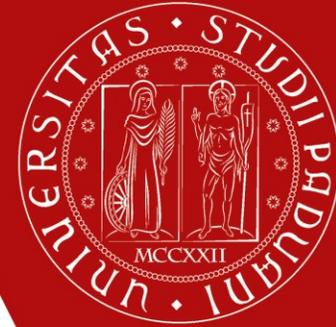


MAPS



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

IA & OH nella Didattica: il ruolo formativo dell'Accademia

Prof. Alessandro Zotti

San Vito Chietino, 19 Settembre 2025

Direttiva Delegata (UE) 2025/1233 della Commissione del 10/04/2025

che modifica la direttiva 2005/36/CE del Parlamento Europeo e del Consiglio per quanto riguarda i requisiti minimi per la formazione del veterinario

All'Art 38, il paragrafo 3 è sostituito dal seguente: La formazione del Veterinario garantisce l'acquisizione da parte del professionista interessato delle conoscenze e abilità seguenti:

g) conoscenze e comprensione adeguate del concetto di **One Health**, comprese le abilità e le competenze per la sua applicazione ed integrazione nella Sanità Pubblica Veterinaria

i) adeguate conoscenze della **gestione dei dati**, delle **tecnologie dell'informazione** e delle **tecnologie digitali e abilità** e le competenza necessarie per la loro applicazione pratica in ambito veterinario

In altre parole:

