# The Implementation of Breadth First Search in Determining of Waris

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**Abstract.** Breadth First Search is one of the search pattern in an expert system inference mechanism. The use of methods of Breadth First Search in the science of Waris, can be used for the recipient of Waris and the amount of the accepted of Waris. Determination of Waris in this study refers to the madzhab of Hanafi and Hambali. There are three categories of recipient of Waris (Dzawil Furudh, 'Ashabah, and Dzawil Arham), with 73 rules of Waris and added with 24 rules for heirs who obstructed, which are made in 10 level decision tree of Waris. The test results against 10 cases heirs acquired the suitability and value of the recipient of waris 33 categorized as Dzawil Furudh, and 4 are categorized 'Ashabah

## 1. Introduction

Problem of Waris is often a crucial thing that sometimes triggered a dispute and caused a crack in a marriage relationship, even to the point of criminal acts such as murder in addressing this Waris issue. In addition to the limitations of experts, the difficulty in determining the proportion of each heir is the complexity of the heirs, so that although many people know and study Waris, it is not necessarily the person can do the calculations in Waris based on Islamic law [1] [2] [3]. In principle, the division of Waris in Islamic law is not to complicate mankind, but to provide convenience for humans and to avoid family fights after the deceased died.

Advances in information technology is now a solution to overcome many problems. Technology is able to adopt the process and the way of human thinking with artificial intelligence technology. The expert system is one part of the artificial intelligence that contains the knowledge and experience inserted by one or many experts into one particular area of knowledge so that everyone can use it to solve specific problems. The purpose of expert system development is not to replace the full human role, but to substitute human knowledge into systems, so that it can be used by many people. To build an expert system must be supported by expert system components that have certain characteristics, such as the possibility of an expert system solution to a problem is varied and has many choices of answers that can be accepted all the traced factors have a large space and not certainly.

Technological devices are designed to enhance a quality of human's life [4], one of those which are enable efficiency and effectiveness in business process within a field of expert system. Expert Systems is defined as a system that organized data process [5], it adopts several knowledge of experts into a

computational code so the computer enable to solve a specific problem and acts as an expert [6]. Refers to several researches, an expert system has an accurate data accessibility and efficient run- time  [7], high  accuracy [8],  and  to  support a  proper decision [9], low cost [10], extended accessibility [11], intensify user knowledge [12], increase productivity [13], provide a better data and information [14],and in the certain cases are potentially used as data storage [15].

The Breadth First Search (BFS) method is a search done by visiting each node systematically at each level until the goal state is found [16], [17]. BFS method in this research is implemented on the search process of heirs who are entitled to receive inheritance or not by using decision tree. In this decision tree there is a node in the content of each heir that is  sorted by kinship factors closest to Muwaris (people who leave their inheritance). As for the calculation of inheritance, used calculations based on calculations in Islamic law.

In the previously research by Prasetiyo, Dewa, and Udjulawa, BFS algorithm was implemented for design of Edugame Icon  Android based  information technology device. As a result, the BFS algorithm could provide a solution in the process of finding the icon, when players had difficulty in finding paired icons [18]. In another study conducted by Astrid Novita Putri investigated BFS algorithm optimization on 3D Engine Third Person Shooter Maze based on intelligent agent android [19]. As a result, the implementation of the Third Person Shooter labyrinth game using the BFS algorithm could complete the results with the point that is used to facilitate the player to complete the game. And the accuracy was around 85% in testing and it could be concluded that BFS algorithm method in the problem of finish time longer but will make it easier for players to complete quickly

