

**STUDY OF THE INFLUENCE OF THE VOTERS' POLITICAL
CULTURE ON VOTE DECISION THROUGH THE SIMULATION OF
A POLITICAL COMPETITION PROBLEM IN SPAIN**

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De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

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Study of the influence of the voters' political culture on vote decision through the simulation of a political competition problem in Spain

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Abstract

This work analyses the interest in some kind of opinion surveys concerning the political competition that gather quantitative information about the preferences of the voters. This interest has been shown after the implementation of a localization algorithm developed with Computational Geometry techniques. The algorithm tries to solve the following problem: We consider two political parties and we are looking for the best position of one of them, inside some margins marked by its political flexibility, that allows it to get the biggest number of voters.

The possible influence of these considerations are shown in the simulation of some data partially based on the survey of Public Opinion and Fiscal Politics, study nº 2615 (July 2005) of the CIS (Sociological Investigations Center of Spain).

Keywords: Political Competition, Elections, Opinion Surveys, Economic Modelling, Computational Geometry, Computer Simulation.

1. Introduction

Many statistical works exist for the study of the intention of the citizens' vote. In that line we can highlight the opinion surveys in political and fiscal topics related with the taxes, considerations that the society receives for the payment of taxes, operation of the public services, the fiscal fraud, the politicians' valuation, ... However, there is a hole regarding quantitative surveys in relation to these topics.

In this work we want to show, through a concrete example, the influence that some kind of quantitative information could have in the adoption of political strategies for the elections. And how more information and bigger economic and politics culture of the citizenship would have notorious effects on the vote decision and the electoral results.

In order to carry out the development of a concrete study, we base on a theoretical model, previously developed by the authors and based on techniques of Computational Geometry (Abellanas et al 2005). This model is the established in works of political competition with some variation:

The points of a plane, that we will call plane of policies represent the different political options about two different topics. We assume that the distance between the points will give an idea of the affinity of the policies related to such topics. Let p and q be two political parties located in the points (p_1, p_2) and (q_1, q_2) , and let (v_{i1}, v_{i2}) $i=1, \dots, n$ be the coordinates of the n points of the set that represents the n voters of a certain population. We consider that each player captures those points that are closer to him than to the other one. To count the points each player gets, we trace the perpendicular bisector of the two positions of the players. Then, each one will get the points located in the half-plane the player belongs to. The winner will be the player that gets more points (Serra & Reville, 1994; Smid, 1997; Aurenhammer & Klein, 2000; Okabe et al., 2000; Roemer, 2001).

In politics, a slight variation in the programs of the parties will be admitted in order to obtain a greater number of votes. We admit that only one party, for example the party p , relaxes its position, that is to say, it can move in a certain neighbourhood. This is the disk with centre p and radius r . We look for the best situation for p within this neighbourhood, the one that approaches it to the greatest number of voters.

In this work we develop an algorithm of search for this best position. It is created from geometric ideas, and with Computational Geometry techniques adapted to the problem. (Abellanas et al 2005, Preparata & Shamos 1985). There exists a wide range of location papers related with this kind of problems, in the international literature (Eiselt et al., 1993, Ghosh and Harche, 1993). The new scope of this paper consists in the consideration of neighborhoods for the location of the players, and on the discrete treatment. The algorithm generated is implemented in this paper for the first time, and allows to study the influence of the strategies adopted by the parties in the voters decision, focused in two topics whose importance is detected through the opinion surveys. We want to note that we do not consider these topics as decisive in the global result of the election, but they can be of enough importance (transcendence) to deserve a political study (analysis) by the parties.

2. The opinion surveys

There are many surveys and statistical studies in great number of topics that entities like the CIS (Center of Sociological Investigations), the INE (National Institute of Statistic) or the CEACS (Center of Advanced Studies in Social Sciences), among others, are carrying out all through the years in Spain

As an example of surveys and information that one can have nowadays on the contents we are interested in, we consider the opinion and fiscal policy survey nº 2616 of the

CIS. With its results, on the one hand, we will simulate the remaining information that is necessary for the development of the work that we present, on the other hand, we will show the necessities of another kind of studies and the lack of citizens' information and preparation in certain areas.