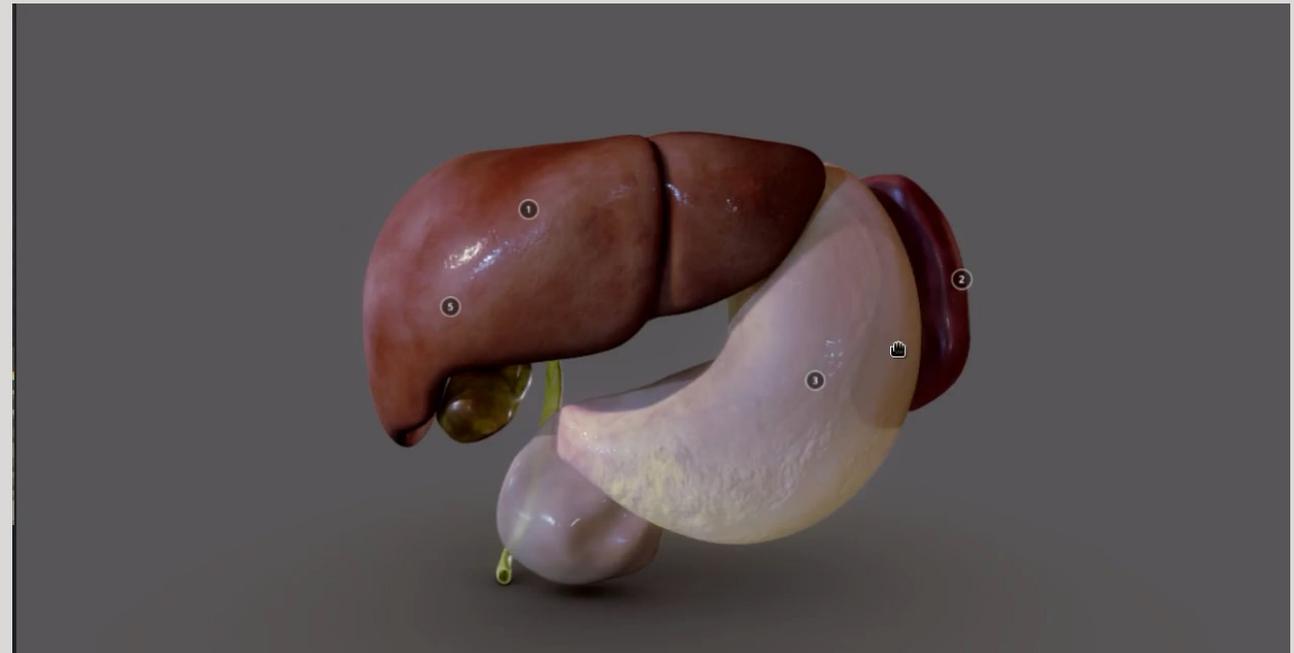
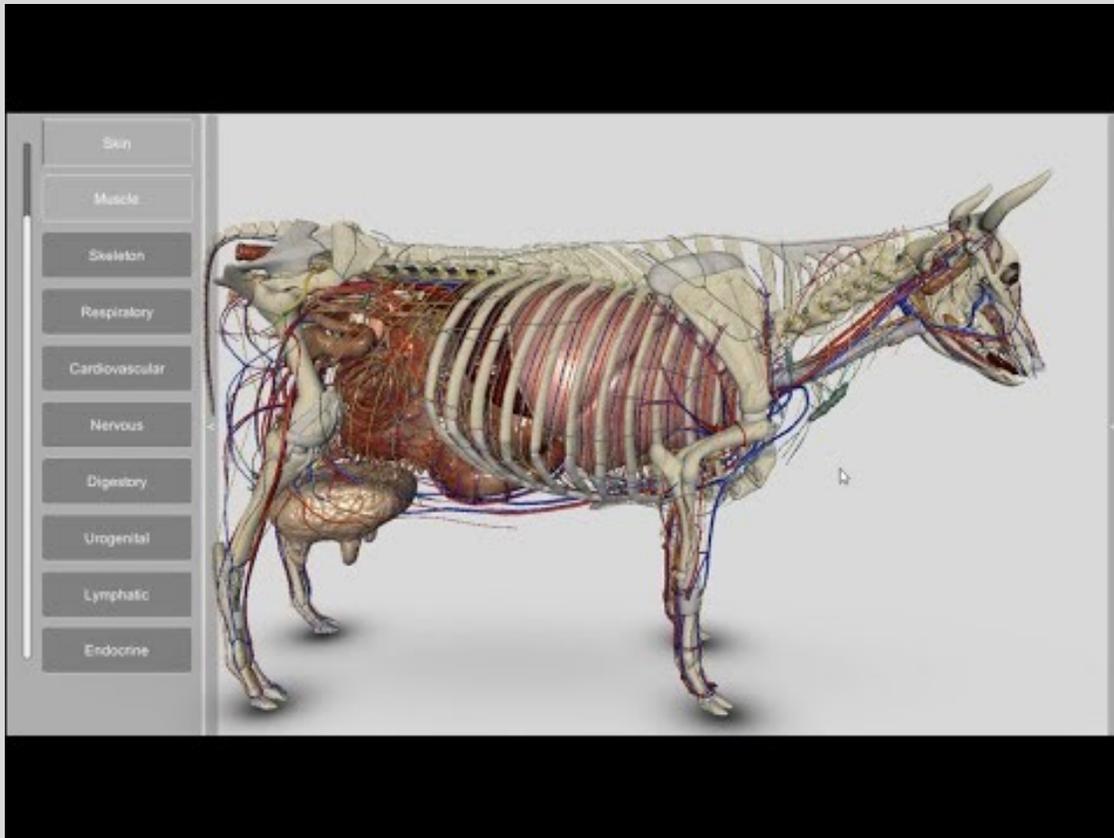
Se l'Accademia vuole mantenere il proprio imprescindibile ruolo di formazione del professionista del futuro, significa che deve introdurre all'interno dei programmi di studio correnti (indicati nell'allegato alla medesima direttiva) **i contenuti didattici e di ricerca più moderni**, in modo che il professionista **del primo giorno sia già avvezzo ad essi, in grado di padroneggiarli ed in alcuni casi di implementarli**

Digitalizzazione ed IA nella didattica significano dal lato delle materie di base: razionalizzazione degli spazi, delle risorse, riduzione dei residui (biologici e non), miglioramento quindi della sostenibilità ambientale e della biosicurezza dello stabilimento didattico con contestuale adeguamento al livello esperienziale delle nuove generazioni di discenti.

