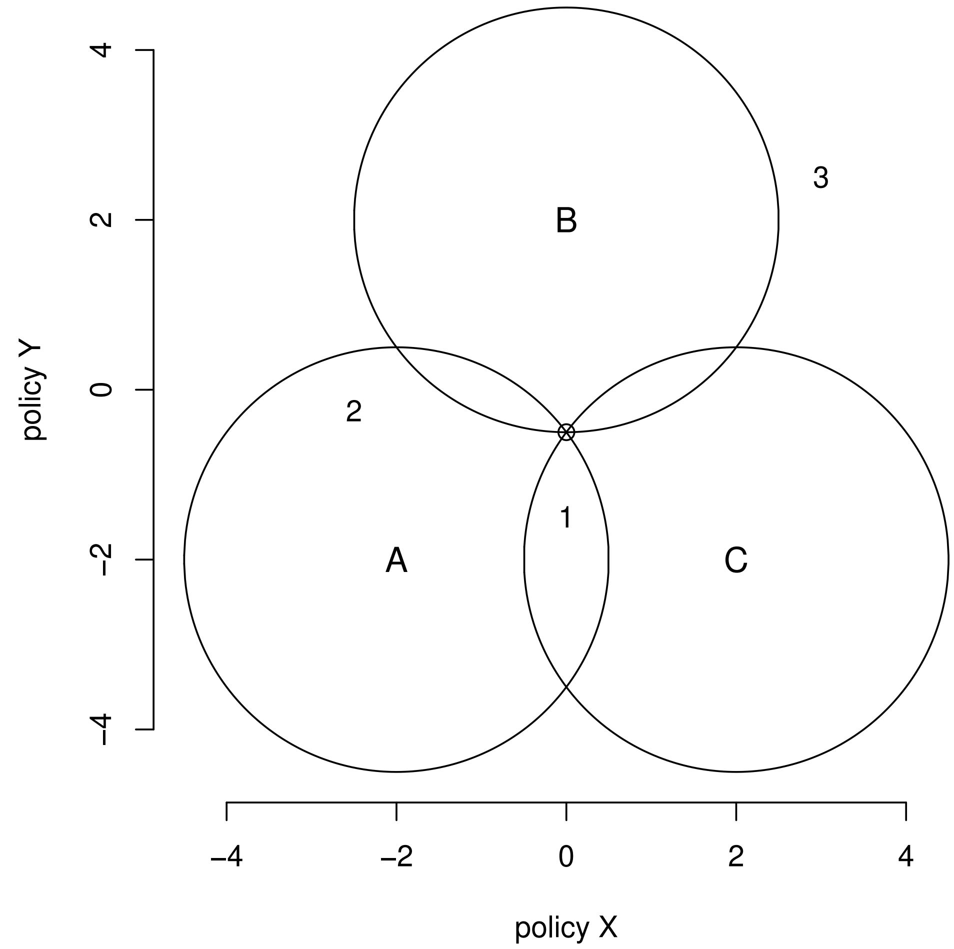
Three Voters with Pareto Set



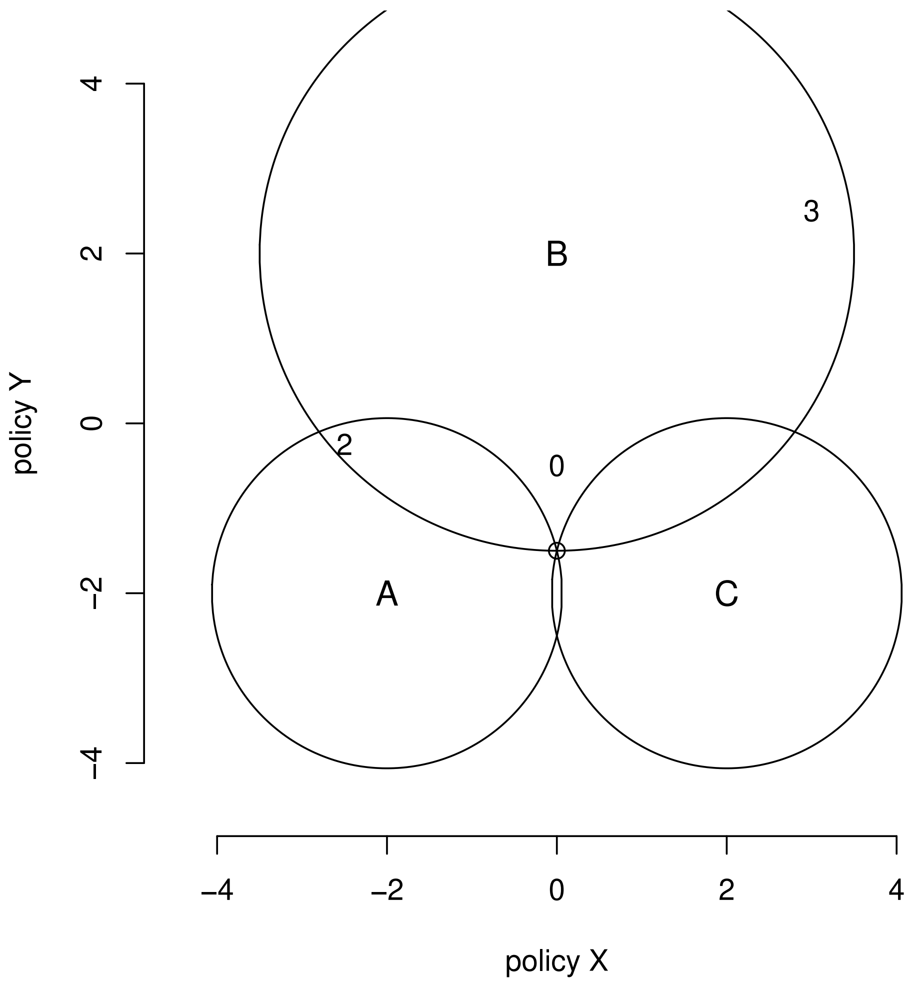
Three Voters Facing an Agenda



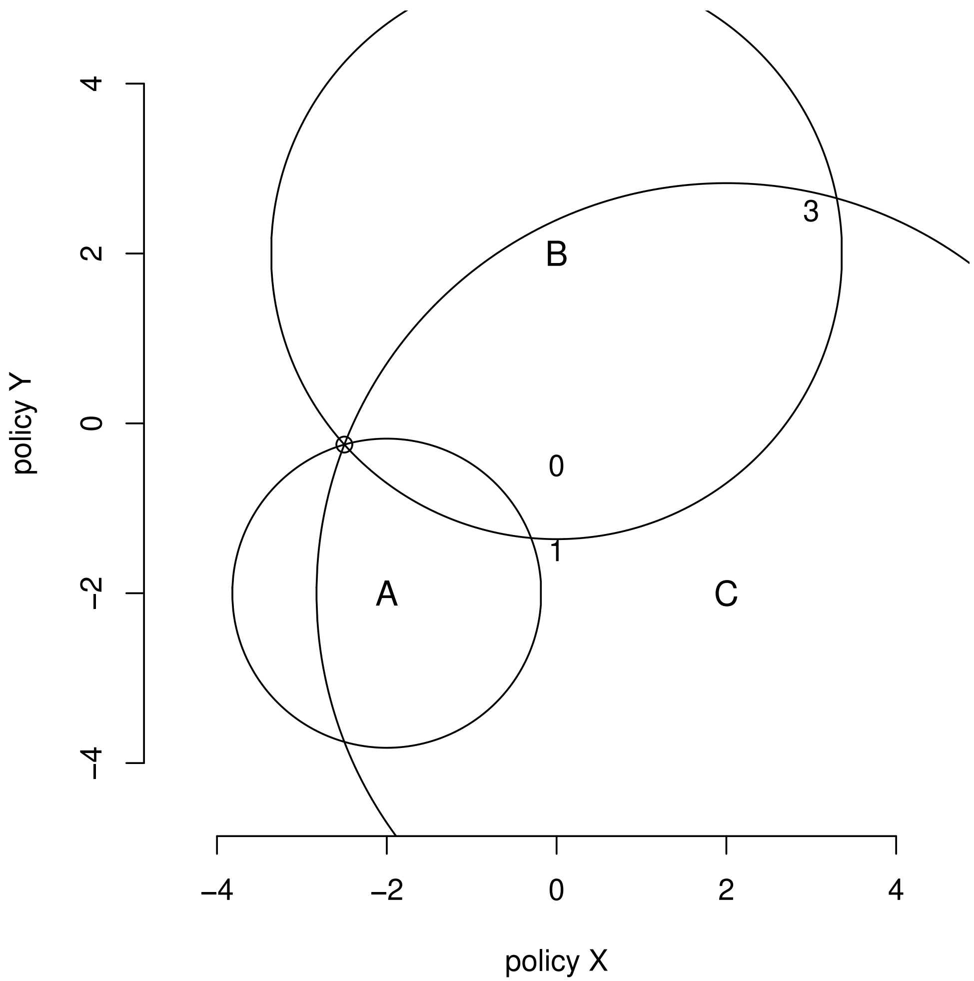
Indifference Curves At Status Quo



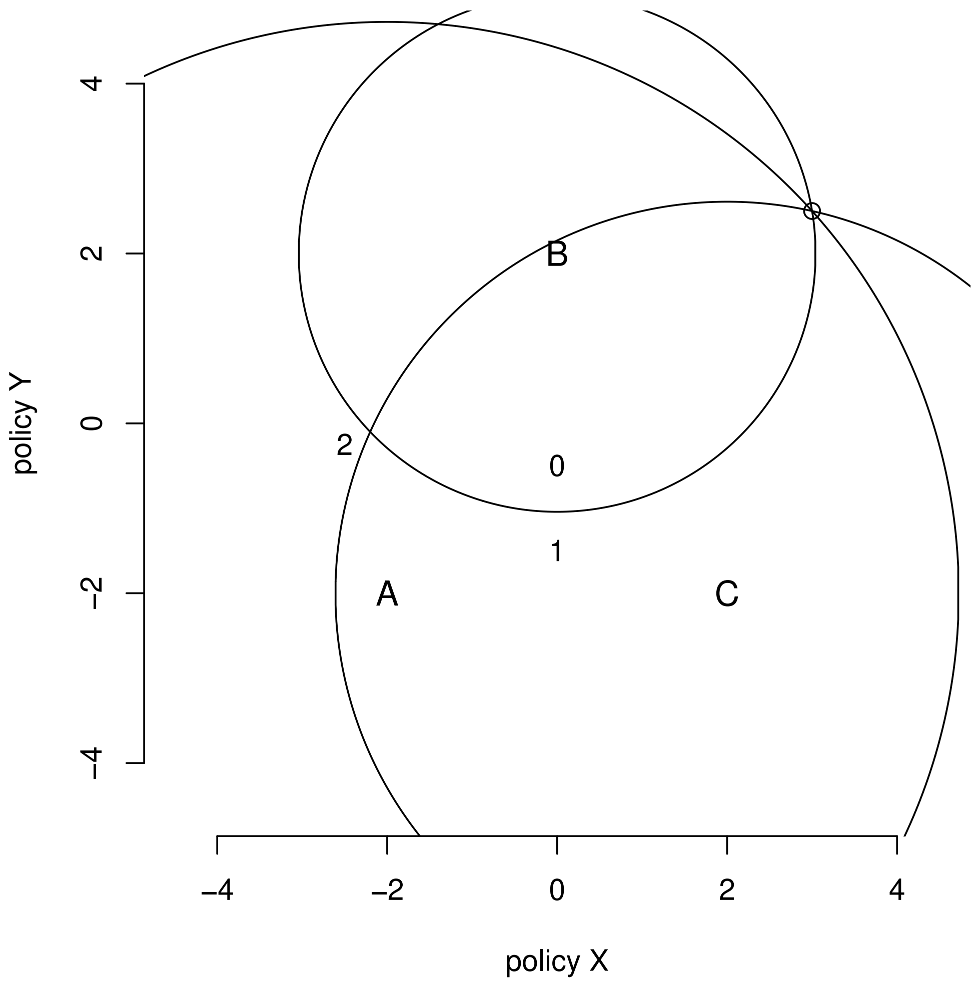
Indifference Curves At First Alternative

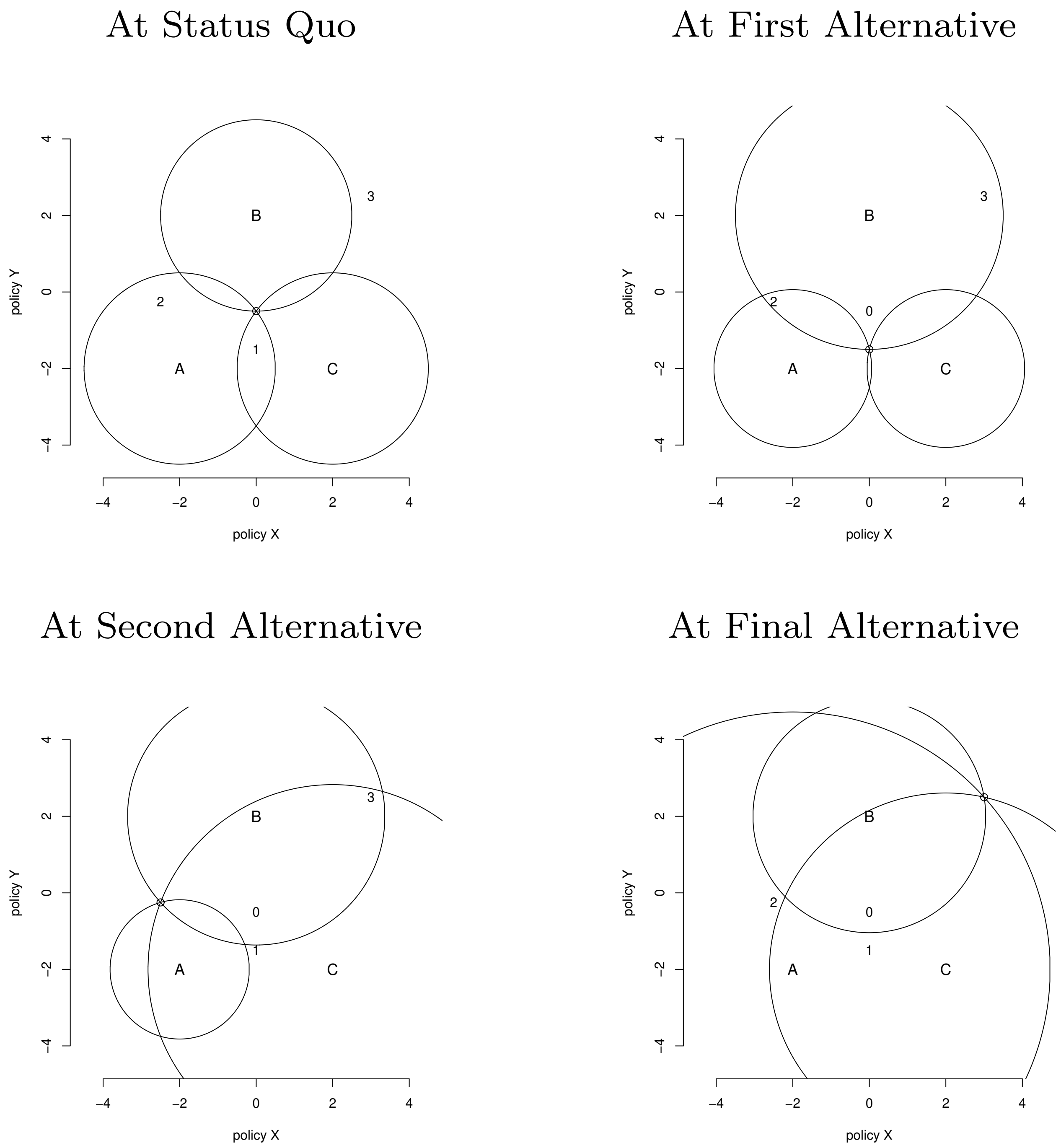


Indifference Curves At Second Alternative



Indifference Curves At Third Alternative




At Status Quo
At First Alternative
At Second Alternative
At Final Alternative
policy X
policy Y
A
B
C
0
1
2
3

- **instability with multidimensional spatial preferences**
- **the chaos theorems**
  - **there is a finite path of pairwise majority votes from any alternative to any other alternative, and back**
  - **power of the agenda setter given sincere voters**

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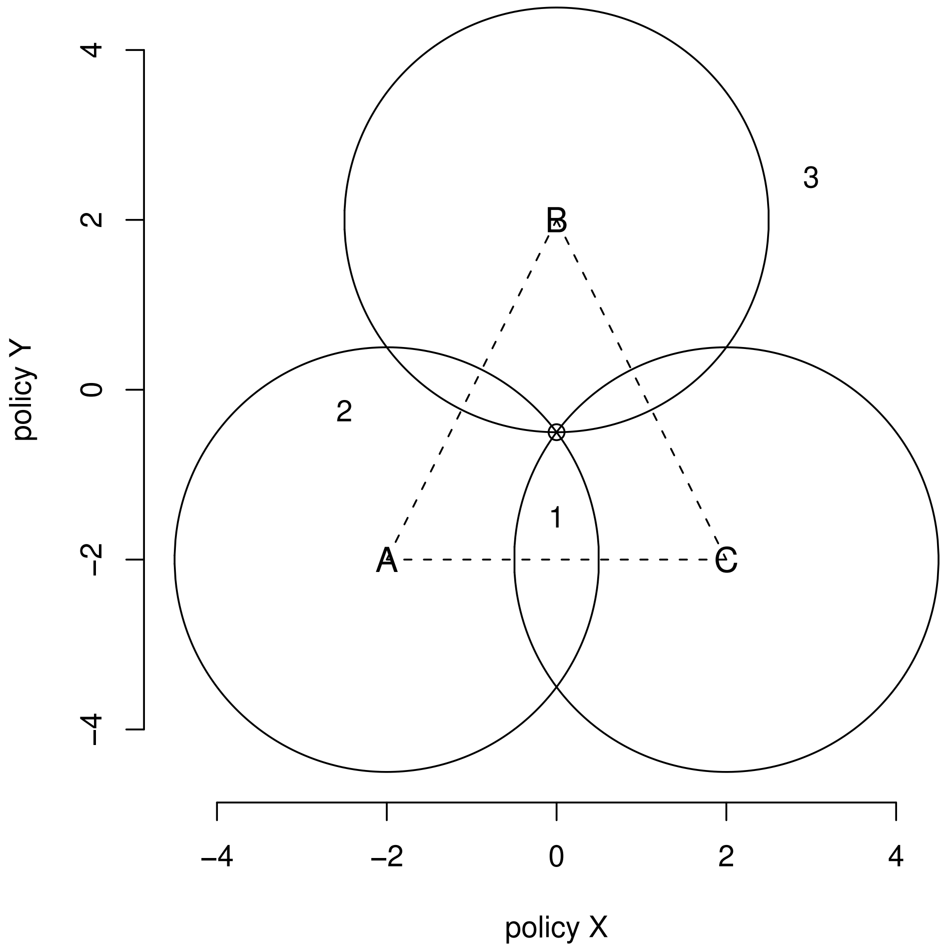
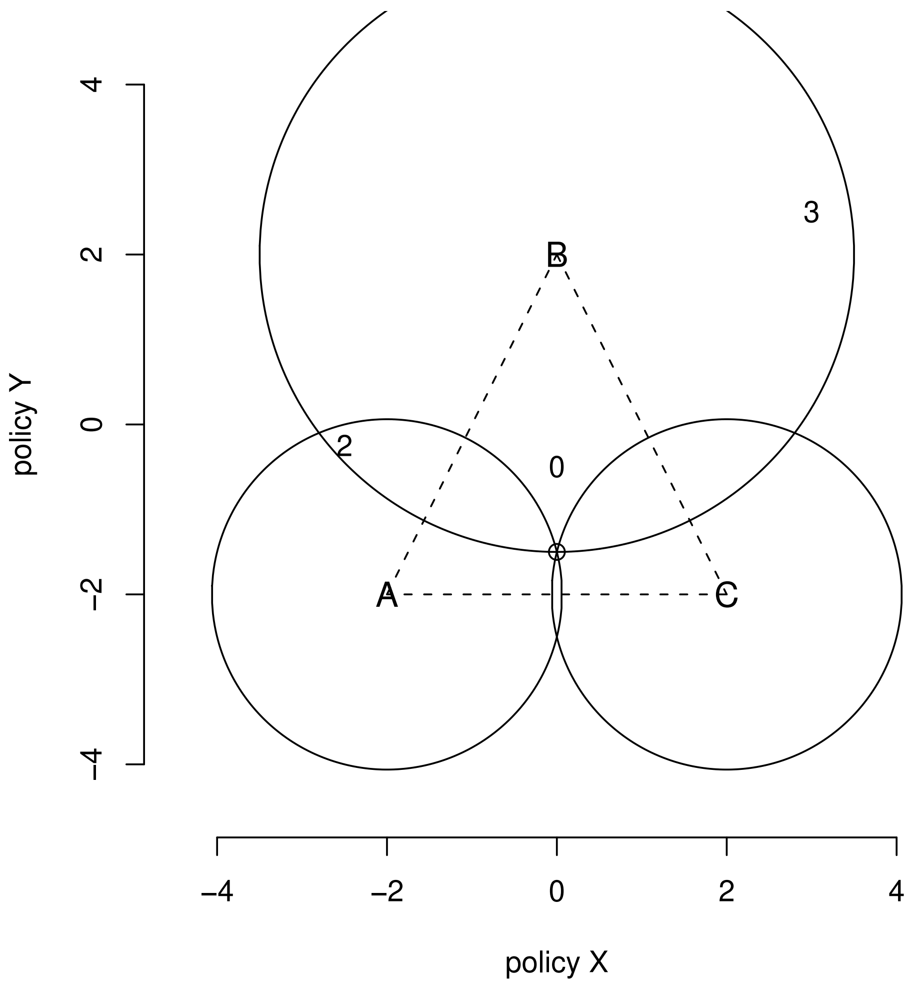
- **strategic voters can keep outcomes inside the Pareto set**

Indifference Curves At Status Quo, with Pareto Set



Indifference Curves At First Alternative, with Pareto Set



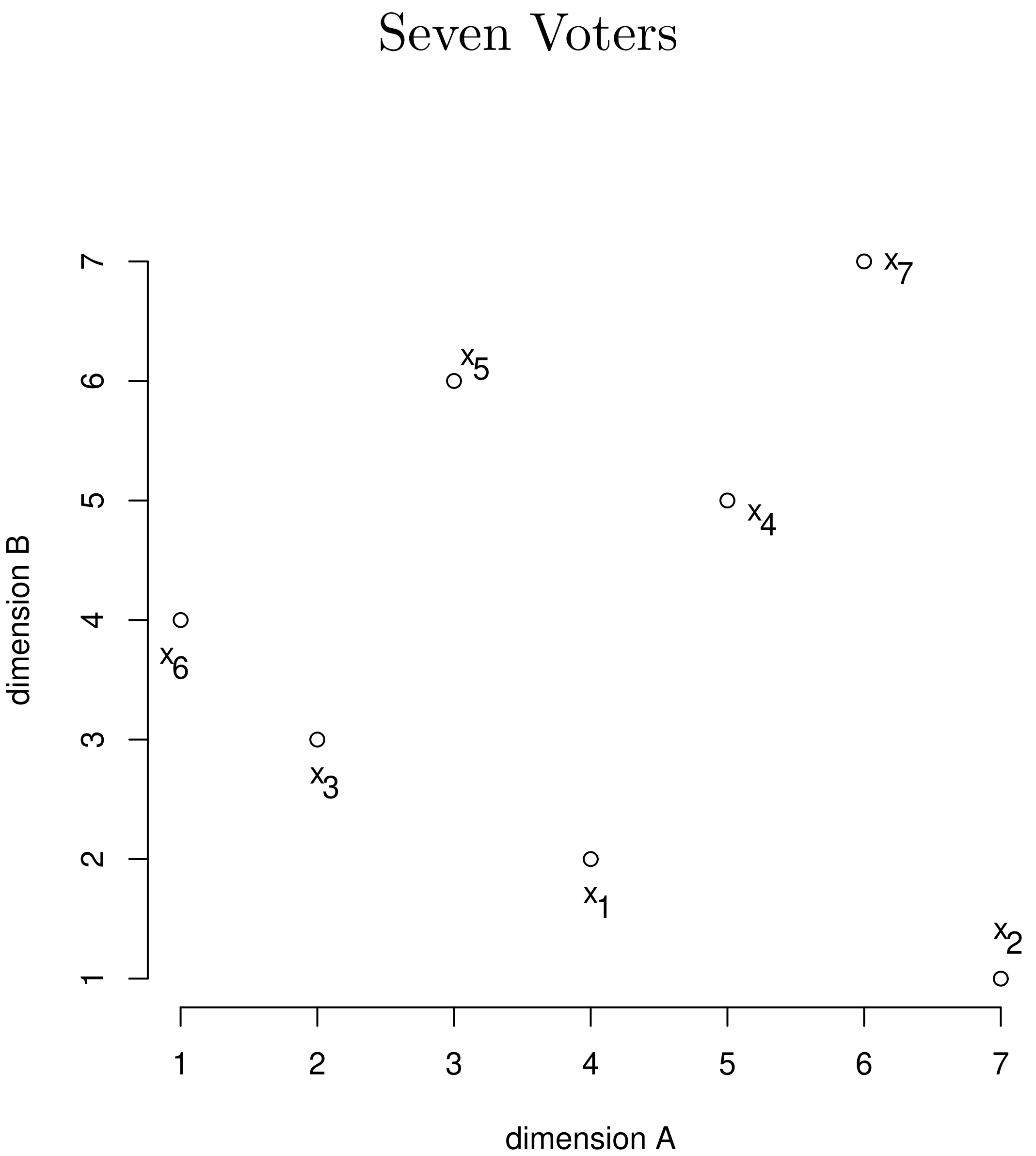
- instability with multidimensional spatial preferences
- strategic voters can keep outcomes inside the Pareto set
  - technically, strategic voters can keep outcomes inside a smaller set, the "uncovered set"

- **instability with multidimensional spatial preferences**
- **strategic voters can keep outcomes inside the Pareto set**
  - **technically, strategic voters can keep outcomes inside a smaller set, the "uncovered set"**
- **if the agenda is endogenous, which means the voters propose alternatives, then strategic voting can keep outcomes inside the uncovered set**

- **the uncovered set**
- **McKelvey, Richard D. 1986. "Covering, Dominance, and Institution-Free Properties of Social Choice." American Journal of Politiccal Science 30: 283–314.**
- x **covers** y**, denoted** xCy**, if** xPy **and for all** z **such that** zPx**,** zPy
- **the uncovered set is the set of all alternatives** w **such** xCw **is false for all** x

