Toposym 2016

Dynamical systems S. Garcia-Ferreir Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case

Dynamical systems on compact metric countable spaces

S. Garcia-Ferreira Coauthors: Y. Rodriguez-López and C. Uzcátegui

Centro de Ciencias Matemáticas Universidad Nacional Autónoma de México sgarcia@matmor.unam.mx

Prague, Czech Republic, 2016

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

Content

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case Questions

1 Ellis semigroup

- 2 Countable spaces
- 3 Ultrafilters
- 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

▲口 → ▲圖 → ▲ 臣 → ▲ 臣 → □ 臣 □

8 Questions

Dynamical systems S. Garcia-Ferreir Ellis Semigroup Countable space

p-limit points p-iterate Cardinality Countable cas

Questions

In our dynamical systems (X, f), X will be a compact metric space and $f: X \to X$ a continuous function.

For $n \in \mathbb{N}$, f^n denotes the *n*-iterate of a continuous function $f: X \to X$.

Given a dynamical system (X, f), the *Ellis semigroup*, denoted by E(X, f), is the pointwise closure of $\{f^n : n \in \mathbb{N}\}$ in the compact space X^X with composition of functions as its algebraic operation.

Dynamical systems . Garcia-Ferreir

Ellis Semigroup Countable spaces Ultrafilters p-limit points p-iterate Cardinality Countable case

In our dynamical systems (X, f), X will be a compact metric space and $f : X \to X$ a continuous function.

For $n \in \mathbb{N}$, f^n denotes the *n*-iterate of a continuous function $f: X \to X$.

Given a dynamical system (X, f), the *Ellis semigroup*, denoted by E(X, f), is the pointwise closure of $\{f^n : n \in \mathbb{N}\}$ in the compact space X^X with composition of functions as its algebraic operation.

Dynamical systems 5. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case

Questions

In our dynamical systems (X, f), X will be a compact metric space and $f: X \to X$ a continuous function.

For $n \in \mathbb{N}$, f^n denotes the *n*-iterate of a continuous function $f: X \to X$.

Given a dynamical system (X, f), the *Ellis semigroup*, denoted by E(X, f), is the pointwise closure of $\{f^n : n \in \mathbb{N}\}$ in the compact space X^X with composition of functions as its algebraic operation.

Dynamical systems 5. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case

Questions

In our dynamical systems (X, f), X will be a compact metric space and $f: X \to X$ a continuous function.

For $n \in \mathbb{N}$, f^n denotes the *n*-iterate of a continuous function $f: X \to X$.

Given a dynamical system (X, f), the *Ellis semigroup*, denoted by E(X, f), is the pointwise closure of $\{f^n : n \in \mathbb{N}\}$ in the compact space X^X with composition of functions as its algebraic operation.

systems S. Garcia-Ferrein Ellis Semigroup Countable space Ultrafilters

Dynamical

p-iterate

Cardinality

Countable cas

Questions

Old Problem

liven a compact metric space X, when are the functions of

$$E(X,f) \setminus \{f^n : n \in \mathbb{N}\} = E(X,f)^n$$

either all continuous or all discontinuous?

The answer is yes when X is a convergent sequence with its limit point.

Dynamical systems . Garcia-Ferre

Ellis Semigroup Countable spaces Ultrafilters p-limit points p-iterate Cardinality Countable case

Old Problem

Given a compact metric space X, when are the functions of

$$E(X,f)\setminus\{f^n: n\in\mathbb{N}\}=E(X,f)^*$$

either all continuous or all discontinuous?

The answer is yes when X is a convergent sequence with its limit point.

Dynamical systems . Garcia-Ferrei

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate

Cardinality

Countable case

Questions

Old Problem

Given a compact metric space X, when are the functions of

$$E(X,f)\setminus\{f^n: n\in\mathbb{N}\}=E(X,f)^*$$

either all continuous or all discontinuous?

E

The answer is yes when X is a convergent sequence with its limit point.

Dynamical systems . Garcia-Ferrei

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate

Cardinality

Countable case

Questions

Old Problem

Given a compact metric space X, when are the functions of

$$E(X,f)\setminus\{f^n: n\in\mathbb{N}\}=E(X,f)^*$$

either all continuous or all discontinuous?

E

The answer is yes when X is a convergent sequence with its limit point.

Content



Countable spaces

1 Ellis semigrou

2 Countable spaces

- 3 Ultrafilters
- 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

▲口 → ▲圖 → ▲ 臣 → ▲ 臣 → □ 臣 □

8 Questions

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

Ultrafilters

p-limit point

p-iterate

Cardinality

Countable case

Questions

heorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

heorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit points
- p-iterate
- Cardinality
- .
- Countable case
- Questions

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

heorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

heorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

Ultrafilters

p-limit point

p-iterate

Cardinality

Countable case

Questions

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

heorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

Ultrafilters

p-limit point

p-iterate

Cardinality

Countable case

Questions

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

Ultrafilters

p-limit point

p-iterate

Cardinality

Countable case

Questions

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

Ultrafilters

p-limit point

p-iterate

Cardinality

Countable case

Questions

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space and every accumulation point of X is periodic. Then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Theorem, 2015

Let (X, f) be a dynamical system such that X is a compact metric countable space. If X has finitely many accumulation points, then either all function of $E(X, f)^*$ are continuous or all of them are discontinuous.

Dynamical systems Garcia-Ferre

Ellis Semigroup

Countable spaces

Ultrafilters p-limit point: p-iterate

Cardinality

Countable case

Example, 2015

There is a dynamical system (X, f) where X is a compact metric countable space such that the orbit of each accumulation point is finite and that there are f_0 , $f_1 \in E(X, f)^*$ so that f_0 is continuous on X and f_1 is discontinuous on X.

The space X is the countable ordinal space $\omega^2 + 1$ which is identified with a suitable subspace of \mathbb{R} .

(日) (圖) (E) (E) (E)

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Example, 2015

There is a dynamical system (X, f) where X is a compact metric countable space such that the orbit of each accumulation point is finite and that there are f_0 , $f_1 \in E(X, f)^*$ so that f_0 is continuous on X and f_1 is discontinuous on X.

The space X is the countable ordinal space $\omega^2 + 1$ which is identified with a suitable subspace of \mathbb{R} .

◆□▶ ◆□▶ ◆三▶ ◆三▶ 三三 のへぐ

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit point: p-iterate Cardinality
- Cardinality
- Countable cas
- Questions

Example, 2015

There is a dynamical system (X, f) where X is a compact metric countable space such that the orbit of each accumulation point is finite and that there are f_0 , $f_1 \in E(X, f)^*$ so that f_0 is continuous on X and f_1 is discontinuous on X.

The space X is the countable ordinal space $\omega^2 + 1$ which is identified with a suitable subspace of \mathbb{R} .

