# Multicriteria Evaluation of Gifted Students


## Abstract

The article deals with the multi-criteria evaluation of gifted students. Students were evaluated with nine criteria: level of learning quality, logic thinking, creativity in spoken and written expressions, broad vocabulary application, text comprehension, knowledge of school subject, reading, speaking, activity and motivation. The research problem is how to evaluate these multicriteria into one final outcome. The fuzzy logic was used for evaluation of gifted students. The advantage of fuzzy logic comes from using of vague variables and settings of weights of importance in used evaluation process.



**Keywords** *gifted student, evaluation of gifted students, fuzzy logic*


## Introduction

The giftedness is described as an individual's ability, which is quantitatively and qualitatively more developed in comparison with their peers, in a specific area valued by the socio-cultural environment (Heward 2013). According to Porter (Porter 1999), these definitions may acquire more concrete form in connection with their conception. It may be either liberal vs. conservative conception (estimates of the amount of the gifted in the population differ), mono - vs. multidimensional (according to the amount of the criteria for the giftedness identification), the definition of potential vs. manifested performance. Our conception of giftedness and it is conceived in the sense of a high ability in the intellect area. The gifted students are those with different cognitive, affective and social characteristics. For example they understand curriculum easily and smartly; use abstract thinking during learning; are self-pacing in solving assignments; have huge knowledge in area of their interest; tend to inductive learning and solving problem; tend to structuring of solving problem and tend to polemic and disagreement; they are active and motivated. Gifted students belong to specific group of students which have also the special educational needs (Heward 2013). For the purpose of respecting these specific educational needs of gifted students, it is usually recommended to modify educational curriculum in its content, process, product, environment and evaluation (Riley, 2011).

In this article we focus on evaluation of gifted students during education. These individuals (as every student) must be evaluated continuously and regularly. This approach helps teachers to orientate themselves in the accuracy of educational goals for gifted students. If the student shows deterioration at school, it´s a sign that something (support of school, family, or individual factors) is wrong in his life. (Callahan 2004)

The gifted student must be evaluated in the context of the sign of his giftedness. The research problem is how to evaluate these criteria into one final outcome. The process of gifted student evaluation must be one of the most important parts of growing up gifted individuals because the outcome is inclusion into the special broad educational program in a form of special school for gifted students or another enriching curriculum. The process of evaluation must be an elaborate system of each school or institution in which they are addressed organizational, conceptual, and ethical and also the methodological issues in which we focus.

## Related works and suggestion of solution of problems

During the evaluation process of gifted students a lot of criteria of giftedness are taken into account (Callahan 2004). For example we can evaluate their level of learning quality, logic thinking, creativity in spoken and written expressions, broad vocabulary application, text comprehension, knowledge of school subject, reading, speaking, activity, motivation, etc. These criteria are very different and vague and we need one final outcome.
During evaluation of partial outputs (criteria) the broad model is suggested (Renzulli and Reis 2004). In the broad model the gifted individual must fulfil all or the most of evaluation criteria, so the methodological problem is how to combine these results.

In praxis and theory (Callahan and Renzulli 2012) is application of the additive model registered. In this model the partial outcomes are easily added for each individual in evaluation process. These outputs in a form of some total points are compared. The advantage of additive model is quite easy evaluation, where we add each point together. On the other hand we

add the criteria with different conditions and relevance (for example logical thinking and motivation), moreover the results from each different criteria could be inappropriately compensate and give mistaken results of evaluation process.

Hunsaker (Hunsaker 2012) notes, that different evaluation criteria cannot be added linearity. He suggests addition of selected criteria which plays key role for evaluation of gifted students and other less important criteria which are used tentatively. To eliminate these disadvantages we suggest combining each result by using the fuzzy logic. The method allows to clear evaluation of larger number of data without compensation of variables. Its advantage comes from using of vague variables and in used evaluation method.

We found that there were no application of the fuzzy logic during evaluation process of gifted individuals according to analyze of available article database (EBSCO, XERXES and Proquest). There are no articles worldwide concerning evaluation of gifted student via computer aided processing. The buildup model enables evaluation of many students from databases and makes the evaluation objective and unified. The fuzzy logic outperformed evaluation process of gifted people by other methods mentioned in (Callahan and Renzulli 2012; Renzulli and Reis 2004; Hunsaker 2012) from this point of view.