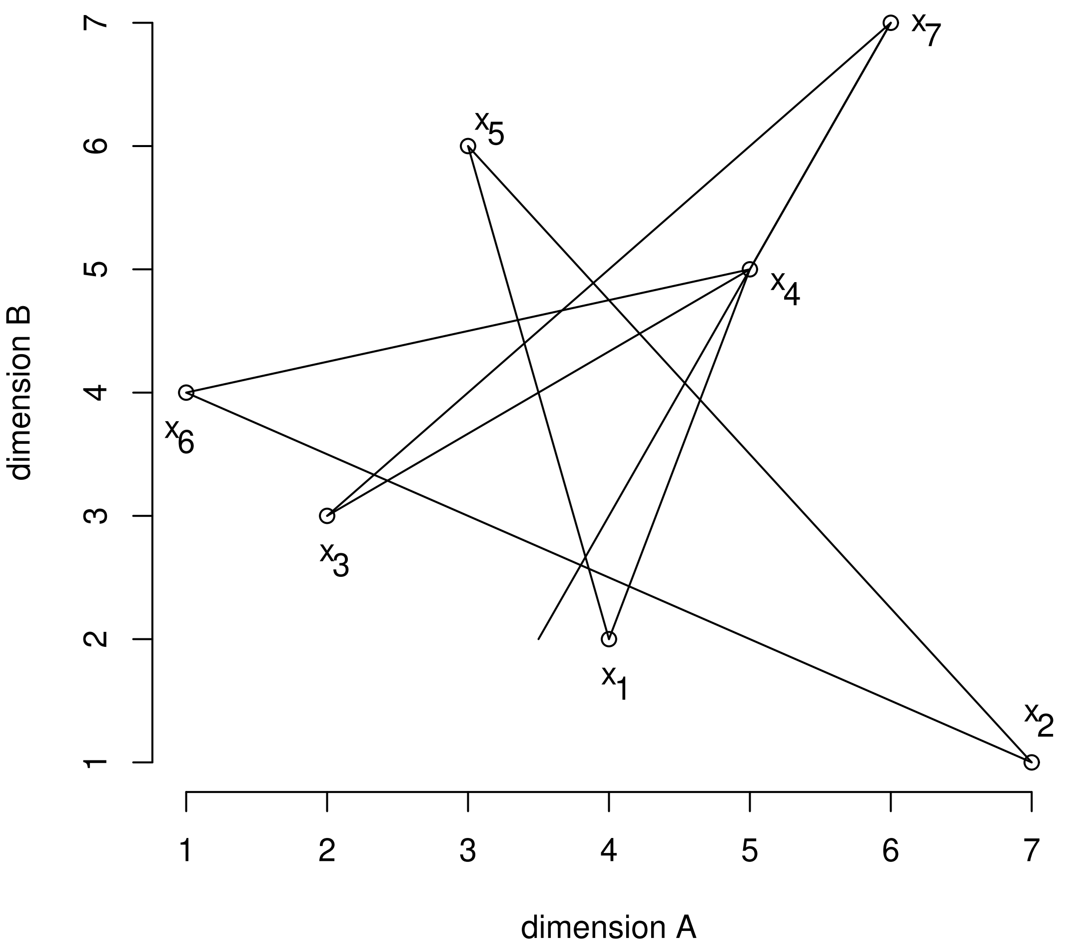
- **the uncovered set and the yolk (generalized median set)**
- **the generalized median set (or the yolk) is the smallest ball that intersects all median lines**

- **the uncovered set and the yolk (generalized median set)**
- **the generalized median set (or the yolk) is the smallest ball that intersects all median lines**
- **the generalized median is the center point of the yolk**
- **the uncovered set is contained in the a region four times the yolk's radius**
- **in general, the yolk shrinks as the number of voters increases (assuming sufficient dispersion)**

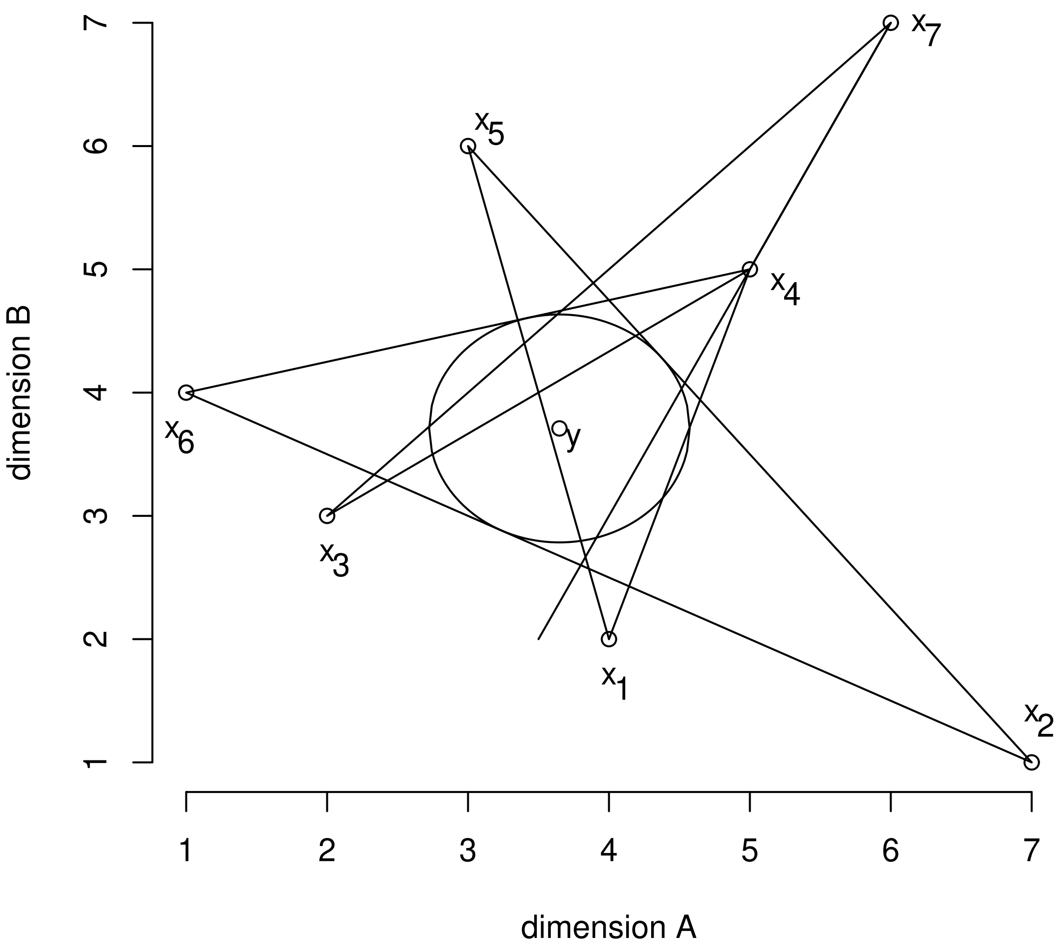


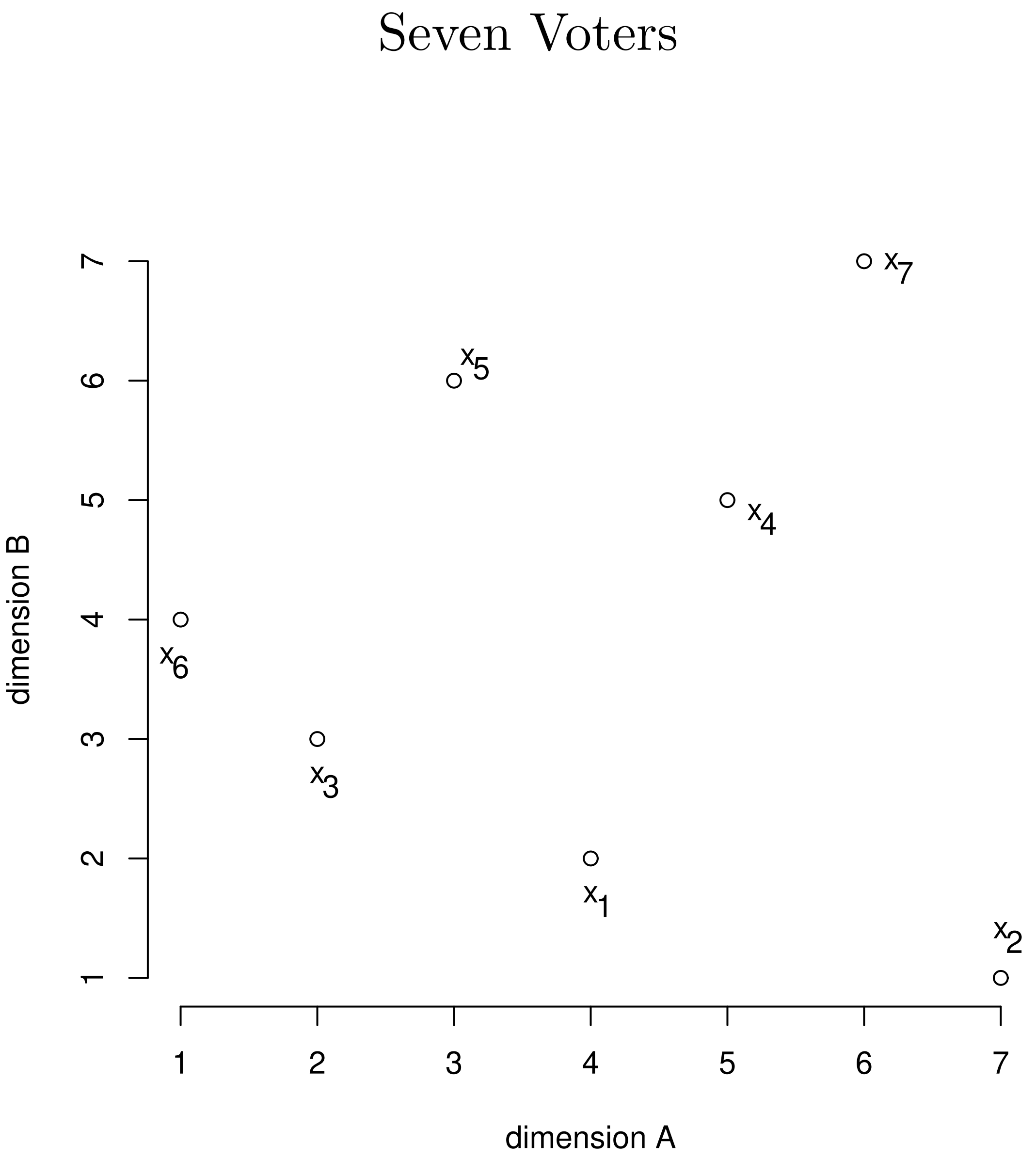
Seven Voters
dimension A
dimension B
1
2
3
4
5
6
7
x_1
x_2
x_3
x_4
x_5
x_6
x_7

Seven Voters with Median Lines

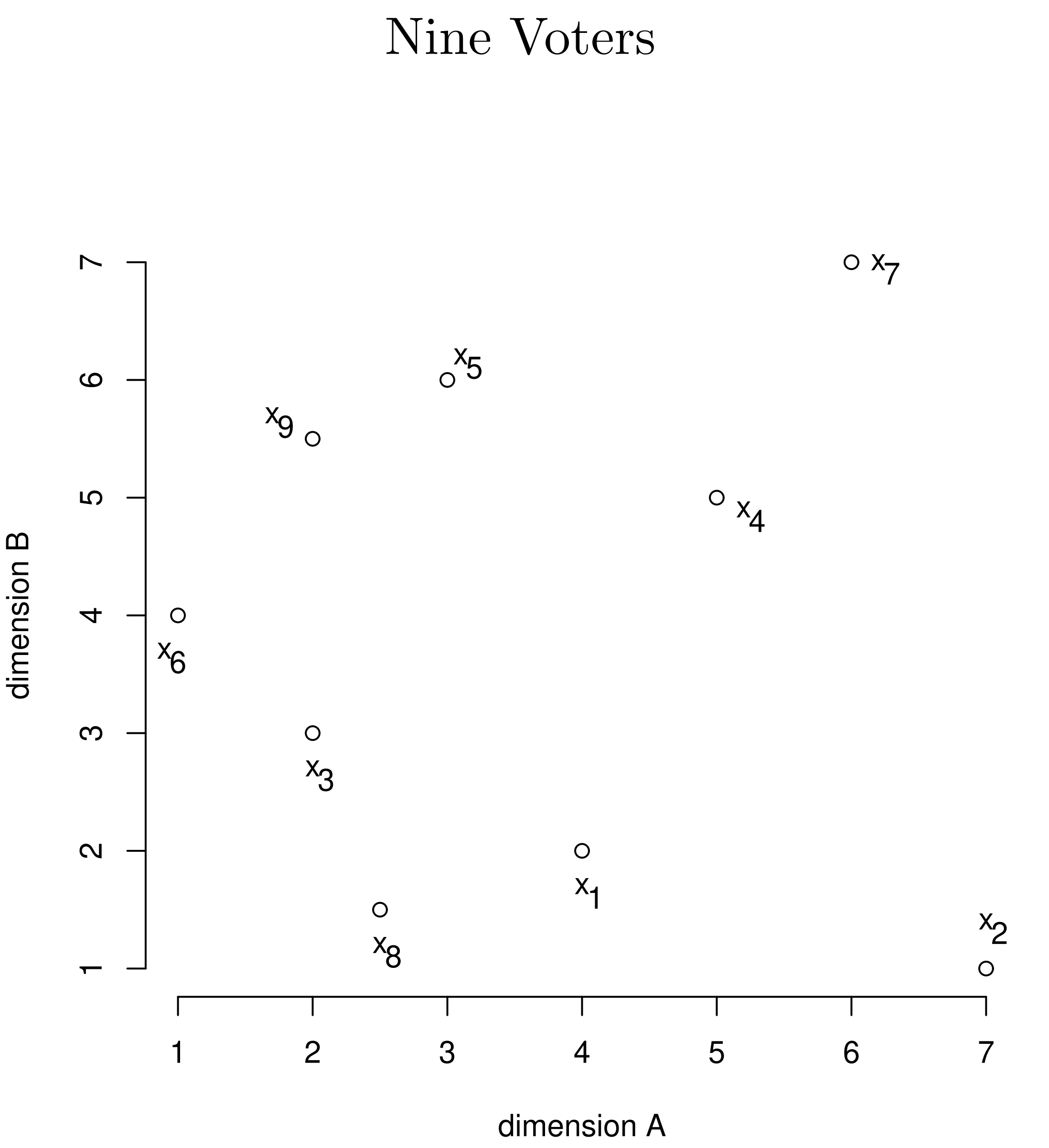


Seven Voters with the Yolk

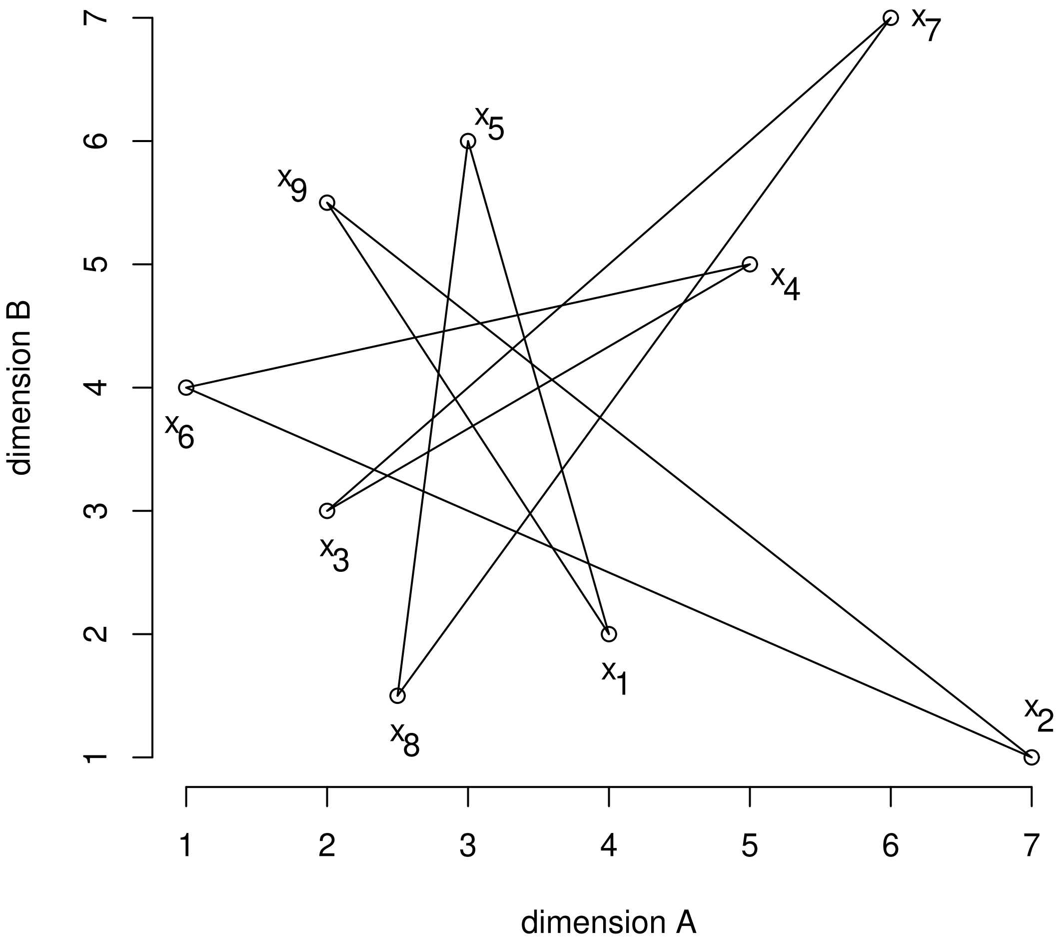




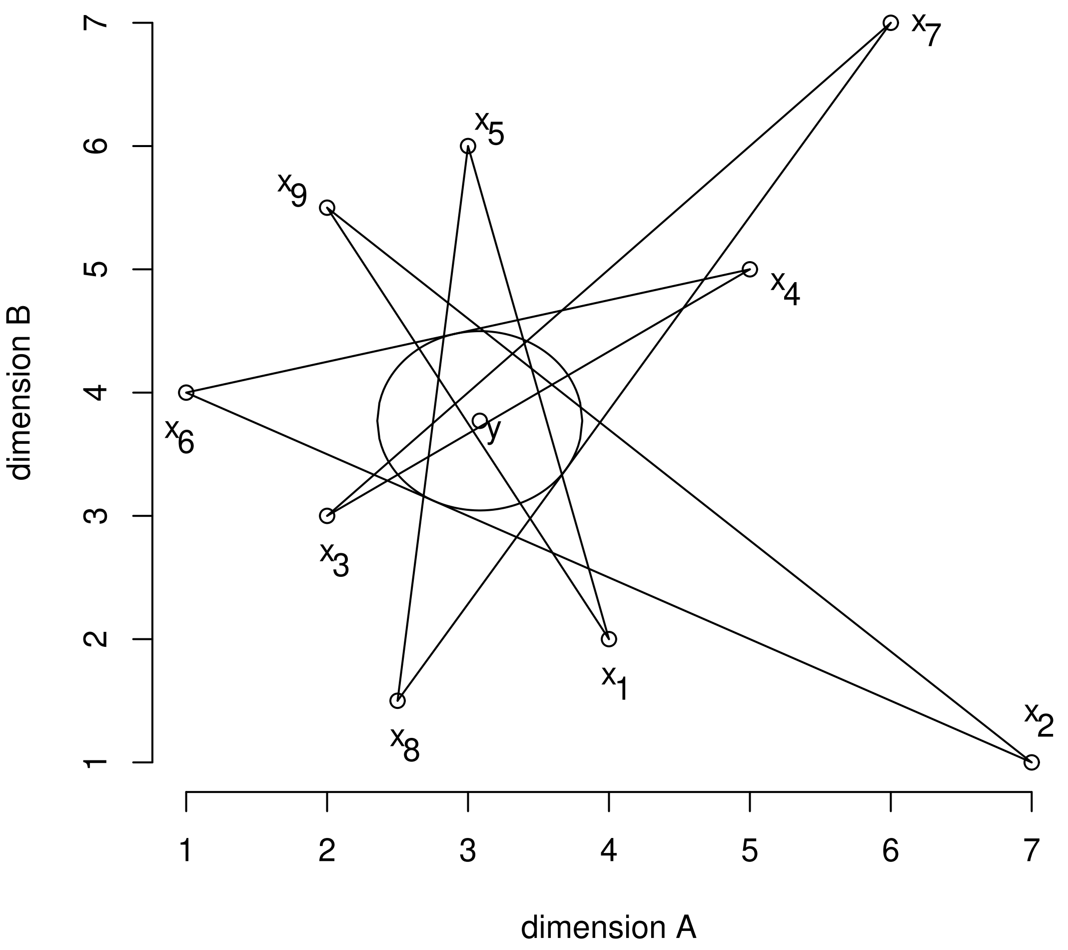
Seven Voters
dimension A
dimension B
1
2
3
4
5
6
7
1
2
3
4
5
6
7
x_1
x_2
x_3
x_4
x_5
x_6
x_7


Nine Voters
dimension B
dimension A
1
2
3
4
5
6
7
x1
x2
x3
x4
x5
x6
x7
x8
x9

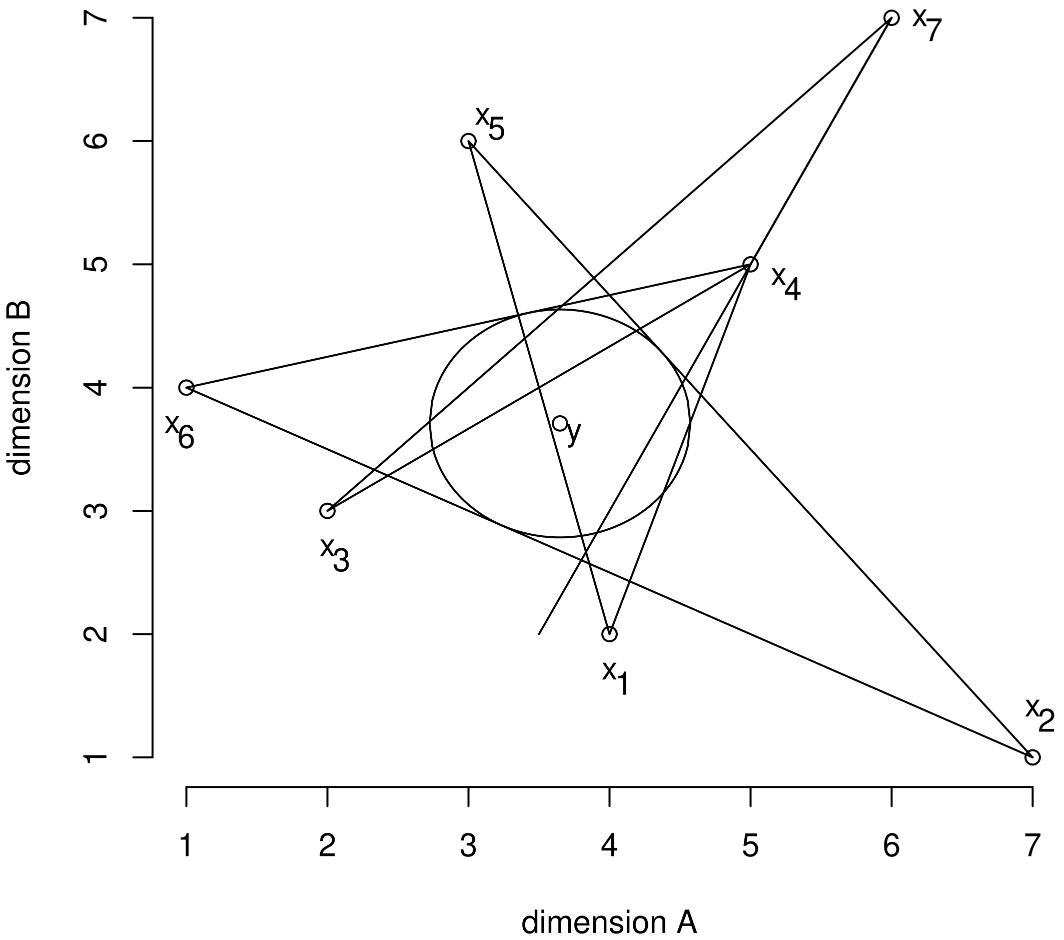
Nine Voters with Median Lines



Nine Voters with the Yolk

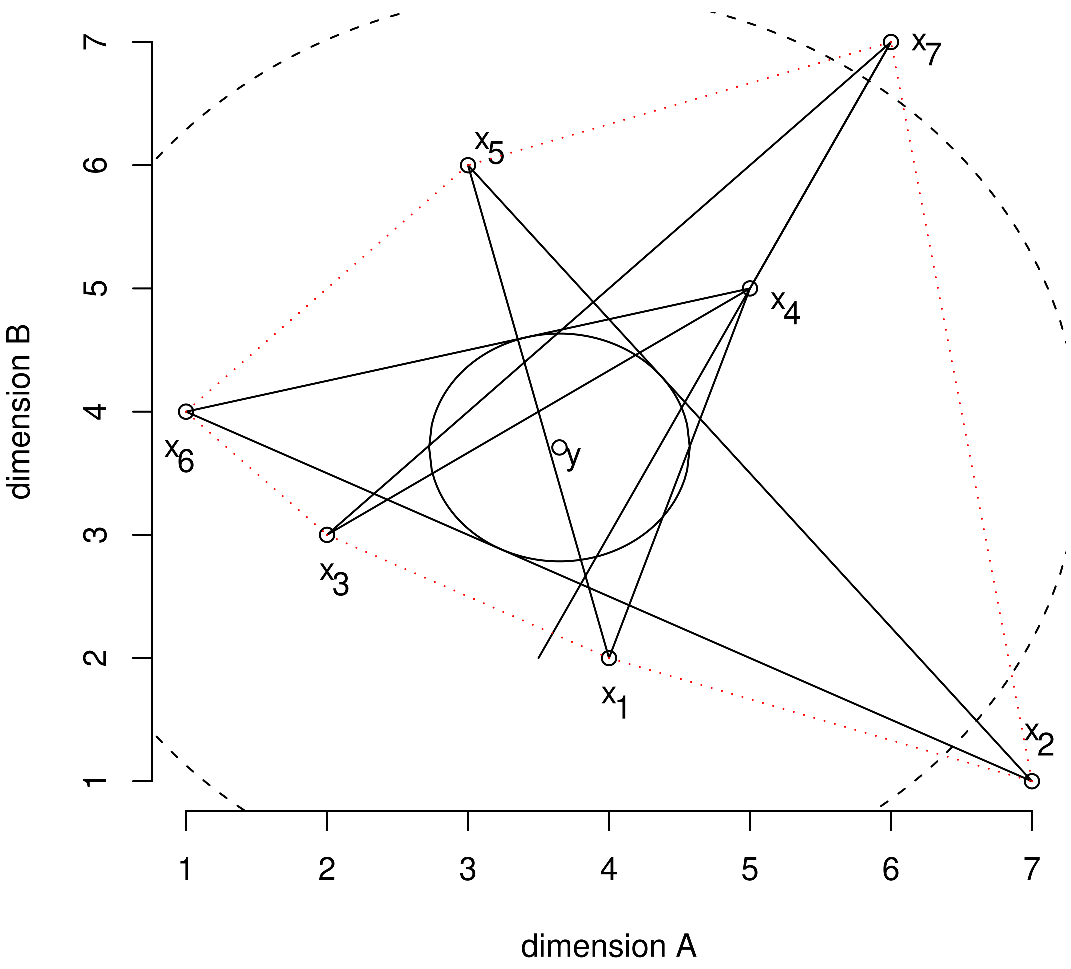


Seven Voters with the Yolk

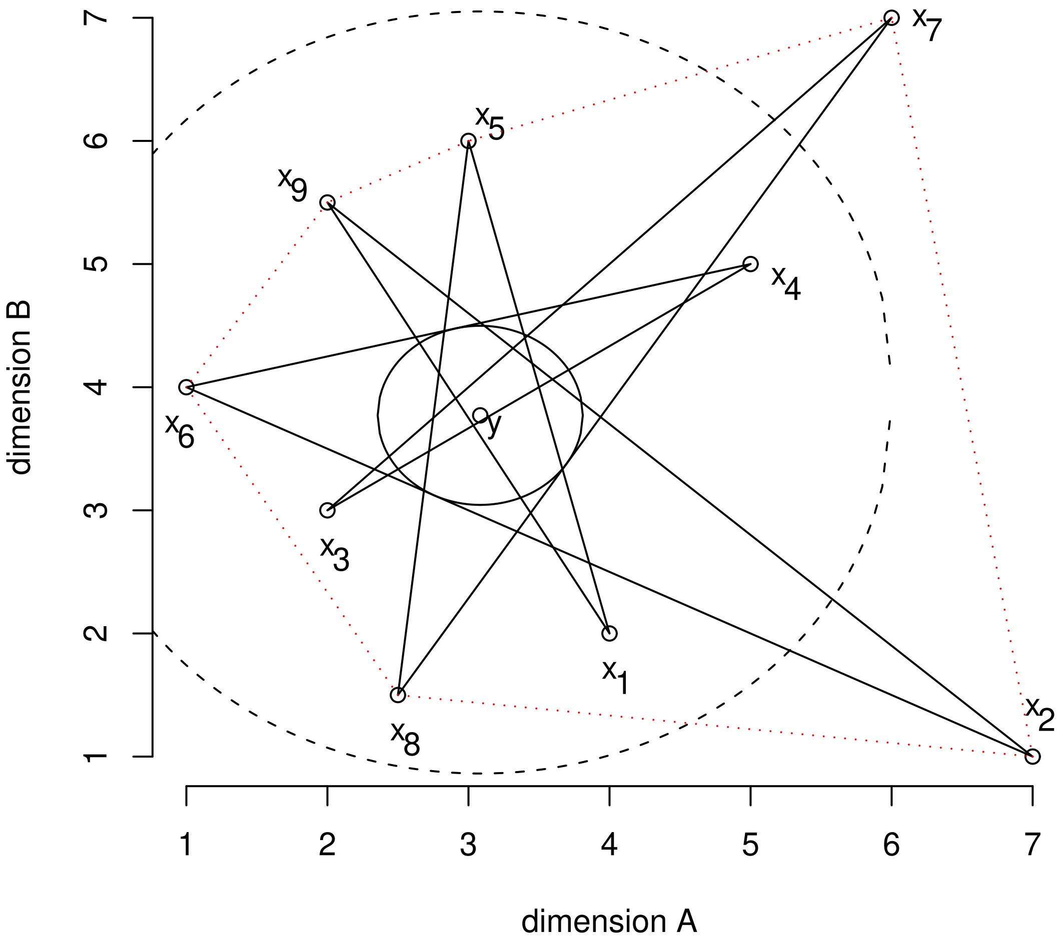


- **the Pareto set and four times the yolk**
- **the uncovered set is contained in the intersection of these two sets**