## 2.  Rule of Waris based on Islamic law

The rule of Waris and its division in Islamic law has the most substantial aspect of justice. The form of justice in the law of Waris does not depend on gender, but on substance. Justice lies in the balance between rights and duties or between necessities and uses, as the Qur'an has mentioned in the letter An Nisa that both men and women have equal rights. The heirs who have the right of Waris from a deceased person - whether generated through a derivative relationship (zunnasbi), asshar relationships, or trust relationships (mawali) - can be grouped into two groups, namely (1) the category of Waris rights contains certainty, based on ittifaq (discuss) by scholars of Islamic law, and (2) groups whose Waris rights are still disputed by Islamic law scholars. The heirs agreed upon Waris rights consist of 15 men and 10 women, among others: Sons; Grandsons transmit men and so on down; Father; Grandfathers from the father, and so on up; Brothers; Brother with the  same  father; Brother  with  the  same mother; Sons of brothers; The son of a brother with the same father; Uncle; Uncle with the same father; Son of Uncle; Son of Uncle with the samw father; Husband; The man   who   freed   slaves;   Daughter; Granddaughters transmit men; Mother; Grandmother from the father and so on up; Grandmother from mother and so on; Sisters; Sister with the same father; Sister with the same mother; Wife; The woman who freed slaves. If the 25 of heirs mentioned above on the part of the men and from the women are all there, then that definitely gets only one of the husband / wife, mother and father, sons and daughters [12].

In Waris law, the division of inheritance is determined by the division according to the group of each category. Those heirs among others: Ashhabul Furudh or Dzawil Furudh is the heirs who have a certain part that has been established in the Qur'an, whose parts will not increase or decrease, except in the problems that occur Ar-radd or Al- 'Aul. Ar-radd  means  the  decrease  of  the  divisor  (the number of parts Furudh) and the increase of the part of the heirs. This is due to the lack of ashhabul furudh while the total number of its parts has not reached the value of 1, so there is a remaining inheritance, while there is no one of the ashabah there who is entitled to receive the remaining property. While Al-'Aul is increasing the divisor (the number of parts furudh) thus causing the reduced part of the heirs. This is due to the number of ashhabul furudh  while  the  total  number of  parts  has exceeded the value of 1, so that among the ashhabul furudh there are those who have not received the appropriate part. The parts specified in the Qur'an have only six, namely: 1 / 2,1 / 4,1 / 8,1 / 3,2 / 3, and 1/6 for the heirs who are entitled to receive part -including ashhabul furudh or  dzawil furudh. Next is the  'Ashabah group where

the heirs of 'ashabah can inherit all possessions when no heirs of ashhabul furudh; inherit the remaining treasures after the part of the heirs ashhabul furudh; or do not inherit the least of the estate if the property is not left after the part of the heirs of the ashhabul furudh.

## 3. Breadth First Search (BFS) for Waris

BFS is a search algorithm that visits all the nodes that are at the same level until the goal state is found. BFS can also be interpreted by a vertex search algorithm in a graph (tree) transversally starting from the root node and checking all neighboring nodes. After that, from each of its neighbor nodes, the algorithm will continue to check all its unextracted neighbor nodes, so on until it finds the destination node of BFS. Interpreter rules ranging from the fact that there is a hypothesis and then the THEN section began in the test to support the initial hypothesis. If found then a suitable of IF rule is used to generate a hypothesis between a new one. Then the chain process keeps repeating, gathering supporting evidence, so the hypothesis proves the truth.

The advantages of this method, among others: do not meet a dead end, if there is a solution, then BFS will find it, if more than one solution is obtained, then the minimum solution will be found. While the weakness of this method, among others: requires a lot of memory, because storing all the nodes in a tree, takes a long time, because it will test the n level to get the solution at level (n + 1). The BFS method is a search that uses the knowledge of a problem to perform a search guide to the node where the solution is located, this search is also known as heuristic. It can be said that the BFS method works based on a combination of the two previous methods.

The implementation of BFS algorithm begins by analyzing the needs of Waris calculations according to Islamic law. The first is to determine the heirs classified as dzawil furudh (found in table 1), ie the heirs who have a certain part set out in the Qur'an, whose portions shall not increase or decrease except in special cases such as Al-'aul and Ar-radd. Second, determine the heirs belonging to 'Ashabah (found in table 2), ie the heirs who get the remaining part after being taken by the heirs dzawil furudh. Third, determine the heirs belonging to dzawil arham (listed in table 3), ie heirs who have a kinship relationship with the heir, in addition to the heirs dzawil furudh and 'ashabah. After determining the heirs, the next is to determine the part of each heir and calculate part of the inheritance earned by the heirs according to his part. The part of heirs and the rules are listed in table 4. These rules will be used by BFS to process the distribution of the inheritance. An example of the calculation of the division of inheritance is shown in table 5. In table 4, rules apply if + Heirs I + Logic + Heirs II + then + Portion (Part of Inheritance value). Where, ! means no other heirs; = means existing or together with other heirs; # means only one heir; > = 2 means more than 2 other heirs; # 2 means more than equal to 2 heirs; and AS means 'Ashabah. The rule presented in table 4 is the result of a decision tree representation for a 10-level Waris in figure 1.