## Fuzzy logic

A fuzzy set $A$ is defined as $(U, \mu_A)$, where $U$ is the relevant universal set and $\mu_A$: $U \rightarrow \langle 0,1 \rangle$ is a membership function, which assigns each element from $U$ to fuzzy set $A$. The membership of the element $x \in U$ of a fuzzy set $A$ is indicated $\mu_A(x)$. We call $F(U)$ the set of all fuzzy set. Then the "classical" set $A$ is the fuzzy set where: $\mu_A$: $U \rightarrow \{0, 1\}$. Thus $x \in A \Leftrightarrow \mu_A(x) = 0$ and $x \notin A \Leftrightarrow \mu_A(x) = 1$. Let $U_i$, $i = 1, 2, ..., n$, be universals. Then the fuzzy relation $R$ on $U = U_1 \times U_2 \times ... \times U_n$ is a fuzzy set $R$ on the universal $U$. The fuzzy logic theory is described in many books such as (Zadeh 1965; Zadeh 2012). The fuzzy application in non-technical field is described in (Dostál 2011; Dostál 2014), but no book in a pedagogical field.

The fuzzy logic system consists of three fundamental steps: fuzzification, fuzzy inference, and defuzzification. See Fig 1.

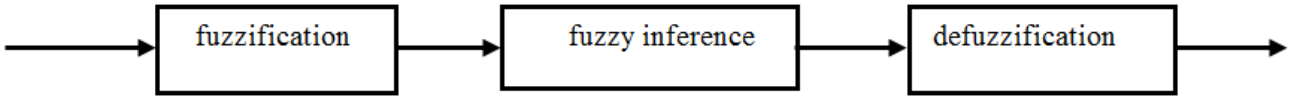


Fig 1. Decision making solved by means of fuzzy logic

## Case study

The case study represents process of evaluation of students in the school subject from school classes.

Table 1: Criteria of evaluation (specific)

| Criterion: | Input | Weight |
|---|---|---|
| 1. Learning quality | LQ | (0.0 – 1.0) |
| 2. Logical thinking | LT | (0.0 – 1.0) |
| 3. Creativity in spoken and written expressions | CSWE | (0.0 – 1.0) |
| 4. Broad vocabulary application | BVA | (0.0 – 1.0) |
| 5. Text comprehension | TC | (0.0 – 1.0) |
| 6. Knowledge of school subject | KS | (0.0 – 1.0) |
| 7. Reading | R | (0.0 – 0.3) |
| 8. Speaking | S | (0.0 – 0.3) |
| 9. Activity and motivation | AM | (0.0 – 0.3) |

We used the nine criteria (learning quality, logical thinking, creativity in spoken and written expressions, broad vocabulary application, text comprehension, knowledge of school subject, reading, speaking, activity and motivation) which has 5 levels (normalized scale A=1.0-0.8, B=0.8-0.6, C= 0.6-0.4, D=0.4.0-0.2, E=0.2-0.0), where A is extraordinary level and E is inadequate level. The individual weights of variables were set up by the experts on gifted students' evaluation. See Table 1.