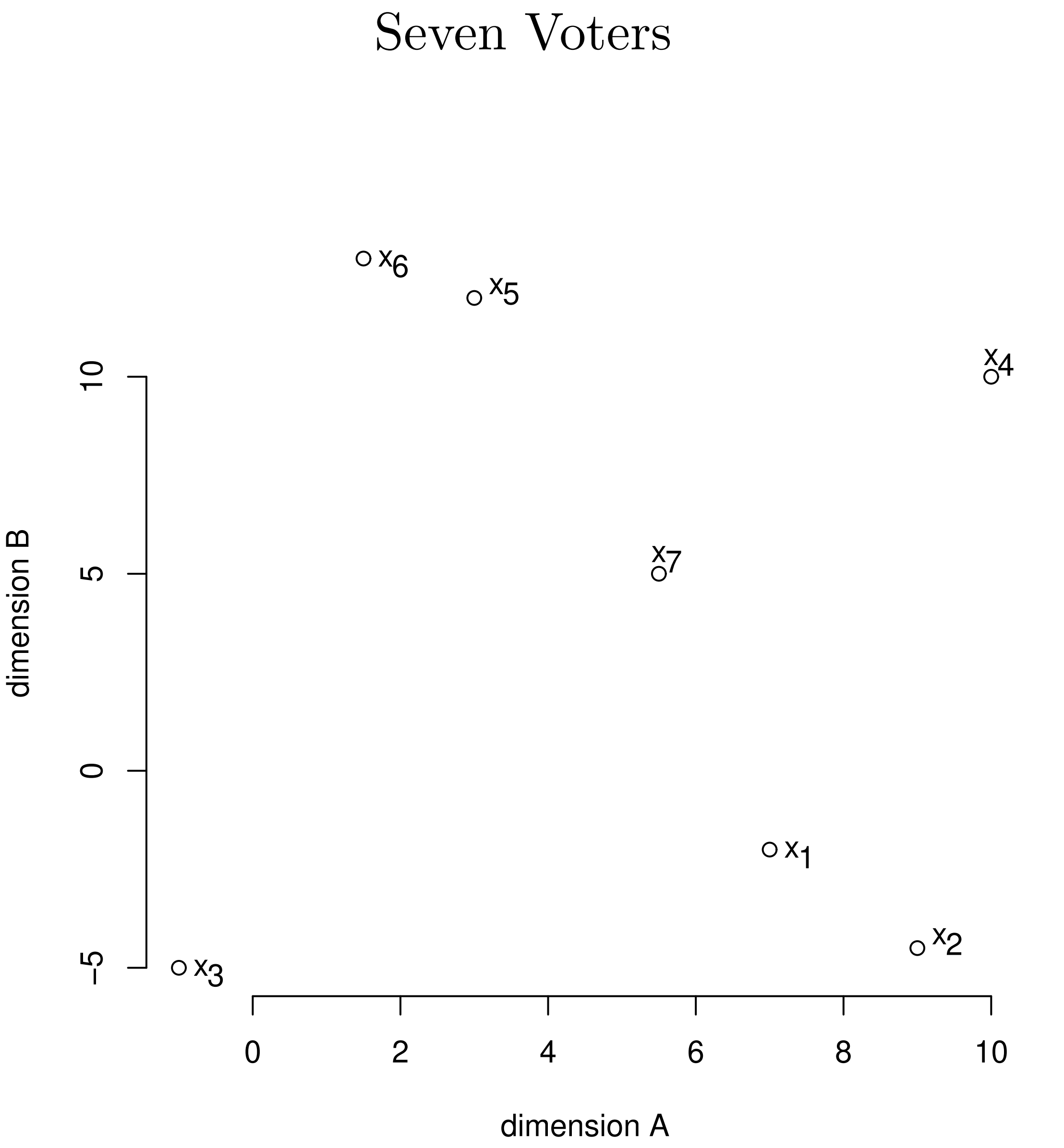
Seven Voters with Uncovered Set Bounds



Nine Voters with Uncovered Set Bounds

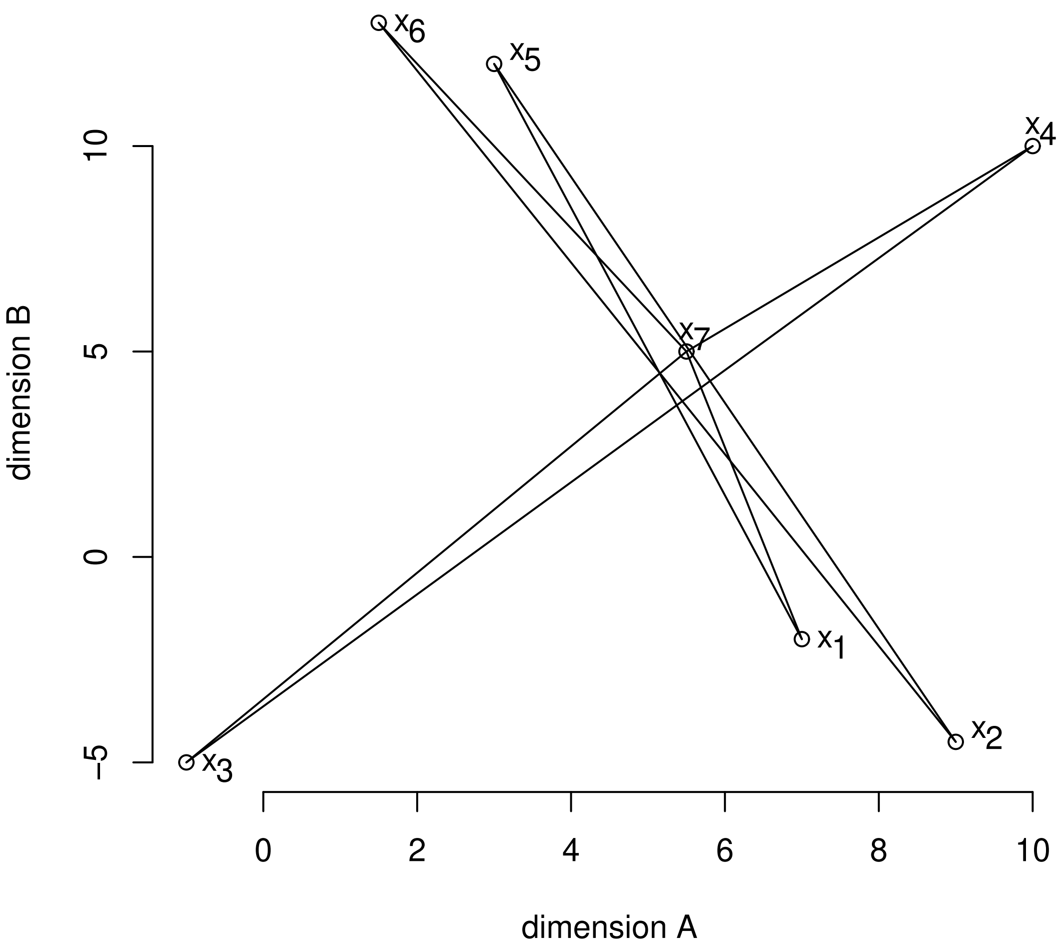


- **the yolk is small when a Condorcet winner almost exists**
- **in this case, strategic, open-agenda outcomes are near where the Condorcet winner would be (if it existed)**

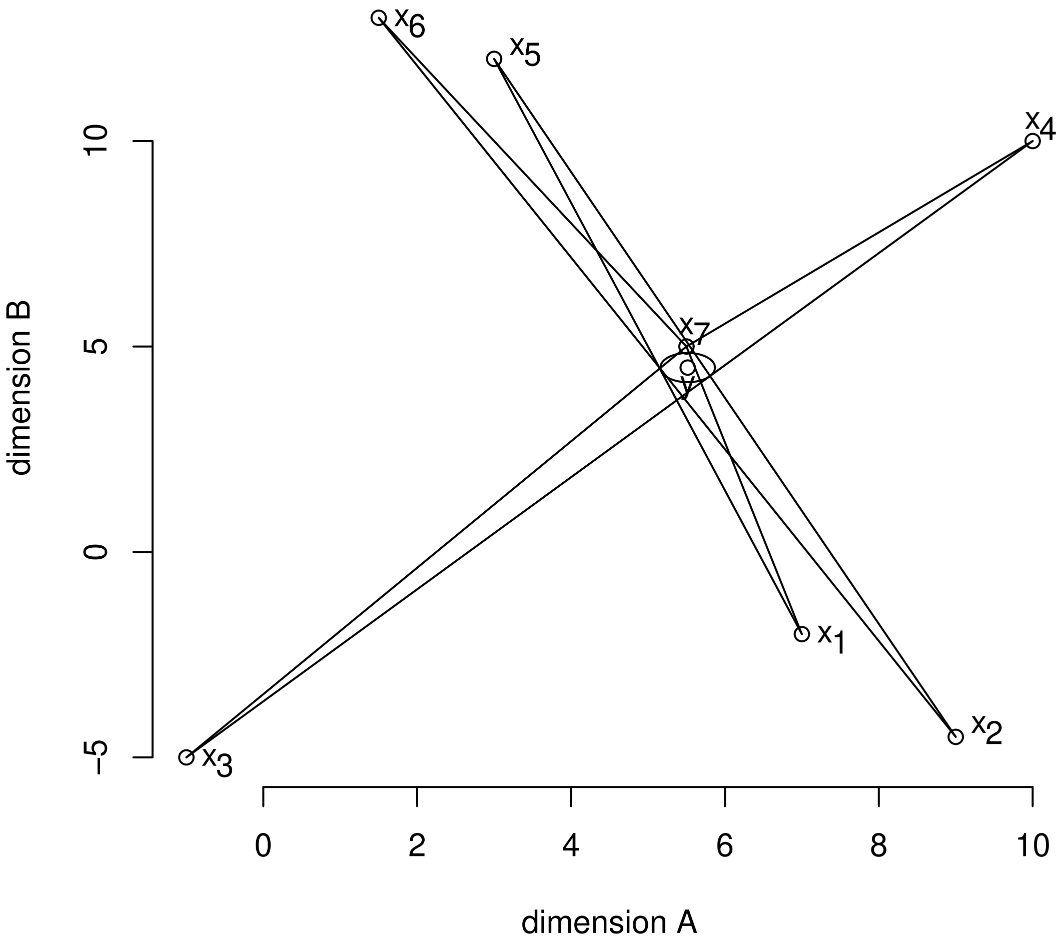


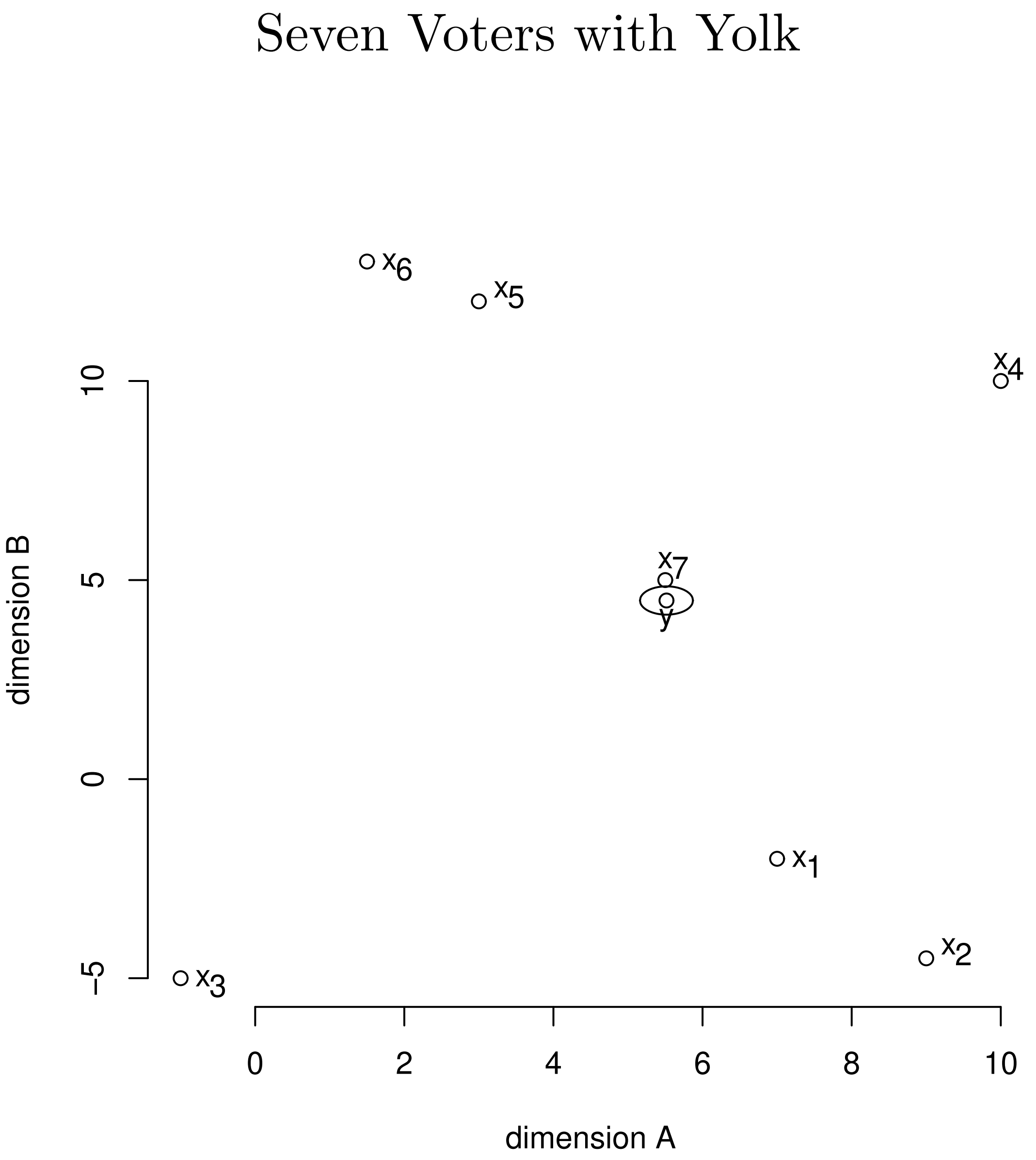
Seven Voters
x6
x5
x4
x7
x1
x2
x3
10
5
0
−5
dimension B
0
2
4
6
8
10
dimension A

Seven Voters with Median Lines

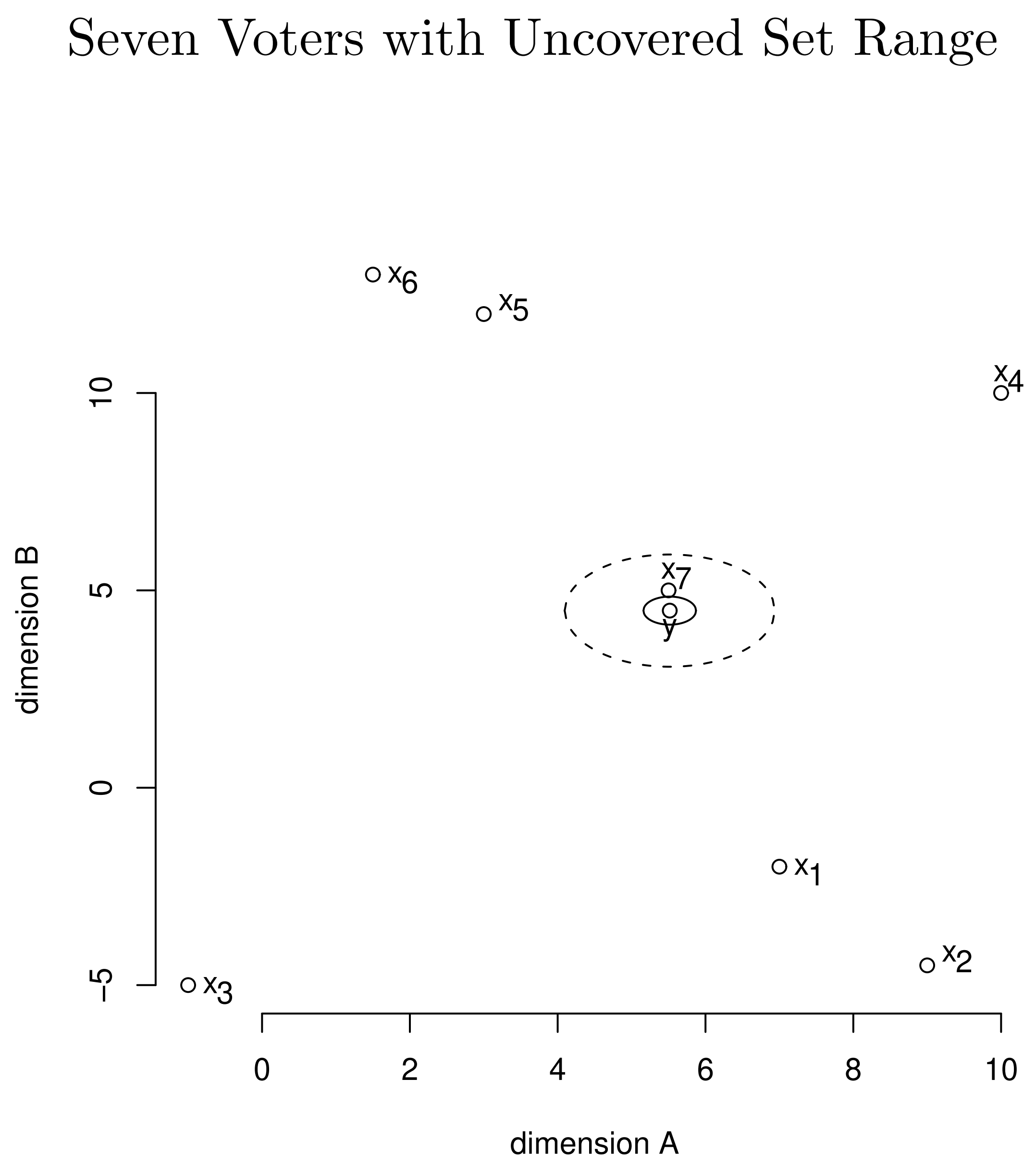


Seven Voters with Yolk



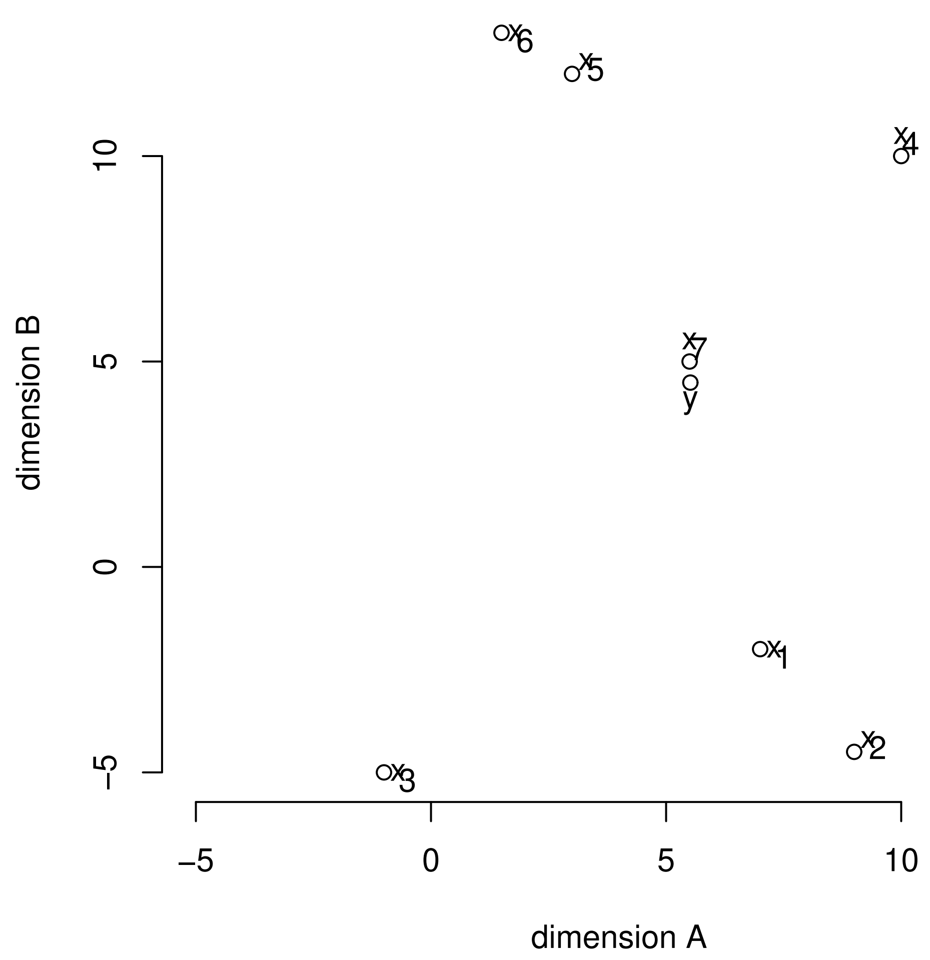


Seven Voters with Yolk
dimension A
dimension B
0
2
4
6
8
10
−5
0
5
10
x1
x2
x3
x4
x5
x6
x7
y

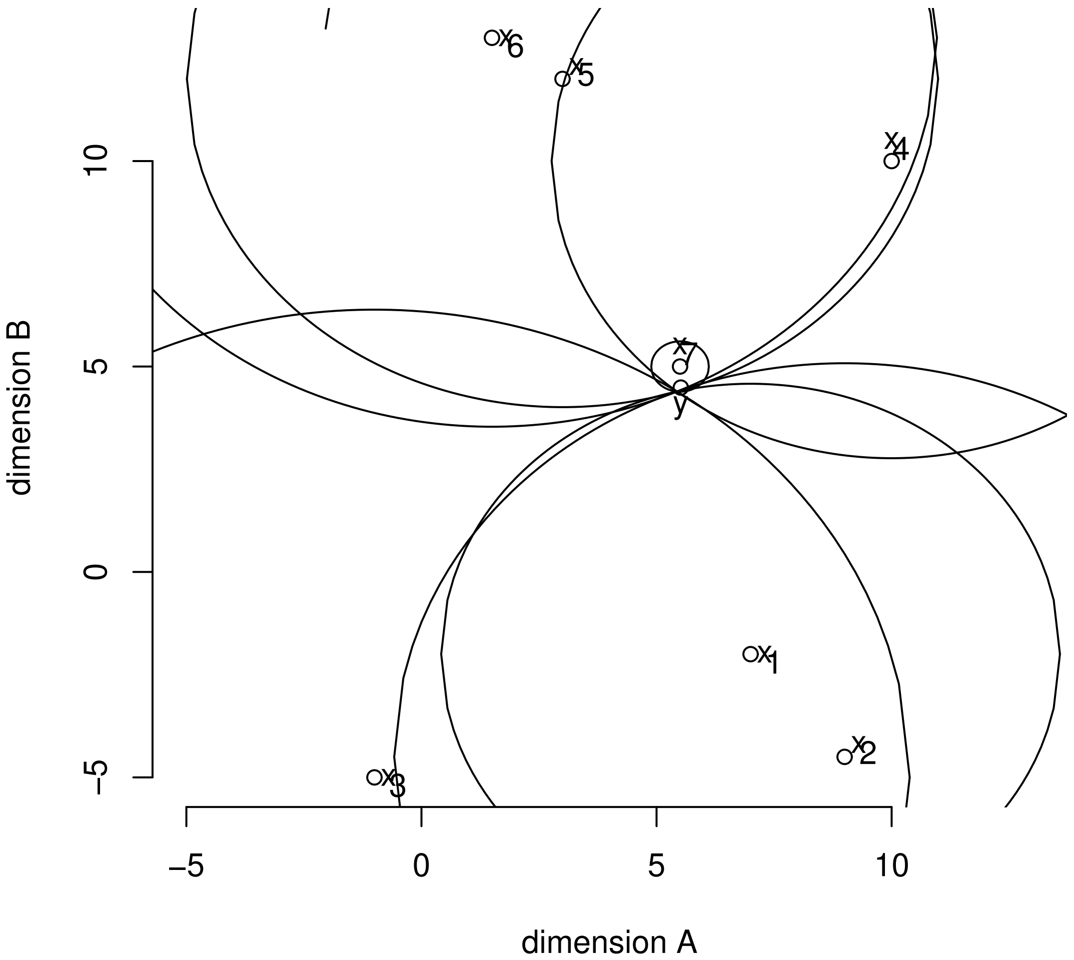

Seven Voters with Uncovered Set Range
dimension A
dimension B
0
2
4
6
8
10
−5
0
5
10
x1
x2
x3
x4
x5
x6
x7
y

