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Research Paper

Generalization of A-Homeomorphisms in Topological Space

Mathematics

KEYWORDS : gα-homeomorphisms, α*-homeomorphisms and α-homeomorphisms.

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ABSTRACT

In this paper we introduce the homeomorphisms such as called gα-homeomorphisms, α-homeomorphisms, α- homeomorphisms, g- homeomorphisms and αg-homeomorphisms. We discuss few definitions of various kinds of closed, open sets and functions such as gα, αg-closed and open sets, pre α-open and gα-irresolute, α-irresolute functions etc. With the detailed study on above mentioned sets and functions, we prove that the relations between the above mentioned homeomorphisms.*

INTRODUCTION:

Research on the field of generalized closed sets was developed by many authors in the last two decades. The theory was extensively developed in the 1990's. Several new concepts were studied and investigated. Generalized homeomorphisms via generalized closed sets and gc-homeomorphisms in terms of preserving generalized closed sets were first introduced by Maki, Sundaram and Balachandran. Every homeomorphism is a generalized homeomorphism but not vice versa. For more generalizations of homeomorphisms and relations among of them, R.Devi introduced the concepts of gα-closed sets in topological spaces. They also introduced and studied the properties of gα -continuous, gα -irresolute, gα –homeomorphism etc. In this paper, we study the relations between the different kinds of homeomorphisms such as gα-homeomorphisms, α*-homeomorphisms and α-homeomorphisms

Throughout this paper (X, τ), (Y, σ) represent non-empty topological spaces on which no separation axioms are assumed unless or otherwise mentioned. For a subset A of a topological space(X, τ), cl (A), int (A), denotes the closure of A, the interior of A.

Let us recall the following definitions, which are useful in studying the relationship between the various kinds of homeomorphisms in detail.

PRELIMNARIES:

Definition: A subset A of X is called α set or 'α–open set' if A⊂ int (cl (int (A))).

Definition: A subset of a topological space (X, τ) is called 'α-closed' if cl (int (cl (A))) ⊂A.

Definition: A subset of a topological space (X, τ) is called 'g-closed' (or)'generalized closed' if cl (A) ⊂A whenever A⊂U and U is open in (X, τ).

Definition: The complement of g- closed set is called 'g-open set'

Definition: A subset A of topological space (X, τ) is called 'gα-closed' (or) 'generalized α-closed' if α-cl (A) ⊂ U whenever A ⊂ U &U is α – open in (X, τ).

Definition: The complement of gα- closed set is called 'gα-open set'

Definition: A map f: (X, τ) → (Y, σ) is said to be 'α –irresolute' if for each α- closed set F of (Y, σ), f-1 (F) is α-closed in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'gα- irresolute' if for each gα- closed set F of (Y, σ), f-1(F) is gα-closed in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'αg- irresolute' if for each αg- closed set F of (Y, σ), f-1(F) is αg-closed in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is called 'α-closed map' if for each closed set F of (X, τ), f (F) is α-closed in (Y, σ).

Definition: A map f: (X, τ) → (Y, σ) is called 'α-open map' if for each open set of (X, τ), f (F) is α-open in (Y, σ).

Definitiono: A map f: (X, τ) → (Y, σ) is called 'g-Open map' if for each open set of (X, τ), f (F) is g-open in (Y, σ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'gα-closed' if for each closed set F of (X, τ), f (F) is gα-closed in (Y, σ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'gα-open' if for each open set F of (X, τ), f (F) is gα-open in (Y, σ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'pre α- closed map' if for each α- closed set F of (X, τ), f (F) is α-closed in (Y, σ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'pre α –open map' if for each α-open set F of (X, τ), f (F) is α-open in(Y, σ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'α-continuous' if for each open (closed) set F of (Y, σ), f-1(F) is α-open (α-closed) in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'gα- continuous' if for each open (closed) set F of (Y, σ), f-1(F) is gα-open (gα-closed) in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'g- continuous' if for each open (closed) set F of (Y, σ), f-1(F) is g-open (g-closed) in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'α- continuous' if for each open (closed) set F of (Y, σ), f-1(F) is α-open (α-closed) in (X, τ).