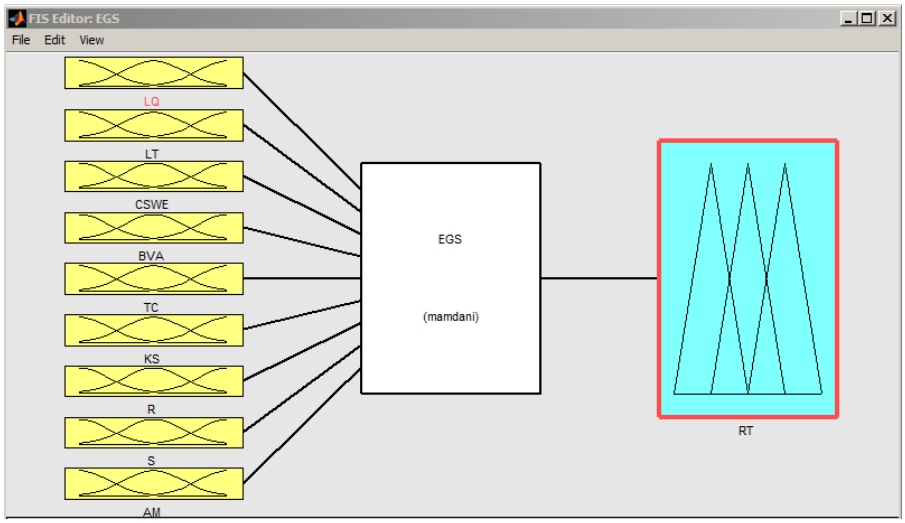


Fig 2. EGS Model

The application of evaluation of gifted students (EGS model) via fuzzy interface system is a result of deep analyses and it has nine inputs Learning quality (LQ); Logical thinking (LT); Creativity in spoken and written expressions (CSW); Broad vocabulary application (BVA); Text comprehension (TC); Knowledge of subject (KS); Reading (R); Speaking (S); Activity and motivation (AM) are used. See Fig 2. The output Rate of Talent (RT) is used.

The fuzzification, defuzzification and fuzzy inference are represented by following steps: The inputs *I=LQ,LT,CSWE,BVA,TC,KS,R,S,AM* have five attributes very low (vl), low (l), medium (m), high (h) and very high (vh) level. See Table 2 and Fig 3.

Table 2: Range for *I*

| Fuzzy $I$ | Variable | Range |
|---|---|---|
| $I_{VL}$ | Very low (vl) | 0.0-0.2 |
| $I_L$ | Low (l) | 0.2-0.4 |
| $I_M$ | Medium (m) | 0.4-0.6 |
| $I_H$ | High (h) | 0.6-0.8 |
| $I_{VH}$ | Very high (vh) | 0.8-1.0 |

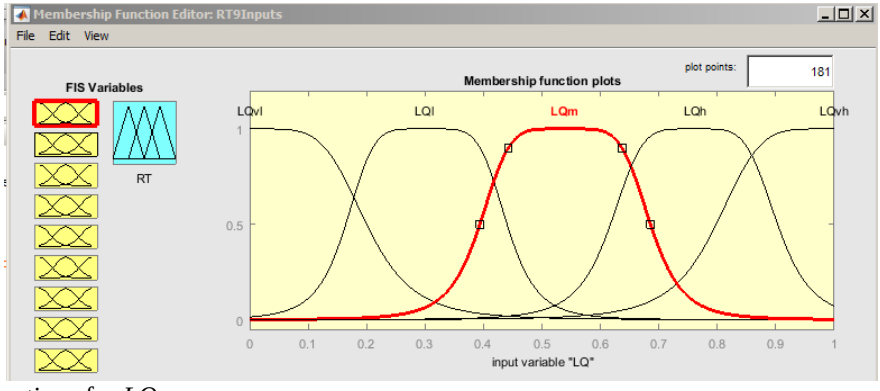


Fig 3. Membership functions for *LQ*

The outputs O=*RT* presents rate of talent it has three attributes low (l), medium (m) and high (h). See Table 3 and Fig 4.

Table 3: Range for *RT*

| Fuzzy *RT* | Variable | Range |
|---|---|---|

| | | |
|---|---|---|
| $RT_L$ | Low (l) | 0.00-0.25 |
| $RT_M$ | Medium (m) | 0.25-0.70 |
| $RT_H$ | High (h) | 0.70-1.00 |