- **the generalized median and indifference curves**

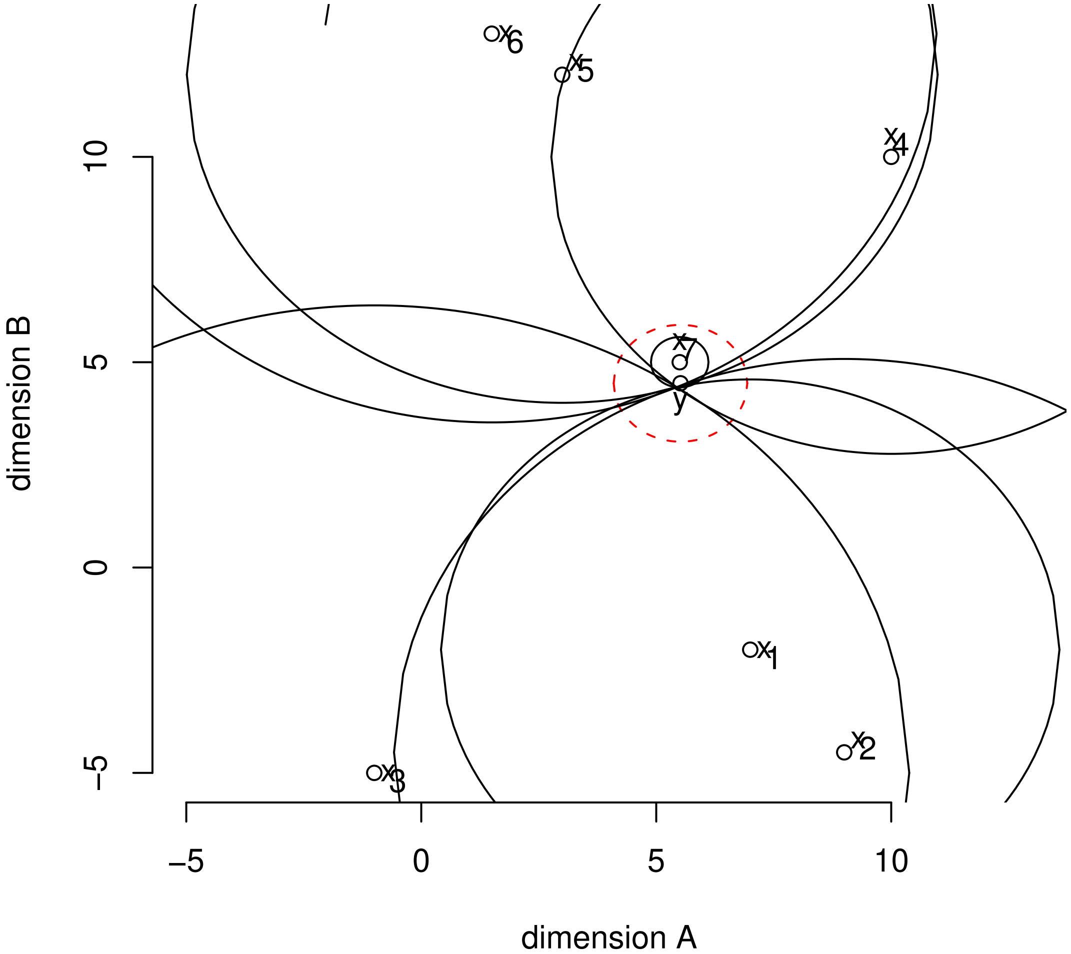
Voters with Generalized Median



Indifference Curves to Generalized Median



Indifference Curves and Uncovered Set Range



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  - **an agenda is an amendment agenda iff it is symmetric and continuous**
  - **a symmetric agenda is nonrepetitive, complete and uniform**
- **for other agendas, strategic voting can confine outcomes to alternatives that are dominant or are in the dominant cycle**

- **"But agenda power has two sources: the ability to choose a procedure for selecting from fixed set of alternatives and the ability to choose that set." (Ordeshook and Schwartz 1987, 194)**

- **heresthetic and the critique of democracy: instability and meaninglessness**

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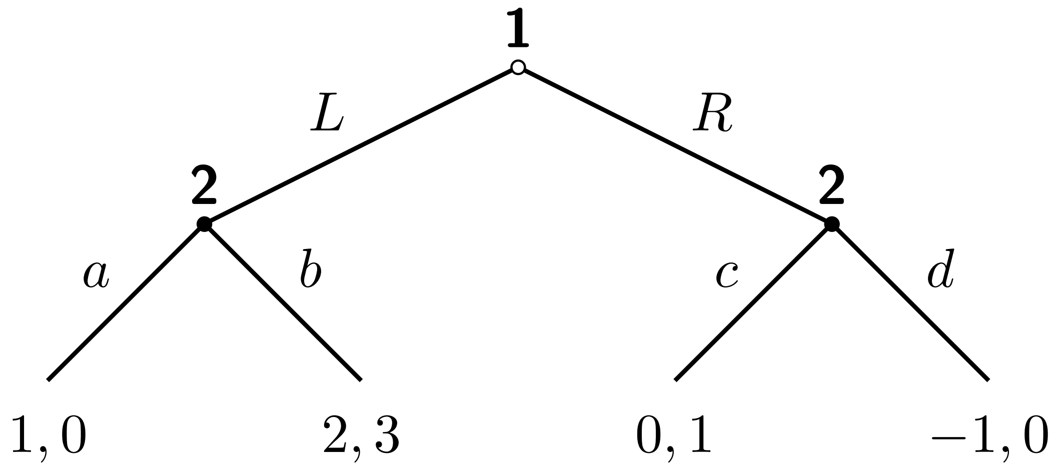
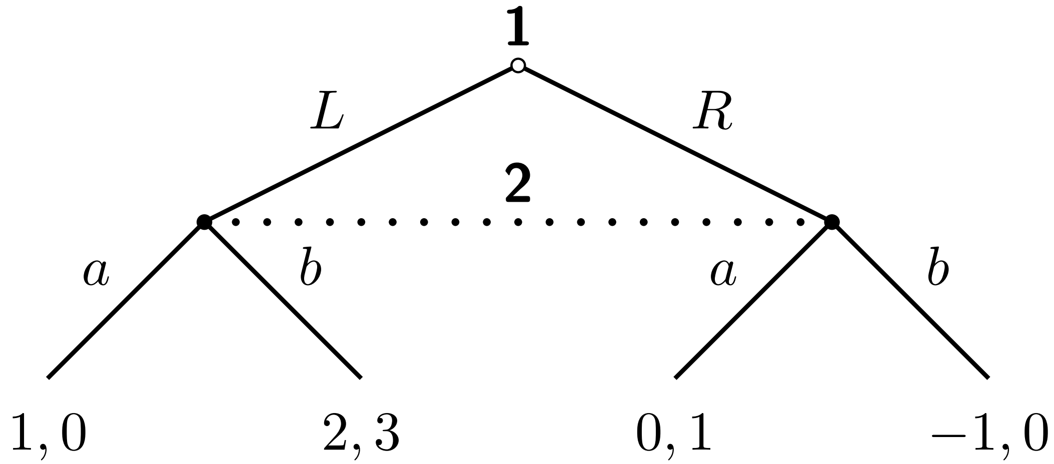
- **possible answers to the critique**
  - **transaction costs induce stability**
  - **similarity of preferences make cycles rare**
  - **similarity of preferences make it possible for people to determine others' preferences**
  - **does sympathy, or affinity, allow one to pin down b in $v = a + bu$?**

- **game theory**
- **noncooperative (no enforceable agreements) versus cooperative game theory**
- **ordinalist**

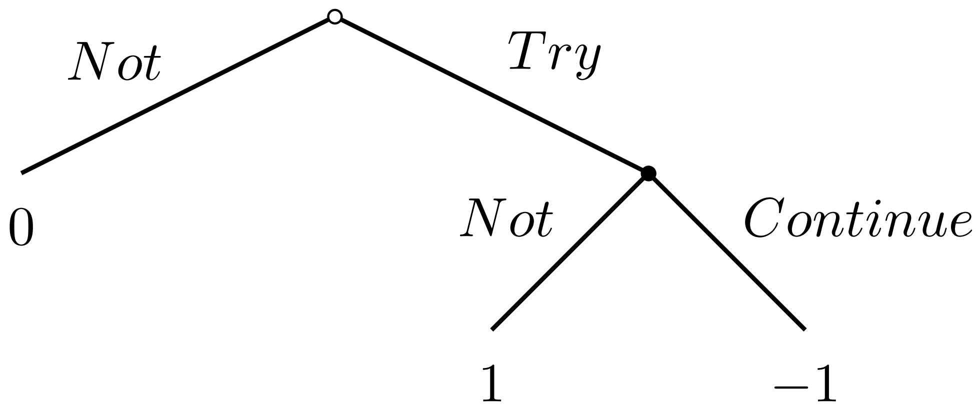
- **game theory concepts**
  - **players**
  - **moves**
  - **outcomes**
  - **preferences and rationality**
  - **common knowledge**
  - **imperfect information**
  - **incomplete information, asymmetric information**
  - **sequential or simultaneous moves (not about time)**
  - **strategies**
  - **equilibrium solutions**
  - **backward induction, or rollback**

Perfect and Imperfect Information

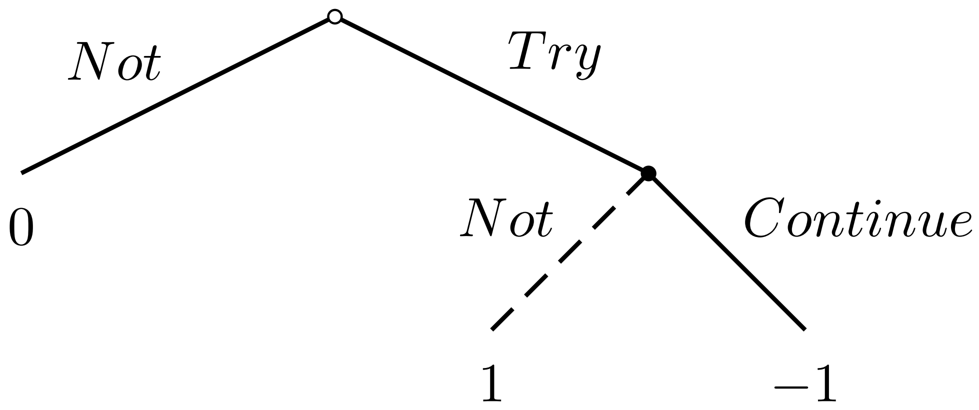




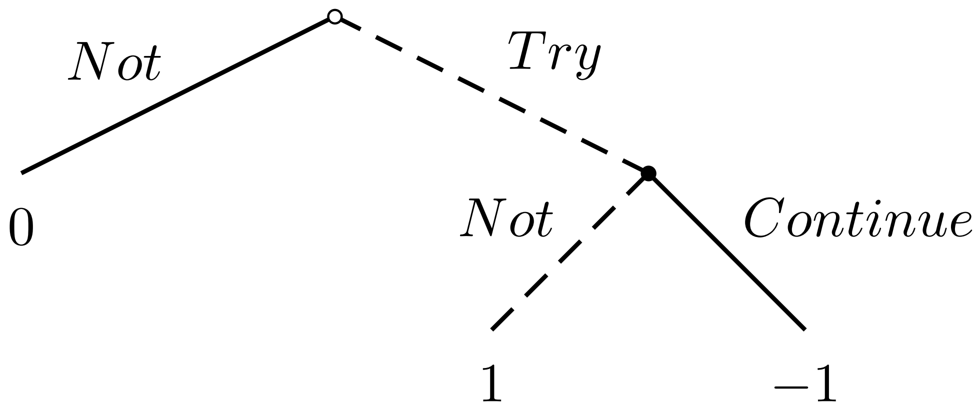
Smoking Game Extensive Form



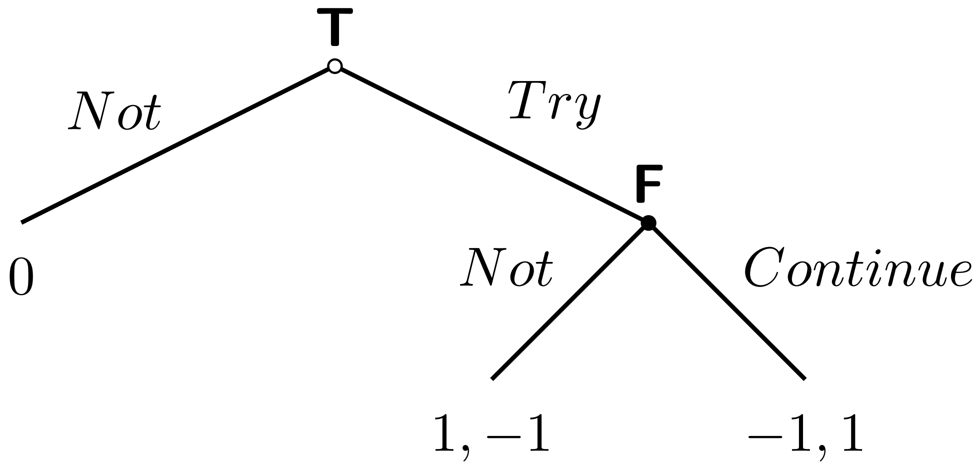
Smoking Game, Rollback Solution



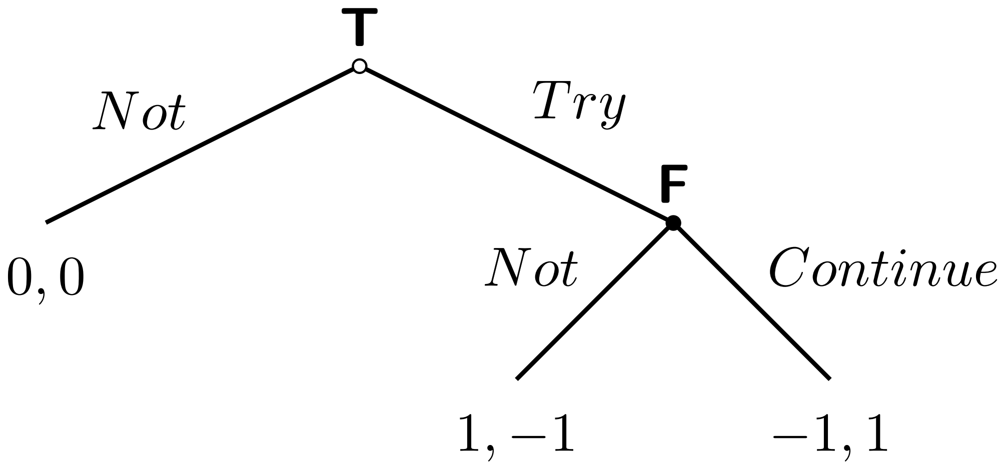
Smoking Game, Rollback Solution



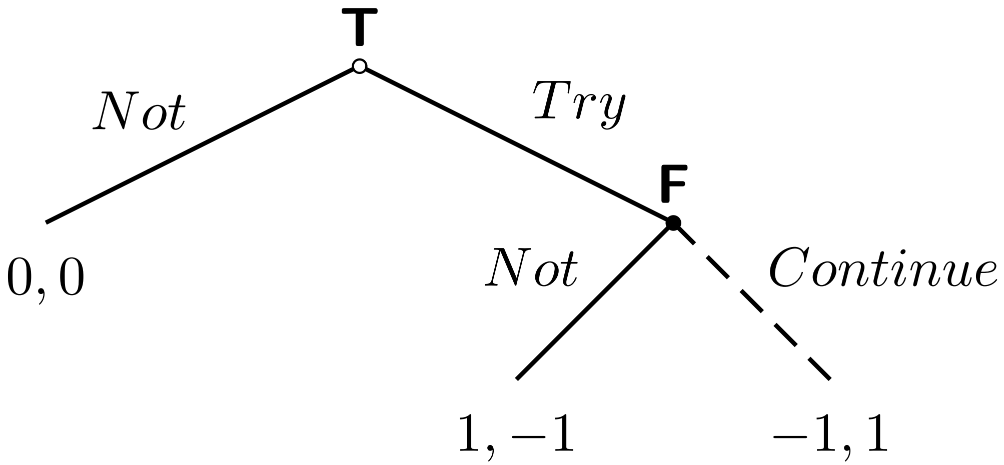
Smoking Game with Addict



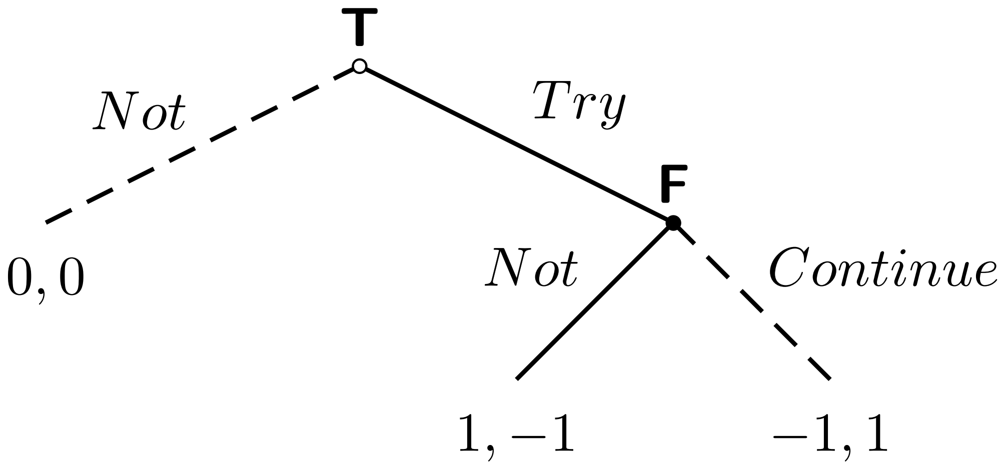
Smoking Game with Addict



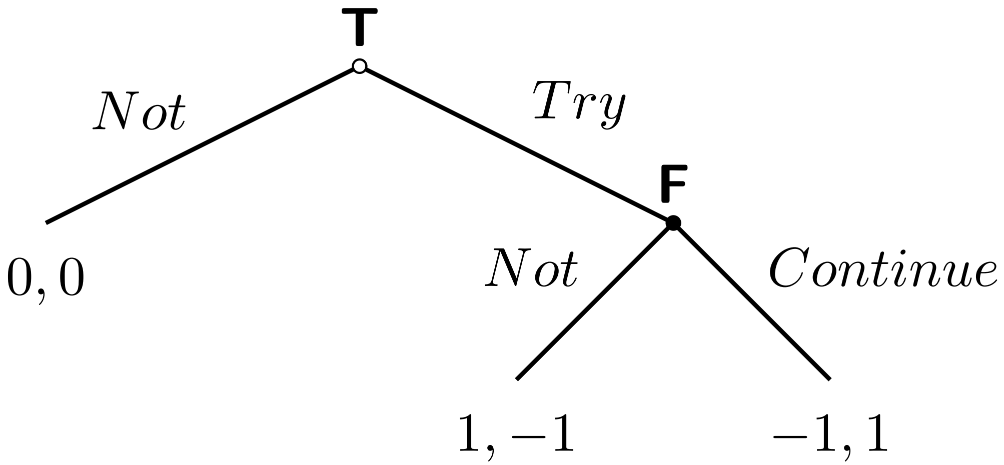
Smoking Game with Addict, Rollback



Smoking Game with Addict, Rollback



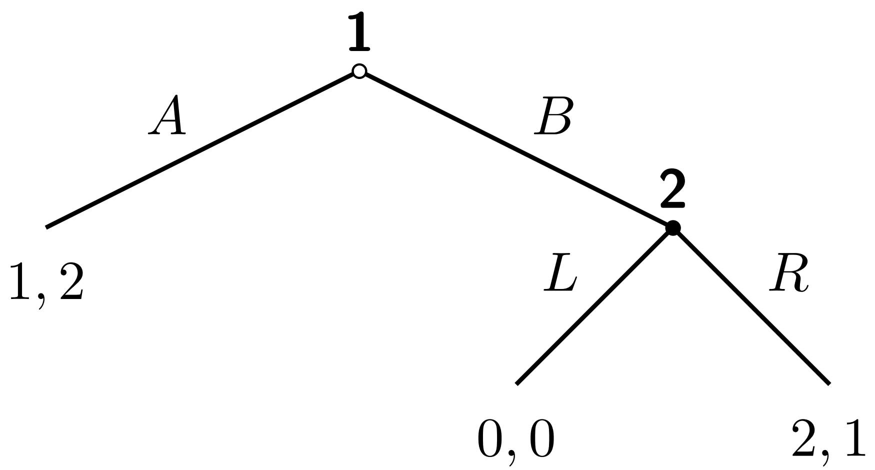
Smoking Game with Addict, Strategic Form



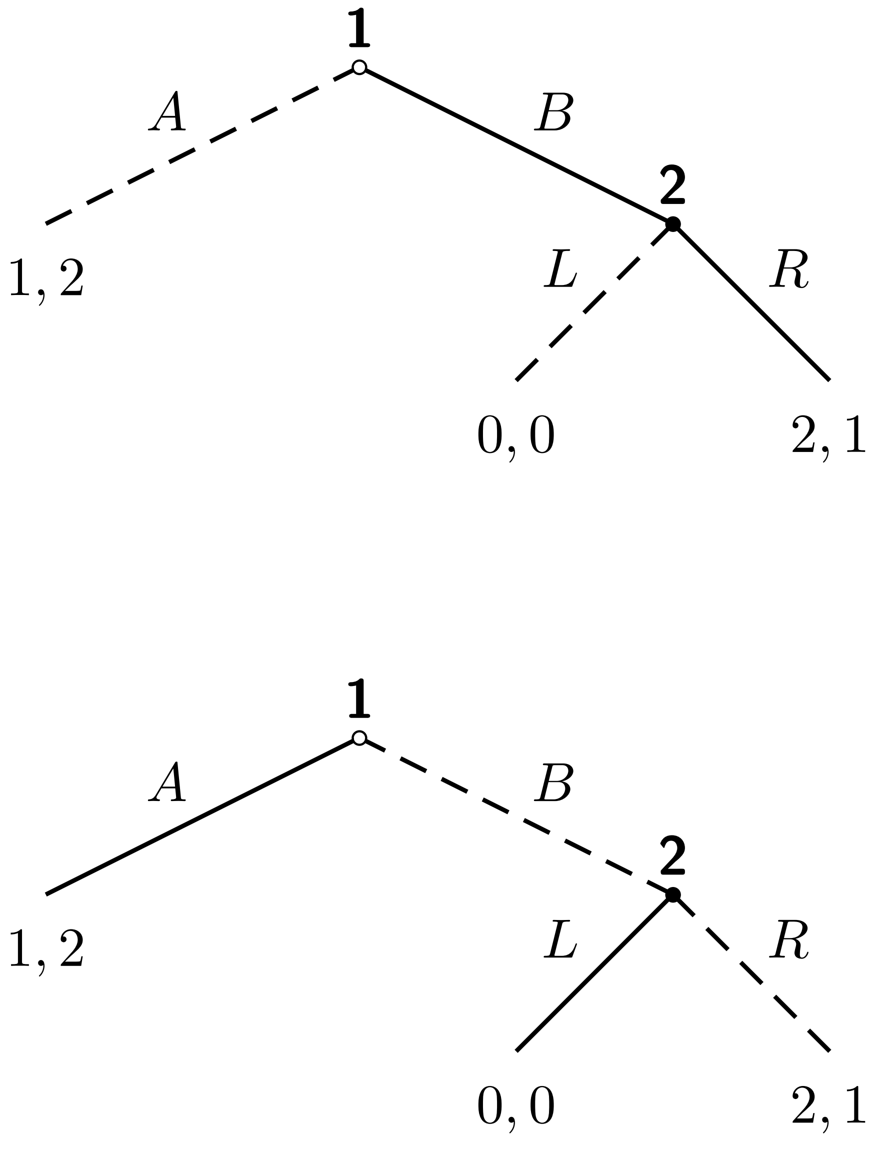
Future

		Not	*Continue*
Today	*Not*	$0, 0$	$0, 0$
	Try	$1, -1$	$-1, 1$

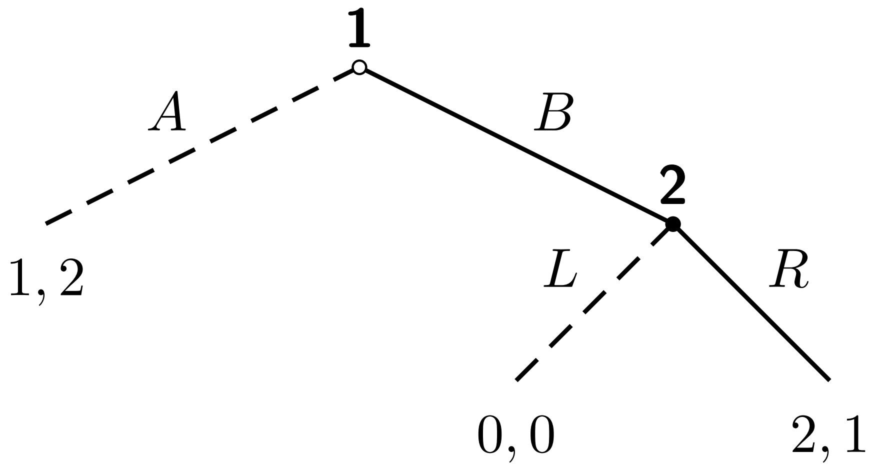
Two-player Extensive Form Game

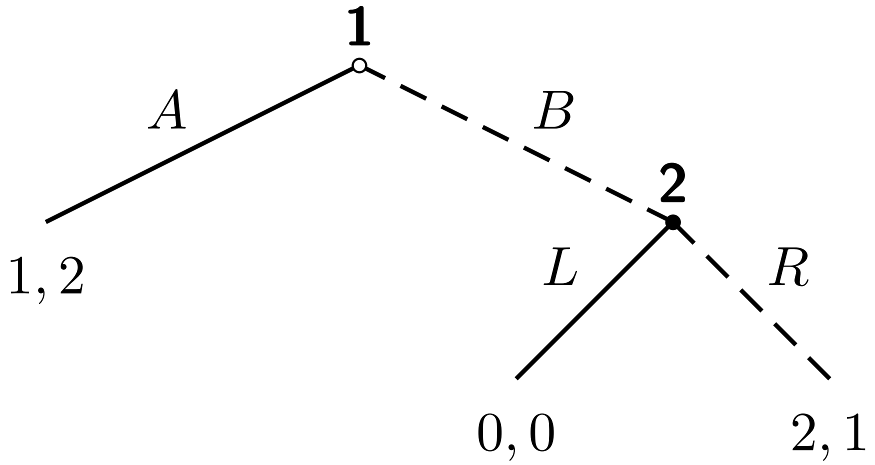


Two-player Extensive Form Game, Nash Equilibria



Two Nash Equilibria, One Features Incredible Threats





- **refining Nash equilibrium**
  - **subgame perfect equilibrium**

- **refining Nash equilibrium**
  - **subgame perfect equilibrium**
  - **trembling hand equilibrium**

Strategic Games (a.k.a Games in Strategic Form)

	L	R
T	w_1, w_2	x_1, x_2
B	y_1, y_2	z_1, z_2

BoS

	$Bach$	$Cage$
$Bach$	$2,1$	$0,0$
$Cage$	$0,0$	$1,2$

BoS

	Bach	*Cage*
Bach	$2, 1$	$0, 0$
Cage	$0, 0$	$1, 2$

Coordination

	Melissa	*Mariah*
Melissa	$2, 2$	$0, 0$
Mariah	$0, 0$	$1, 1$

PD

	Don't Confess	*Confess*
Don't Confess	$3, 3$	$0, 4$
Confess	$4, 0$	$1, 1$

PD

	Don't Confess	*Confess*
Don't Confess	3, 3	0, 4
Confess	4, 0	1, 1

Hawk-Dove

	Dove	*Hawk*
Dove	3, 3	1, 4
Hawk	4, 1	0, 0

A Strategic Game with no Pure Strategy Nash Equlibrium

Matching Pennies

	$Head$	$Tail$
$Head$	$1, -1$	$-1, 1$
$Tail$	$-1, 1$	$1, -1$

BoS

	$Bach$	$Cage$
$Bach$	$2, 1$	$0, 0$
$Cage$	$0, 0$	$1, 2$

- **mixed strategy equilibrium**
  - **there are two pure strategy equilibria:** (B, B) **and** (C, C)