**Table 1.** Heirs of *Dzawil Furudh.*

| Code | Heirs |
|------|-------|
| A001 | Wife |
| A002 | Husband |
| A003 | Mother |
| A004 | Father |
| A005 | Grandmother form Mother |
| A006 | Grandmother from Father |
| A007 | Grandfahter from Father |
| A008 | Daughter |
| A009 | Granddughter from Son |
| A010 | Sister |
| A011 | Sister with the same Father |
| A012 | Sister with the same Mother |
| A013 | Brother with the same Mother |

**Table 2.** Heirs of *'Ashabah.*

| Code | Heirs |
|------|-------|
| B001 | Son |
| B002 | Grandson |
| B003 | Father |
| B004 | Grandfahter from Father |
| B005 | Brother |
| B006 | Brother with the same Father |
| B007 | Son of Brother |
| B008 | Son of Brother with the same Father |
| B009 | Brother of Father |
| B010 | Brother of Father with the same Father |
| B011 | Son of Brother of Father |
| B012 | Son of Brother of Father with the same Father |
| B013 | Boy who get freedom |
| B014 | Girl who get freedom |

**Table 3.** Heirs of zawil Arham.

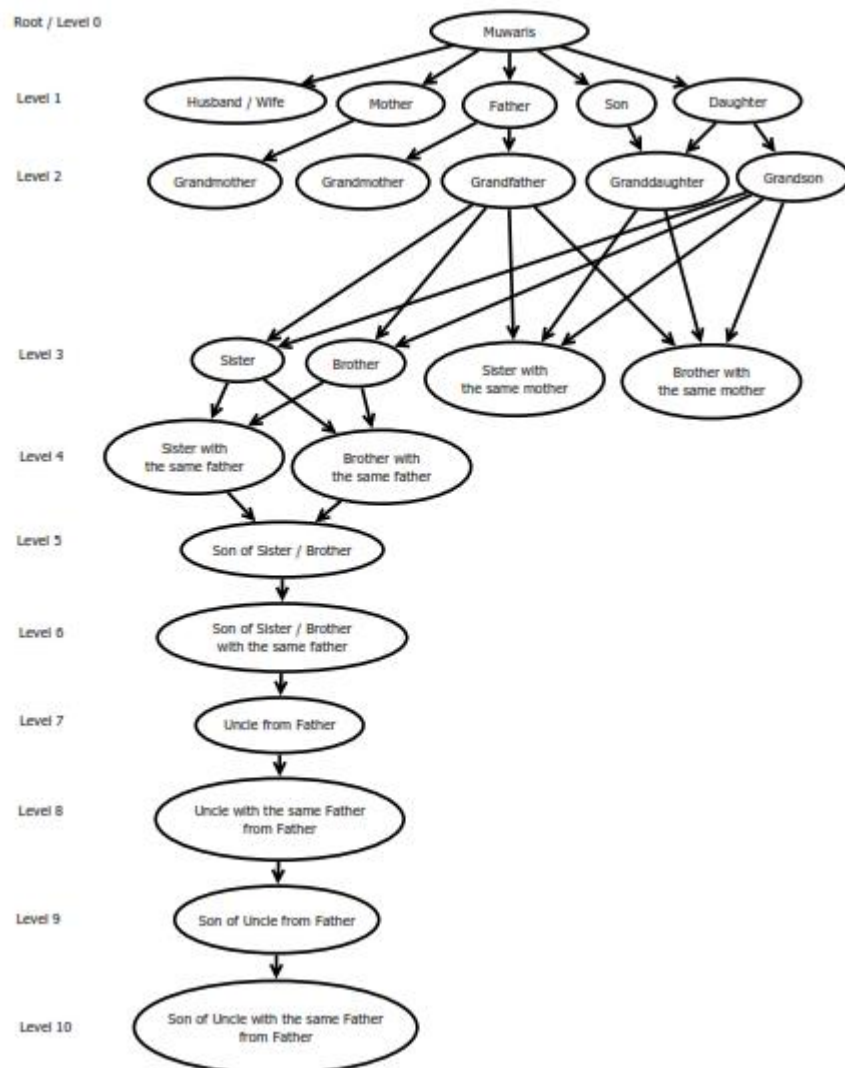| Code | Heirs |
|------|-------|
| C001 | Grandson from Daughter |
| C002 | Granddaughter from Daughter |
| C003 | Grandfather from Mother |
| C004 | Daughter from Brother |
| C005 | Daughter from Brother with the same |
| C006 | Son from Sister |
| C007 | Dauthter from Sister |
| C008 | Son from Sister with the same Father |