Definition: A map f: (X, τ) → (Y, σ) is said to be 'αg- continuous' if for each open (closed) set F of (Y, σ), f-1(F) is αg-open (αg-closed) in (X, τ).

Definition: A function f: (X, τ) → (Y, σ) is said to be 'Homeomorphism' if it satisfy the following conditions.
(i) it is bijective (1-1 & onto)
(ii) bi-continuous

Definition: A function f: (X, τ) → (Y, σ) is said to be 'α- homeomorphism' if it satisfy the following conditions.
(i) it is bijective (1-1 & onto)
(ii) α – irresolute
(iii) Pre α- open map.

Definition: A function f: (X, τ) → (Y, σ) is said to be 'g-homeomorphism' if it satisfy the following conditions
(i) it is bijective (1-1 & onto)
(ii) g- continuous
(iii) g- Open map.

Definition: A function f: (X, τ) → (Y, σ) is said to be 'α*-homeomorphism' if it satisfy the following conditions.
(i) it is bijective (1-1 & onto)
(ii) Continuous map
(iii) α- open map.

Definition: A function f: (X, τ) → (Y, σ) is said to be 'gα- homeomorphism' if it satisfy the following conditions

(i) it is bijective (1-1 & onto)
(ii) gα- continuous
(iii) gα- open map.

Theorem:
Every Homeomorphism is α- homeomorphism. Converse is not true.

Proof:
Let f: (X, τ) → (Y, σ) be a homeomorphism. Then
a) f is bijective
b) f is bi- continuous

We have to prove, f is α- homeomorphism.
(i.e.) to prove:
(i) f is bijective
(ii) f is α- irresolute
(iii) f is pre α-open.

From the hypothesis, we have f is bijective.......... (1)
Now to prove, f is α- irresolute.
(i.e.) to prove: For each α- closed set F of (Y, σ), f -1(F) is α - closed set (X, τ)
Since, f is bi continuous
⇒ for each closed set in F in (Y, σ), f-1(F) is closed in (X, τ).
⇒ f -1(F) is α- closed in (X, τ) (since every closed set is α- closed)

Hence, f is α- irresolute............. (2)
Now to show that, f is pre α-open map.
(i.e.) to show that for each α-open set F of (X, τ), f (F) is α-open in (Y, σ).
Since f is bi-continuous,
For each open set F of (X, τ), (f -1)-1(F) is open in (Y, σ).
⇒ f (F) is open in (Y, σ).
⇒ f (F) is α-open in (Y, σ) (since every open set is α –open set).

f is pre α – open ....(3)
From (1), (2) & (3)
⇒ f is α- homeomorphism

Converse Part:
Let X = {a, b, c}
τ = {X, φ, {a}, {c}, {a, c}}
ζ (closed sets of X) ={X, φ, {b, c}, {a, b},{b}}
α –open sets of X ={X, φ, {a}, {c}, {a, c}}
α – closed sets of X ={X, φ, {b, c}, {a, b}, {b}}
Let Y = {1, 2, 3}
σ = {Y, φ, {2}, {3}, {2, 3}}
ζ1 (closed sets of Y) ={Y, φ, {1, 3}, {1, 2}, {1}}
α –open sets of Y ={Y, φ, {2}, {3}, {2, 3}}
α – closed sets of Y ={Y, φ, {1, 3}, {1, 2}, {1}}

Let a function f: (X, τ) → (Y, σ) be defined by
f ({a})={1}
f ({b})={2}
f ({c})={3}

It is clearly seen that, f is bijective.............. (1)
Let V = {1, 2} be an α -closed in (Y, σ).
∴f -1 (V) = f -1({1, 2})
= {a, b}, which is α–closed in (X, τ)

⇒ f is α- irresolute ....(2)
Let M={c} be α- open in (X, τ).
∴f (M) = f ({c})
= {1} which is α-open set in (Y, σ).

⇒ f is pre α- open ....(3)
Hence, f is α- homeomorphism.
Let V = {2} be an open set in(Y, σ).
∴f -1 (V) = f -1 ({2})
= {b}, which is not open in (X, τ).