BoS

	$Bach$	$Cage$
$Bach$	$2, 1$	$0, 0$
$Cage$	$0, 0$	$1, 2$

- **mixed strategy equilibrium**
  - **there are two pure strategy equilibria:** (B, B) **and** (C, C)
  - **every pure strategy that is part of a Nash equilibrium in pure strategies is a best response to every equilibrium mixed strategy**
  - **this implies that every equilibrium mixed strategy yields the same payoff as the associated equilibrium pure strategy**

BoS

	$Bach$	$Cage$
$Bach$	$2,1$	$0,0$
$Cage$	$0,0$	$1,2$

- **mixed strategy equilibrium**
  - **let** (a_1, a_2) **denote a mixed strategy equilibrium, where each** $a_j(B)$ **denotes the probability that** B **is chosen by player** j

BoS

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$Bach$	$2,1$	$0,0$
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- **mixed strategy equilibrium**
  - **let** (a_1, a_2) **denote a mixed strategy equilibrium, where each** $a_j(B)$ **denotes the probability that** B **is chosen by player** j
  - $(a_1, a_2) = ((1,0),(1,0))$ **and** $(a_1, a_2) = ((0,1),(0,1))$ **are the pure strategy equilibria**
  - **any mixed strategy equilibrium must yield the same payoff to a player as do pure strategies in the support of the mixed strategy**

BoS

	$Bach$	$Cage$
$Bach$	$2, 1$	$0, 0$
$Cage$	$0, 0$	$1, 2$

- **mixed strategy equilibrium**
  - **let** $U_1(s_1 \mid s_2)$ **denote player 1's expected utility with strategy** s_1 **given that player 2 uses strategy** s_2
  - **because** $s_1 = B$ **and** $s_1 = C$ **are both in the support of any mixed equilibrium** a_1**, we have**

$$U_1(B \mid a_2) = U_1(C \mid a_2)$$

expanding

$$2a_2(B) + 0a_2(C) = 0a_2(B) + 1a_2(C)$$

which implies $a_2(B) = 1/3$

BoS

	$Bach$	$Cage$
$Bach$	$2, 1$	$0, 0$
$Cage$	$0, 0$	$1, 2$

- **mixed strategy equilibrium**
  - **let** $U_2(s_2 \mid s_1)$ **denote player 2's expected utility with strategy** s_2 **given that player 1 uses strategy** s_1
  - **because** $s_2 = B$ **and** $s_2 = C$ **are both in the support of any mixed equilibrium** a_2**, we have**

$$U_2(B \mid a_1) = U_2(C \mid a_1)$$

expanding

$$1a_1(B) + 0a_1(C) = 0a_1(B) + 2a_1(C)$$

which implies $a_1(B) = 2/3$

- **BoS mixed strategy equilibrium**
  - **the unique solution to**

$$U_1(B \mid a_2) = U_1(C \mid a_2)$$
$$U_2(B \mid a_1) = U_2(C \mid a_1)$$

that is, to

$$2a_2(B) + 0a_2(C) = 0a_2(B) + 1a_2(C)$$
$$1a_1(B) + 0a_1(C) = 0a_1(B) + 2a_1(C)$$

is $a_2(B) = 1/3$**,** $a_1(B) = 2/3$

  - **the unique mixed strategy equilibrium is** $(a_1, a_2) = ((2/3, 1/3), (1/3, 2/3))$

- **BoS mixed strategy equilibrium**
- **consider affine transformations of the payoffs**
- **transform player 1's payoffs by** $v_1 = e + bu_1$ **and tranform player 2's payoffs by** $v_2 = f + du_2$**,** $b > 0$ **and** $d > 0$
- **Now**

$$U_1(B \mid a_2) = U_1(C \mid a_2)$$
$$U_2(B \mid a_1) = U_2(C \mid a_1)$$

is

$$(e + 2b)a_2(B) + (e + 0b)a_2(C) = (e + 0b)a_2(B) + (e + 1b)a_2(C)$$
$$(f + 1d)a_1(B) + (f + 0d)a_1(C) = (f + 0d)a_1(B) + (f + 2d)a_1(C)$$

- **affine transformations of the payoffs**

$$(e+2b)a_2(B)+(e+0b)a_2(C)=(e+0b)a_2(B)+(e+1b)a_2(C)$$

$$(f+1d)a_1(B)+(f+0d)a_1(C)=(f+0d)a_1(B)+(f+2d)a_1(C)$$

because $e(a_2(B)+a_2(C))$ **and** $f(a_1(B)+a_1(C))$ **cancel in each equation, we have**

$$2ba_2(B)+0ba_2(C)=0ba_2(B)+1ba_2(C)$$

$$1da_1(B)+0da_1(C)=0da_1(B)+2da_1(C)$$

Now b **and** d **can be divided out to give**

$$2a_2(B)+0a_2(C)=0a_2(B)+1a_2(C)$$

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which is exactly the original pair of conditions

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which is exactly the original pair of conditions

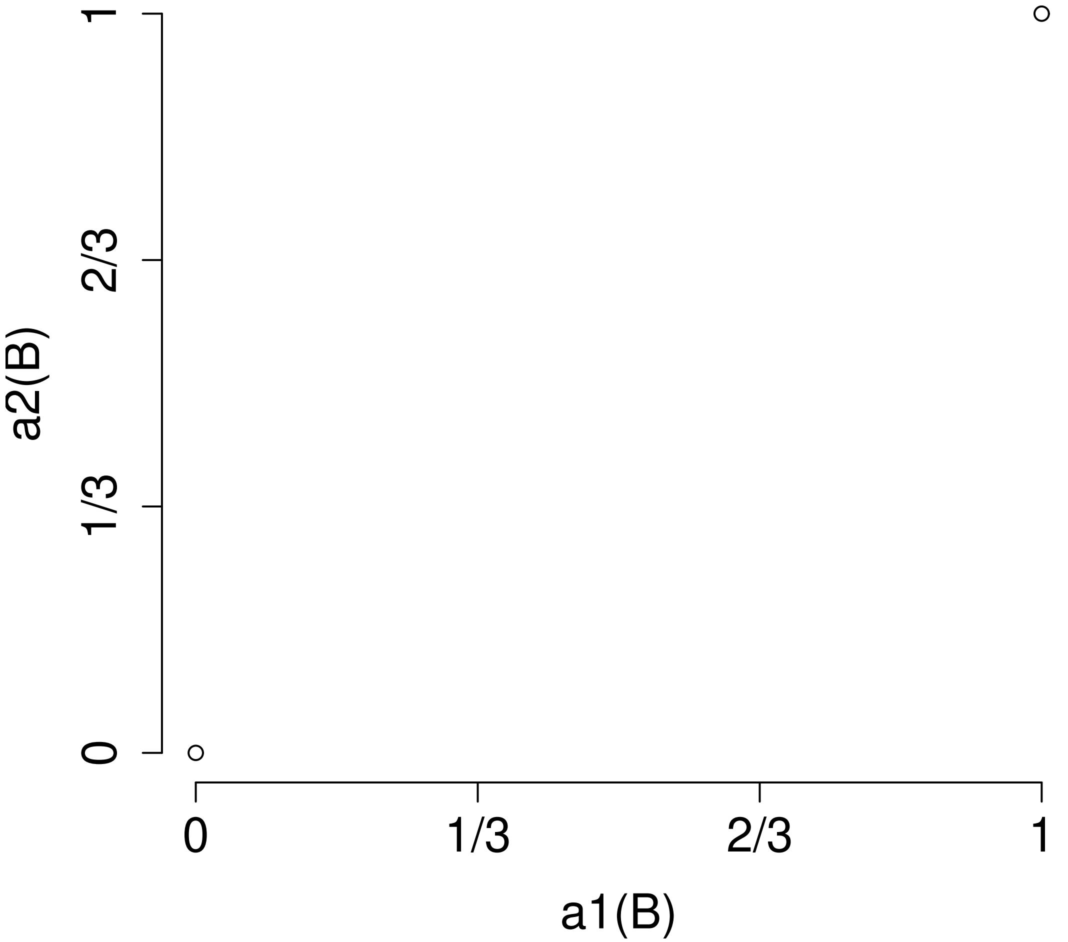
- **affine transformation of the payoffs do not change the equilibrium**

BoS

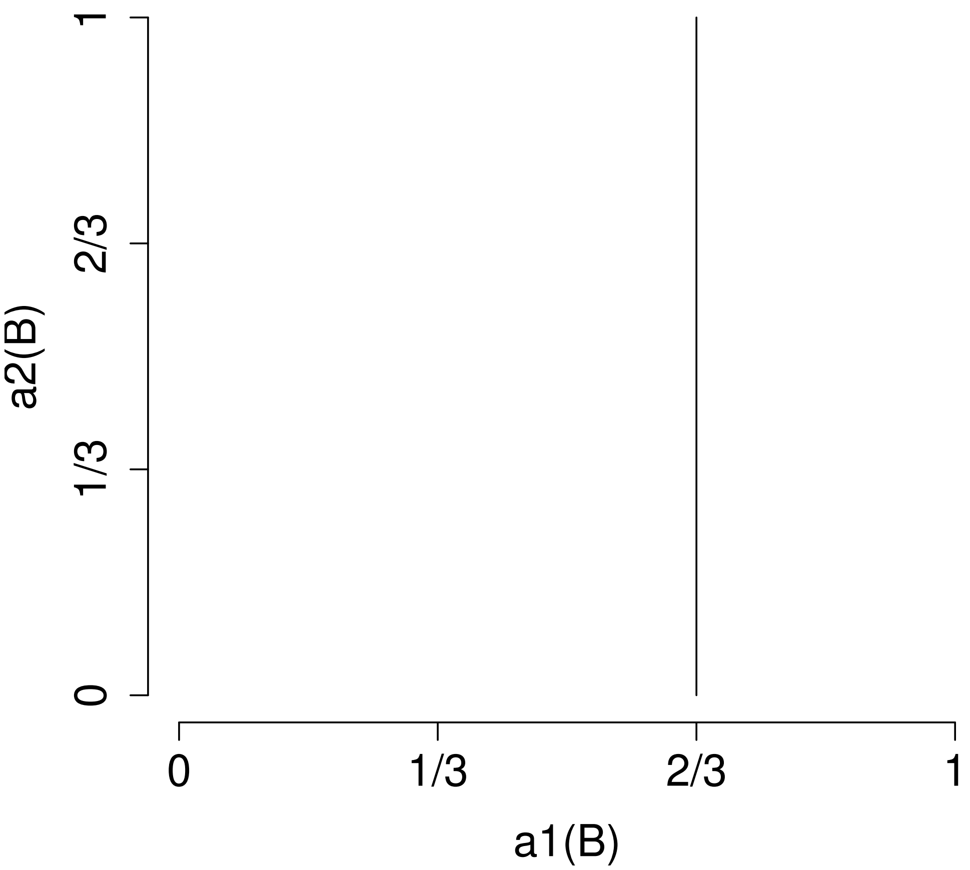
	$Bach$	$Cage$
$Bach$	$2, 1$	$0, 0$
$Cage$	$0, 0$	$1, 2$

- **consider the best-response correspondence**

BoS Pure Strategy Nash Equilibria



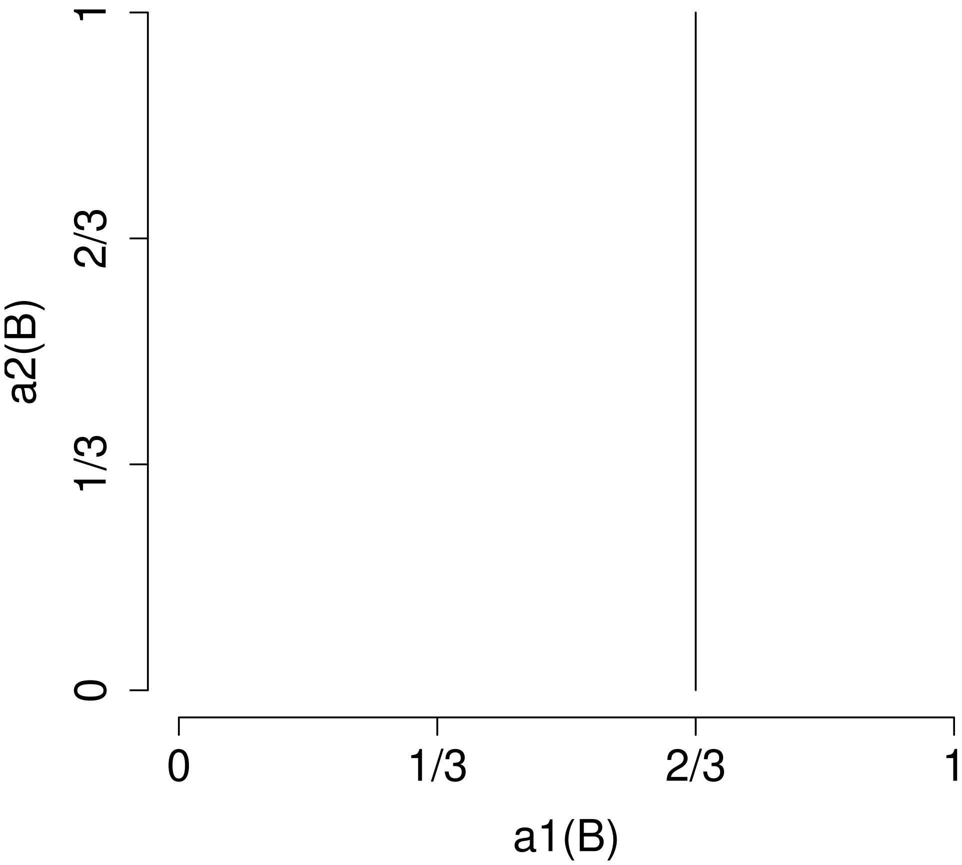
Player 2's Response to $a_1(B) = 2/3$



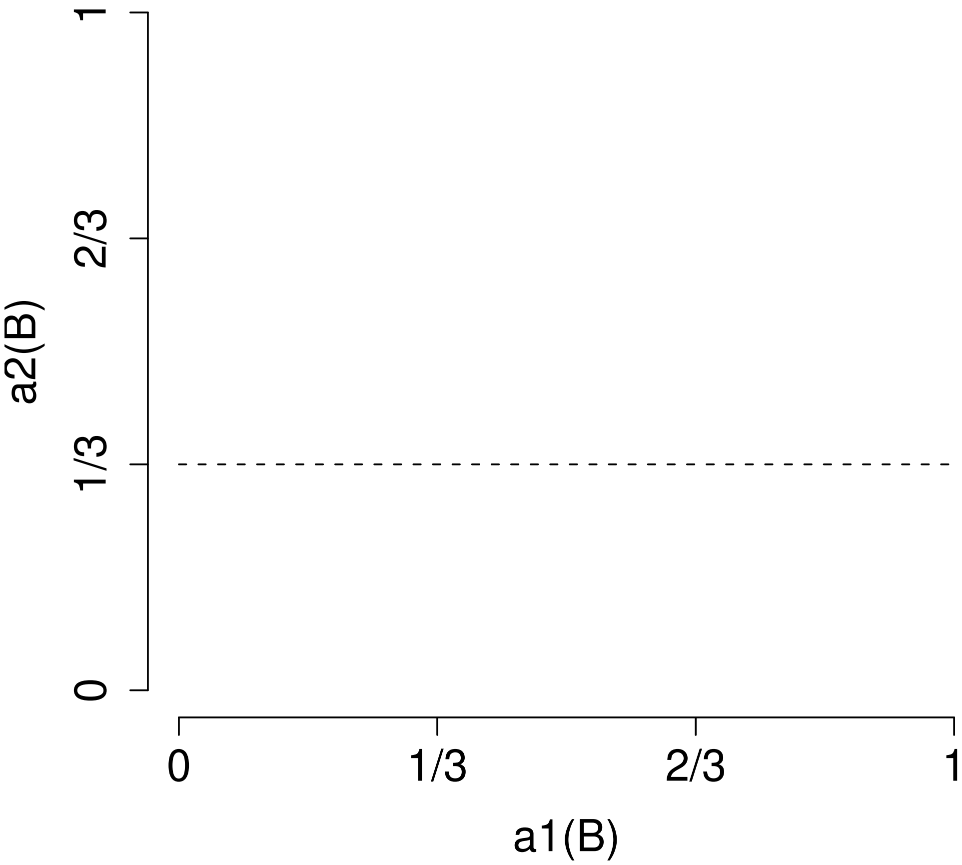
Player 2's Response to $a_1(B) = 2/3$

$$U_2(B \mid a_1 = (2/3, 1/3)) = U_2(C \mid a_1 = (2/3, 1/3))$$

$$1 * (2/3) + 0 * (1/3) = 0 * (2/3) + 2 * (1/3)$$



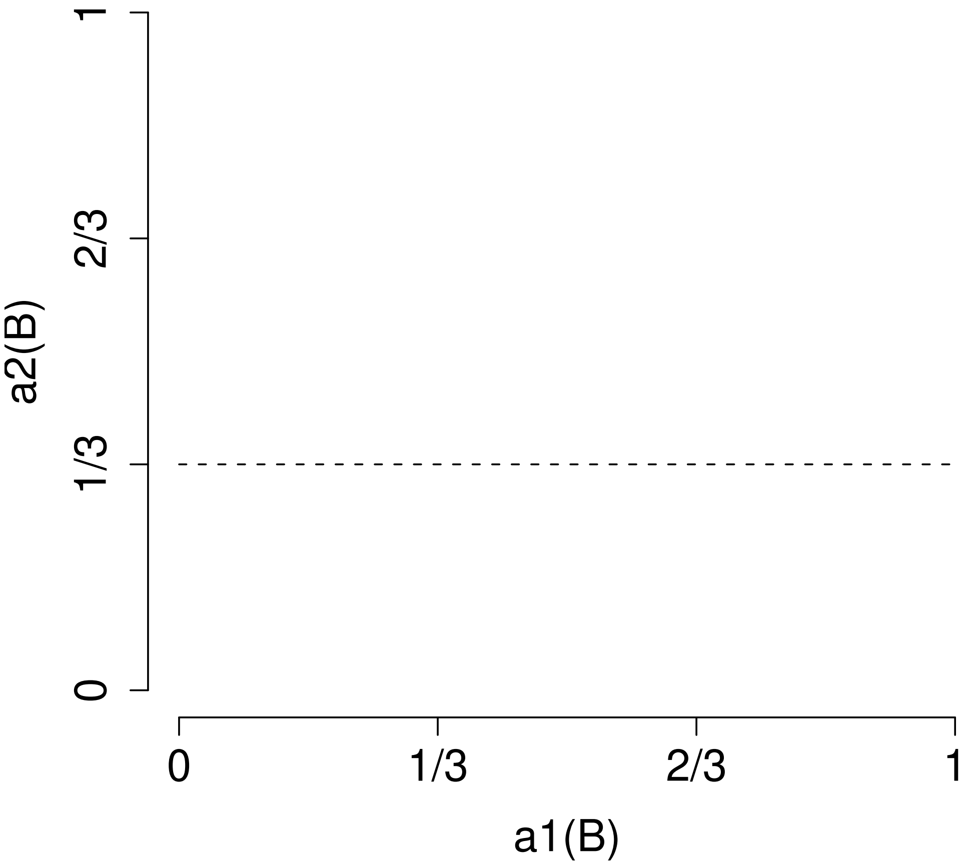
Player 1's Response to $a_2(B) = 1/3$

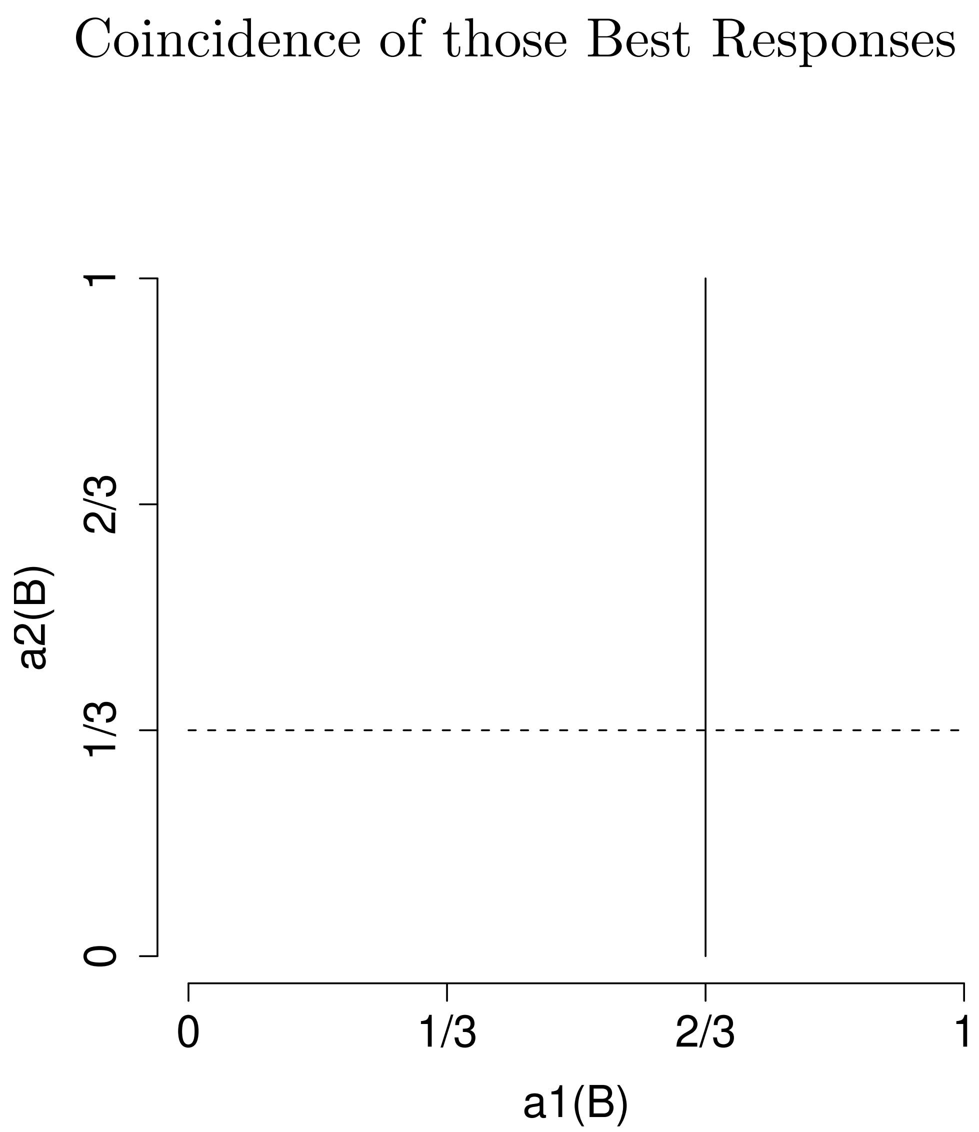


Player 1's Response to $a_2(B) = 1/3$

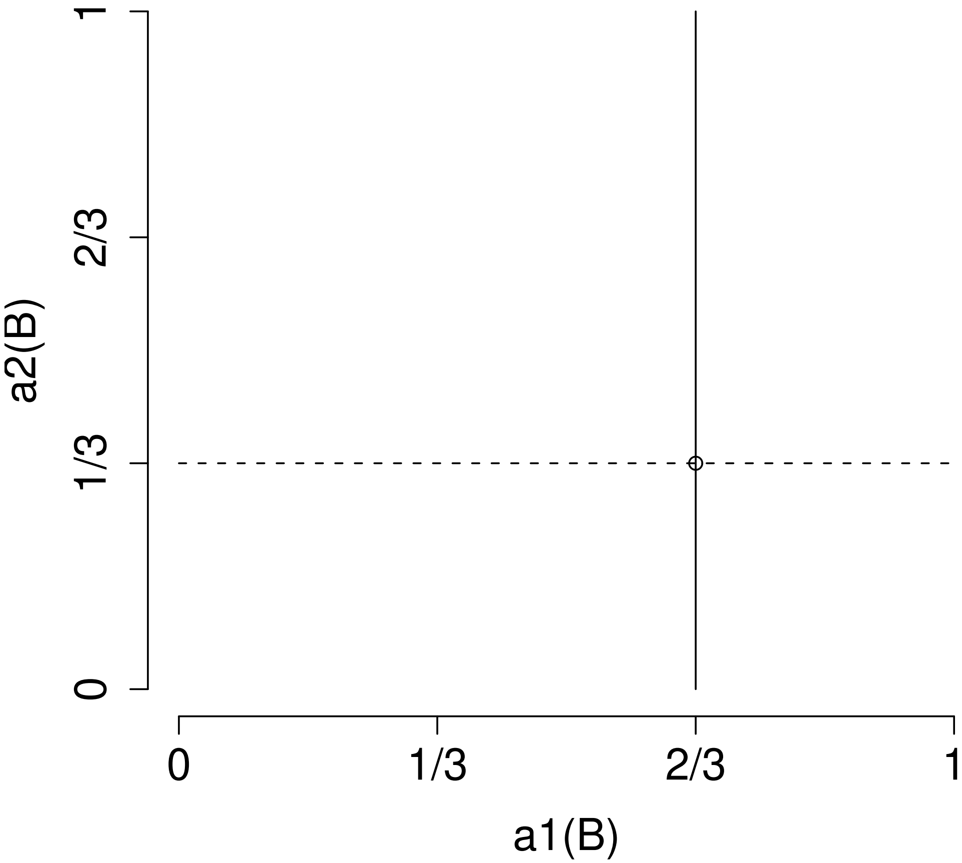
$$U_1(B \mid a_2 = (1/3, 2/3)) = U_1(C \mid a_2 = (1/3, 2/3))$$

$$2 * (1/3) + 0 * (2/3) = 0 * (1/3) + 1 * (2/3)$$

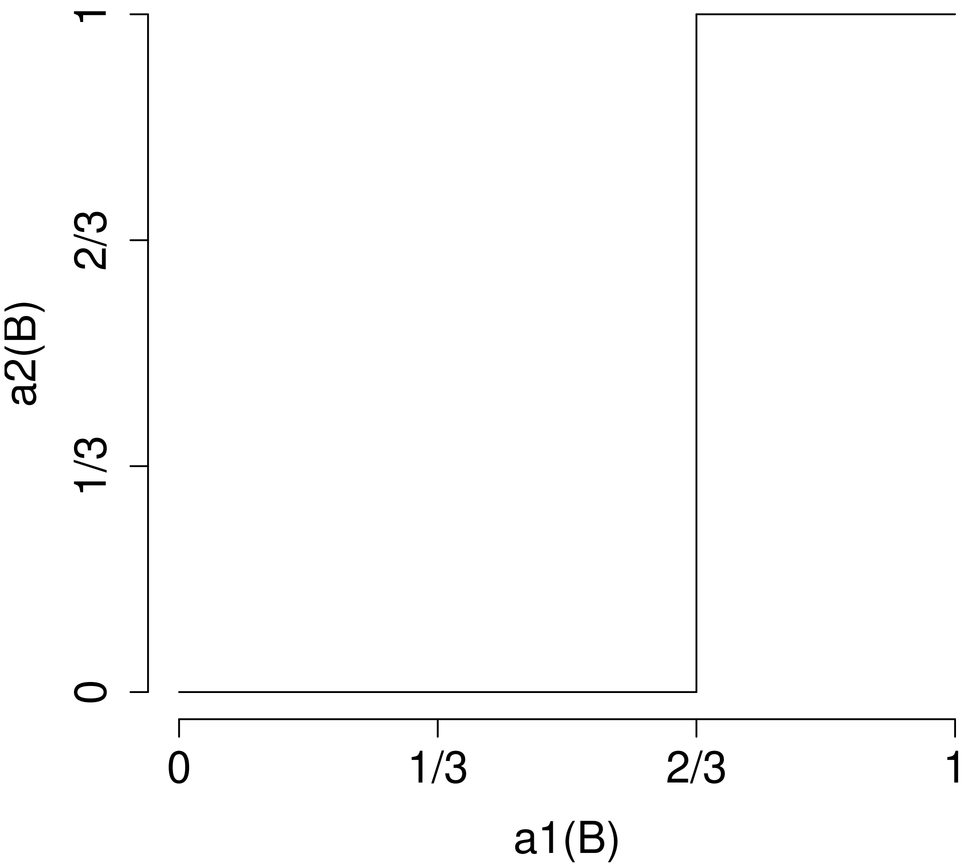



Coincidence of those Best Responses
1
2/3
1/3
0
a2(B)
0
1/3
2/3
1
a1(B)