Dal punto di vista delle materie professionalizzanti significano invece: **miglioramento della analisi e della gestione dei dati anamnestici-epidemiologici e quindi delle *performance* diagnostiche sia in ambito preventivo-ispettivo che clinico-terapeutico.**

La evoluzione didattica NON PUO' ESSERE DISGIUNTA dalla QUALITA' della RICERCA universitaria sia nelle materie di base che nelle materie professionalizzanti

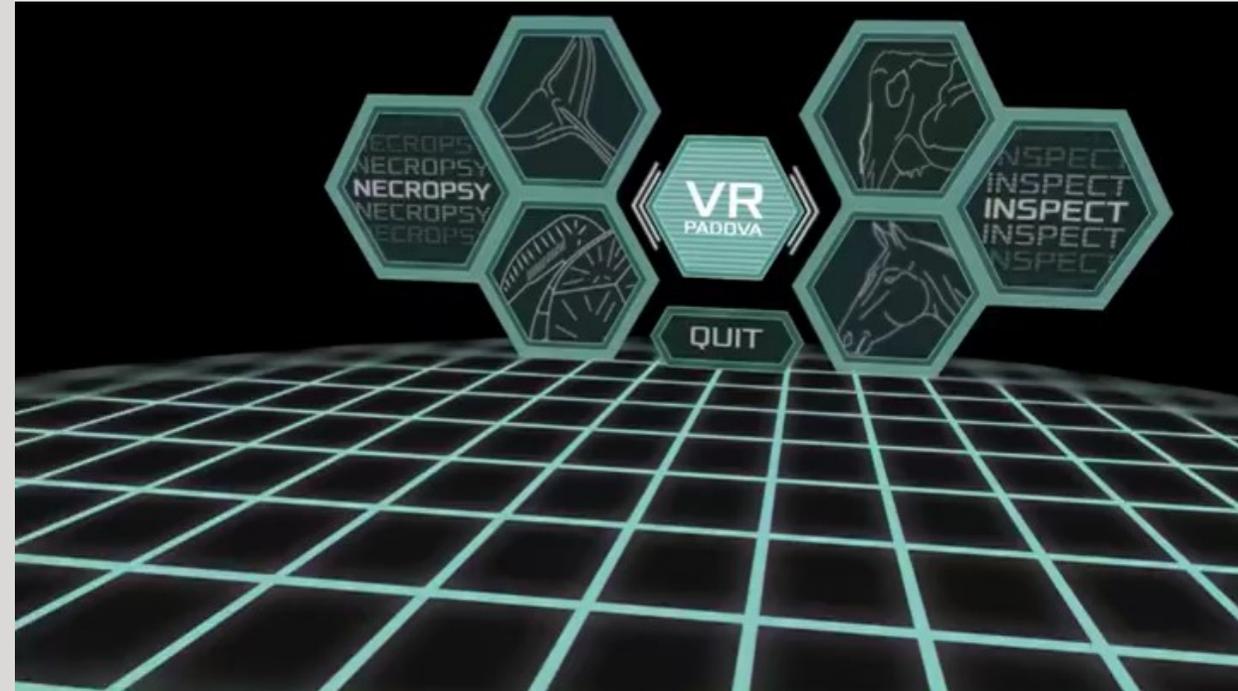
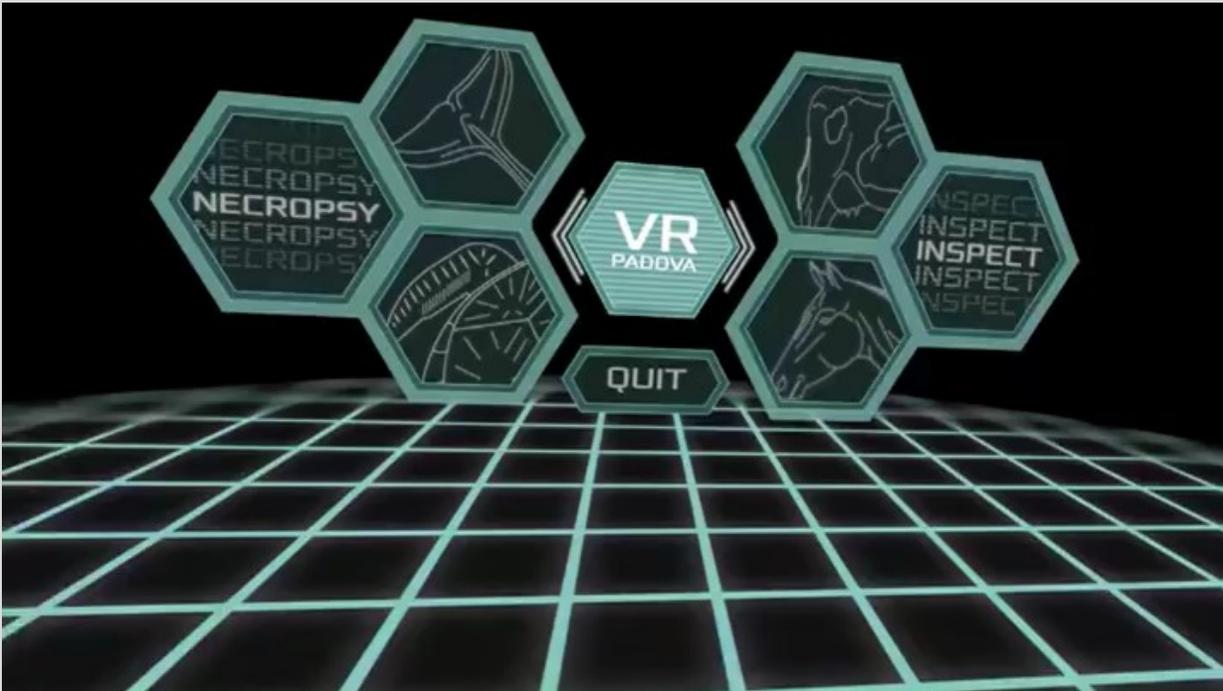
L'Utilizzo di *APP* nelle materie di base



