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Topological vector spaces of cochains and chains for Eucledian compacta

For an arbitrary compact K of the Eucledian space $\mathbb{R}^n$ we define the spaces $C^p(K)$ of *germs* of p-forms and $C_p(K)$ of p-currents on K using the inverse system $\{U_\alpha, i_{\alpha\beta}, A\}$ of all open neighborhoods U_α of K in $\mathbb{R}^n$ and embeddings $i_{\alpha\beta}\colon U_\alpha \subseteq U_\beta$, $\alpha, \beta \in A$.

We raise the problem of studying $\mathbb{R}$-shape type of K. It turns out to be complicated enough. However, we obtain the following results.

Theorem 1. *$C^p(K)$ and $C_p(K)$ are locally convex topological vector spaces. Moreover, $C^p(K)$ is also a commutative cochain space with an operation $\wedge$ extended from $C^p(U_\alpha)$ (U_α is open) to $C^p(K)$, $p = 0, 1, \ldots$.*

The spaces $H^p(K)$ and $H_p(K)$ of *the de Rham cohomologies and homologies for K* are defined as well.

Theorem 2. *The spaces of the Chech cohomologies $\check{H}^p(K)$ and Chech homologies $\check{H}_p(K)$ are isomorphic to the de Rham cohomologies $H^p(K)$ and the de Rham homologies $H_p(K)$ of the compact K.*

Unfortunately, $C^p(K)$ is not Hausdorff, but by slightly changing $C_p(K)$ we construct a new cochain space (we also denote it $C^p(K)$), which is Hausdorff, nuclear and barreled (but incomplete). The new $C_p(K)$ is nuclear and complete (but nonbarreled).

We construct new cochains $\tilde{C}^p(K)$ and chains $\tilde{C}_p(K)$ of the compact K, which are herediterily reflexive and dual to each other, and a continuous epimorphism (not topological homomorphim) $\varphi\colon \tilde{C}^p(K) \to C^p(K)$ and concider on $C^p(K)$ a new factor topology of $\tilde{C}^p(K) \big/ \ker\varphi$.

Theorem 3. *In this new topology $C^p(K)$ becomes a reflexive topological vector space with the strong dual $C_p(K)$ (in new topology). Cohomologies $H^p(K)$ and homologies $H_p(K)$ are reflexive and dual to each other in the topologies induced from $C^p(K)$ and $C_p(K)$, respectively.*

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