BoS Mixed Strategy Equilibrium



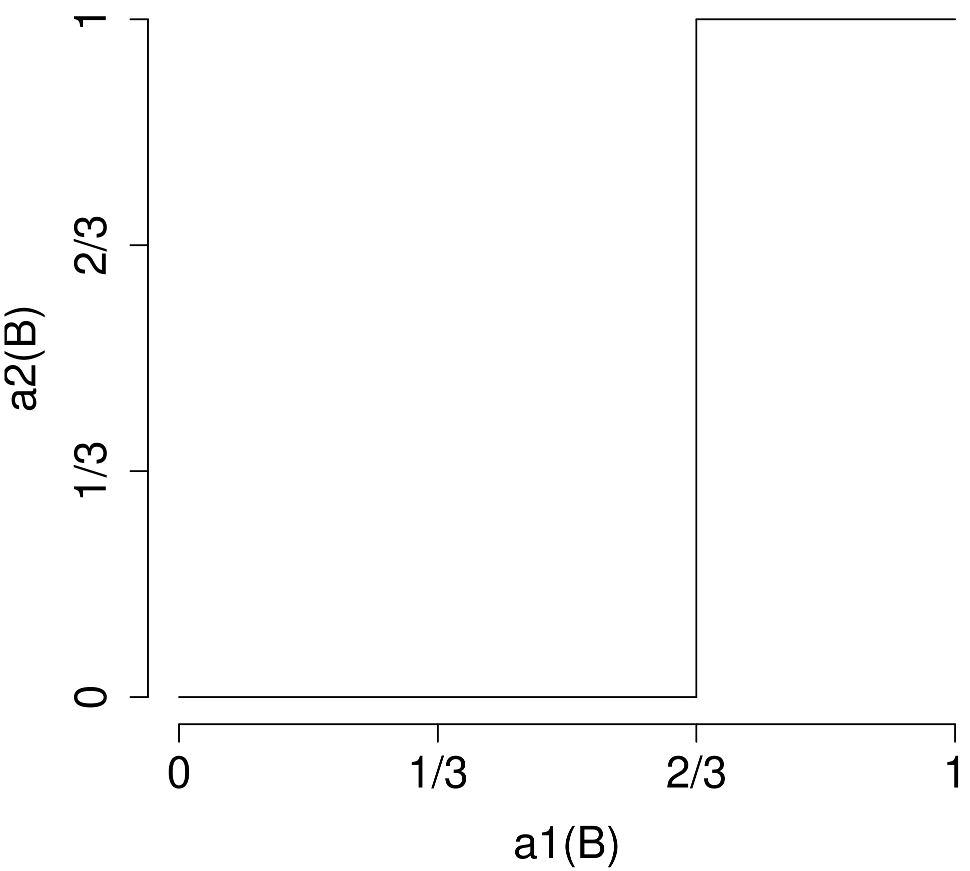
Complete Best Response Graph for Player 2



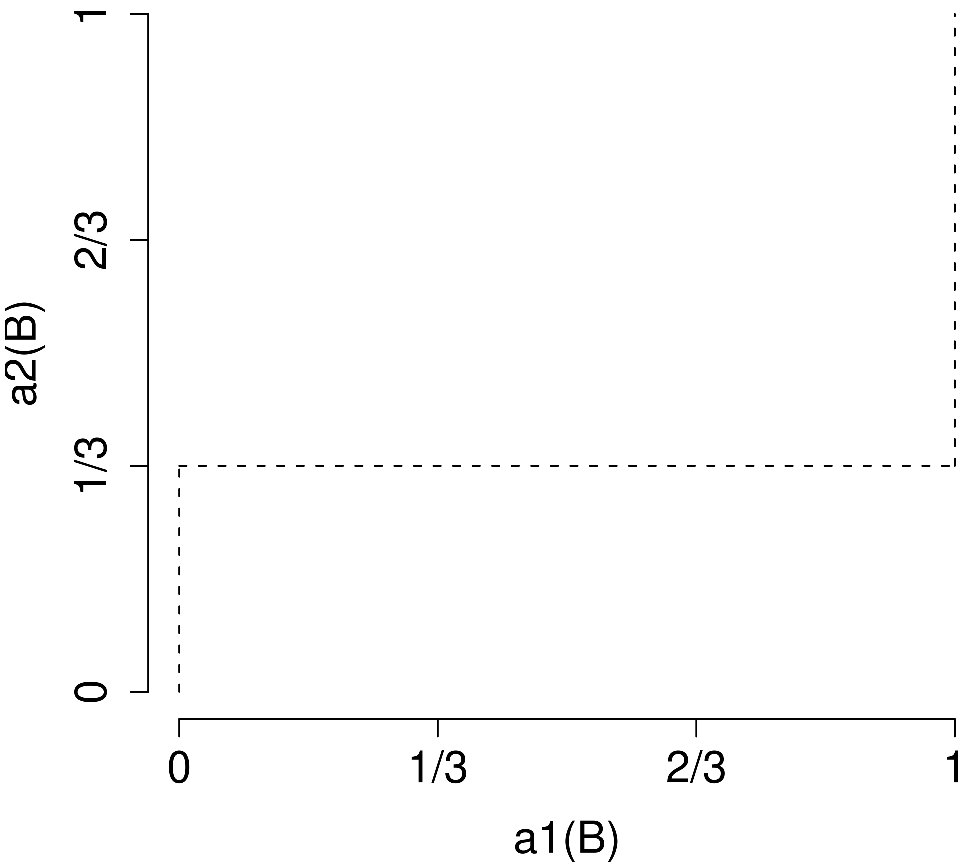
Complete Best Response Graph for Player 2

$$U_2(B \mid a_1 = (1/2, 1/2)) < U_2(C \mid a_1 = (1/2, 1/2))$$

$$1 * (1/2) + 0 * (1/2) < 0 * (1/2) + 2 * (1/2)$$



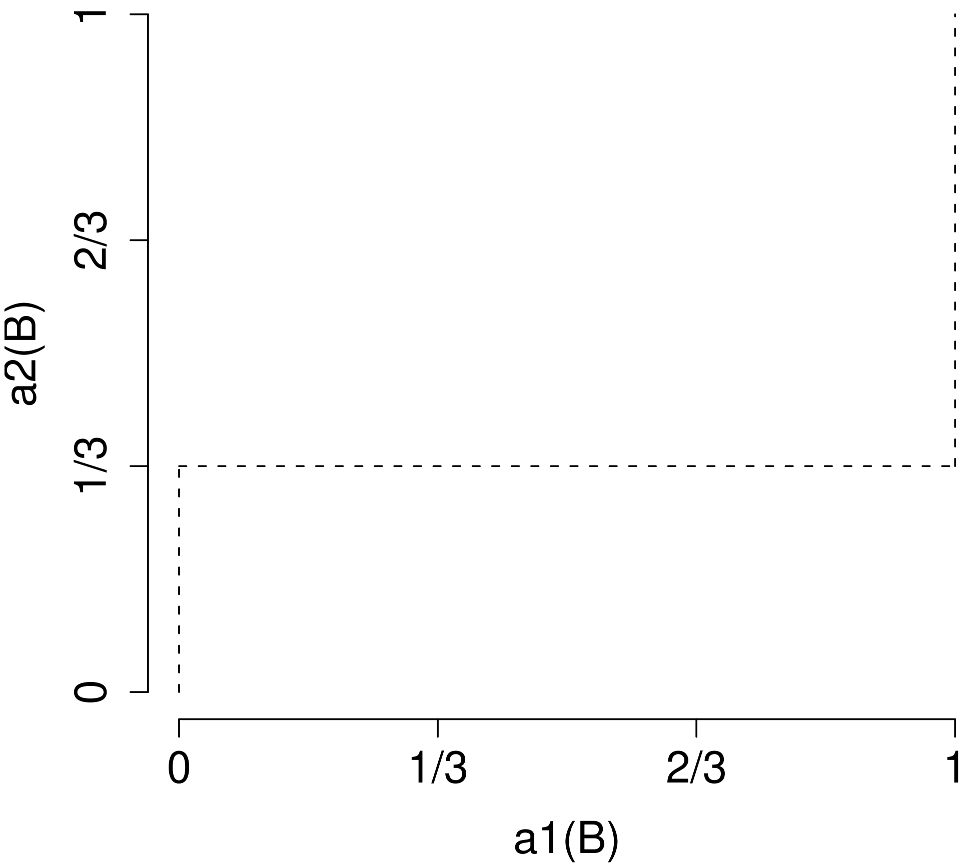
Complete Best Response Graph for Player 1



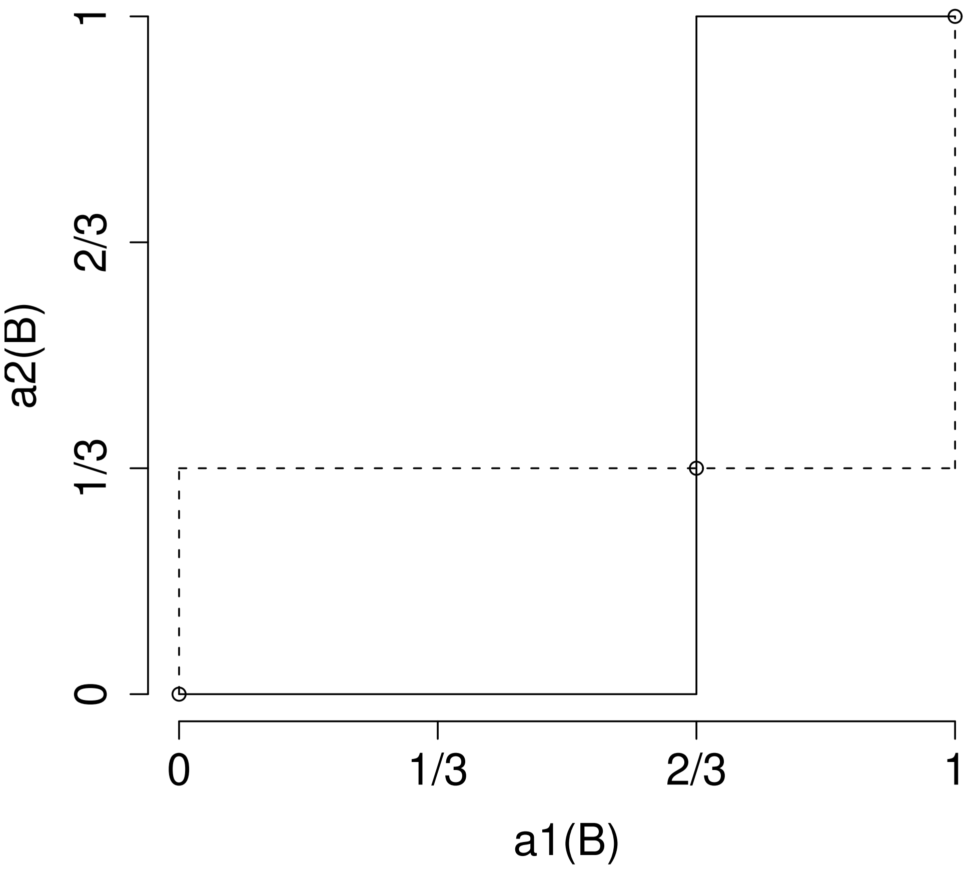
Complete Best Response Graph for Player 1

$$U_1(B \mid a_2 = (1/2, 1/2)) > U_1(C \mid a_2 = (1/2, 1/2))$$

$$2 * (1/2) + 0 * (1/2) > 0 * (1/2) + 1 * (1/2)$$



Full BoS Best Response Correspondence

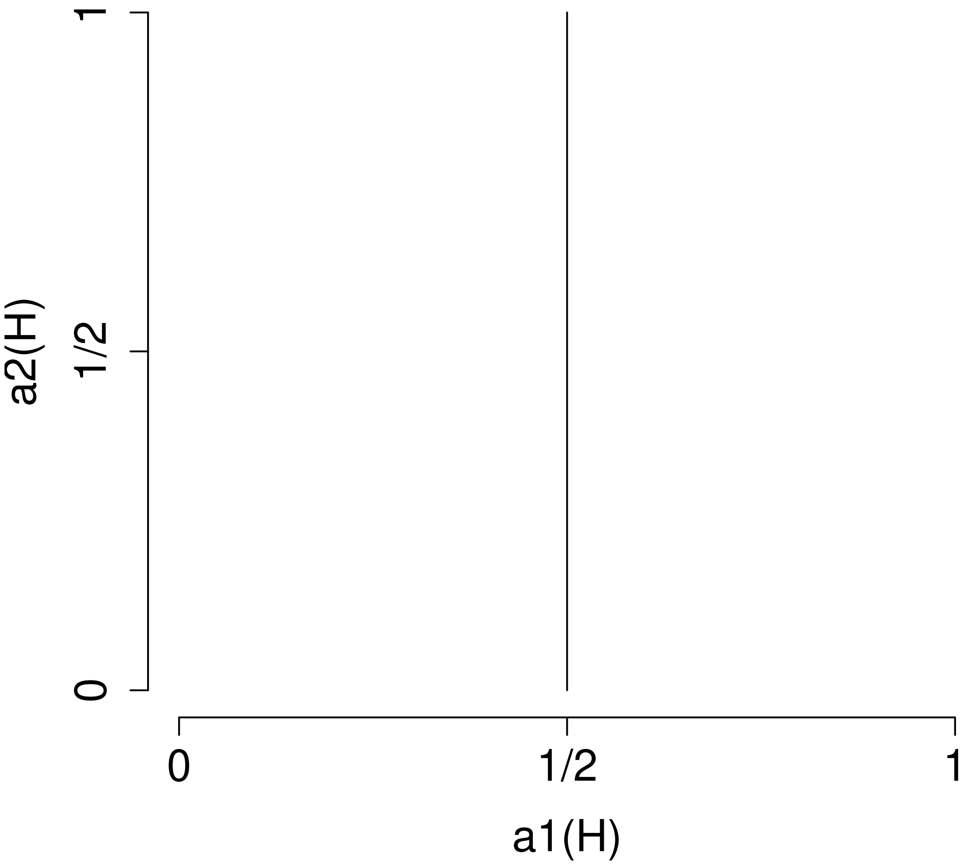


Matching Pennies

	$Head$	$Tail$
$Head$	$1,-1$	$-1,1$
$Tail$	$-1,1$	$1,-1$

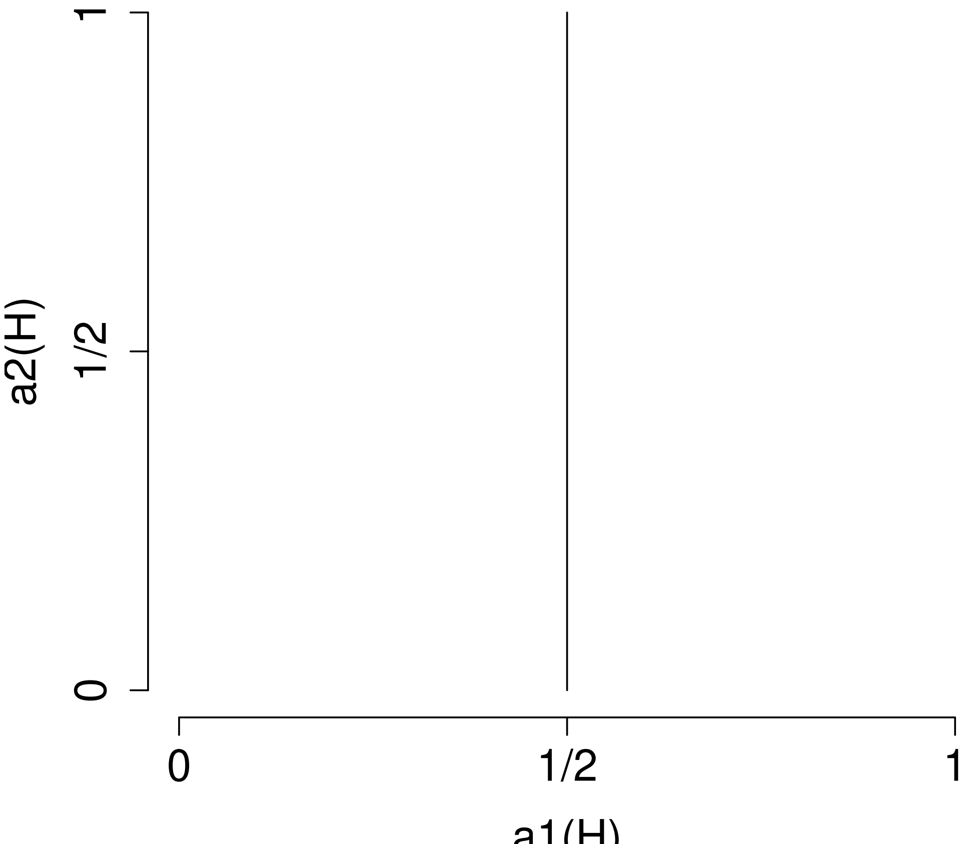
- **consider the best-response correspondence**

Player 2's Response to $a_1(H) = 1/2$

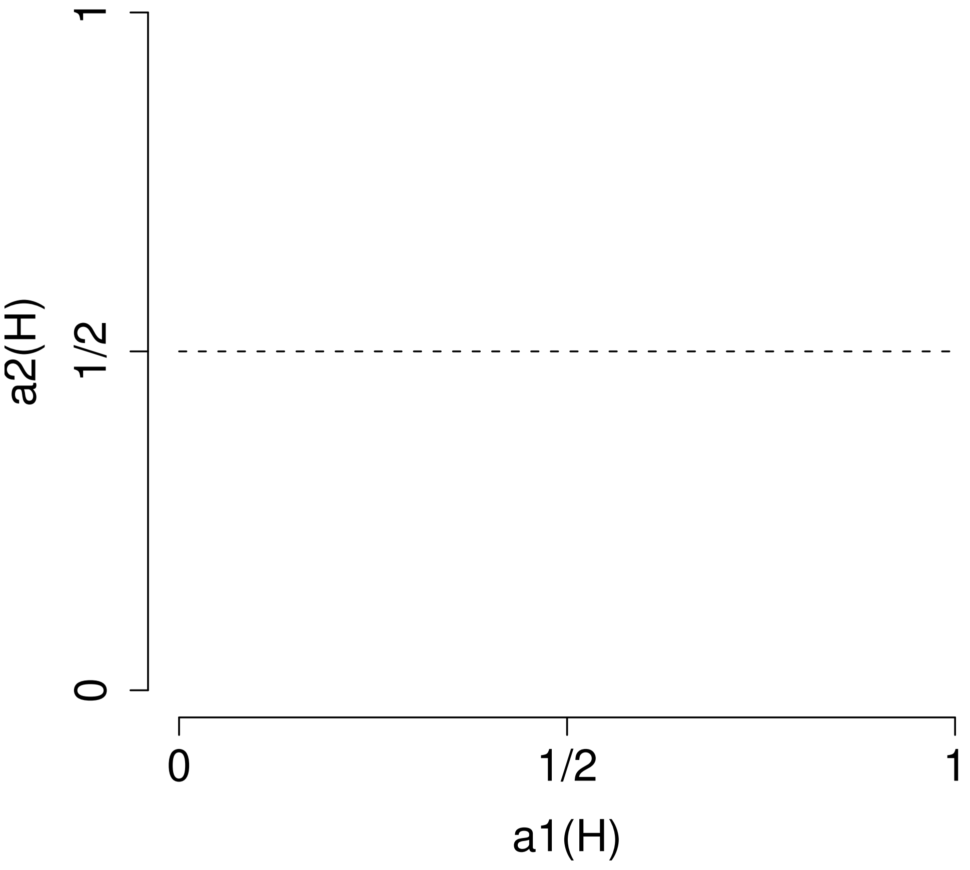


Player 2's Response to $a_1(H) = 1/2$

$$U_2(H \mid a_1 = (1/2, 1/2)) = U_2(T \mid a_1 = (1/2, 1/2))$$
$$-1 * (1/2) + 1 * (1/2) = 1 * (1/2) - 1 * (1/2)$$



Player 1's Response to $a_2(H) = 1/2$



Player 1's Response to $a_2(H) = 1/2$

$$U_1(H \mid a_2 = (1/2, 1/2)) = U_1(T \mid a_2 = (1/2, 1/2))$$
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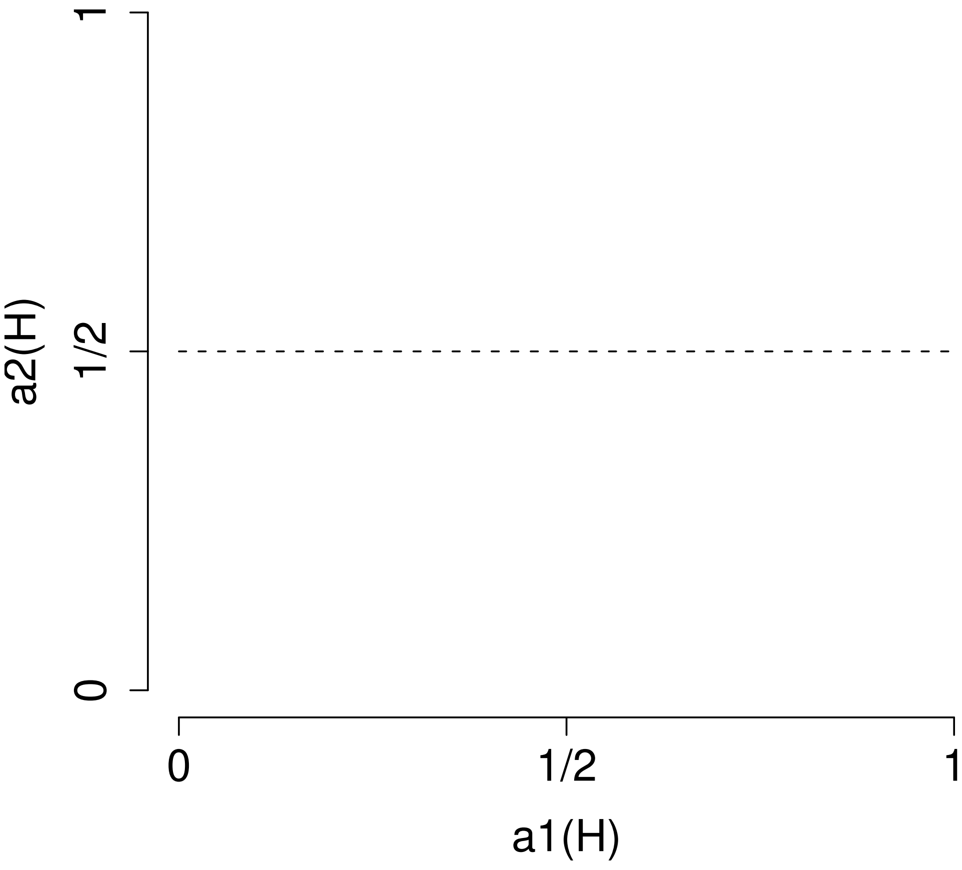
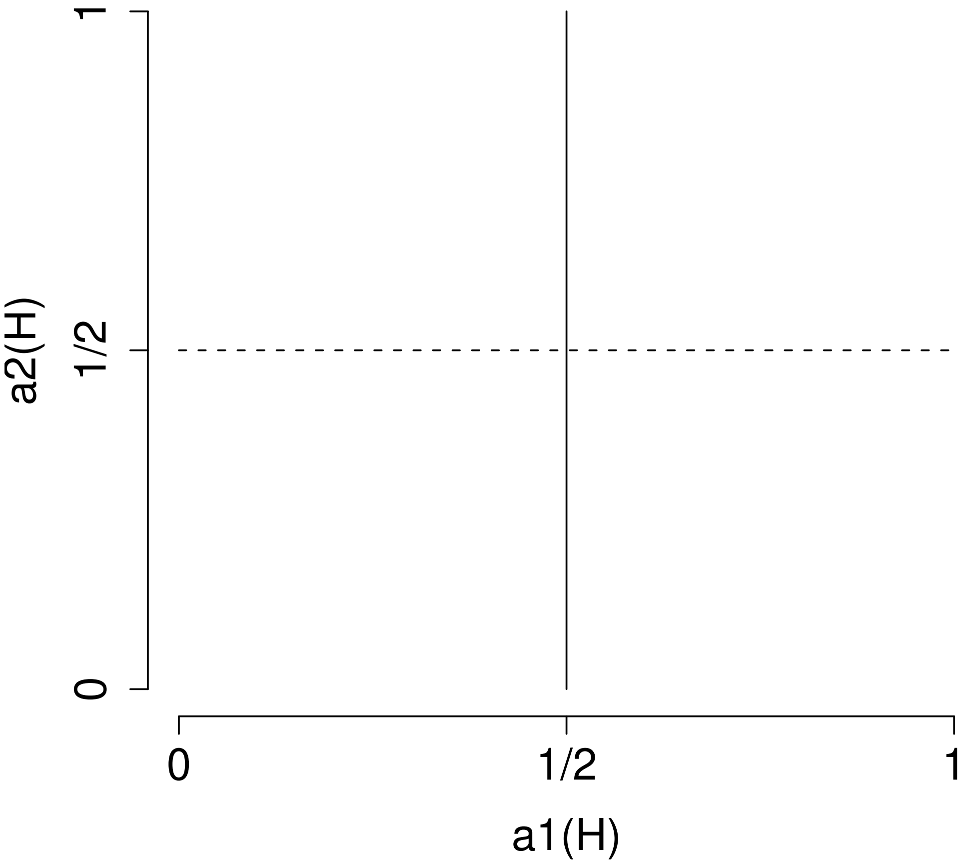
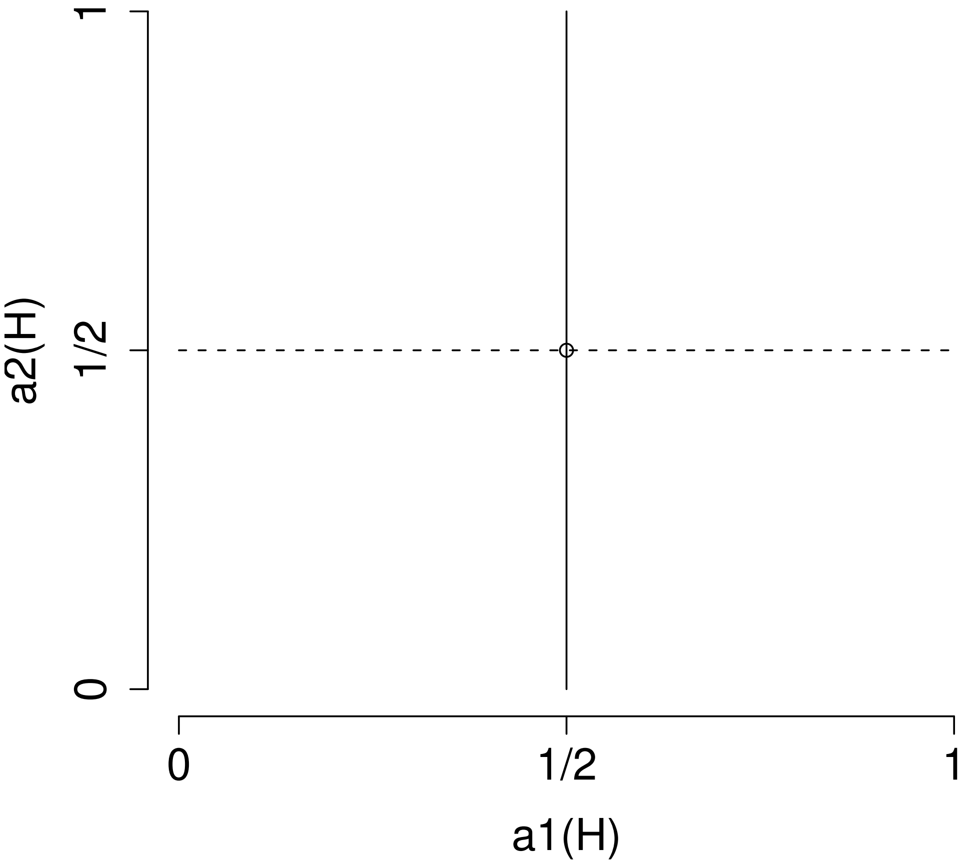