◆□▶ ◆□▶ ◆三▶ ◆三▶ 三三 のへぐ

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit points p-iterate Cardinality
- Countable cas
- Questions

Example, 2015

There is a dynamical system (X, f) where X is a compact metric countable space such that the orbit of each accumulation point is finite and that there are f_0 , $f_1 \in E(X, f)^*$ so that f_0 is continuous on X and f_1 is discontinuous on X.

The space X is the countable ordinal space $\omega^2 + 1$ which is identified with a suitable subspace of \mathbb{R} .

- ロ ト - 4 回 ト - 4 □ - 4

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit points p-iterate Cardinality
- Countable cas
- Questions

Example, 2015

There is a dynamical system (X, f) where X is a compact metric countable space such that the orbit of each accumulation point is finite and that there are f_0 , $f_1 \in E(X, f)^*$ so that f_0 is continuous on X and f_1 is discontinuous on X.

The space X is the countable ordinal space $\omega^2 + 1$ which is identified with a suitable subspace of \mathbb{R} .

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup

Countable spaces

- Ultrafilters
- p-limit points p-iterate Cardinality
- Countable cas
- Questions

Example, 2015

There is a dynamical system (X, f) where X is a compact metric countable space such that the orbit of each accumulation point is finite and that there are f_0 , $f_1 \in E(X, f)^*$ so that f_0 is continuous on X and f_1 is discontinuous on X.

The space X is the countable ordinal space $\omega^2 + 1$ which is identified with a suitable subspace of \mathbb{R} .

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters p-limit points p-iterate Cardinality

Countable cas

Questions

In this talk we were interested on the cardinality of the Ellis demigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili tablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \leq \mathfrak{c}$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup

Countable spaces

Ultrafilters p-limit poin

p-iterate

Cardinality

Countable case

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical* systems: Either $|E(X, f)| \le c$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters

p-limit poin

p-iterate

Cardinality

Countable case

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \le c$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters

. . .

curumancy

Countable case

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \le c$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters

p-iterate

Cardinality

Countable ca

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \le \mathfrak{c}$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters

n-iterate

Cardinality

Countable ca

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \le \mathfrak{c}$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \le c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters

n-iterate

Cardinality

Countable ca

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \le \mathfrak{c}$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq c$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality c.

Dynamical systems

Ellis Semigroup

Countable spaces

Ultrafilters

n-iterate

Cardinality

Countable ca

Questions

In this talk we were interested on the cardinality of the Ellis semigroup E(X, f). The work of A. Köhler (1995) and M. E. Glasner and Megrehisvili (2006) contain very interesting results about the cardinality of E(X, f). Indeed, M. E. Glasner and Megrehisvili stablished the *Bourgain-Fremlin-Talagrand dichotomy for dynamical systems*: Either $|E(X, f)| \le \mathfrak{c}$ or E(X, f) contains a copy of $\beta \mathbb{N}$.

We will be mostly concerned with countable compact metrizable spaces. In this case, it is evident that $|E(X, f)| \leq \mathfrak{c}$. Moreover, since E(X, f) is a separable metric space, then E(X, f) is either countable or has cardinality \mathfrak{c} .

Content

Dynamical systems

- S. Garcia-Ferreir Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case
- 1 Ellis semigroup
- 2 Countable spaces
- 3 Ultrafilters
- 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

▲口 → ▲圖 → ▲ 臣 → ▲ 臣 → □ 臣 □

8 Questions

Ultrafilters

Dynamical systems . Garcia-Ferrei Ilis Semigroup

Countable space

Ultrafilters

p-limit points p-iterate Cardinality Countable case Questions $\beta(\mathbb{N})$ will denote the set of all ultrafilters on \mathbb{N} y $\mathbb{N}^* = \beta(\mathbb{N}) \setminus \mathbb{N}$ will be the set of all free ultrafilters on \mathbb{N} .

 $\beta(\mathbb{N})$ is the Stone-Čech compactification of the natural numbers \mathbb{N} with the discrete topology.

If $A \subseteq \mathbb{N}$, then $\hat{A} = \{p \in \beta(\mathbb{N}) : A \in p\}$ is a basic open subset of $\beta(\mathbb{N})$ and $A^* = \hat{A} \setminus \mathbb{N}$ is a basic open subset of \mathbb{N}^* .

Ultrafilters

Dynamical systems Garcia-Ferre

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable cas

 $\beta(\mathbb{N})$ will denote the set of all ultrafilters on \mathbb{N} y $\mathbb{N}^* = \beta(\mathbb{N}) \setminus \mathbb{N}$ will be the set of all free ultrafilters on \mathbb{N} .

 $\beta(\mathbb{N})$ is the Stone-Čech compactification of the natural numbers \mathbb{N} with the discrete topology.

If $A \subseteq \mathbb{N}$, then $\hat{A} = \{p \in \beta(\mathbb{N}) : A \in p\}$ is a basic open subset of $\beta(\mathbb{N})$ and $A^* = \hat{A} \setminus \mathbb{N}$ is a basic open subset of \mathbb{N}^* .

Ultrafilters

Dynamical systems . Garcia-Ferreir

Countable spaces

Ultrafilters

p-limit points p-iterate Cardinality Countable case Questions $\beta(\mathbb{N})$ will denote the set of all ultrafilters on \mathbb{N} y $\mathbb{N}^* = \beta(\mathbb{N}) \setminus \mathbb{N}$ will be the set of all free ultrafilters on \mathbb{N} .

 $\beta(\mathbb{N})$ is the Stone-Čech compactification of the natural numbers \mathbb{N} with the discrete topology.

If $A \subseteq \mathbb{N}$, then $\hat{A} = \{p \in \beta(\mathbb{N}) : A \in p\}$ is a basic open subset of $\beta(\mathbb{N})$ and $A^* = \hat{A} \setminus \mathbb{N}$ is a basic open subset of \mathbb{N}^* .

- ロ ト - 4 回 ト - 4 □ - 4
Ultrafilters

Dynamical systems Garcia-Ferreir

Countable spaces

Ultrafilters

p-limit points p-iterate Cardinality Countable case Questions $\beta(\mathbb{N})$ will denote the set of all ultrafilters on \mathbb{N} y $\mathbb{N}^* = \beta(\mathbb{N}) \setminus \mathbb{N}$ will be the set of all free ultrafilters on \mathbb{N} .

 $\beta(\mathbb{N})$ is the Stone-Čech compactification of the natural numbers \mathbb{N} with the discrete topology.

If $A \subseteq \mathbb{N}$, then $\hat{A} = \{p \in \beta(\mathbb{N}) : A \in p\}$ is a basic open subset of $\beta(\mathbb{N})$ and $A^* = \hat{A} \setminus \mathbb{N}$ is a basic open subset of \mathbb{N}^* .