2.1. Public opinion and politics fiscal survey n° 2616 of the CIS

Technical data:

- Place of distribution: Spain
- Universe notes: Population over 18 years.
- Size of file: Designed: 2500 respondents. Featured: 2483 respondents.
- Geography Terms: 167 municipalities and 47 provinces.
- Methodology Notes: Random selection of sample by random routes.
- Data were collected by questionnaires in a face- to-face interview.
- For a confidence level of 95,5%, MoE (Margin of error) $\pm 2.0\%$ for the sample set (we suppose simple random sampling).
- Dates of Production: From 1 to 13 of July, 2005.
- It includes questions like this:

Opinion related to the demand degree of the citizens to the different public services. Considerations that the citizen receives for the payment of taxes. Evaluation of the quantity of resources that the State dedicates to the diverse public services. Opinion about the necessity of the taxes increase for the improvement of the services. Valuation of the quantity of taxes that the Spaniards pay. Justice in the distribution of the payment of taxes, ...

All these questions are answered through the possibilities: nothing, little, quite or a lot.

3. The algorithm and the simulation

3.1. A graphic approximation to the algorithm

The algorithm that we use for the resolution of the problem presented in section 1 has been created starting from the following graphic ideas:

1.- An optimum situation for p , is always found on the boundary of the neighbourhood, and it is in the arc of the circumference located between the two points of tangent lines from q to the circumference (visible part of the neighbourhood of p from q). This is because if we consider a point of the inner part of the neighbourhood, p' and we trace the perpendicular bisector corresponding to p' and q , then, any point located on the segment that joins p' and q would have its bisector parallel to the previous, that is to say, if the point p approaches the boundary, its Voronoi region (half-plane) will be greater and will contain the previous (Okabe, A. et al, 2000). As a consequence, it is possible to capture more points. Figure 1

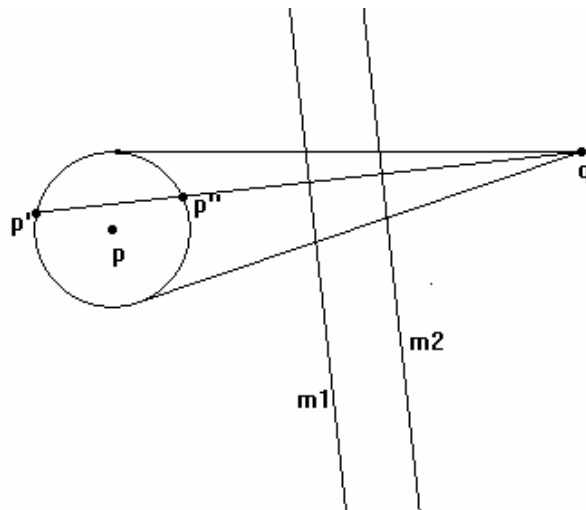


Figure 1: Zone where the optimal situation for p is located

2.- It is based on the localization of intersections of circumferences. On the one hand, we have the circumference centred in p that indicates the environment of flexibility for the corresponding political party; on the other hand, for each voter: v_i , we trace the circumference centred in this point that goes through q . In the intersection zone the first party captures v_i , since in any point p of this zone, the distance between v_i and p is shorter than the distance between v_i and q . Figure 2.

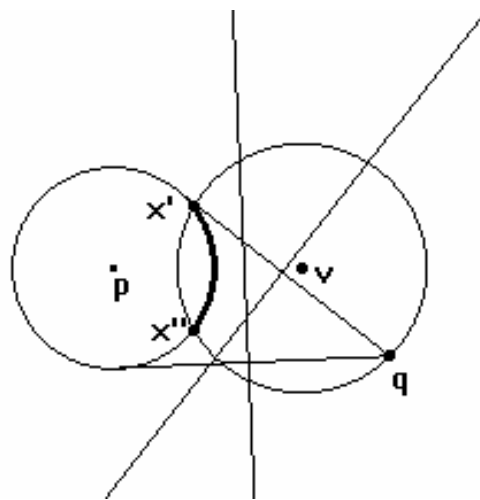


Figure 2: Captation zone for p of the point v

The best area for p inside the environment will be in the arc of maximum intersection of the previous intersection zones inside the visible part (Abellanas et al, 2005).