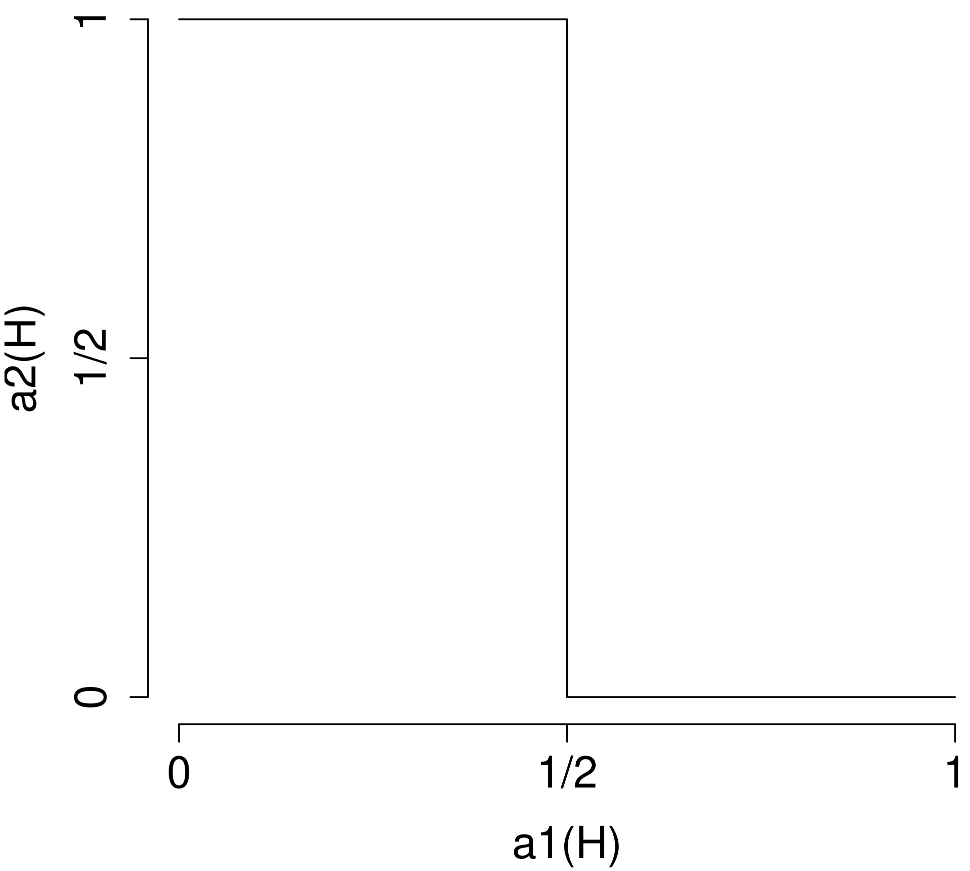
Coincidence of those Best Responses



Matching Pennies Mixed Strategy Equilibrium

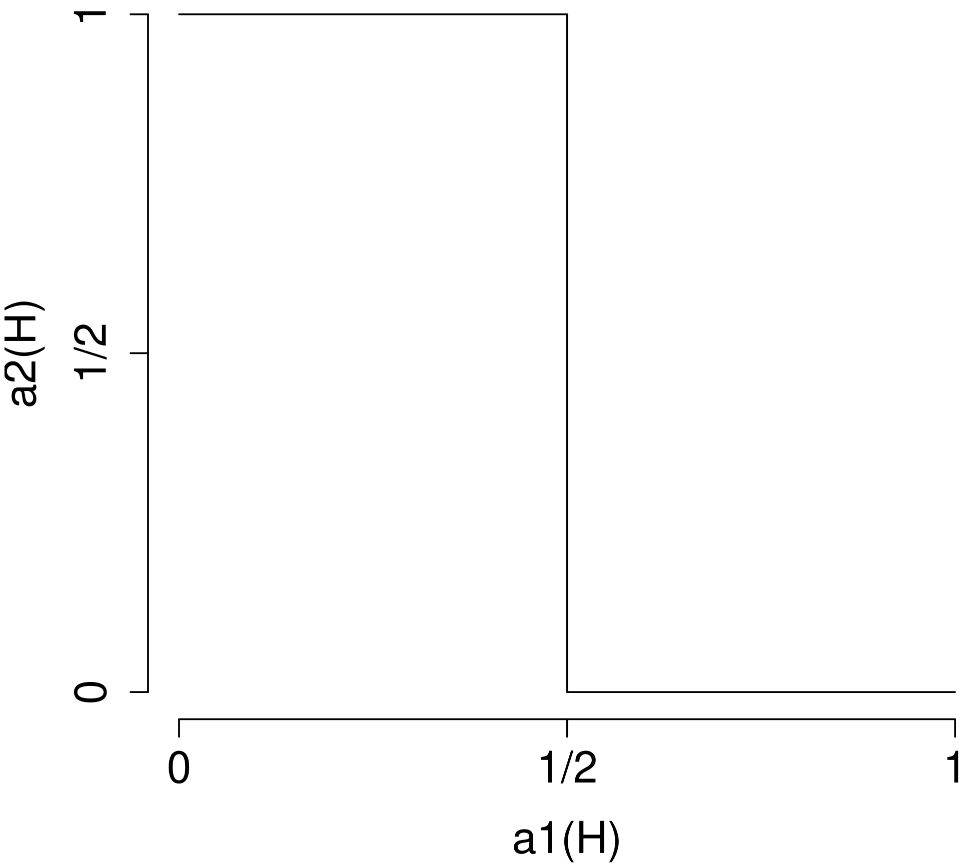


Complete Best Response Graph for Player 2

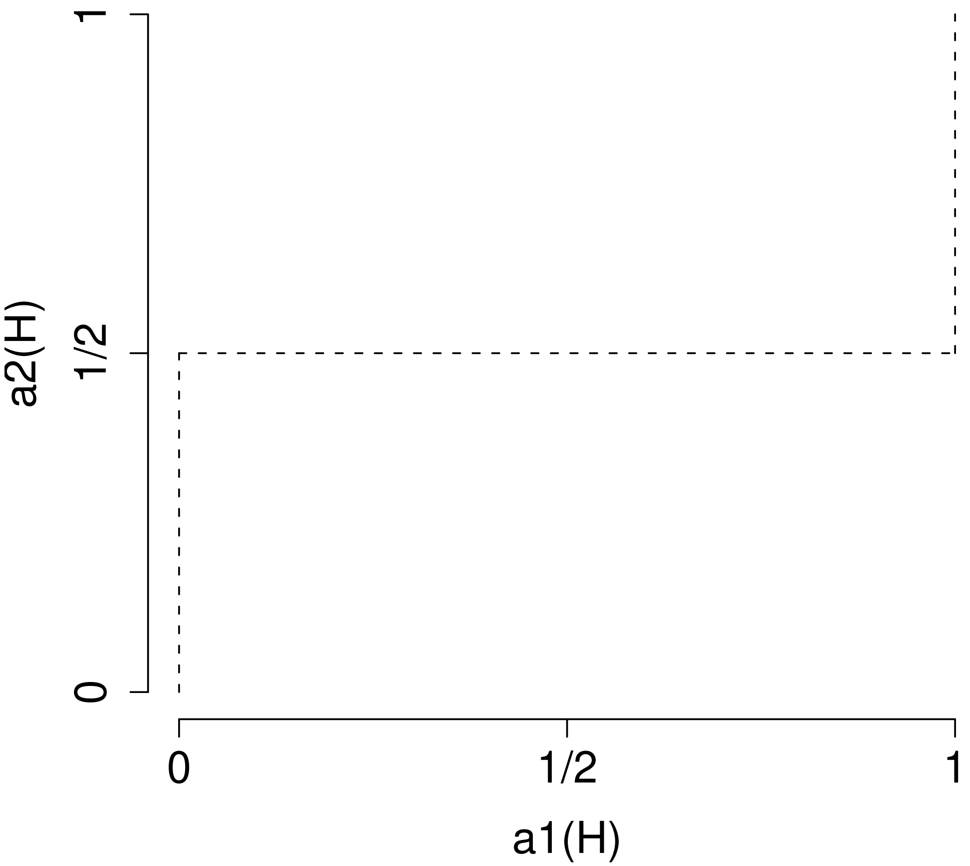


Complete Best Response Graph for Player 2

$$U_2(H \mid a_1 = (1/3, 2/3)) > U_2(T \mid a_1 = (1/3, 2/3))$$
$$-1 * (1/3) + 1 * (2/3) > 1 * (1/3) - 1 * (2/3)$$



Complete Best Response Graph for Player 1



Complete Best Response Graph for Player 1

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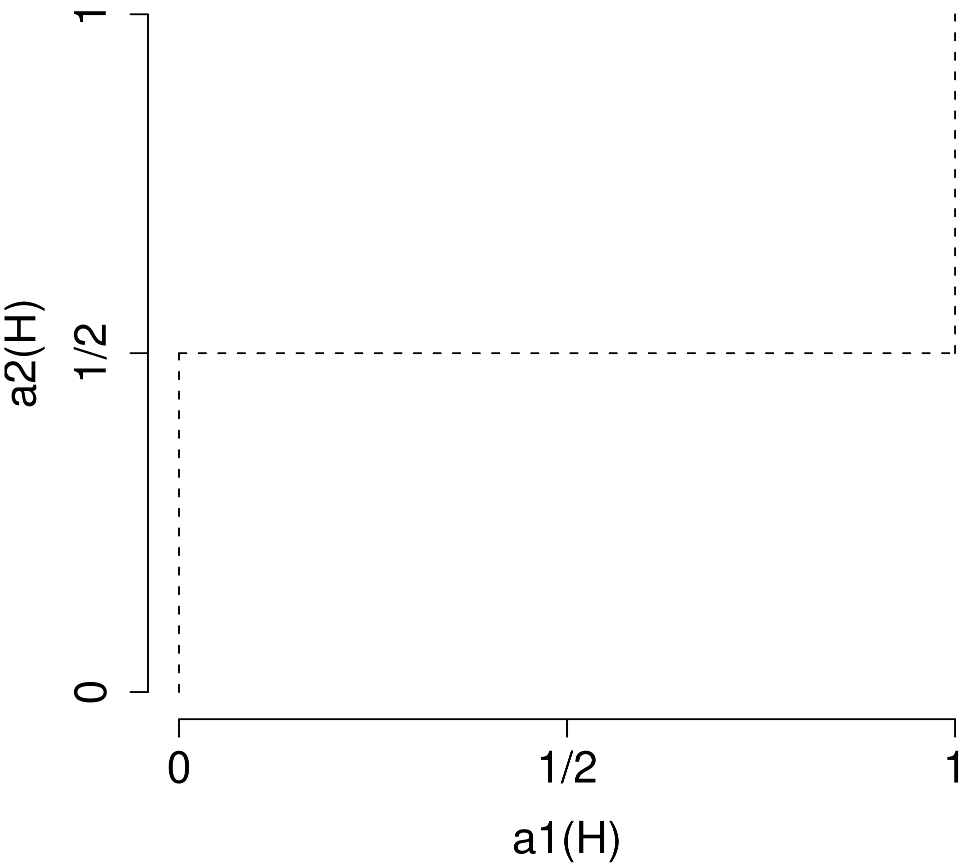
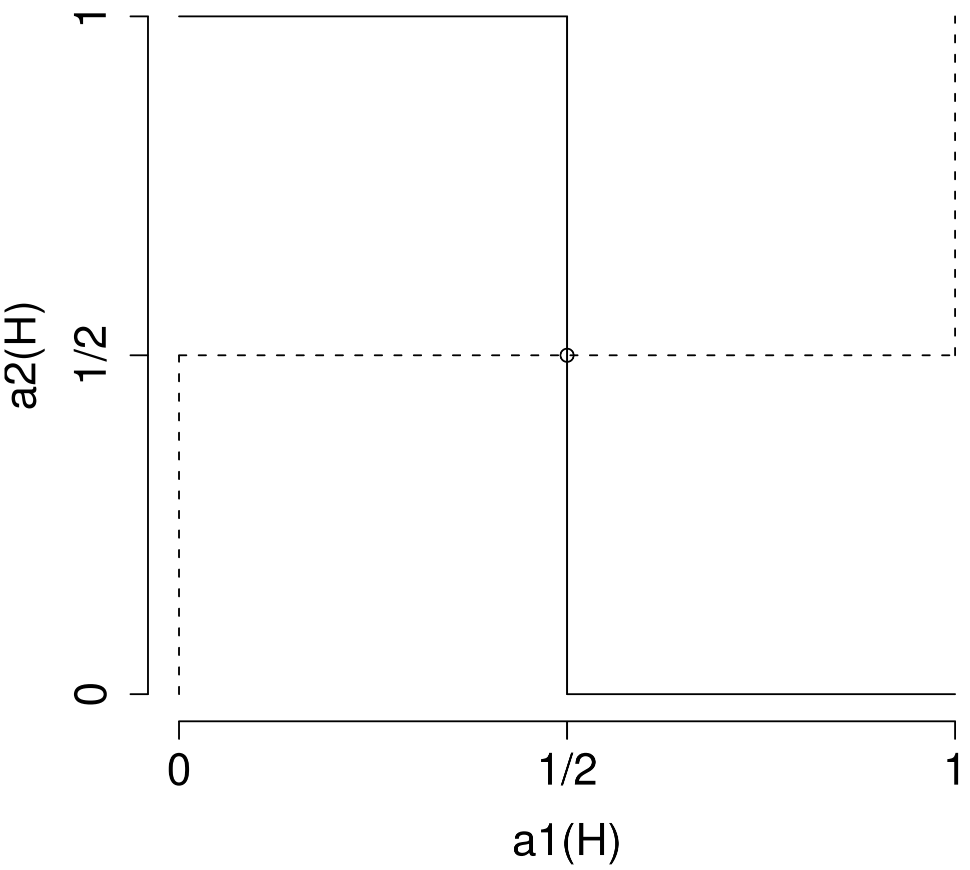


Full Matching Pennies Best Response Correspondence



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- **a belief μ_j of player j is a function that assigns a probability to every possible combination of the other players' actions**

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  - **every player has a belief μ_j that puts positive probability only on the actions in the other players' sets Z_{-j} and that puts positive probability on all such actions**
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- **rationalizability represents the idea that every player thinks every other player is rational**
- **actions that have positive probability in a Nash equilibrium are rationalizable**

Which Strategies are Rationalizable for Each Player?

	b_1	b_2	b_3	b_4
a_1	$0,7$	$2,5$	$7,0$	$0,1$
a_2	$5,2$	$3,3$	$5,2$	$0,1$
a_3	$7,0$	$2,5$	$0,7$	$0,1$
a_4	$0,0$	$0,-2$	$0,0$	$10,-1$

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a_4	$0, 0$	$0, -2$	$0, 0$	$10, -1$

(a_2, b_2)**:** a_2 **is a best response to** $\mu_2 = (0, 1, 0, 0)$ **and** b_2 **is a best response to** $\mu_1 = (0, 1, 0, 0)$

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(a_2, b_2): a_2 is a best response to $\mu_2 = (0, 1, 0, 0)$ and b_2 is a best response to $\mu_1 = (0, 1, 0, 0)$

a_1 is a best response to b_3, b_3 is a best response to a_3, a_3 is a best reponse to b_1, and b_1 is a best reponse to a_1

so a_1 is rationalizable if P1 believes that P2 believes that P1 believes that P2 believes that P1 plays a_1 (degenerate beliefs)

a_4 is a best response to b_4, but b_4 is never a best response

Iterated Elimination of Strictly Dominated Strategies

	L	R
T	$3, 0$	$0, 1$
M	$0, 0$	$3, 1$
B	$1, 1$	$1, 0$

Iterated Elimination of Strictly Dominated Strategies

	L	R
T	$3,0$	$0,1$
M	$0,0$	$3,1$
B	$1,1$	$1,0$

$U_1(B \mid L) < U_1((1/2, 1/2, 0) \mid L)$ **and**
$U_1(B \mid R) < U_1((1/2, 1/2, 0) \mid R)$

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	L	R
T	$3,0$	$0,1$
M	$0,0$	$3,1$

$U_2(L \mid T) < U_2(R \mid T)$ **and** $U_2(L \mid M) < U_2(R \mid M)$

Iterated Elimination of Weakly Dominated Strategies

	L	R
T	$1, 1$	$0, 0$
M	$1, 1$	$2, 1$
B	$0, 0$	$2, 1$

Iterated Elimination of Weakly Dominated Strategies

	L	R
T	$1, 1$	$0, 0$
M	$1, 1$	$2, 1$
B	$0, 0$	$2, 1$

- **outcome depends on the order in which strategies are eliminated**
  - **eliminate T first, then L, and the outcome has player 2 choosing R with payoffs $(2, 1)$**

Iterated Elimination of Weakly Dominated Strategies

	L	R
T	$1,1$	$0,0$
M	$1,1$	$2,1$
B	$0,0$	$2,1$

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  - **eliminate T first, then L, and the outcome has player 2 choosing R with payoffs $(2,1)$**
  - **eliminate B first, then R, and the outcome has player 2 choosing L with payoffs $(1,1)$**

- **trembling hand equilibrium redux**

o be filled in

- **strategic voting in electoral systems**
- **examples of electoral system features**
  - **districts and district magnitude (M)**
  - **presidents versus parliaments**
  - **proportional representation (PR)**
    * **with quotas (e.g., Hare: $Q = V/M$)**
    * **with averages (divisor methods) (e.g., d'Hondt: $a_i(t) = v_i/(s_i(t) + 1)$)**
  - **party lists**
  - **runoffs (dual ballots)**

- examples of voting rules
  - majority rule
  - plurality voting with one winner (winner take all, first past the post)
  - plurality voting with $M > 1$
  - approval voting
  - Borda count
  - utilitarian systems

- **examples of voting rules**
  - **majority rule**
  - **plurality voting with one winner (winner take all, first past the post)**
  - **plurality voting with $M > 1$**
  - **approval voting**
  - **Borda count**
  - **utilitarian systems**
- **there is extensive theory for single districts, little for whole systems**

- **Duverger's Law: electoral systems cause party systems**
  - **plurality voting (with $M = 1$) favors a two-party system**
  - **PR favors a multiparty system**
- **motivated by strategic voting (voters) and coalition formation (elites)**

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  - **plurality voting (with $M = 1$) favors a two-party system**
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- **motivated by strategic voting (voters) and coalition formation (elites)**
- **generalizing Duverger's Law for $M > 1$**
  - **the $M + 1$ rule**
  - **non-Duvergerian outcomes: parties finishing below the $M + 1$-th place get equal numbers of votes greater than zero**
  - **leads to the bimodality hypothesis, which Cox tests using the SF ratio: $v_{M+2}/v_{M+1} = 0$ or , $v_{M+2}/v_{M+1} = 1$**

- **strategic voting under plurality voting (Cox)**
- **preferences: von Neumann-Morgenstern utilities** $u_i = (u_{i1}, \ldots, u_{iK})'$**,** $\max(u_i) = 1$**,** $\min(u_i) = 0$
- **beliefs:** $F_i = F$ **(common knowledge)**
- **expectations: proportions** $\pi_i = (\pi_{i1}, \ldots, \pi_{iK})'$
- **publicly generated expectations:** $\pi_i = \pi$
- **vote to maximize expected utility** $\sum_{k=1}^{K} \pi_{ik} u_{ik}$

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- **publicly generated expectations:** $\pi_i = \pi$
- **vote to maximize expected utility** $\sum_{k=1}^{K} \pi_{ik} u_{ik}$
- **rational expectations condition: if given beliefs** F **everyone votes optimally in light of** π**, the result is expected vote shares that equal** π

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- **preferences: von Neumann-Morgenstern utilities** $u_i = (u_{i1}, \ldots, u_{iK})'$**,** $\max(u_i) = 1$**,** $\min(u_i) = 0$
- **beliefs:** $F_i = F$ **(common knowledge)**
- **expectations: proportions** $\pi_i = (\pi_{i1}, \ldots, \pi_{iK})'$
- **publicly generated expectations:** $\pi_i = \pi$
- **vote to maximize expected utility** $\sum_{k=1}^{K} \pi_{ik} u_{ik}$
- **rational expectations condition: if given beliefs** F **everyone votes optimally in light of** π**, the result is expected vote shares that equal** π
- **Theorem 1: If** $0 < \pi_j < \pi_{M+1}$ **for** $j > M+1$**, then** π **is not a limit of rational expectations**
- **Corollary: If** π **is a limit of rational expectations, then** $\pi \in \{0, \pi_{M+1}\}$ **for all** $j > M+1$

- **Duverger's Law, the $M + 1$ rule and other strategic voting: examples (using $>$ to denote P_i), find the rational expectations Nash equilibrium vote distributions**

  $1/8 \quad A > B > C$

  $4/8 \quad B > C > A$

  $3/8 \quad A > C > B$

- **simple plurality**
  - **(**A**,** $1/2$**;** B**,** $1/2$**;** C**,** 0**)**
  - **(**A**,** $1/2$**;** B**,** 0**;** C**,** $1/2$**)**
- **plurality with** $M = 2$
- **two-stage with plurality** $M = 2$ **in first stage**
- **Borda count**
  - **consider coalition-proof refinement to Nash equilibrium**

- **Duverger's Law, the $M+1$ rule and other strategic voting: examples (using $>$ to denote P_i)**

  $1/8 \quad A > B > C > D$

  $2/8 \quad B > C > D > A$

  $2/8 \quad D > B > C > A$

  $1/8 \quad A > C > D > B$

  $2/8 \quad D > A > C > B$

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- **plurality with** $M = 2$

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- **parties may help solve coordination dilemmas**
  - **electoral (party-in-elections)**
  - **legislative (party-in-government)**
  - **one role for activists: high intensity or high resource people who work or spend to promote focal points**
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- **parties may help deploy resources efficiently**
  - **information about policies and candidates (cheap for voters and candidates)**

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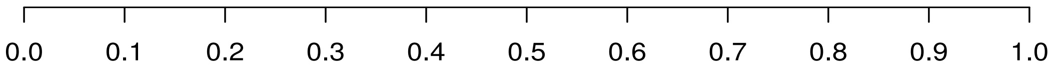
voting model example



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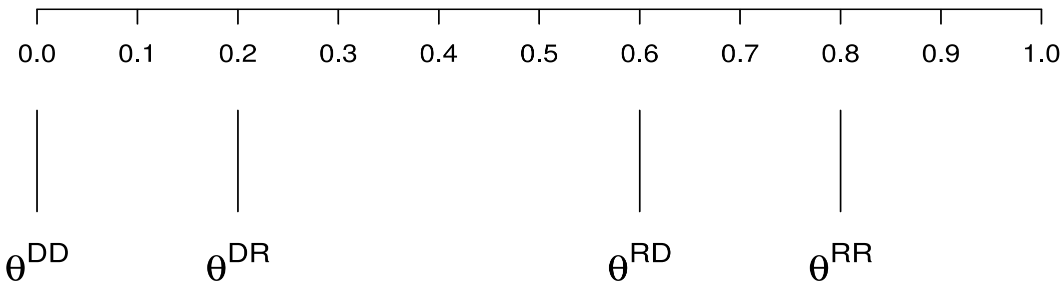

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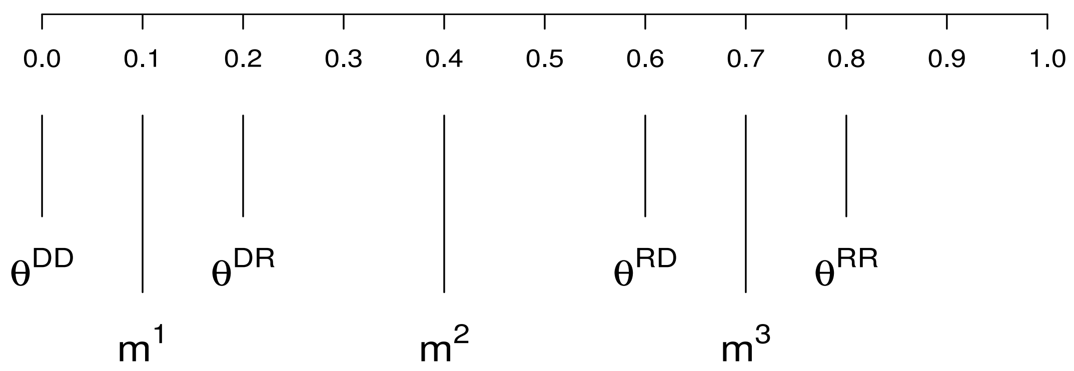

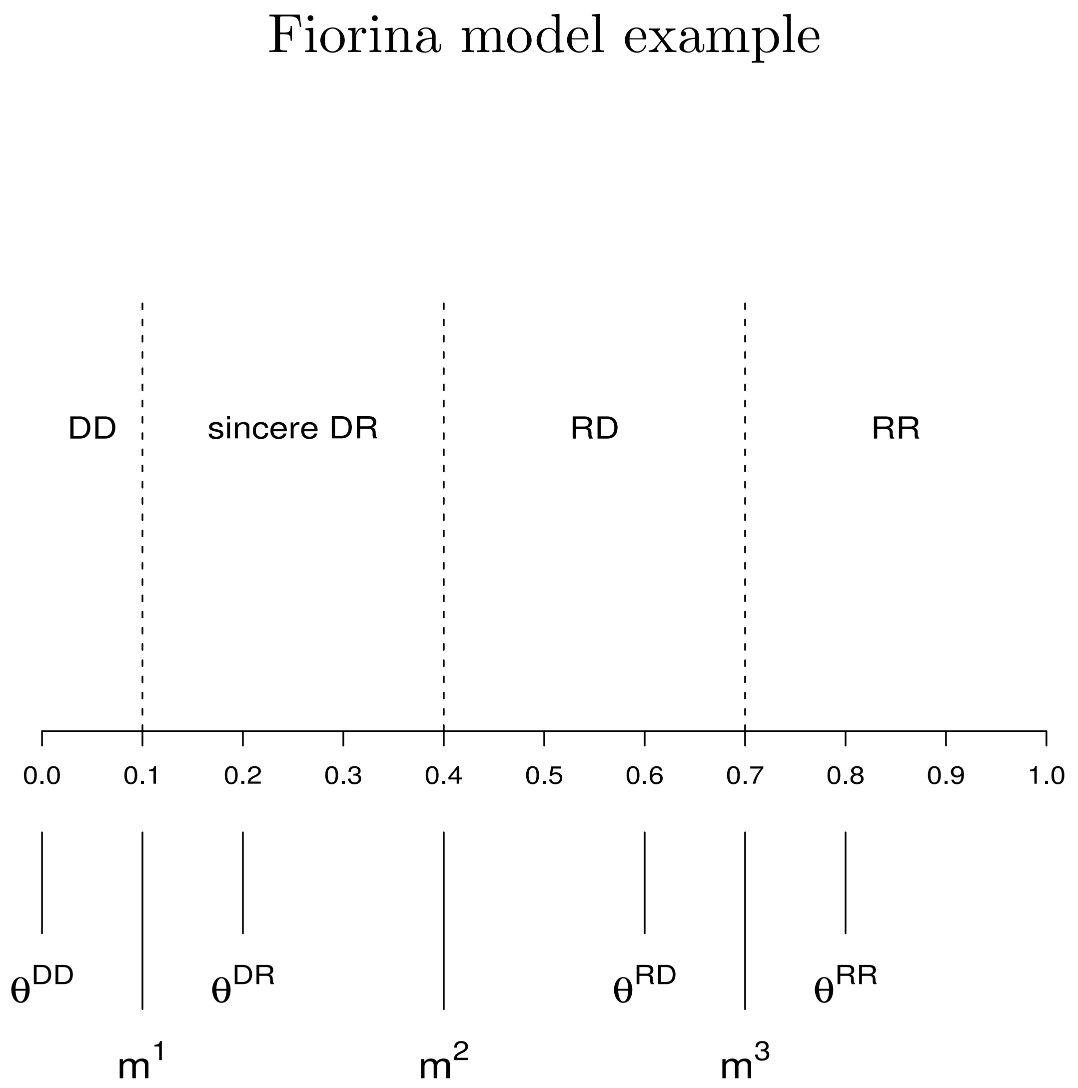
Fiorina model example
DD
sincere DR
RD
RR
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
θDD
θDR
θRD
θRR
m1
m2
m3