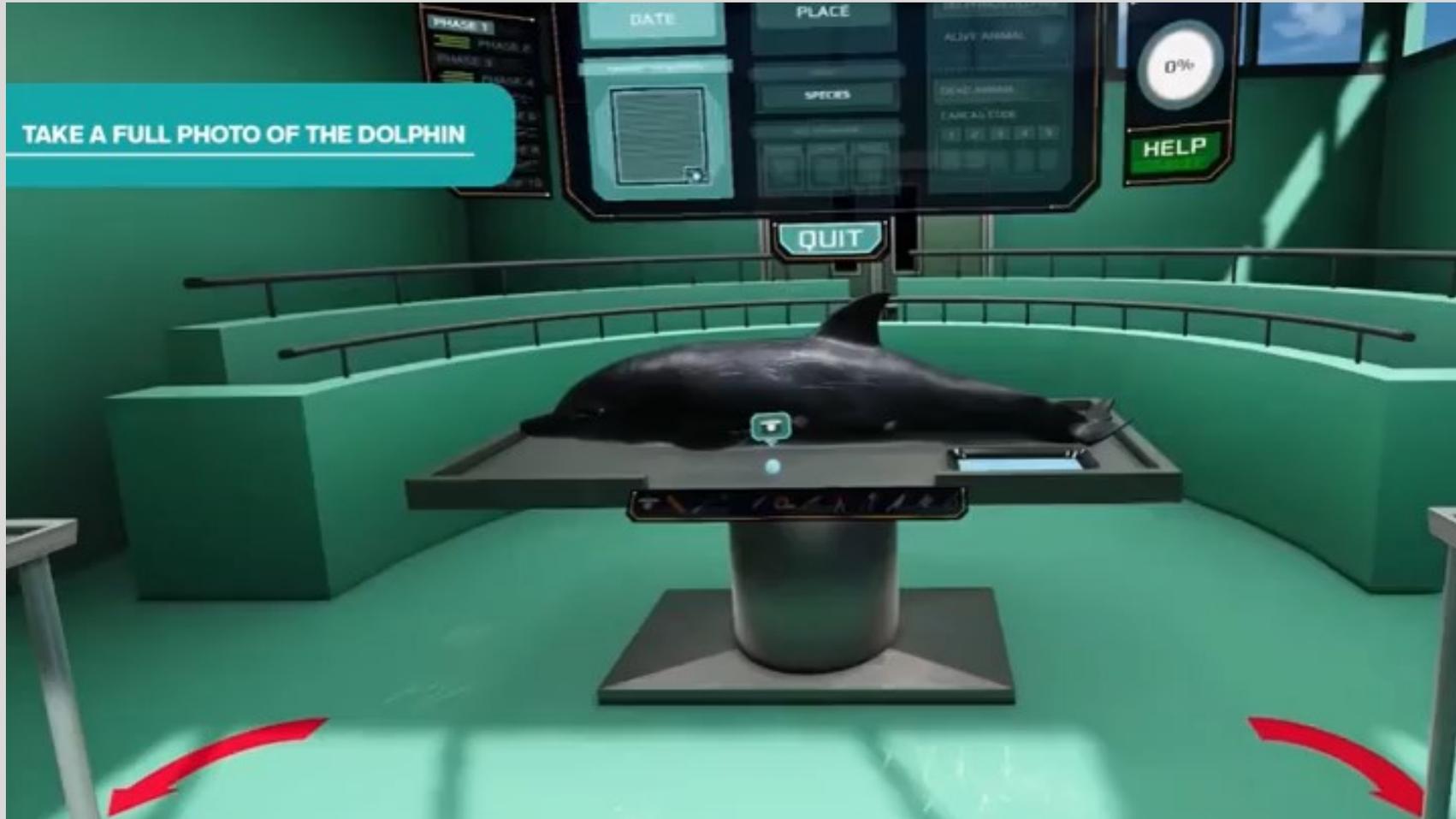
L'Utilizzo di VR nella ricostruzione di organi