**Figure 1.** Decision tree of Waris.

**Table 4.** Rules of Waris with *Dzawil Furudh*, '*Ashabah*, and *Dzawil Arham.*

| Code | Heirs I | Logic | Heirs II | Portion |
|------|---------|-------|----------|---------|
| R1 | A001 | ! | A008 | ¼ |
| R2 | A001 | ! | A009 | ¼ |
| R3 | A001 | ! | B001 | ¼ |
| R4 | A001 | ! | B002 | ¼ |
| R5 | A001 | = | A008 | 1/8 |
| R6 | A001 | = | A009 | 1/8 |
| R7 | A001 | = | B001 | 1/8 |
| R8 | A001 | = | B002 | 1/8 |
| R9 | A002 | ! | A008 | ½ |
| R10 | A002 | ! | A009 | ½ |
| R11 | A002 | ! | B001 | ½ |
| R12 | A002 | ! | B002 | ½ |
| R13 | A002 | = | A008 | ¼ |
| R14 | A002 | = | 1009 | ¼ |
| R15 | A002 | = | B001 | ¼ |
| R16 | A002 | = | B002 | ¼ |
| R17 | A003 | ! | A008 | 1/3 |
| R18 | A003 | ! | A009 | 1/3 |
| R19 | A003 | ! | B001 | 1/3 |
| R20 | A003 | ! | B002 | 1/3 |
| R21 | A003 | = | A004 | 1/3 SISA |
| R22 | A003 | = | A001 | 1/3 SISA |
| R23 | A003 | = | A002 | 1/3 SISA |
| R24 | A003 | = | A008 | 1/6 |
| R25 | A003 | = | A009 | 1/6 |
| R26 | A003 | = | A001 | 1/6 |
| R27 | A003 | = | B002 | 1/6 |
| R28 | A003 | >=2 | A010 | 1/6 |
| R29 | A003 | >=2 | A011 | 1/6 |
| R30 | A003 | >=2 | A011 | 1/6 |
| R31 | A003 | >=2 | A013 | 1/6 |
| R32 | A004 | = | A008 | 1/6 + AS |
| R33 | A004 | = | A009 | 1/6 + AS |
| R34 | A004 | = | B001 | 1/6 + AS |
| R35 | A004 | = | B002 | 1/6 + AS |
| R36 | A005 | = | A008 | 1/6 |
| R37 | A005 | = | A009 | 1/6 |
| R38 | A005 | = | B001 | 1/6 |
| R39 | A005 | = | B002 | 1/6 |
| R40 | A006 | ! | A008 | 1/6 |
| R41 | A006 | ! | A009 | 1/6 |
| R42 | A006 | ! | B001 | 1/6 |
| R43 | A006 | ! | B002 | 1/6 |
| R44 | A006 | = | A008 | 1/6 |
| R45 | A006 | = | A009 | 1/6 |
| R46 | A006 | = | B001 | 1/6 |
| R47 | A006 | = | B002 | 1/6 |
| R48 | A007 | = | A008 | 1/6 + AS |
| R49 | A007 | = | A009 | 1/6 + AS |
| R50 | A007 | = | B001 | 1/6 + AS |