- models of institutional balancing
- a president and a legislature (treated as unicameral)
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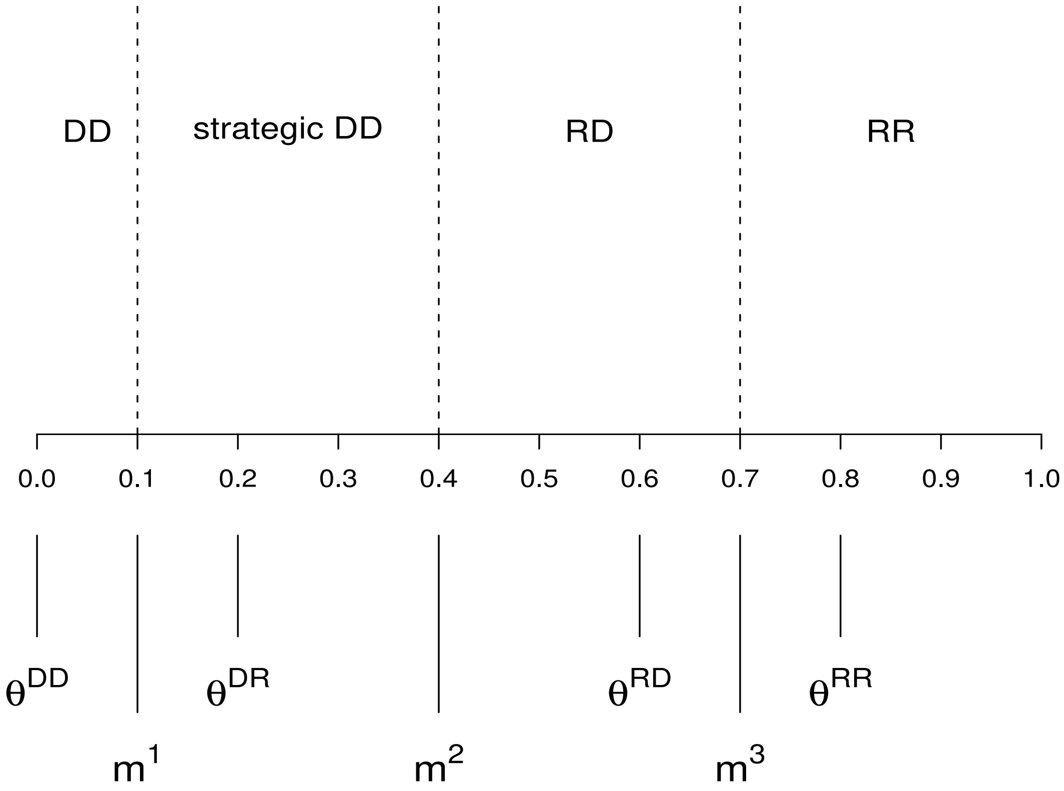
  - Fiorina's model with strategic voting: voters choose the closest policy, taking into account how others will vote

strategic model example



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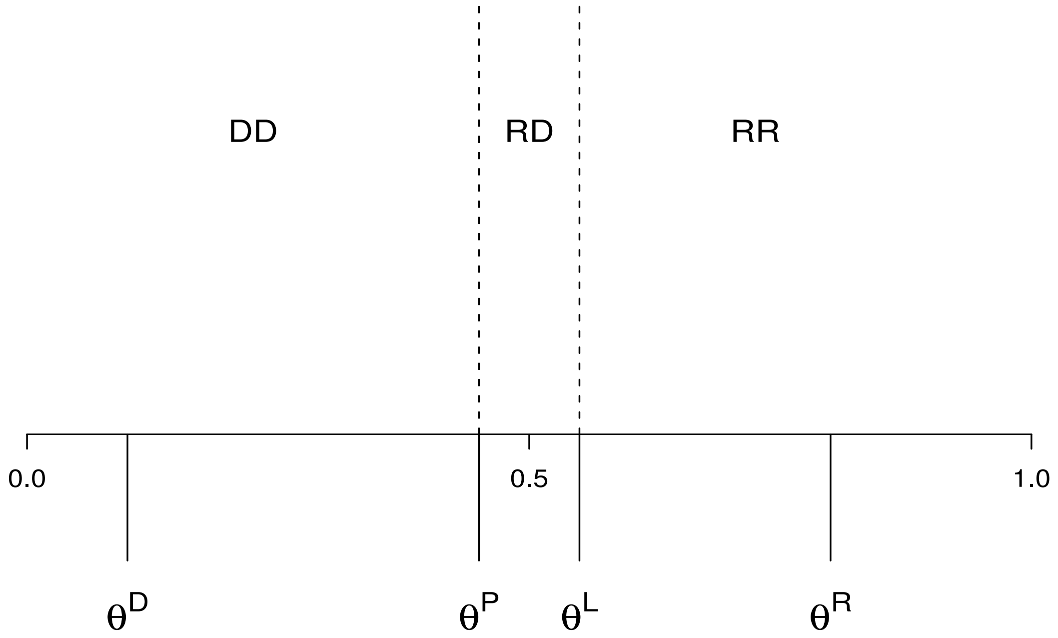
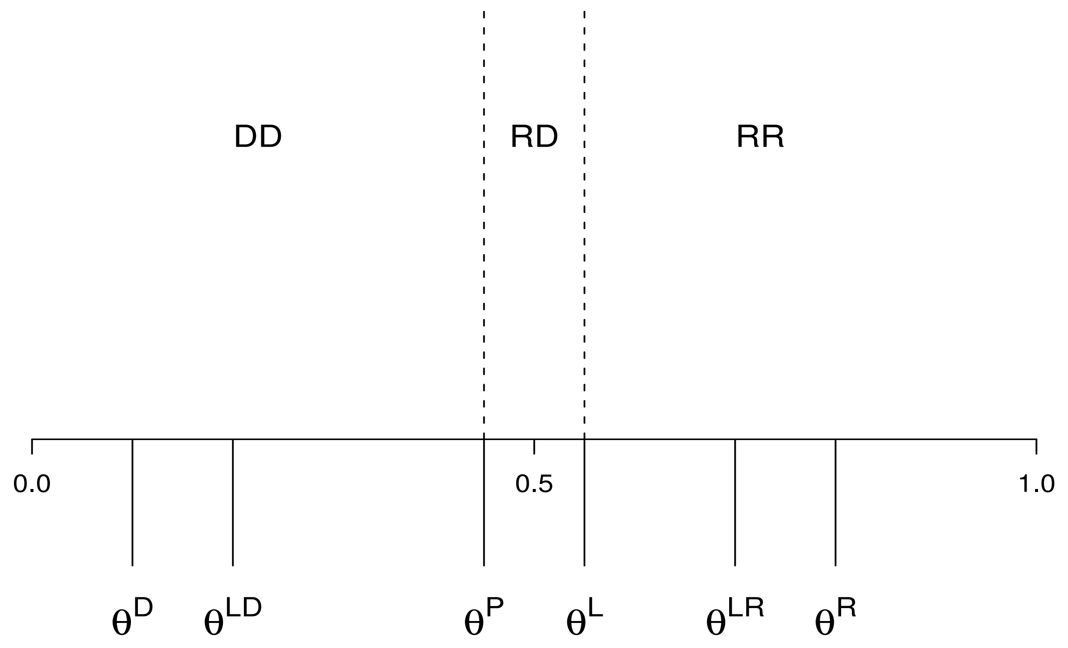
- **ticket splits go only one way**

Alesina-Rosenthal model: presidential year, uncertain



A-R model: pres. year with post-election policies



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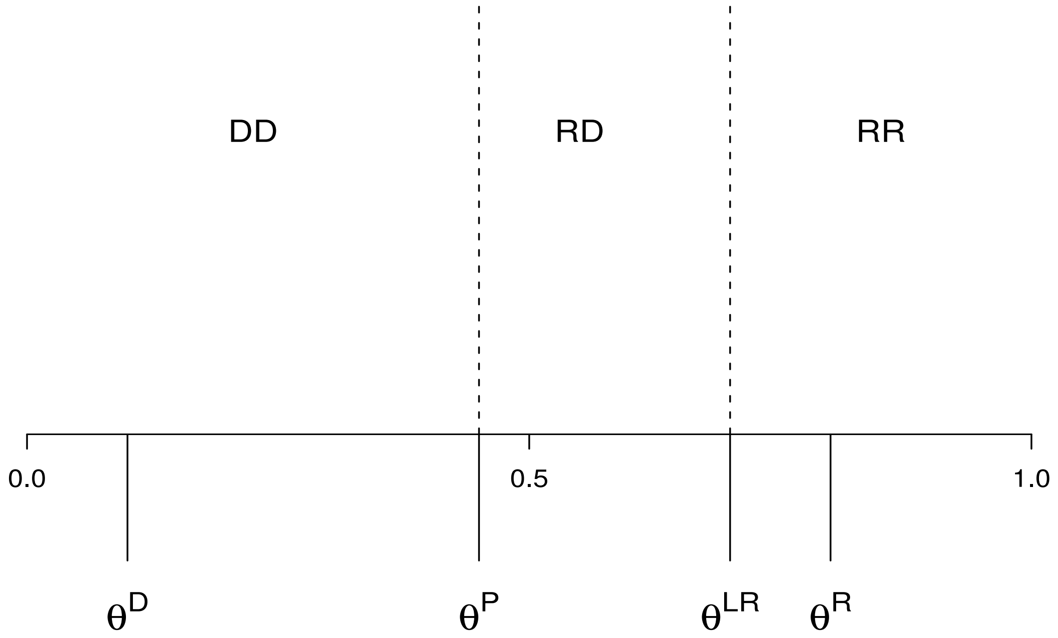

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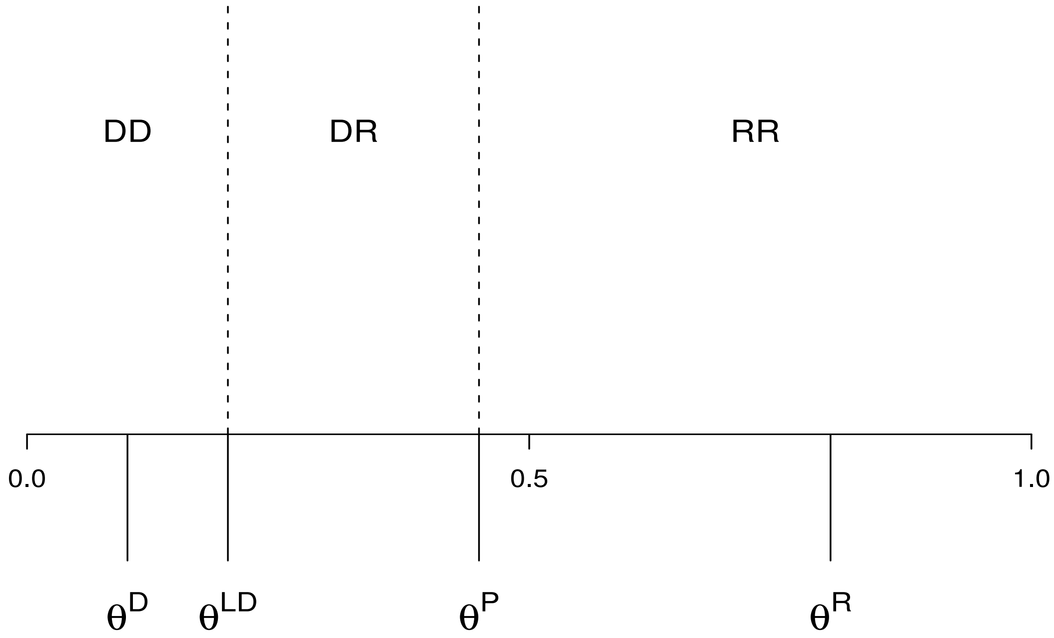
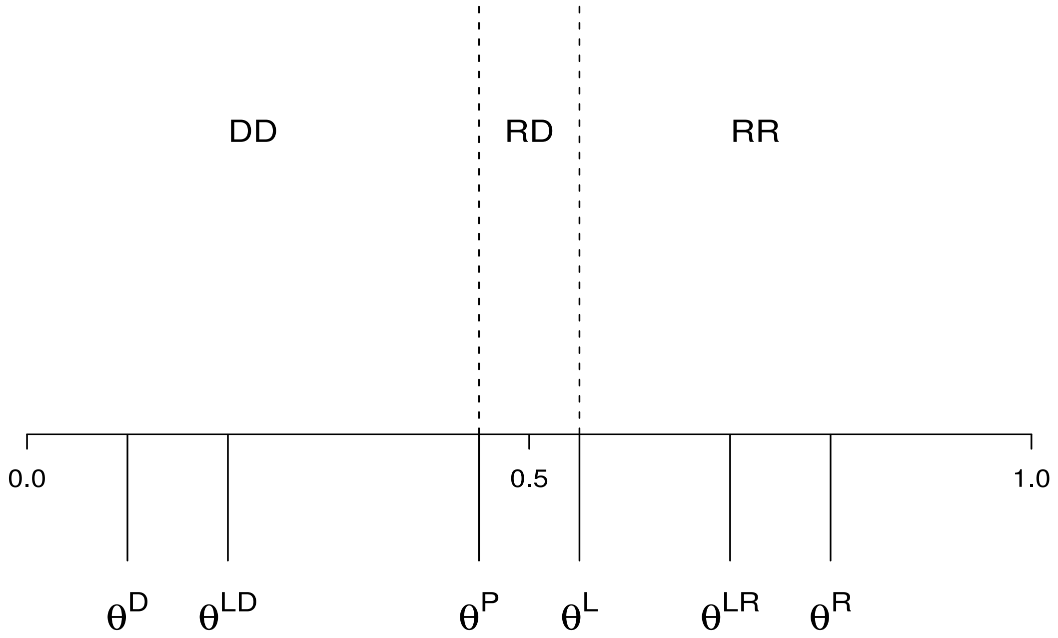
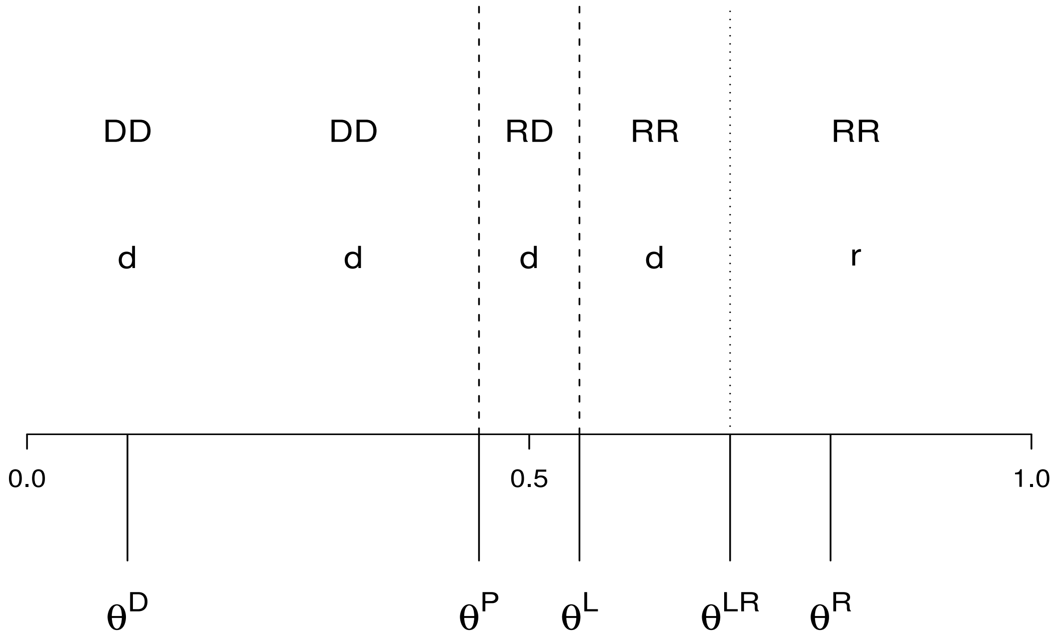


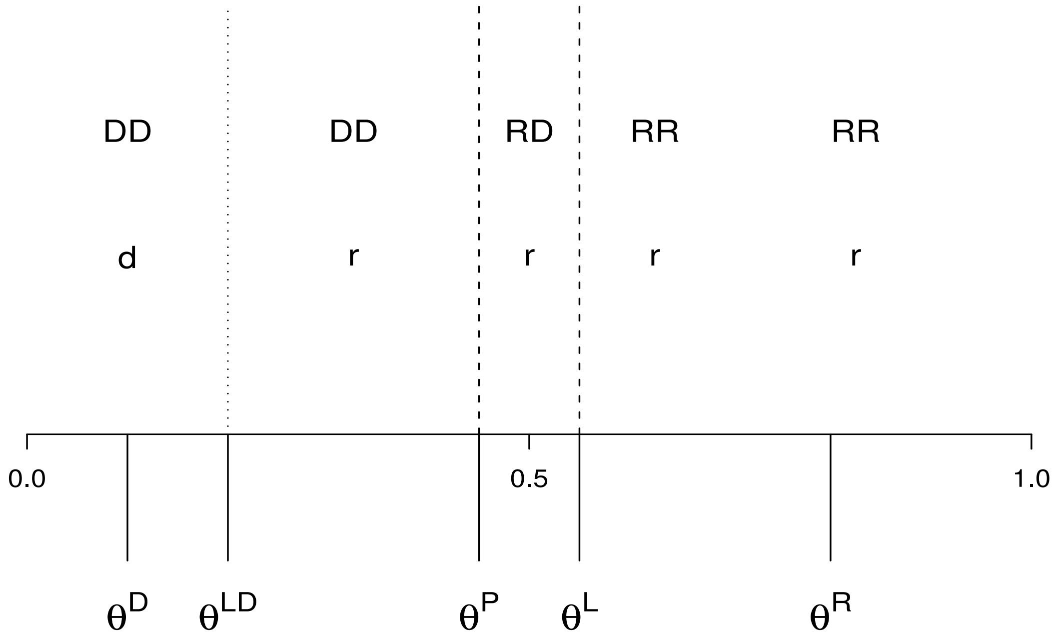
A-R model: pres. year, post-election policies



A-R model: midterm with Republican president



A-R model: midterm with Democratic president



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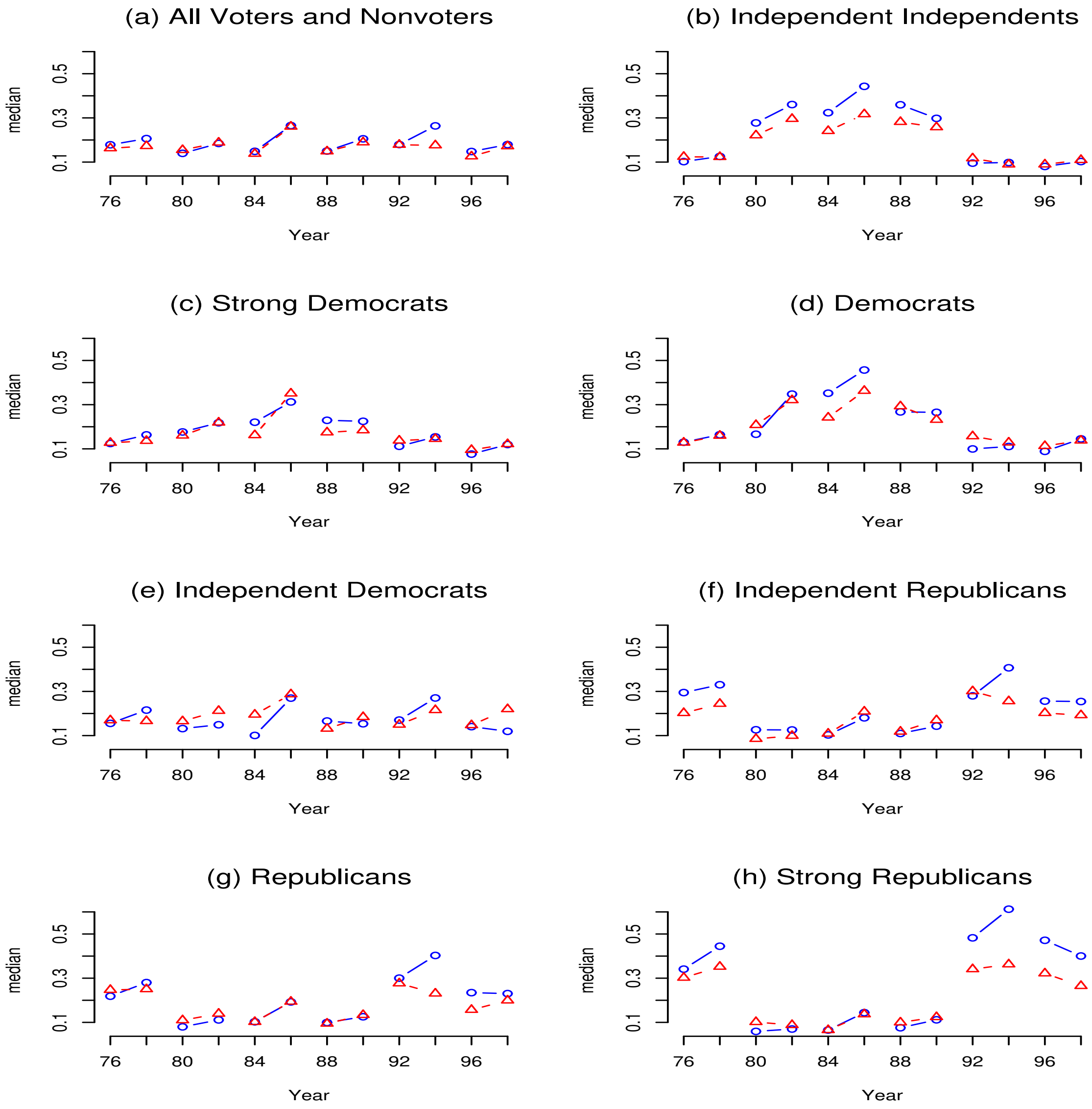
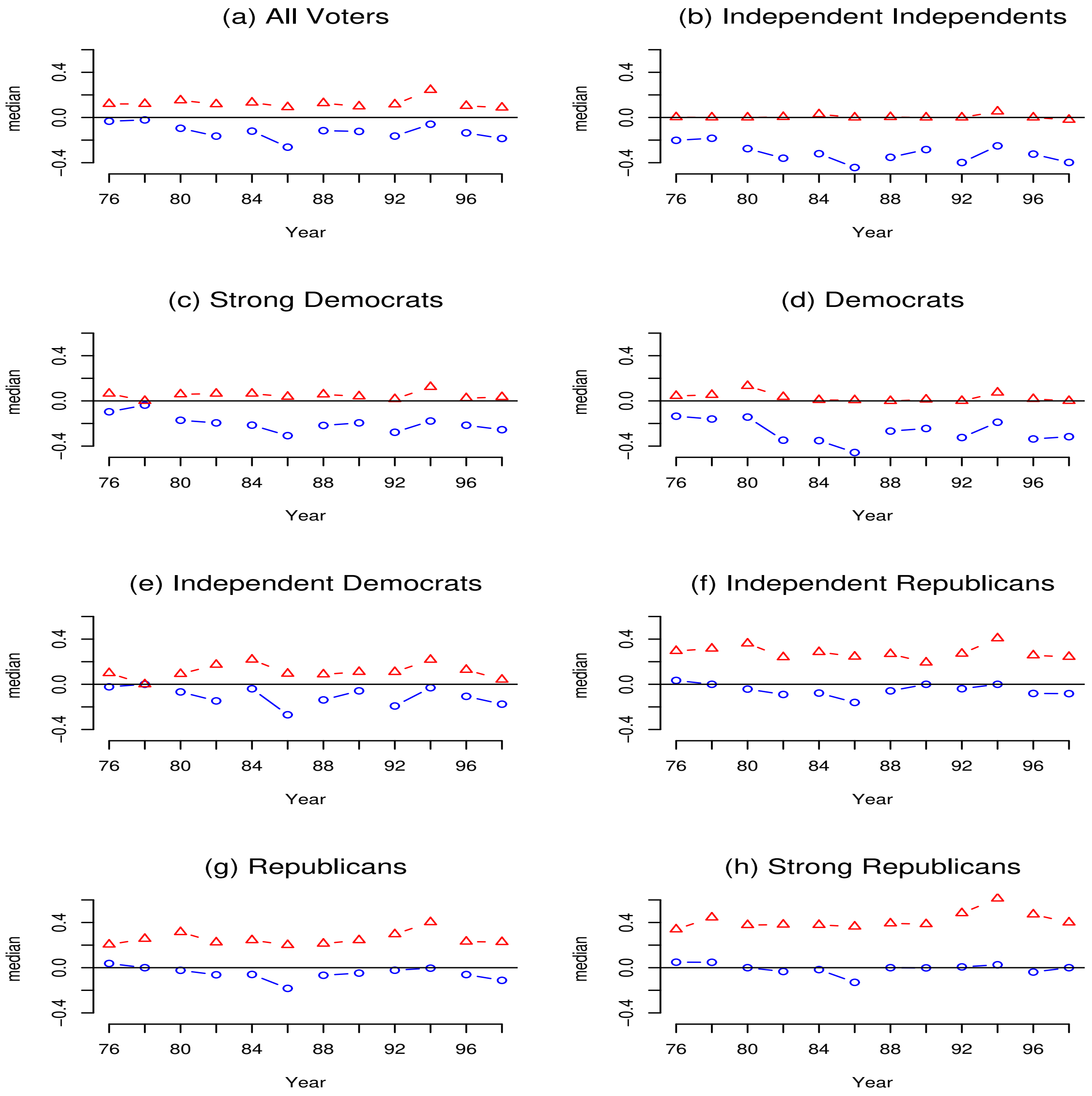
  - **Stimson's data going back to 1960 (and earlier)**
  - **NES data going back to 1976**

Median Absolute Difference, Self versus Winner's Party



Median Signed Difference, Self versus Both Parties



- **coordinating voting: how?**
  - **parties and party signaling**
  - **networks of voters**
  - **imitation**