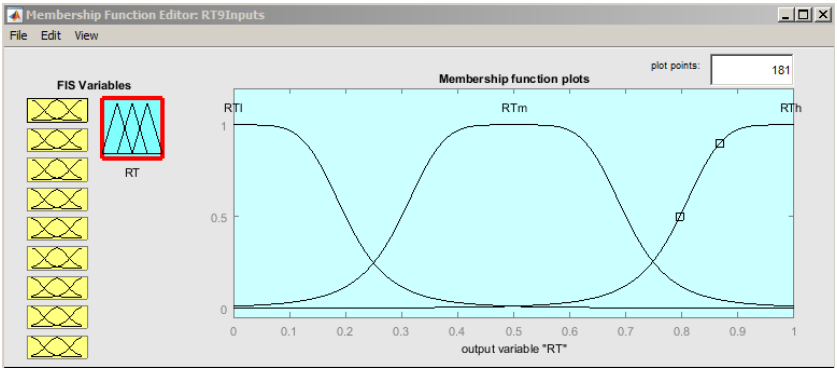


Fig 4. Membership functions for *RT*

The fuzzy inference is represented by set ups of rules such as:
If *LQ*=vl and *LT*=vl and *CSWE*=vl and *BVA*=vl and *TC*=vl and *KS*=vl and *R*=vl and *S*=vl and *AM*=vl then *RT* =vl
If *LQ*= l and *LT*= l *and CSWE*= l and *BVA*= l and TC= l and *KS*= l and *R*= l and *S*= l and *AM*= l then *RT* = l
If *LQ*=m and *LT*=m and *CSWE*=m and *BVA*= m and *TC*=m and *KS*=m and *R*=m and *S*=m and *AM*=m then *RT* =m
If *LQ*= h and *LT*= h and *CSWE*= h and *BVA*= h and *TC*= h and *KS*= h and *R*= h and *S*= h and *AM*= h then *RT* = h
If *LQ*=vh and *LT*=vh and *CSWE*=vh and *BVA*=vh and *TC*=vh and *KS*=vh and *R*=vh and *S*=vh and *AM*=vh then *RT*=vh

and some others. See Fig 5.

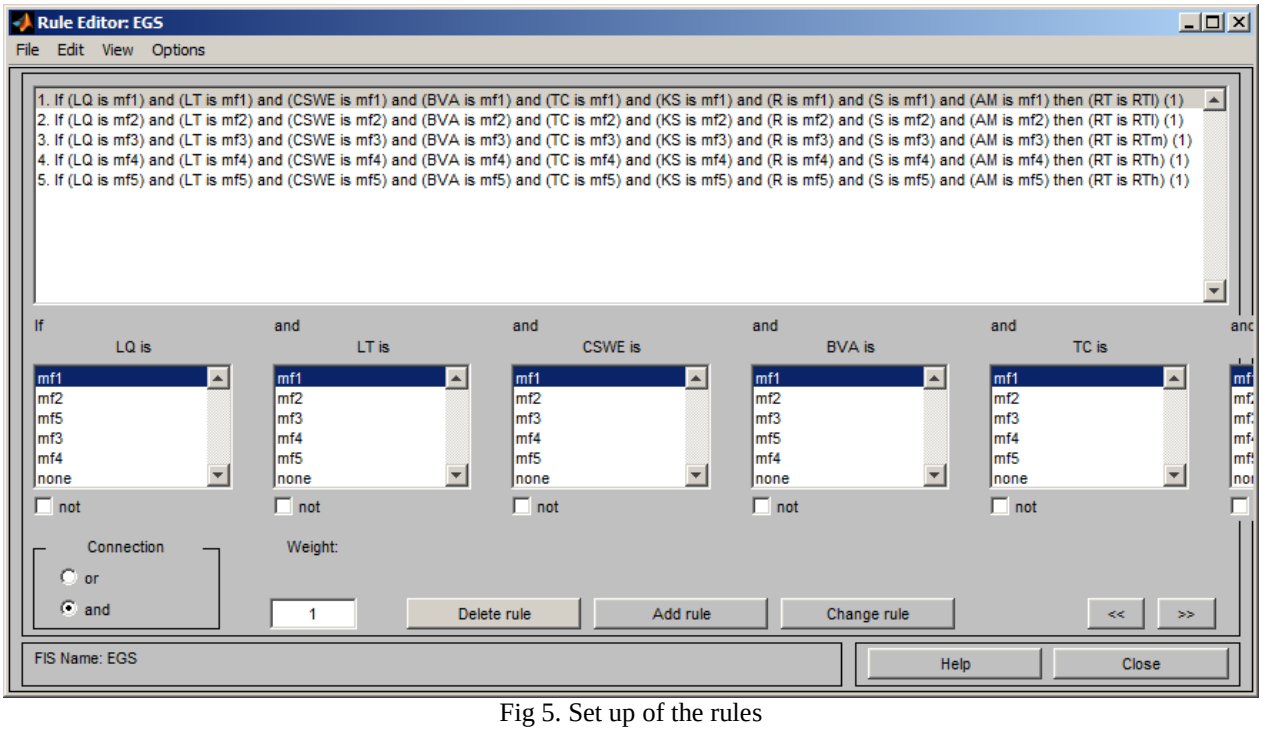


Fig 5. Set up of the rules

The fuzzy model was tuned with the help of MATLAB surface viewer. The rate of talent *RT* is dependent on nine inputs *LQ, LT, CSWE, BVA, TC, KS, R,S, AM*. The dependence of *RT* on *LQ* and *LT* is presented on Fig 6.