| Code | Heirs I | Logic | Heirs II | Portion |
|------|---------|-------|----------|---------|
| R51 | A007 | = | B002 | 1/6 + AS |
| R52 | A008 | # | - | ½ |
| R53 | A008 | #2 | - | 2/3 |
| R54 | A008 | = | B001 | ½ AS |
| R55 | A009 | # | - | ½ |
| R56 | A009 | >=2 | A008 | 2/3 |
| R57 | A009 | = | A008 | 1/6 |
| R58 | A009 | = | B002 | AS |
| R59 | A010 | # | - | ½ |
| R60 | A010 | #2 | - | 2/3 |
| R61 | A010 | = | B005 | AS |
| R62 | A010 | = | A008 | AS |
| R63 | A010 | = | A007 | AS |
| R64 | A011 | # | - | ½ |
| R65 | A011 | #2 | - | 2/3 |
| R66 | A011 | = | A010 | 1/6 |
| R67 | A011 | = | B006 | AS |
| R68 | A011 | = | A008 | AS |
| R69 | A011 | = | A007 | AS |
| R70 | A012 | # | - | 1/6 |
| R71 | A012 | #2 | - | 1/3 |
| R72 | A013 | # | - | 1/6 |
| R73 | A013 | #2 | - | 1/3 |
| R74 | B001 | = | A008 | 2 X A008 |
| R75 | A005 | = | A003 | Not Get |
| R76 | A006 | = | A003 | Not Get |
| R77 | A006 | = | A004 | Not Get |
| R78 | A007 | = | A004 | Not Get |
| R79 | A009 | >=2 | A008 | Not Get |
| R80 | A009 | = | B001 | Not Get |
| R81 | A010 | = | B001 | Not Get |
| R82 | A010 | = | A004 | Not Get |
| R83 | A011 | = | B005 | Not Get |
| R84 | A011 | = | B001 | Not Get |
| R85 | A011 | >=2 | A010 | Not Get |
| R86 | A011 | = | A004 | Not Get |
| R87 | A012 | = | B002 | Not Get |
| R88 | A012 | = | B001 | Not Get |
| R89 | A012 | = | A009 | Not Get |
| R90 | A012 | = | A008 | Not Get |
| R91 | A012 | = | A007 | Not Get |
| R92 | A012 | = | A004 | Not Get |
| R93 | A013 | = | A004 | Not Get |
| R94 | A013 | = | A007 | Not Get |
| R95 | A013 | = | A008 | Not Get |
| R96 | A013 | = | A009 | Not Get |
| R97 | B002 | = | B001 | Not Get |

**Table 5.** The Example of Waris count.

| Heirs | Total | Portion | | Count | Nominal (Rp) |
|-------|-------|---------|---|-------|--------------|
| **Heir: Rp 50.000.000, Total Basic Problem: 24** | | | | | |
| Wife | 1 | 1/8 | 3 | 50.000.000x 3/24 | 6.250.000 |
| Mother | 1 | 1/6 | 4 | 50.000.000x 4/24 | 8.333.333 |
| Father | 1 | 1/6 | 4 | 50.000.000x 4/24 | 8.333.333 |
| Son | 1 | AS | 13 | 50.000.000x 13/24 | 27.083.333 |

## 4. Result and discussion

BFS algorithm was used for determining of waris, begin from determined the heirs classified as dzawil furudh, determined the heirs belonging to 'Ashabah, determined the heirs belonging to dzawil arham. Then, determine the part of each heir and calculate part of the inheritance earned by the heirs according to his part.

We tested the BFS algorithm with 10 scenarios of inheritance distribution cases presented in Table 6. The tests were grouped by 3 cases, including normal cases, Al-'aul cases, and Ar-Radd cases. Where DF codes for heirs belonging to Dzawul Furudh, AS to 'Ashabah, and Mahjub are heirs who do not get inheritance due to being obstructed by other heirs. Based on the results of the experments obtained that from all probable cases tested, BFS able to pass the calculation of the division of heirs exactly in accordance with the rules of Islamic law.