Ultrafilters

Dynamical systems 6. Garcia-Ferreir Ellis Semigroup

Countable spaces

Ultrafilters

p-limit points p-iterate Cardinality Countable case Questions $\beta(\mathbb{N})$ will denote the set of all ultrafilters on \mathbb{N} y $\mathbb{N}^* = \beta(\mathbb{N}) \setminus \mathbb{N}$ will be the set of all free ultrafilters on \mathbb{N} .

 $\beta(\mathbb{N})$ is the Stone-Čech compactification of the natural numbers \mathbb{N} with the discrete topology.

If $A \subseteq \mathbb{N}$, then $\hat{A} = \{p \in \beta(\mathbb{N}) : A \in p\}$ is a basic open subset of $\beta(\mathbb{N})$ and $A^* = \hat{A} \setminus \mathbb{N}$ is a basic open subset of \mathbb{N}^* .

Content

Dynamical systems

- S. Garcia-Ferreira Ellis Semigroup Countable spaces Ultrafilters **p-limit points** p-iterate Cardinality Countable case
- Questions

- 1 Ellis semigroup
- 2 Countable spaces
- 3 Ultrafilters
- 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

▲口 → ▲圖 → ▲ 臣 → ▲ 臣 → □ 臣 □

8 Questions

Dynamical systems

Ellis Semigroup Countable spaces Ultrafilters **p-limit points**

Cardinality Countable c

Questions

Definition [Several mathematicians]

Let $p \in \mathbb{N}^*$. Let X a space and $(x_n)_{n \in \mathbb{N}}$ a sequence in X. We say that $x \in X$ is a *p*-limit of $(x_n)_{n \in \mathbb{N}}$ if for every neighborhood V of x we have that $\{n \in \mathbb{N} : x_n \in V\} \in p$.

We write $x = p - \lim_{n \to \infty} x_n$.

 $x \in X$ is an accumulation point of $\{x_n : n \in \mathbb{N}\}$ iff there is $p \in \mathbb{N}^*$ such that $x = p - \lim_{n \to \infty} x_n$.

In a compact space, every sequence has a p-limit point for every $p\in\mathbb{N}^*.$

・ロト ・ 一下・ ・ モト・ ・ モト・

э

Dynamical systems S. Garcia-Ferreira Ellis Semigroup Countable spaces Ultrafilters p-limit points

p-iterate Cardinality Countable c

Definition [Several mathematicians]

Let $p \in \mathbb{N}^*$. Let X a space and $(x_n)_{n \in \mathbb{N}}$ a sequence in X. We say that $x \in X$ is a *p*-limit of $(x_n)_{n \in \mathbb{N}}$ if for every neighborhood V of x we have that $\{n \in \mathbb{N} : x_n \in V\} \in p$.

We write $x = p - \lim_{n \to \infty} x_n$.

 $x \in X$ is an accumulation point of $\{x_n : n \in \mathbb{N}\}$ iff there is $p \in \mathbb{N}^*$ such that $x = p - \lim_{n \to \infty} x_n$.

In a compact space, every sequence has a p-limit point for every $p\in\mathbb{N}^*.$

ヘロト 人間ト 人団ト 人団ト

э.

Dynamical systems S. Garcia-Ferreira Ellis Semigroup Countable spaces Ultrafilters p-limit points

Cardinality

Questions

Definition [Several mathematicians]

Let $p \in \mathbb{N}^*$. Let X a space and $(x_n)_{n \in \mathbb{N}}$ a sequence in X. We say that $x \in X$ is a *p*-limit of $(x_n)_{n \in \mathbb{N}}$ if for every neighborhood V of x we have that $\{n \in \mathbb{N} : x_n \in V\} \in p$.

We write $x = p - \lim_{n \to \infty} x_n$.

 $x \in X$ is an accumulation point of $\{x_n : n \in \mathbb{N}\}$ iff there is $p \in \mathbb{N}^*$ such that $x = p - \lim_{n \to \infty} x_n$.

In a compact space, every sequence has a p-limit point for every $p\in\mathbb{N}^*.$

Dynamical systems S. Garcia-Ferreira Ellis Semigroup Countable spaces Ultrafilters p-limit points

p-iterate Cardinality

Questions

Definition [Several mathematicians]

Let $p \in \mathbb{N}^*$. Let X a space and $(x_n)_{n \in \mathbb{N}}$ a sequence in X. We say that $x \in X$ is a *p*-limit of $(x_n)_{n \in \mathbb{N}}$ if for every neighborhood V of x we have that $\{n \in \mathbb{N} : x_n \in V\} \in p$.

We write $x = p - \lim_{n \to \infty} x_n$.

 $x \in X$ is an accumulation point of $\{x_n : n \in \mathbb{N}\}$ iff there is $p \in \mathbb{N}^*$ such that $x = p - \lim_{n \to \infty} x_n$.

In a compact space, every sequence has a p-limit point for every $p\in\mathbb{N}^*.$

Dynamical systems S. Garcia-Ferreira Ellis Semigroup Countable spaces Ultrafilters p-limit points

p-iterate Cardinality

Questions

Definition [Several mathematicians]

Let $p \in \mathbb{N}^*$. Let X a space and $(x_n)_{n \in \mathbb{N}}$ a sequence in X. We say that $x \in X$ is a *p*-limit of $(x_n)_{n \in \mathbb{N}}$ if for every neighborhood V of x we have that $\{n \in \mathbb{N} : x_n \in V\} \in p$.

We write $x = p - \lim_{n \to \infty} x_n$.

 $x \in X$ is an accumulation point of $\{x_n : n \in \mathbb{N}\}$ iff there is $p \in \mathbb{N}^*$ such that $x = p - \lim_{n \to \infty} x_n$.

In a compact space, every sequence has a p-limit point for every $p\in\mathbb{N}^*.$

Content

Dynamical systems

- S. Garcia-Ferreir Ellis Semigroup Countable space Ultrafilters p-limit points
- p-iterate
- Cardinality Countable case Questions

- 1 Ellis semigroup
- 2 Countable spaces
- 3 Ultrafilters
 - 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

ヘロト ヘ週ト ヘヨト ヘヨト

Ξ.

8 Questions

Dynamical systems

S. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters

p-limit point

p-iterate

Cardinality Countable cas Questions

Definition

et (X, f) a dynamical system. For each $p \in \mathbb{N}^*$, we define $p^{o}: X \to X$ as $f^{p}(x) = p - lim_{n \to \infty} f^{n}(x)$ for all $x \in X$.

 f^p is called the *p-iterate* of *f*, for $p \in \mathbb{N}^*$.