⇒ f is not continuous
Hence f is not homeomorphism; however f is α- homeomorphism
Hence the proof

Theorem:
Every homeomorphism is α*-homeomorphism. Converse is not true.

Proof:
Let f: (X, τ) → (Y, σ) be a homeomorphism.
⇒ f is bijective & f is bi- continuous.
To prove: f is α*-homeomorphism
(i.e.) to prove:

(i) f is bijective
(ii) f is continuous map.
(iii) f is α- open map.

From the hypothesis, we seen that f is bijective& continuous.
It is enough, to show that f is α –open.
(i.e.) to show that, for every open set A in (X, τ), f (A) is α-open in (Y, σ).
Let A be the open set in (X, τ).
=>A⊂ X & A ∈ τ
f (A) ⊂f (X)

f (A) ⊂ Y (since f(X) =Y)..........(1)
int (f(A))⊂ int Y
cl (int (f(A)))⊂ cl (int (Y))
int (cl (int (f(A))))⊂ int (cl(f(A)))

int (cl (int (f(A))))⊂ Y...........(2)
From (1) & (2)
f (A) ⊂ Y ⇒ int (cl(int (f(A)))) ⊂ Y
⇒ f (A) ⊂ int (cl (int (f(A))))
Thus, f (A) is α-open in (Y, σ)
Thus, f is α- open map.
Hence, f is α*-homeomorphism.

Converse Part:
Let X = {a, b, c}
τ = {X, φ, {a}, {c}, {a, c}}
ζ (closed sets of X) ={X, φ, {b, c}, {a, b},{b}}
α –open sets of X ={X, φ, {a}, {c}, {a, c}}
α – closed sets of X ={X, φ, {b, c}, {a, b}, {b}}
Let Y = {1, 2, 3}
σ = {Y, φ, {1}, {2}, {1, 2}}
ζ1 (closed sets of Y) ={Y, φ, {2, 3}, {1, 3}, {3}}
α –open sets of Y ={Y, φ, {1}, {2}, {1, 2}}
α – closed sets of Y ={Y, φ, {2, 3}, {1, 3}, {3}
Let a function f: (X, τ) → (Y, σ) be defined by
f ({a})={3}
f ({b})={2}
f ({c})={1}

It is clearly seen that, f is bijective (1-1& onto)........... (1)
Let F = {1, 3} be closed in (Y, σ).
∴ f -1(F) = f -1({1, 3})
= {a, b}, which is closed in (X, τ).

⇒ f is continuous ....(2)
Let M ={c} be open in (X, τ).
∴f (M) = f ({c})
= {1} which is α-open set in (Y, σ).

⇒ f is α- open map ....(3)
Hence, f is α*- homeomorphism.
Let V= {b} be closed in (X, τ).
∴ (f -1) -1 (V) = (f -1)-1 ({b})
= {1}, which is not closed in (Y, σ).

⇒ f-1 is not continuous……. (4)
Hence f is not homeomorphism however f is α*- homeomorphism.

Theorem:
Every α*- homeomorphism is α-homeomorphism but converse is need not true.

Proof:
Let f: (X, τ) → (Y, σ) be α*- homeomorphism.

a) f is bijective
b) f is continuous
c) f is α- open map

To prove: f is α- homeomorphism
(i.e.) to prove:
(i) f is bijective
(ii) f is α –irresolute
(iii) f is pre α-open map.

From the hypothesis, f is bijective (1-1& onto)....... (1)
Now to show that, f is α –irresolute.
(i.e.) to show that, for each closed set F of (Y, σ), f-1 (F) is α-closed in (X, τ).
Let F be the closed in(Y, σ).
Since f is continuous
=>for each closed set in F in (Y, σ), f-1 (F) is closed in (X, τ).
⇒ f-1 (F) is α- closed in (X, τ) (since every closed set is α- closed)

Hence, f is α- irresolute............. (2)
Next to show that, f is pre α-open map.
(i.e.) to show that, for each α-open set A of (X, τ), f(A) is α-open set in (Y, σ).
Let A be α- open set in (X, τ).
To show that, f (A) is α-open set in (Y, σ).
Since f is α- open map, for each open set A of (X, τ), f (A) is α-open set in (Y, σ).
⇒f (A) is α-open in (Y, σ).