The development of the algorithm is included in Appendix A. The program is freely available asking authors.

3.2. Simulation with an example of the national politics (Spain)

Following the presented competition model, the idea is to simulate some data partially based on the results obtained in the survey of the CIS (section 2.1) that allow us to

develop the search for the best policies of a party in relation to two specific topics and to evaluate which would be the benefits of having this information previously. This survey serves us as a statistic and numeric guide for the generation of the data: the number of interviewed or the answers to questions such as the evaluation of the quantity of resources that the State dedicates to certain services, allow us to work with data fitting reality, for the simulation of the problem at national level.

We propose to add previous surveys questions like:

- 1.- Choose the two services that you consider high-priority of the following list: Education, Public Works, Defence, Health, Housing, Justice, Work and Social Matters, Transport and Communications, Environment.
- 2.- Knowing that the current Government dedicated the following percentages from the total expense to these services in 2005, tell me: what percentage would you dedicate to the same ones?
- 3.- Would it affect to your vote decision to know in advance how much money the political parties would dedicate to each of the services? If so, what margin of difference with the quantity that you want to dedicate would you admit to the party that you would vote?

Questions like these allow us to choose two important topics for the citizens with quantitative information of their opinions and with effects about their possible vote decision.

We choose as policies to evaluate the investment in education and health and we generate the answers to the questions 1, 2 and 3 randomly using the real percentages of the answers in the CIS survey previously mentioned. The policies of the parties faced have been taken as:

- q the PP (Partido Popular) Spanish party's mean investment in education and the mean investment in health during its 8 years of government.
- p PSOE (Partido Socialista Obrero Español) Spanish party's mean investment in education and the mean investment in health during its 2 years of government.

These quantities have been extracted from the Consolidated General Government Budget (1997-2006): policies of expense (chapters 1 to 8). We have compared different government periods, with different circumstances for the two parties, because of the lack of information about quantitative data in the electoral programs of the parties in a same electoral period.

According to these values, we think about the possibility of studying how would the voter be affected by the expense policies' variation in education and health in the sense of finding, inside a margin, the appropriate policy to capture the biggest number of followers.

Remark:

As the simulation is based in real surveys, we can choose any other item that parties consider relevant for the citizens in an electoral period, such as Justice, Work, Defence,...

3.3. Algorithm implementation

The algorithm has been implemented in the computer using the C programming language. The C is a powerful programming language, of general purpose, that allows to solve problems of any scientific area in an appropriate time of execution.

Input:

- The two parties' location.

- Radius of the environment of political flexibility for a party.
- Voters location v_i , $i=1,\dots,2276$.

Output:

- Number of voters that each party always captures in any position of its neighbourhood (points v_i for which there does not exist intersection between the circumferences of the second step of section 3.1).
- Number of voters that the party that changes its politics captures by locating in the optimal region (points v_i for which there exists common intersection between the circumferences of the second step of section 3.1).
- Optimal region where the party should be located in order to capture the biggest number of voters.

3.4. Results

Following the ideas of the section 3.3, we consider

- The political plane settles down with the percentages of the expense dedicated to education and health, of the Consolidated General Government Budget for the expense policies (26 elements).
- The policy followed by the first party (PSOE) and the second party (PP) have been determined with the mean percentage dedicated to these two policies calculated from the total mean expense during the two years of PSOE party's government (years 2005, 2006) and the same for PP party (years 1997, 2004): $p=(0.6,1.4)$, $q=(1.6,8.9)$.
- The political flexibility environment is enlarging in the diverse studies.

- The voters and their preferences have been generated randomly by using the results of the CIS survey mentioned in section 3.2 (concretely with the answers to the question related to the quantity of resources that the State dedicates to the diverse public services) that became under the government of the PSOE. Then:
 - Voters that prefer more investment in education or health than the one invested by the current government.
 - Voters that agree with the investment in some of the elements
 - Voters that prefer a smaller investment in education or health.

The graphic situation of the problem is shown in figure 3.