Unfortunately, *f^p* is not in general continuous.

Dynamical systems

S. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters

p-limit points

p-iterate

Cardinality Countable cas Questions

Definition

Let (X, f) a dynamical system. For each $p \in \mathbb{N}^*$, we define $f^p: X \to X$ as $f^p(x) = p - \lim_{n \to \infty} f^n(x)$ for all $x \in X$.

 f^p is called the *p*-iterate of f, for $p \in \mathbb{N}^*$.

Unfortunately, *f^p* is not in general continuous.

Dynamical systems

S. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters

p-limit points

p-iterate

Cardinality Countable cas

Definition

Let (X, f) a dynamical system. For each $p \in \mathbb{N}^*$, we define $f^p: X \to X$ as $f^p(x) = p - \lim_{n \to \infty} f^n(x)$ for all $x \in X$.

◆□▶ ◆□▶ ◆三▶ ◆三▶ 三三 のへぐ

f^p is called the *p*-iterate of f, for $p \in \mathbb{N}^*$.

Unfortunately, *f^p* is not in general continuous.

Dynamical systems

S. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters

p-iterate

Cardinality Countable ca

Definition

Let (X, f) a dynamical system. For each $p \in \mathbb{N}^*$, we define $f^p: X \to X$ as $f^p(x) = p - \lim_{n \to \infty} f^n(x)$ for all $x \in X$.

◆□▶ ◆□▶ ◆三▶ ◆三▶ 三三 のへぐ

 f^p is called the *p*-iterate of f, for $p \in \mathbb{N}^*$.

Unfortunately, f^p is not in general continuous.

Dynamical systems

- S. Garcia-Ferrei
- Countable space
- Ultrafilters
- p-limit points

p-iterate

Cardinality Countable case Questions Let X = [0,1] and let $f : [0,1] \rightarrow [0,1]$ any continuous function such that f(0) = 0, f(1) = 1 and f(t) < 1 for all $t \in (0,1)$. Then, f is a continuous function such that $f^{p}[[0,1)] = 0$ and $f^{p}(1) = 1$, for each $p \in \mathbb{N}^{*}$. Therefore, f^{p} is not continuous at 1, for any $p \in \mathbb{N}^{*}$.

Example

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space

ortraniters

p-limit points

p-iterate

Cardinality Countable case Questions

Let X = [0, 1] and let $f : [0, 1] \rightarrow [0, 1]$ any continuous function such that f(0) = 0, f(1) = 1 and f(t) < 1 for all $t \in (0, 1)$. Then, f is a continuous function such that $f^{p}[[0, 1)] = 0$ and $f^{p}(1) = 1$, for each $p \in \mathbb{N}^{*}$. Therefore, f^{p} is not continuous at 1, for any $p \in \mathbb{N}^{*}$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space
- Ultrafilters
- p-limit points
- p-iterate
- Cardinality Countable cas Questions

Example

Let X = [0, 1] and let $f : [0, 1] \rightarrow [0, 1]$ any continuous function such that f(0) = 0, f(1) = 1 and f(t) < 1 for all $t \in (0, 1)$. Then, f is a continuous function such that $f^p[[0, 1)] = 0$ and $f^p(1) = 1$, for each

▲□▼▲□▼▲□▼▲□▼ □ ● ●

 $m{
ho}\in\mathbb{N}^*.$ Therefore, $f^{m{
ho}}$ is not continuous at 1, for any $m{
ho}\in\mathbb{N}^*.$

Example

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space
- Ultrafilters
- p-limit points
- p-iterate
- Cardinality Countable case Questions

Let X = [0,1] and let $f : [0,1] \rightarrow [0,1]$ any continuous function such that f(0) = 0, f(1) = 1 and f(t) < 1 for all $t \in (0,1)$. Then, f is a continuous function such that $f^p[[0,1)] = 0$ and $f^p(1) = 1$, for each $p \in \mathbb{N}^*$. Therefore, f^p is not continuous at 1, for any $p \in \mathbb{N}^*$.

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space
- Ultrafilters
- p-limit points
- p-iterate
- Cardinality Countable case Questions

Example

Let X = [0,1] and let $f : [0,1] \rightarrow [0,1]$ any continuous function such that f(0) = 0, f(1) = 1 and f(t) < 1 for all $t \in (0,1)$. Then, f is a continuous function such that $f^{p}[[0,1)] = 0$ and $f^{p}(1) = 1$, for each $p \in \mathbb{N}^{*}$. Therefore, f^{p} is not continuous at 1, for any $p \in \mathbb{N}^{*}$.

Dynamical systems

- S. Garcia-Ferreir
- Countable space
- p-limit points

p-iterate

Cardinality Countable cas Questions v using the p-iteration, for $p\ineta(\mathbb{N})$, we can see that $E(X,f)=\{f^p:p\ineta(\mathbb{N})\}$ d

$$E(X,f)^* \subseteq \{f^p : p \in \mathbb{N}^*\}$$

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

for any dynamical system (X, f).

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space

p-iterate

Cardinality Countable ca Ouestions By using the *p*-iteration, for $p \in \beta(\mathbb{N})$, we can see that $E(X, f) = \{f^p : p \in \beta(\mathbb{N})\}$ and $E(X, f)^* \subseteq \{f^p : p \in \mathbb{N}^*\}$ for any dynamical system (X, f)

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

Dynamical systems

- S. Garcia-Ferrei
- Countable space
- Ultrafilters
- p-limit point

p-iterate

- Cardinality
- Countable ca
- Questions

By using the $p\text{-iteration, for }p\in\beta(\mathbb{N}),$ we can see that

$$E(X,f) = \{f^p : p \in \beta(\mathbb{N})\}$$

and

$$E(X,f)^* \subseteq \{f^p : p \in \mathbb{N}^*\}$$

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

for any dynamical system (X, f).

Dynamical systems

S. Garcia-Ferrei

Ellis Semigroup Countable space Ultrafilters

p-iterate

Cardinality Countable cas Questions

Definition

For $p \in \beta(\mathbb{N})$ and $n \in \mathbb{N}$, we define

$$p+n=p-\lim_{m\to\infty}(m+n)$$

Folklor

Now, if $p, q \in \beta(\mathbb{N})$, then we define

$$p+q=q-\lim_{n\to\infty}p+n$$

We know that $\beta(\mathbb{N})$ and \mathbb{N}^* with this operation + are a semigroups.

イロト 不得 トイヨト イヨト

э.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space
- Ultrafilters
- p-limit point

p-iterate

Cardinality Countable ca

Questions

Definition

For $p \in \beta(\mathbb{N})$ and $n \in \mathbb{N}$, we define

$$p+n=p-\lim_{m\to\infty}(m+n)$$

Folklor

Now, if $p, q \in \beta(\mathbb{N})$, then we define

$$p+q=q-\lim_{n\to\infty}p+n$$

We know that $\beta(\mathbb{N})$ and \mathbb{N}^* with this operation + are a semigroups.