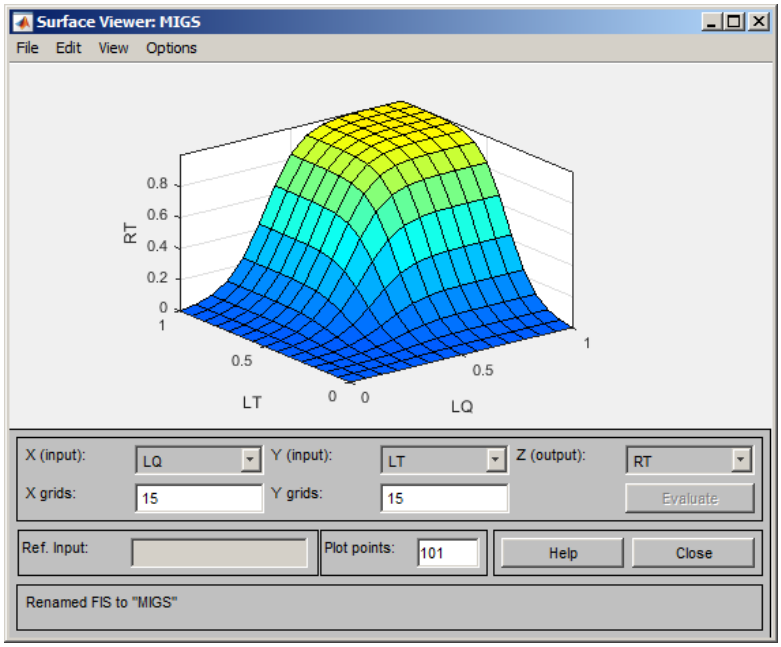


Fig 6. Surface viewer graph

The input values *LQ* = 0.93 (very high), *LT* = 0.92 (very high), *CSWE* = 0.87 (very high), *BVA* = 0.99 (very high), *TC* = 0.88 (very high), *KS* = 0.93 (very high), *R* = 0.94 (very high), *S* = 0.92 (very high), *AM* = 0.90 (very high) gives the result *RT* = 0.853, that means that the rate of student is RT=0.853 and it means high gifted student. The inputs and outputs are presented in Fig 7.