Thus, f is pre α-open map........... (3)
From (1), (2) & (3)
⇒ f is α- homeomorphism .

Converse Part:
Let X = {1, 2, 4}
τ = {X, φ, {2}, {4}, {2, 4}}
ζ (closed sets of X) ={X, φ, {1,4}, {1,2},{1}}
α –open sets of X ={X, φ, {2}, {4}, {2, 4}}
α – closed sets of X={X, φ, {1, 4}, {1, 2} {1}}
Let Y = {a, b, c}
σ = {Y, φ, {b}, {c}, {b, c}}
ζ1 (closed sets of Y) ={Y, φ, {a, c}, {a, b},{a}}
α –open sets of Y ={Y, φ, {b}, {c}, {b, c}}
α – closed sets of Y ={Y, φ, {a, c}, {a, b}, {a}}
Let a function f: (X, τ) → (Y, σ) be defined by
f ({1})= {b, a}
f ({2})={a}
f ({4})={c, b}

It is clearly seen that, f is bijective (1-1& onto).......... (1)
Let V= {a, b} be closed set in (Y, σ).
∴ f -1 (V) = f -1({a, b})
= {1}, which is α -closed in (X, τ).

⇒ f is α- irresolute ....(2)
Let F = {4} be α -open sets in (X, τ).
∴f (F) = f ({4})
= {b, c} which is α-open set in (Y, σ).

⇒ f is pre α- open ....(3)
Hence, f is α- homeomorphism.

Let V= {2} be an open in (X, τ).
f (V) = f ({2})
= {a}, which is not open in (Y, σ). .
⇒ f is not α- open map ....(2)

Hence f is not α*- homeomorphism, however f is α- homeomorphism.
Hence the proof

Theorem:
Every α*- homeomorphism is gα-homeomorphism. Converse is not true.

Proof:
Let f: (X, τ) → (Y, σ) be α*- homeomorphism. Then

a) f is bijective (1-1 &onto)
b) f is continuous
c) f is α- open map

To prove: f is gα- homeomorphism.
(i.e.) to prove:
(i) f is bijective(1-1 &onto)
(ii) f is gα –continuous
(iii) f is gα- open map .

From the hypothesis, we have f is bijective………. (1)
Now to show that, f is gα–continuous .
(i.e.) to show that, for each closed set in (Y, σ), then there exists gα –closed set in (X, τ).
Let A be the closed set in(Y, σ).
(i.e.) .To show that, f -1 (A) is gα – closed in (X, τ).
Since f is continuous,
⇒ for each closed set in A in (Y, σ). , f -1 (A) is closed in (X, τ).
⇒ f -1(A) is gα- closed in (X, τ) (since every closed set is gα – closed set)

⇒ f is gα–continuous ……….(2)
Now to prove, f is gα – open map
Since f is gα – continuous, then f-1 is also gα- continuous
(By the result, "For any bijection f: (X, τ) → ((Y, σ) the following statements are equivalent
(i) f -1 is also αg- continuous
(ii) f is αg- open map ")

⇒ f is gα- open map……………..(3)
From (1), (2) and (3)
Hence f is gα- homeomorphism.

Converse Part:
Let X = {a, b, c}
τ = {X, φ, {a}, {b}, {a, b}}
ζ (closed sets of X) ={X, φ, {b ,c}, {a, c},{c}}
gα –is open sets of X ={X, φ, {b, c}, {a, c}, {c}}
Let Y = {a, b, c}
σ = {Y, φ, {b}, {c}, {b, c}}
ζ1 (closed sets of Y) ={Y, φ, {a, c}, {a, b},{a}}
gα –closed sets of Y ={Y, φ, {a, c}, {a, b}, {a}}
Let a function f: (X, τ) → (Y, σ) be defined by
f ({a})={b}
f ({b})={a}
f ({c})={c}

It is clearly seen that, f is bijective (1-1& onto)........... (1)
Let F= {a, c} be closed set in (Y, σ).
∴f -1 (F) = f -1 ({a, c})
= {b, c}, which is gα- closed in (X, τ).