Dynamical systems

Countable spaces

Ultrafilters

p-limit points

p-iterate

Cardinality

Countable case

Questions

Definition

For $p \in \beta(\mathbb{N})$ and $n \in \mathbb{N}$, we define

$$p+n=p-\lim_{m\to\infty}(m+n)$$

Folklore

Now, if $p, q \in \beta(\mathbb{N})$, then we define

$$p+q=q-\lim_{n\to\infty}p+n.$$

We know that $\beta(\mathbb{N})$ and \mathbb{N}^* with this operation + are a semigroups.

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

Dynamical systems

Ellis Semigroup Countable spac

.

p-iterate

Cardinality

Questions

Definition

For $p \in \beta(\mathbb{N})$ and $n \in \mathbb{N}$, we define

$$p+n=p-\lim_{m\to\infty}(m+n)$$

Folklore

Now, if $p, q \in \beta(\mathbb{N})$, then we define

$$p+q=q-\lim_{n\to\infty}p+n.$$

We know that $\beta(\mathbb{N})$ and \mathbb{N}^* with this operation + are a semigroups.

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup Countable space Ultrafilters p-limit points **p-iterate** Cardinality Countable case

Questions

heorem, Folklore

If (X, f) is a dynamical system, then,

$$f^p \circ f^q = f^{q+p},$$

for every $p, q \in \beta(\mathbb{N})$.

Notice that if f^p is continuous for some $p \in \mathbb{N}^*$, then f^{p+n} is also continuous for all $n \in \mathbb{N}$.

◆□▶ ◆□▶ ◆□▶ ◆□▶ ●□

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space Ultrafilters
- p-limit points
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem, Folklore

If (X, f) is a dynamical system, then,

$$f^p \circ f^q = f^{q+p},$$

for every $p, q \in \beta(\mathbb{N})$.

Notice that if f^p is continuous for some $p \in \mathbb{N}^*$, then f^{p+n} is also continuous for all $n \in \mathbb{N}$.

▲ロト ▲帰ト ▲ヨト ▲ヨト 三日 - の々ぐ

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters

p-iterate

Cardinality

Countable case

Questions

Theorem, Folklore

If (X, f) is a dynamical system, then,

$$f^p \circ f^q = f^{q+p},$$

for every $p, q \in \beta(\mathbb{N})$.

Notice that if f^p is continuous for some $p \in \mathbb{N}^*$, then f^{p+n} is also continuous for all $n \in \mathbb{N}$.

▲ロト ▲帰ト ▲ヨト ▲ヨト 三日 - の々ぐ

Content

Dynamical systems

- S. Garcia-Ferrei Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality Countable case Questions

- 1 Ellis semigroup
- 2 Countable spaces
- 3 Ultrafilters
- 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

ヘロト ヘ週ト ヘヨト ヘヨト

æ

8 Questions

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable case Questions

⁻heorem

Let (X, f) be a dynamical system. Then E(X, f) is finite iff there exist M > 0 such that $|\mathcal{O}_f(x)| < M$ for each $x \in X$.

It is noteworthy that $E(X, f)^*$ could be finite and E(X, f) could be infinite. For instance, if X is a convergent sequence with its limit point and f is the shift function, then E(X, f) is infinite and $E(X, f)^*$ has only one point.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case Questions

Theorem

Let (X, f) be a dynamical system. Then E(X, f) is finite iff there exist M > 0 such that $|\mathcal{O}_f(x)| < M$ for each $x \in X$.

It is noteworthy that $E(X, f)^*$ could be finite and E(X, f) could be infinite. For instance, if X is a convergent sequence with its limit point and f is the shift function, then E(X, f) is infinite and $E(X, f)^*$ has only one point.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable case

Theorem

Let (X, f) be a dynamical system. Then E(X, f) is finite iff there exist M > 0 such that $|\mathcal{O}_f(x)| < M$ for each $x \in X$.

It is noteworthy that $E(X, f)^*$ could be finite and E(X, f) could be infinite. For instance, if X is a convergent sequence with its limit point and f is the shift function, then E(X, f) is infinite and $E(X, f)^*$ has only one point.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points p-iterate

Cardinality

Countable case

Theorem

Let (X, f) be a dynamical system. Then E(X, f) is finite iff there exist M > 0 such that $|\mathcal{O}_f(x)| < M$ for each $x \in X$.

It is noteworthy that $E(X, f)^*$ could be finite and E(X, f) could be infinite. For instance, if X is a convergent sequence with its limit point and f is the shift function, then E(X, f) is infinite and $E(X, f)^*$ has only one point.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points p-iterate

Cardinality

Countable case

Theorem

Let (X, f) be a dynamical system. Then E(X, f) is finite iff there exist M > 0 such that $|\mathcal{O}_f(x)| < M$ for each $x \in X$.

It is noteworthy that $E(X, f)^*$ could be finite and E(X, f) could be infinite. For instance, if X is a convergent sequence with its limit point and f is the shift function, then E(X, f) is infinite and $E(X, f)^*$ has only one point.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points

Cardinality

Countable case

Questions

Theorem

Let (X, f) be a dynamical system. Then E(X, f) is finite iff there exist M > 0 such that $|\mathcal{O}_f(x)| < M$ for each $x \in X$.

It is noteworthy that $E(X, f)^*$ could be finite and E(X, f) could be infinite. For instance, if X is a convergent sequence with its limit point and f is the shift function, then E(X, f) is infinite and $E(X, f)^*$ has only one point.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case Questions

For a dynamical system (X, f), the ω -limit set of $x \in X$, denoted by $\omega_f(x)$, is the set of points $y \in X$ for which there exists an increasing sequence $(n_k)_{k\in\mathbb{N}}$ such that $f^{n_k}(x) \to y$.

Theorem

Let (X, f) be a dynamical system. $E(X, f)^*$ is finite iff there is $M \in \mathbb{N}$ such that $|\omega_f(x)| \leq M$ for each $x \in X$.
Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points
- p-iterate
- Cardinality
- Countable case Questions

For a dynamical system (X, f), the ω -limit set of $x \in X$, denoted by $\omega_f(x)$, is the set of points $y \in X$ for which there exists an increasing sequence $(n_k)_{k\in\mathbb{N}}$ such that $f^{n_k}(x) \to y$.

「heorem

Let (X, f) be a dynamical system. $E(X, f)^*$ is finite iff there is $M \in \mathbb{N}$ such that $|\omega_f(x)| \leq M$ for each $x \in X$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points
- p-iterate
- Cardinality
- Countable case Questions

For a dynamical system (X, f), the ω -limit set of $x \in X$, denoted by $\omega_f(x)$, is the set of points $y \in X$ for which there exists an increasing sequence $(n_k)_{k\in\mathbb{N}}$ such that $f^{n_k}(x) \to y$.