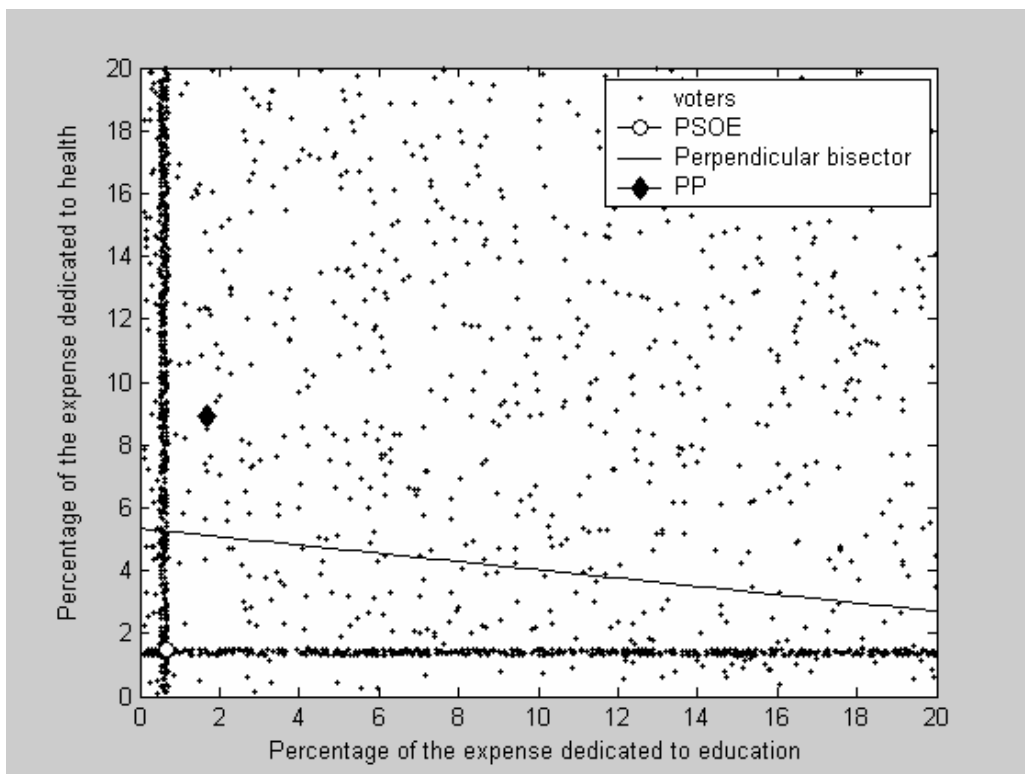


Figure 3: Graphic situation of the problem

- For the study of the variation of the results in the capture of voters, flexibility in the politics of investment of one of the parties (in the example of figure 4, of 0.8% for the party p) will be allowed.

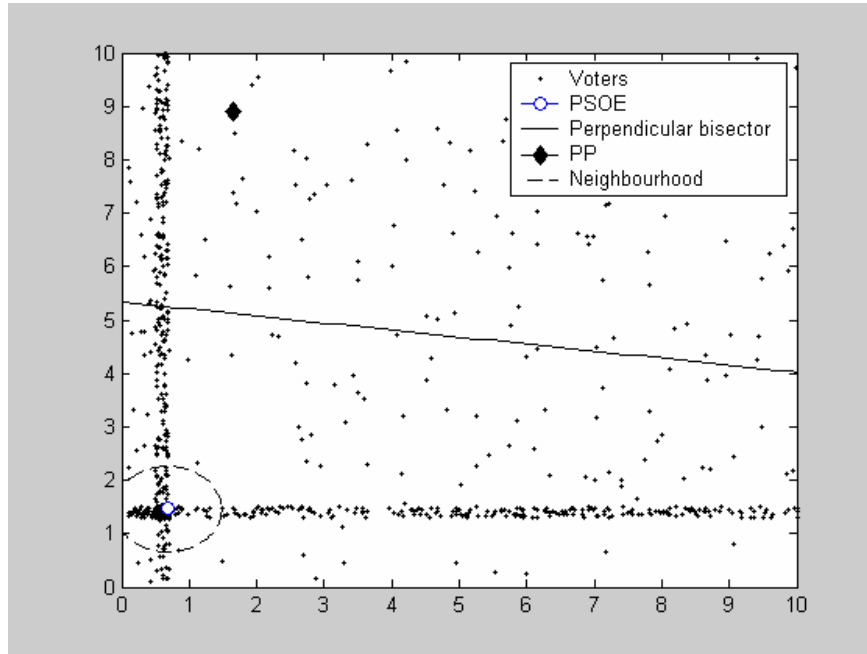


Figure 4: Flexibility in expense policy for the first party

The execution of the algorithm finds voters that even with this flexibility would not be captured by the party and voters that would be (figure 5).