⇒ f is gα- continuous ....(2)
Let V= {a} be open sets in (Y, σ).
∴f (V) = f ({a})
= {b} which is gα-open set in (Y, σ) .

⇒ f is gα- open map............(3)
From (1), (2) & (3)
f is gα- homeomorphism but f is not α*- homeomorphism.
Let M = {b} be open in (Y, σ).
∴f -1(M) = f -1 ({b})
= {a} which is open in (X, τ)
Thus, f is continuous
Let V= {a, b} be open in (X, τ).
∴f (V) =f({a, b})
= {a, b} which is not α -open in (Y, σ)
Thus f is not α -continuous
Hence f is not α*- homeomorphism however f is gα-homeomorphism Hence the proof

Theorem:
Every g- homeomorphism is a αg-homeomorphism. Converse is not true.

Proof:
Let a function f: (X, τ) → (Y, σ) be g- homeomorphism. Then

a) f is bijective (1-1 &onto)
b) f is g-continuous
c) f is g- open map

To prove: f is αg- homeomorphism
(i.e.) to prove:
(i) f is bijective(1-1 &onto)
(ii) f is αg –continuous
(iii) f is αg- open map .

From the hypothesis, we have f is bijective…… (1)
Now to show that, f is αg–continuous .
(i.e.) to show that, for each closed set F of (Y, σ), f-1 (F) is αg –closed set in (X, τ).
Since f is g-continuous,
⇒ for each closed set in F in (Y, σ). , f-1 (F) is g-closed in (X, τ).
⇒ f-1(F) is αg- closed in (X, τ) (since every g– closed set is αg-closed)

Hence, f is αg – continuous………….. (2)
Next to show that, f is αg – open map
(i.e.) to show that, For each open set V of (X, τ), f(V) is αg – open in (Y, σ)
Since, f is g-open map, for each open set V of (X, τ), f(V) is g-open in (Y, σ)
⇒ f (V) is open in(Y, σ)
⇒ f (V) is αg – open in(Y, σ) (Since every open set is αg – open set)
Hence f is gα- homeomorphism.

Converse Part:
Let X = {a, b, c}
τ = {X, φ, {b}, {c}, {c, b}}
ζ (closed sets of X) ={X, φ, {a ,c}, {a, b},{c}}
g- Open sets of X ={X, φ, {b, c}, {b}, {c}}
αg- Open sets of X ={X, φ, {b, c}, {b}, {c}}
g- Closed sets of X ={X, φ, {a, c}, {a, b}, {a}}
αg –Closed sets of X ={X, φ, {a, c}, {a, b}, {a}}
Let Y = {r, s, t}
σ = {Y, φ, {s}, {t}, {s, t}}
ζ 1 (closed sets of Y) ={Y, φ, {r, t}, {r, s},{r}}
g –closed sets of Y ={Y, φ, {r, t}, {r, s},{r}}
αg –closed sets of Y ={Y, φ, {r, t}, {r, s},{r}}
Let a function f: (X, τ) → (Y, σ) be defined by
f ({a})={s}
f ({b})={t}
f ({c})={r}
It is clearly seen that, f is bijective (1-1& onto)........... (1)

Let M= {r, s} be a closed set in (Y, σ).
Then, f-1 (M) = f-1 ({r, s})
= {a, c}, which is αg- closed in (X, τ).
⇒ f is αg- continuous ....(2)
Let K= {b} be open sets in (X, τ).
∴f (K) = f ({b})
= {t} which is αg-open set in (Y, σ) .
⇒ f is αg- open map ....(3)
Hence, f is αg- homeomorphism.
Let V={r} be open set in (Y, σ).
f -1 (V) = f -1 ({r})
= {c} which is g-closed in (X, τ)
Thus f is not continuous
Hence f is not g- homeomorphism however f is αg-homeomorphism
Hence the proof

Theorem:
Every gα- homeomorphism is a αg-homeomorphism. Converse is not true.