Theorem

Let (X, f) be a dynamical system. $E(X, f)^*$ is finite iff there is $M \in \mathbb{N}$ such that $|\omega_f(x)| \leq M$ for each $x \in X$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points
- Cardinality
- Countable case
- Questions

For a dynamical system (X, f), the ω -limit set of $x \in X$, denoted by $\omega_f(x)$, is the set of points $y \in X$ for which there exists an increasing sequence $(n_k)_{k \in \mathbb{N}}$ such that $f^{n_k}(x) \to y$.

Theorem

Let (X, f) be a dynamical system. $E(X, f)^*$ is finite iff there is $M \in \mathbb{N}$ such that $|\omega_f(x)| \leq M$ for each $x \in X$.

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space
- Ultrafilters
- p-limit point
- p-iterate
- Cardinality Countable car

For a dynamical system (X, f), let P_f denote the set of all periods of the periodic points of (X, f) which are accumulation points.

heorem

Let (X, f) be a dynamical system. If $E(X, f)^*$ is finite, then P_f is finite.



For a dynamical system (X, f), let P_f denote the set of all periods of the periodic points of (X, f) which are accumulation points.

heorem

Let (X, f) be a dynamical system. If $E(X, f)^*$ is finite, then P_f is finite.



For a dynamical system (X, f), let P_f denote the set of all periods of the periodic points of (X, f) which are accumulation points.

Theorem

Let (X, f) be a dynamical system. If $E(X, f)^*$ is finite, then P_f is finite.



countable spa

p mine pon

p-iterate

Cardinality

Questions

For a dynamical system (X, f), let P_f denote the set of all periods of the periodic points of (X, f) which are accumulation points.

Theorem

Let (X, f) be a dynamical system. If $E(X, f)^*$ is finite, then P_f is finite.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigrou
- Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable case Questions

heorem

Let (X, f) be a dynamical system. If P_f is infinite, then E(X, f) has at least size \mathfrak{c} .

Theorem

Let (X, f) be a dynamical system and assume that X has a point with dense orbit. If f^p is continuous for every $p \in \mathbb{N}^*$, then $|E(X, f)^*| \leq |X|$.

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigrou
- Countable space
- Ultrafilters
- p-limit points
- p-iterate
- Cardinality
- Countable case Questions

Theorem

Let (X, f) be a dynamical system. If P_f is infinite, then E(X, f) has at least size c.

Theorem

Let (X, f) be a dynamical system and assume that X has a point with dense orbit. If f^p is continuous for every $p \in \mathbb{N}^*$, then $|E(X, f)^*| \leq |X|$.

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigrou
- Countable space
- Ultrafilters
- p-limit points
- p-iterate
- Cardinality
- Countable case

Theorem

Let (X, f) be a dynamical system. If P_f is infinite, then E(X, f) has at least size \mathfrak{c} .

Theorem

Let (X, f) be a dynamical system and assume that X has a point with dense orbit. If f^p is continuous for every $p \in \mathbb{N}^*$, then $|E(X, f)^*| \leq |X|$.

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigrou
- Countable space
- Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem

Let (X, f) be a dynamical system. If P_f is infinite, then E(X, f) has at least size \mathfrak{c} .

Theorem

Let (X, f) be a dynamical system and assume that X has a point with dense orbit. If f^p is continuous for every $p \in \mathbb{N}^*$, then $|E(X, f)^*| \leq |X|$.

▲ロト ▲帰ト ▲ヨト ▲ヨト 三日 - の々ぐ

Content

Dynamical systems

- S. Garcia-Ferrei Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality Countable case
- Questions
- 2 Countable space
 3 Ultrafilters
 4 The p-limit po
 5 p-iterate
 - 6 Cardinality
 - 7 Countable case

▲口 → ▲圖 → ▲ 臣 → ▲ 臣 → □ 臣 □

8 Questions

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters p-limit points
- precideo
- Cardinality
- Countable case

heorem, S. Mazurkiewicz and W. Sierpinski, 1920

Every compact metric countable space is homeomorphic to a countable ordinal with the order topology.

In what follows, our phase space will be the compact metric space $\omega^{\alpha}+1$ where α is a countable ordinal.

For our convenience, X' will denote the set of limit points of X, d will stand for the unique point of $\omega^{\alpha} + 1$ of CB-rank α and $\{d_n : n \in \mathbb{N}\}$ will be the collection of all its points with CB-rank equal to $\alpha - 1$.

・ロト ・ 四ト ・ ヨト ・ ヨト

э

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Theorem, S. Mazurkiewicz and W. Sierpinski, 1920

Every compact metric countable space is homeomorphic to a countable ordinal with the order topology.

In what follows, our phase space will be the compact metric space $\omega^{\alpha}+1$ where α is a countable ordinal.

For our convenience, X' will denote the set of limit points of X, d will stand for the unique point of $\omega^{\alpha} + 1$ of CB-rank α and $\{d_n : n \in \mathbb{N}\}$ will be the collection of all its points with CB-rank equal to $\alpha - 1$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Theorem, S. Mazurkiewicz and W. Sierpinski, 1920

Every compact metric countable space is homeomorphic to a countable ordinal with the order topology.

In what follows, our phase space will be the compact metric space $\omega^\alpha+1$ where α is a countable ordinal.

For our convenience, X' will denote the set of limit points of X, d will stand for the unique point of $\omega^{\alpha} + 1$ of CB-rank α and $\{d_n : n \in \mathbb{N}\}$ will be the collection of all its points with CB-rank equal to $\alpha - 1$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Theorem, S. Mazurkiewicz and W. Sierpinski, 1920

Every compact metric countable space is homeomorphic to a countable ordinal with the order topology.

In what follows, our phase space will be the compact metric space $\omega^\alpha+1$ where α is a countable ordinal.

For our convenience, X' will denote the set of limit points of X, d will stand for the unique point of $\omega^{\alpha} + 1$ of CB-rank α and $\{d_n : n \in \mathbb{N}\}$ will be the collection of all its points with CB-rank equal to $\alpha - 1$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Theorem, S. Mazurkiewicz and W. Sierpinski, 1920

Every compact metric countable space is homeomorphic to a countable ordinal with the order topology.

In what follows, our phase space will be the compact metric space $\omega^\alpha+1$ where α is a countable ordinal.