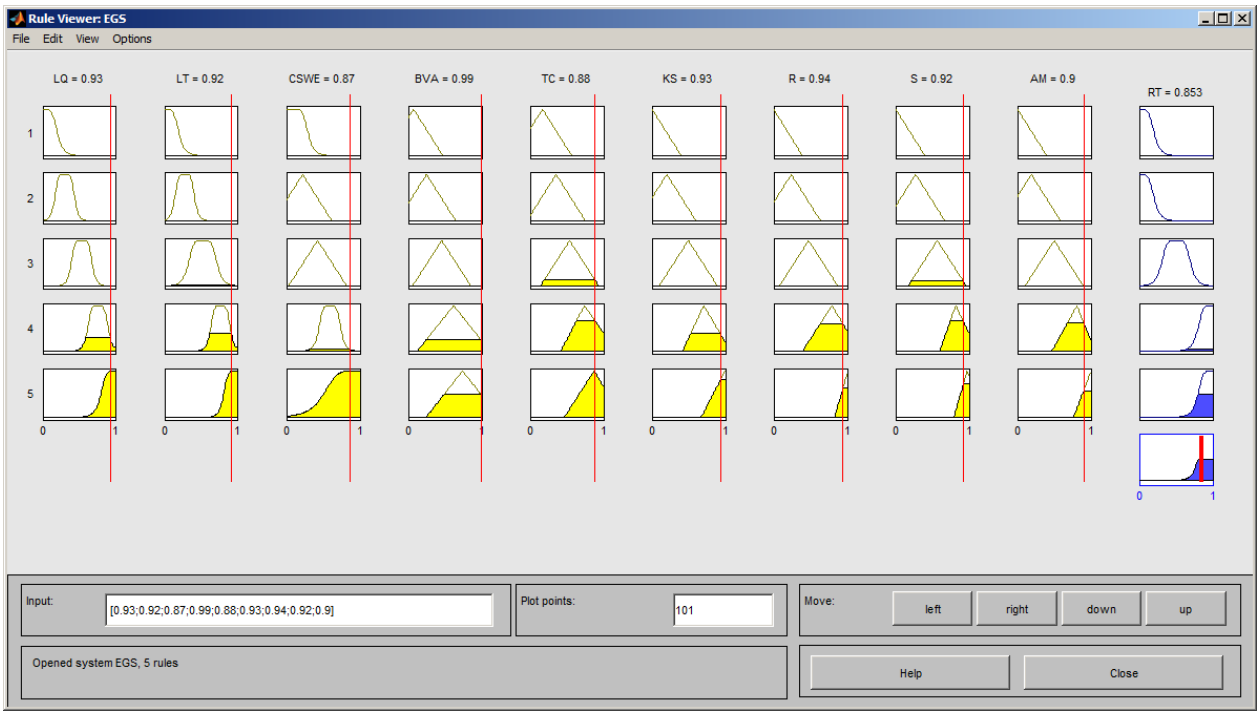


Fig 7. Rules viewer

The students from group with high level of talent demonstrated criteria of giftedness. They have an excellent logical memory; better quality of learning; advanced thought processes; understand abstract concepts better than their peers; see unusual

relations and links; show good observation skills; be able to differ even insignificant details; manifest developed vocabulary; have a great knowledge in specific areas of interest.

It was evaluated many students and it results in following proportions: 20% for high, 55% for medium and 25% for low gifted students. The results serves to create the groups of high, medium and low talented student and for their specific education.

## Conclusion

In this article we presented the process of evaluation of gifted students in the school subject from ordinary school classes. Students were evaluated with nine criteria: level of learning quality, logic thinking, creativity in spoken and written expressions, broad vocabulary application, text comprehension, knowledge of school subject, reading, speaking, activity and motivation, in which the class teacher evaluated all students in nine criteria, where A was extraordinary level and E inadequate level. We didn´t use "additive model", which is applied in many evaluation process, because of inappropriately compensation of each results of evaluation process.

For evaluating results from nine different criteria we used the fuzzy logic. The method allowed to clear evaluation of larger number of data without compensation of variables. This computing method is very suitable for mentioned purposes and it leads to higher quality of analyses and evaluation of students and educational process themselves.

## References


Callahan, C.M. (2004). *Program Evaluation in Gifted Education.* USA: Corwin Press – A Sage Publications Company.

Callahan, C.M. and Renzulli, J. (2012). Considerations for Identification of Gifted and Talented Students: An Introduction to Identification. In Callahan, C.M., Herberg-Davis, H.L. *Fundamentals of Gifted Education: Considering Multiple Perspectives.* UK: Routledge, p.83 – 91.

Dostál, P. and Machů, E. Fuzzy Clustering in Education of Gifted Pupils, In *The 26th International Business Information Management Association Conference*, Spain, 2015, p.1331-1336, ISBN: 978-0-9860419-5-2.

Dostál, P. (2011). *Advanced decision making in business and public services*. Czech Republic: CERM Academic Publishing House.

Dostál, P. (2014). The Use of Soft Computing in Management. In Vasant, P. *Handbook of Research on Novel Soft Computing Intelligent Algorithms: Theory and Practical Applications*. USA: IGI Globe, 2013.

Heward, W.L. (2013). Exceptional Children. An Introduction to Special Education. Ohio: Pearson Education.

Hunsaker, S.L. (2012). *The Theory and Practise of Identifying Students for Gifted and Talented Education Services.* USA: Prufrock.

Porter, L. (1999). *Gifted Young Children*. A guide for teachers and parents. Buckingham: Open University Press.

Renzulli, J.S. and Reis, S.M. (2004). *Identification of Students for Gifted and Talented Programs (Essential Readings in Gifted Education Series).* Corwin Press: Thousand Oaks - CA.

Riley, T. L. (2011). *Teaching Gifted Students in the Inclusive Classroom*. USA: Prufrock.

Zadeh, L.A. (1965). Fuzzy sets. *Information and Control* 8, 338-353.

Zadeh, L.A. (2012). *A Definition of Soft Computing* - adapted from L.A. Zadeh. Retrieved January 10, 2013, from http://www.soft-computing.de/def.html.