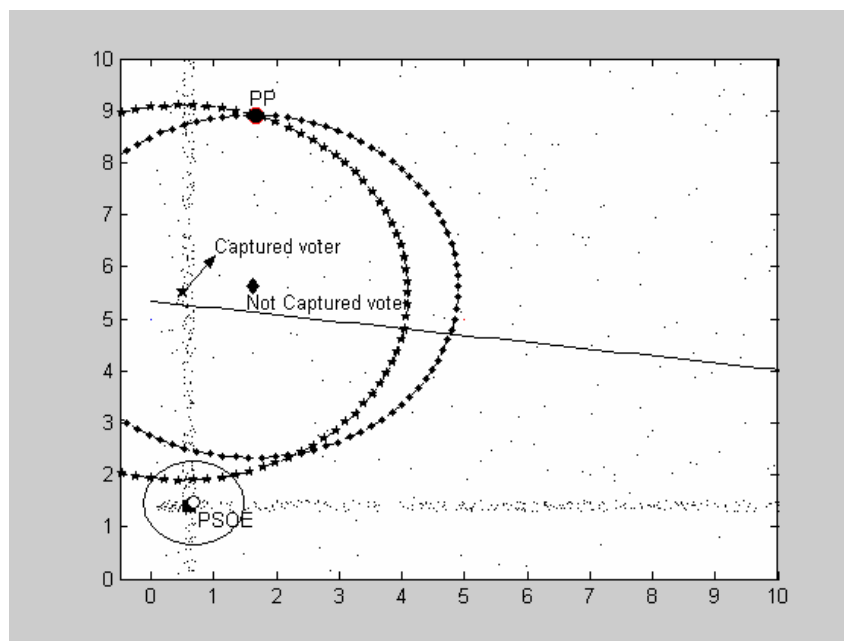


Figure 5: Study of the captures of voters with political flexibility

The results obtained for this example are:

In the generated situation, the vote intention reflected for these two parameters would give the victory to the PSOE that would get 1277 voters against the 999 of the PP.

Study 1: Flexibility for the first party: winner party

- Political flexibility from 0,8% to the PSOE is allowed. This makes it increase its gain up to 1312 voters. This optimal situation is possible if it locates in the circumference arc defined by the points $(x_1, x_2) = (1.32, 1.73)$ and $(x_1, x_2) = (1.37, 1.59)$. That supposes an expense in education, x_1 , between 1.32% and 1.37% and in health, x_2 , between 1.59% and 1.73%, with $(x_1 - 0.6)^2 + (x_2 - 1.4)^2 = (0.8)^2$.

Study 2: Flexibility for the second party: loser party

- Political flexibility from 0,6% to the PP is allowed. This makes it increase its gain up to 1078 voters (it continues losing).
- Flexibility of 0.8%. Its gain increases up to 1138 voters. A technical tie takes place. This optimal situation is possible if he locates in the circumference arc defined by the points $(x_1, x_2) = (2.25, 8.44)$ and $(x_1, x_2) = (2.28, 8.48)$. That supposes an expense in education, x_1 , between 2.25% and 2.28% and in health, x_2 , between 8.44% and 8.48%, with $(x_1 - 1.66)^2 + (x_2 - 8.91)^2 = (0.8)^2$.
- Flexibility of 0.9%. Its gain increases up to 1166 voters. It becomes winner party. This optimal situation is possible if it locates in the circumference arc delimited by the points $(x_1, x_2) = (2.312, 8.350)$ and $(x_1, x_2) = (2.316, 8.355)$, or in the circumference arc defined by the points $(x_1, x_2) = (2.332, 8.377)$ and $(x_1, x_2) = (2.339, 8.386)$, with $(x_1 - 1.66)^2 + (x_2 - 8.91)^2 = (0.9)^2$.