**Table 6.** Testing Cases of Waris

| No | Problem | | | Count of Waris | | | Conclusion | |
|----|---------|---|---|----------------|---|---|------------|---|
| | Heir | Almarhum | Heir | Rule | Portion | Nominal (Rp) | Correct | Incorrec |
| | | | No | | | | | |
| 1. | 16.000.000 | Wife | Husband | DF | 1/4 | 4.000.00 | ✓ | |
| | | | Son | AS | Sisa | 12.000.00 | ✓ | |
| 2. | 20.000.000 | Mother | Grandmother | DF | 1/6 | 3.333.33 | ✓ | |
| | | | Daughter | DF | 2/3 | 13.333.33 | ✓ | |
| | | | Sister | DF | AS | 3.333.33 | ✓ | |
| | | | Sister with the same Mother | *Mahjub* | - | Ter*hijab* oleh | ✓ | |
| 3. | 30.000.000 | Husband | Wife | DF | 1/8 | 3.750.00 | ✓ | |
| | | | Grandmother from Father | DF | 1/6 | 5.000.00 0 | ✓ | |
| | | | Daughter | DF | Sisa | 7.083.33 | ✓ | |
| | | | Son | AS | 2xSisa | 14.166.66 | ✓ | |
| 4. | 50.000.000 | Husband | Wife | DF | 1/8 | 6.250.00 | ✓ | |
| | | | Mother | DF | 1/6 | 8.333.33 | ✓ | |
| | | | Daughter | DF | 2/3 | 33.333.33 | ✓ | |
| | | | Sister | DF | Sisa | 1.041.66 | ✓ | |
| | | | Brother | AS | Sisa | 1.041.66 | ✓ | |
| 5. | 20.000.000 | Husband | Wife | DF | 1/4 | 5.000.00 | ✓ | |
| | | | Mother | DF | 1/6 | 3.333.33 | ✓ | |
| | | | Sister from the same Mother | DF | 1/3 | 3.333.33 3 | ✓ | |
| | | | Brother from the same Mother | DF | 1/3 | 3.333.33 3 | ✓ | |
| | | | Son from Brother | AS | Sisa | 5.000.00 | ✓ | |
| 6. | 30.000.000 | Husband | Wife | DF | 1/8 | 3.750.00 | ✓ | |
| | | | Father | AS | 1/6 | 5.000.00 | ✓ | |
| | | | Mother | DF | 1/6 | 5.000.00 | ✓ | |
| | | | Son | AS | 2xSisa | 10.833.33 | ✓ | |
| | | | Daughter | DF | Sisa | 5.416.66 | ✓ | |

Table 6. Cont.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Al* | | | | | |
| 7. | 40.000.000 | Wife | Husband | DF | 1/2 | 12.000.00 | ✓ |
| | | | Grandmother from Father | DF | 1/6 | 4.000.000 | ✓ |
| | | | Sister with the same Father | DF | 2/3 | 16.000.000 | ✓ |
| | | | Brother with the same Mother | DF | 1/3 | 8.000.000 | ✓ |
| 8. | 20.000.000 | Husband | Wife | DF | 1/4 | 4.615.38 | ✓ |
| | | | Mother | DF | 1/6 | 3.076.92 | ✓ |
| | | | Sister with the same Father | DF | 2/3 | 12.307.692 | ✓ |
| | | *Ar-* | | | | | |
| 9. | 20.000.000 | Husband | Wife | DF | 1/8 | 2.608.69 | ✓ |
| | | | Mother | DF | 1/6 | 3.478.26 | ✓ |
| | | | Daughter | DF | 1/2 | 10.434.78 | ✓ |
| | | | Grand daughter | DF | 1/6 | 3.478.26 | ✓ |
| 10. | 25.000.000 | Husband | Wife | DF | 1/8 | 3.260.87 | ✓ |
| | | | Grandmother from Father | DF | 1/6 | 4.347.826 | ✓ |
| | | | Daughter | DF | 1/2 | 13.043.47 | ✓ |
| | | | Grand daughter | DF | 1/6 | 4.347.82 | ✓ |

## 5. Conclusion

Breadth First Search method applied to the application of Waris calculation according to Islamic law can run well. This method applies to the case of the heirs who are entitled to get the treasure by making a rule first on the database. In determining the value of Waris rights carried out first search of the heirs entitled to Waris rights, after it determined the value of inheritance rights to the heirs by using calculations according to imam Hanafi and imam Hanbali

For the future research, it can be developed to automate the distribution of Waris for special cases such as musharakah, gharawain, and al-jaddu wal-ikhwah. Where musharaka is linguistically means "united", that is, if the heirs who in the calculation of the mawaris should have an inheritance, but did not get, it is recommended to the beneficiary who gets a share. Gharawain means two bright ones, two bright problems of solution. The two problems are: 1. Division of inheritance if the heirs of husband, mother, and father. 2. Distribution of inheritance if the heirs of wives, mothers, and fathers. While al-jaddu wal-ikhwah is a condition where there are grandfathers as heirs along with brothers of heirs.

## Acknowledgement

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