For our convenience, X' will denote the set of limit points of X, d will stand for the unique point of $\omega^{\alpha} + 1$ of CB-rank α and $\{d_n : n \in \mathbb{N}\}$ will be the collection of all its points with CB-rank equal to $\alpha - 1$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Theorem, S. Mazurkiewicz and W. Sierpinski, 1920

Every compact metric countable space is homeomorphic to a countable ordinal with the order topology.

In what follows, our phase space will be the compact metric space $\omega^\alpha+1$ where α is a countable ordinal.

For our convenience, X' will denote the set of limit points of X, d will stand for the unique point of $\omega^{\alpha} + 1$ of CB-rank α and $\{d_n : n \in \mathbb{N}\}$ will be the collection of all its points with CB-rank equal to $\alpha - 1$.

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality

Countable case Questions

Lema

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(i)
$$f(y)$$
 is a limit point for every $y \in (\omega^{\alpha} + 1)'$.

(*ii*) The range of f is
$$\omega^{\alpha} + 1 \setminus \{w\}$$
.

iii) If
$$x \in (\omega^{\alpha} + 1)'$$
, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$.

 $(iv) \ 1 \leq CB(f(d))$

Lema

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spaces Ultrafilters p-limit points p-iterate Cardinality Countable case
- Questions

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold: (i) f(y) is a limit point for every $y \in (\omega^{\alpha} + 1)'$. (ii) The range of f is $\omega^{\alpha} + 1 \setminus \{w\}$.

iii) If
$$x \in (\omega^{\alpha} + 1)'$$
, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$.

```
(iv) \ 1 \leq CB(f(d))
```

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case

Questions

Lema

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(*i*) f(y) is a limit point for every $y \in (\omega^{\alpha} + 1)'$. *ii*) The range of f is $\omega^{\alpha} + 1 \setminus \{w\}$. *iii*) If $x \in (\omega^{\alpha} + 1)'$, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$ *iv*) $1 \leq CB(f(d))$

Lema

Dynamical systems

S. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case

Lountable ca

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(i) f(y) is a limit point for every $y \in (\omega^{\alpha} + 1)'$.

(ii) The range of f is $\omega^{\alpha} + 1 \setminus \{w\}$. (iii) If $x \in (\omega^{\alpha} + 1)'$, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$. (iv) $1 \leq CB(f(d))$.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable case

Questions

Lema

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

(i) f(y) is a limit point for every $y \in (\omega^{\alpha} + 1)'$.

```
(ii) The range of f is \omega^{\alpha} + 1 \setminus \{w\}.
```

iii) If $x \in (\omega^{\alpha} + 1)'$, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$. iv) $1 \leq CB(f(d))$.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable case

Questions

Lema

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

◆□▶ ◆□▶ ◆三▶ ◆三▶ 三三 のへぐ

(i) f(y) is a limit point for every $y \in (\omega^{\alpha} + 1)'$.

(*ii*) The range of f is
$$\omega^{\alpha} + 1 \setminus \{w\}$$
.

(iii) If
$$x \in (\omega^{\alpha} + 1)'$$
, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$.
(iv) $1 \leq CB(f(d))$.

Dynamical systems

S. Garcia-Ferreira

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable case

Questions

Lema

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

◆□▶ ◆□▶ ◆三▶ ◆三▶ 三三 のへぐ

(i) f(y) is a limit point for every $y \in (\omega^{\alpha} + 1)'$.

(*ii*) The range of f is
$$\omega^{\alpha} + 1 \setminus \{w\}$$
.

(iii) If
$$x \in (\omega^{\alpha} + 1)'$$
, then $\emptyset \neq f^{-1}(x) \subseteq (\omega^{\alpha} + 1)'$.

(iv) $1 \leq CB(f(d))$.

Dynamical systems

S. Garcia-Ferreir

Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality

Countable case

_emma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

i) Let $x \in (\omega^{\alpha} + 1)'$ so that $CB(x) = \gamma < \alpha$ and $CB(y) < \gamma$ for every $y \in f^{-1}(x)$. If $(x_n)_{n \in \mathbb{N}}$ is a sequence such that $x_n \to x$ and $CB(x_n) = \gamma - 1$, for each $n \in \mathbb{N}$, then there is $N \in \mathbb{N}$ such that if $n \ge N$, then $CB(z) < CB(x_n)$ for all $z \in f^{-1}(x_n)$. i) f(d) = d.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Countable case
- Questions

Lemma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

i) Let $x \in (\omega^{\alpha} + 1)'$ so that $CB(x) = \gamma < \alpha$ and $CB(y) < \gamma$ for every $y \in f^{-1}(x)$. If $(x_n)_{n \in \mathbb{N}}$ is a sequence such that $x_n \to x$ and $CB(x_n) = \gamma - 1$, for each $n \in \mathbb{N}$, then there is $N \in \mathbb{N}$ such that if $n \ge N$, then $CB(z) < CB(x_n)$ for all $z \in f^{-1}(x_n)$. ii) f(d) = d.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Countable case
- Questions

Lemma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

i) Let $x \in (\omega^{\alpha} + 1)'$ so that $CB(x) = \gamma < \alpha$ and $CB(y) < \gamma$ for every $y \in f^{-1}(x)$. If $(x_n)_{n \in \mathbb{N}}$ is a sequence such that $x_n \to x$ and $CB(x_n) = \gamma - 1$, for each $n \in \mathbb{N}$, then there is $N \in \mathbb{N}$ such that if $n \ge N$, then $CB(z) < CB(x_n)$ for all $z \in f^{-1}(x_n)$. ii) f(d) = d.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality

Countable case

Questions

Lemma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(i) Let x ∈ (ω^α + 1)' so that CB(x) = γ < α and CB(y) < γ for every y ∈ f⁻¹(x). If (x_n)_{n∈ℕ} is a sequence such that x_n → x and CB(x_n) = γ − 1, for each n ∈ ℕ, then there is N ∈ ℕ such that if n ≥ N, then CB(z) < CB(x_n) for all z ∈ f⁻¹(x_n).
(ii) f(d) = d.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality

Countable case

Questions

Lemma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(i) Let x ∈ (ω^α + 1)' so that CB(x) = γ < α and CB(y) < γ for every y ∈ f⁻¹(x). If (x_n)_{n∈ℕ} is a sequence such that x_n → x and CB(x_n) = γ − 1, for each n ∈ ℕ, then there is N ∈ ℕ such that if n ≥ N, then CB(z) < CB(x_n) for all z ∈ f⁻¹(x_n).
(ii) f(d) = d.