Proof:
Let a function f: (X, τ) → (Y, σ) be gα - homeomorphism. Then
a) f is bijective (1-1 &onto)
b) f is gα -continuous
c) f is gα - open map

To prove: f is αg- homeomorphism
(i.e.) to prove:
(i) f is bijective(1-1 &onto)
(ii) f is αg –continuous
(iii) f is αg- open map .

From the hypothesis, we have f is bijective…… (1)
Now to show that, f is αg–continuous .
(i.e.) to show that, for each closed set in (Y, σ), then there exists αg -closed in (X, τ).
Since f is gα-continuous,
⇒ for each closed set in F in (Y, σ). , f -1 (F) is gα -closed in (X, τ).
⇒ f -1 (F) is gα -closed in (X, τ).
Let f -1 (F) = M
⇒α-cl(M)⊂U Whenever M⊂U where U is α-open in (X, τ).

Hence f -1 (F) = M is αg- closed map……… (2)
Thus, f is αg- continuous.
Next to show that, f is αg- open map
(i.e.) to show that, For each open set V of (X, τ), f (V) is αg– open in (Y, σ)
Since, f is gα-open map,
For each open set V of (X, τ), f (V) is gα-open in (Y, σ)
⇒ (f (V))c is gα-closed in (Y, σ), for each closed set Vc in (X, τ).
Let (f (V))c = N is gα-closed in (Y, σ)
⇒α-cl (N)⊂U Whenever N⊂U where U is α-open in (X, τ).
⇒α-cl (N)⊂U Whenever N⊂U where U is open in (X, τ).
Hence (f (V))c = N is αg- closed in(Y, σ)

Thus f is αg- open map……….. (3)
From (1), (2) and (3)
Hence f is αg- homeomorphism.

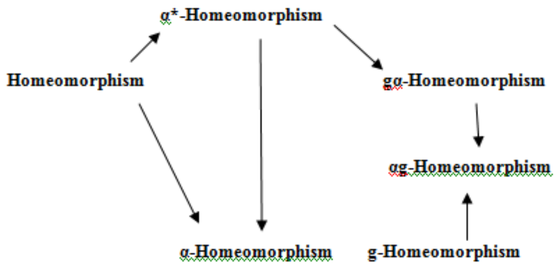
Converse Part:
Let X = {a, b, c}
τ = {X, φ, {a}, {c}, {c, a}}
ζ (closed sets of X) ={X, φ, {b ,c}, {a, b},{b}}
α-closed sets of X ={X, φ, {b ,c}, {a, b},{b}}
αg –closed sets of X ={X, φ, {b ,c}, {a, b},{b}}

Let Y = {1, 2, 3}
σ = {Y, φ, {1}, {2}, {1, 2}}
ζ 1 (closed sets of Y) ={Y, φ, {2, 3}, {1, 3},{3}}
α –open sets of Y ={Y, φ, {1, 2}, {2}, {1}}
αg –open sets of Y ={Y, φ, {1, 2}, {2}, {1}}
gα –closed sets of Y ={Y, φ, {2, 3}, {1, 3}, {3}}
Let a function f: (X, τ) → (Y, σ) be defined by
f ({a}) ={2}
f ({b}) ={1}
f ({c}) ={3}

It is clearly seen that, f is bijective (1-1& onto)........... (1)
Let V= {1, 3} be a closed set in (Y, σ).
Then, f -1 (V) = f -1 ({1, 3})
= {b, c}, which is αg- closed in (X, τ).

⇒ f is αg- continuous............ (2)
Let K= {a} be open sets in (X, τ).
Then, f (K) = f ({a})
= {2} which is αg-open set in (Y, σ) .
⇒ f is αg- open map ....(3)
Hence, f is αg- homeomorphism.
Let V = {3} be open set in (Y, σ).
∴f -1 (V) = f -1 ({3})
= {c} which is not gα-closed in (X, τ)
Thus f is not gα- continuous
Hence f is not gα- homeomorphism however f is αg-homeomorphism
Hence the proof

CONCLUSION:
From the above discussions, we have the following relations between the different kinds of homeomorphisms which lead to develop or draw the wide applications of it in the areas of medical, engineering …etc. In the following diagram, A B means A implies B but not conversely.



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