4. Conclusions

An efficient and original algorithm has been created based on geometric techniques, for the localization of the optimal position, relative to some items, for a player in a competition game between two players in which one of them is allowed to move inside some margins in order to increase its gain. This algorithm has been programmed in C language and it has been executed on a problem of political competition in the Spanish environment. This situation has been simulated partly from real data collected from an opinion survey carried out by the CIS. The results obtained after the study can be summarized in the following ones:

- There are very few quantitative data about political opinions of the citizens.
- The political parties are reluctant to commit themselves in questions relative to valuation, not existing quantitative commitments in their electoral programs, for example in the line of public expense and investments.
- To keep in mind these elements and to spread them for a greater citizens' economic and political culture can be decisive for the vote decisions and for the electoral results.
- The previous knowledge for the political parties of the opinions of the citizens in decisive topics for them that can be measured quantitatively, could help the parties to choose an optimal strategy that assures them the biggest caption of voters. This idea is shown in the example developed inside the budgetary policy of Spain in the last years.

If we suppose the expense in education and health high-priority for the citizens (something that is supported partially in the answers of the CIS nº 2616 survey), then, the variation of the investment of the losing party of the last elections (PP) in 0.9% could be decisive in the results of it. This example can be developed in numerous competition studies within the economic framework and it allows to find, in an efficient way, optimal positions for the search for the victory.

We have not tried to do an overall analysis of items that may influence in the citizen's vote, due to the extent of them. We propose to restrict the study to those important elements for the voters in a specific period according to the results that the surveys yield. Anyway, we could do (enlarge) the study including more than two relevant topics. The generalization of the algorithm would be based on the intersection of higher dimension neighborhoods (figures).

Appendix A: Development of the algorithm

Let C be the boundary circumference of the circle centred in the point p where p can move. We will suppose that the point q is outside of C . Let p' and p'' be the tangency points between C and the tangent lines to C traced from q (p' the right tangency point and p'' the left one seen from q).

We will suppose that points v_i are exterior to C . For each point v_i let us consider x'_i and x''_i as the intersection points between C and the circumference centred in v_i that goes through q . x'_i is the right intersection point and x''_i is the left one seen from v_i . Figure 2

Procedure:

Step 1: Find p' and p'' and consider a counter c' with initial value $c' = 0$.

Step 2: Let L be an empty list and let m be a counter with initial value $m = 0$.

For each point v_i find the intersection between C and the circumference centred in v_i that goes through q .

2.1. If there is no intersection because the circumference C is contained in the circle centred in v_i that goes through q , increase m by one unit.

2.2. If there is no intersection because the corresponding circles are disjoint, preserve the value of m .

2.3. If the intersection has two points outside of the visible part of C from q , then increase m by one unit.

2.4. Otherwise:

2.4.1. If both points belong to the visible part of C from q , then include them in the list L .

2.4.2. If x'_i belongs to the visible part of C from q and x''_i doesn't, then include x'_i in L .

2.4.3. If x''_i belongs to the visible part of C from q and x'_i doesn't, then include x''_i in L and increase c' by one unit.

Step 3. Arrange the points of L according to the angle with respect to p (clockwise).

Step 4. Let $c = c' + m$ and $x = p'$. Trace the list L doing the following for each element:

4.1. If it is a x'_i element, let $c = c + 1$, and if $c > m$ then let $m = c$ and $x = x'_i$

4.2. If it is a x''_i element, let $c = c - 1$.

Remark: If x'_i and x''_i coincide because the corresponding circumferences are tangent, we consider x'_i previous to x''_i in the list L .

Once we end the execution of the algorithm, the counter m indicates the maximum number of points v_i that the point p can obtain closer to it than to q , if we locate at a point of the arc of C whose initial extreme is the point stored in the variable x and the last extreme is the following to that point in the list L .

The worst-case time complexity of the algorithm, is $O(n \log n)$. That is because: we can execute the step 1 in constant time. The step 2 requires a constant number of operations for each point v_i , therefore it is executed in linear time. The step 3 requires $O(n \log n)$ operations in the worst-case, because it is considered an arrangement of a list of n

elements. And the step 4 requires a quantity of operations that is proportional to the number of elements of the list L that is linear in the worst case.

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