Dynamical systems

- S. Garcia-Ferreira
- Ellis Semigroup Countable spac Ultrafilters p-limit points
- p-iterate
- Cardinality

Countable case

Questions

Lemma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(i) Let x ∈ (ω^α + 1)' so that CB(x) = γ < α and CB(y) < γ for every y ∈ f⁻¹(x). If (x_n)_{n∈ℕ} is a sequence such that x_n → x and CB(x_n) = γ − 1, for each n ∈ ℕ, then there is N ∈ ℕ such that if n ≥ N, then CB(z) < CB(x_n) for all z ∈ f⁻¹(x_n).
(ii) f(d) = d.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points
- Cardinality

Countable case

Lemma

Let $(\omega^{\alpha} + 1, f)$ be a dynamical system with $\alpha \ge 1$ a countable successor ordinal, such that there exists $w \in \omega^{\alpha} + 1$ with a dense orbit. Then the following conditions hold:

(i) Let x ∈ (ω^α + 1)' so that CB(x) = γ < α and CB(y) < γ for every y ∈ f⁻¹(x). If (x_n)_{n∈ℕ} is a sequence such that x_n → x and CB(x_n) = γ − 1, for each n ∈ ℕ, then there is N ∈ ℕ such that if n ≥ N, then CB(z) < CB(x_n) for all z ∈ f⁻¹(x_n).
(ii) f(d) = d.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space
- p-limit point
- p-iterate
- Cardinality
- Countable case

Theorem

Let $(\omega^2 + 1, f)$ be a dynamical system such that there exists $w \in \omega^2 + 1$ with a dense orbit. Then f^p is continuous, for every $p \in \mathbb{N}^*$, and $E^*(\omega^2 + 1, f)$ is countable.

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigrou
- Countable spa
- Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem

Let $(\omega^2 + 1, f)$ be a dynamical system such that there exists $w \in \omega^2 + 1$ with a dense orbit. Then f^p is continuous, for every $p \in \mathbb{N}^*$, and $E^*(\omega^2 + 1, f)$ is countable.

< □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > < □ > <

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigrou
- Ultrafiltore
- p-limit point
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem

Let $(\omega^2 + 1, f)$ be a dynamical system such that there exists $w \in \omega^2 + 1$ with a dense orbit. Then f^p is continuous, for every $p \in \mathbb{N}^*$, and $E^*(\omega^2 + 1, f)$ is countable.

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigrou Countable spac Ultrafilters p-limit points
- p-iterate
- Cardinality
- Countable case

There is a continuous function $f : \omega^3 + 1 \rightarrow \omega^3 + 1$ such that there is a point of $\omega^3 + 1$ with a dense orbit, and

• f^p is discontinuous for every $p \in \mathbb{N}^*$.
Dynamical systems S. Garcia-Ferrei Ellis Semigroup Countable space Ultrafilters

p-limit point

p-iterate

Cardinality

Countable case

Questions

Theorem

There is a continuous function $f:\omega^3+1 ightarrow\omega^3+1$ such that

• there is a point of $\omega^3 + 1$ with a dense orbit, and

• f^p is discontinuous for every $p \in \mathbb{N}^*$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem

There is a continuous function $f:\omega^3+1\rightarrow\omega^3+1$ such that

- \blacksquare there is a point of ω^3+1 with a dense orbit, and
- f^p is discontinuous for every $p \in \mathbb{N}^*$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space
- n-limit noin
- p-iterate
- Cardinality
- Countable case
- Questions

Theorem

There is a continuous function $f:\omega^3+1\rightarrow\omega^3+1$ such that

- \blacksquare there is a point of ω^3+1 with a dense orbit, and
- f^p is discontinuous for every $p \in \mathbb{N}^*$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigrou
- Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable case
- Questions

xample

There is a continuous function $f: \omega^2 + 1 \rightarrow \omega^2 + 1$ such that $E(\omega^2 + 1, f)$ is homeomorphic to the space $\omega^2 + 1$.



p-iterate

Cardinality

Countable case

Questions

Example

There is a continuous function $f: \omega^2 + 1 \rightarrow \omega^2 + 1$ such that $E(\omega^2 + 1, f)$ is homeomorphic to the space $\omega^2 + 1$.

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space
- Ultrafilters
- p-limit points
- p-iterate
- Cardinality
- Countable case
- Questions

Example

There is a continuous function $f: \omega^2 + 1 \rightarrow \omega^2 + 1$ such that $E(\omega^2 + 1, f)$ is homeomorphic to the space $\omega^2 + 1$.

Content

Dynamical systems

- S. Garcia-Ferrei Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate Cardinality Countable case **Ouestions**
- 1 Ellis semigroup
- 2 Countable spaces
- 3 Ultrafilters
- 4 The p-limit points
- 5 p-iterate
- 6 Cardinality
- 7 Countable case

▲口 → ▲圖 → ▲ 臣 → ▲ 臣 → □ 臣 □

8 Questions

Dynamical systems

- S. Garcia-Ferrei
- Ellis Semigroup Countable spaces Ultrafilters p-limit points p-iterate Cardinality Countable case

Questions

Question

Is there a dynamical system (X, f) such that X is connected and there are two functions $f_0, f_1 \in E^*(X, f)$ such that f_0 is continuous and f_1 is discontinuous?

Given a dynamical system $(\omega^{\alpha} + 1, f)$ with dense orbit, where $\alpha > 3$, is $E(\omega^{\alpha} + 1, f)$ always countable?

◆□▶ ◆□▶ ◆□▶ ◆□▶ ●□

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spaces Ultrafilters p-limit points p-iterate Cardinality Countable case

Questions

Question

Is there a dynamical system (X, f) such that X is connected and there are two functions $f_0, f_1 \in E^*(X, f)$ such that f_0 is continuous and f_1 is discontinuous?

Given a dynamical system $(\omega^{\alpha} + 1, f)$ with dense orbit, where $\alpha > 3$, is $E(\omega^{\alpha} + 1, f)$ always countable?

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spaces Ultrafilters p-limit points p-iterate Cardinality

Questions

Question

Is there a dynamical system (X, f) such that X is connected and there are two functions $f_0, f_1 \in E^*(X, f)$ such that f_0 is continuous and f_1 is discontinuous?

Given a dynamical system $(\omega^{\alpha} + 1, f)$ with dense orbit, where $\alpha > 3$, is $E(\omega^{\alpha} + 1, f)$ always countable?

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable space Ultrafilters p-limit points p-iterate
- Cardinality
- Countable case
- Questions

Question

Given an arbitrary compact metric countable space X, is there a continuous function $f : X \to X$ such that E(X, f) is homeomorphic to X?

・ロット (雪) (日) (日) (日)

Dynamical systems

- S. Garcia-Ferreir
- Ellis Semigroup Countable spac Ultrafilters
- p-limit point
- p-iterate
- Cardinality
- Countable cas
- Questions

Question

Given an arbitrary compact metric countable space X, is there a continuous function $f : X \to X$ such that E(X, f) is homeomorphic to X?

▲ロト ▲帰ト ▲ヨト ▲ヨト 三日 - の々ぐ