L'esperienza di VR nella anatomia/fisiologia



L'esperienza di VR nelle necroscopie



Le nuove tecnologie sono uno strumento per:

- standardizzare le attività di base
- aumentare le esperienze
- utilizzare tutti i sensi nell'apprendimento
- adeguarsi alle nuove generazioni
- ridurre la necessità di animali/organi
- affinare le competenze

Le nuove tecnologie non:

- sostituiscono la necessità di acquisizione delle conoscenze
- sostituiscono le attività pratiche e il tirocinio
- sono esaustive per la formazione



MAPS



Conferenza del
Dipartimento di
Medicina Veterinaria

Salute Animale, IA e One Health

Didattica nelle materie professionalizzanti



UNIVERSITÀ
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UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI MEDICINA VETERINARIA
E SCIENZE ANIMALI

Sergio Ghidini

IA e digitalizzazione nell'Ispezione degli Alimenti di Origine Animale

Medicina Traslazionale: è la branca della Medicina Sperimentale finalizzata a trasformare in attività clinica i risultati della ricerca di base **che possono derivare dal laboratorio come pure da modelli animali questi ultimi prevalentemente topi e, più recentemente, pesci** (*from bench to bedside*)

Medicina Comparata: disciplina finalizzata al miglioramento della comprensione dei meccanismi delle malattie umane ed animali attraverso l'analisi delle similitudini e delle differenze biologiche intercorrenti tra le diverse specie.

Poteva anche essere definita come il campo di studio delle similitudini e delle differenze tra Medicina Umana e Medicina Veterinaria (biotecnologie riproduttive, retrovirus oncogeni)

Medicina Comparata: prevede l'utilizzo di modelli animali di **malattia spontanea** in relazione alle patologie dell'uomo sia con finalità traslazionale ma anche come **trasferimento bidirezionale** di conoscenze dalla ricerca di base alla pratica clinica (*from animals to bedside and back to animals*)

Salute Unica: La Medicina Comparata diviene **Medicina Unica in campo clinico** contribuendo alla realizzazione del paradigma olistico della *One Health* proposto dalla Organizzazione Mondiale della Sanità (*WHO*) ovvero l'approccio integrato al mantenimento della salute dell'uomo e degli animali (e dell'ambiente)

News feature

<https://doi.org/10.1038/s41591-022-02025-5>



SICK AS A DOG: HOW UNDERSTANDING CANINE DISEASES WILL SAVE HUMAN LIVES

Dogs develop diseases similar to those of humans, and their inbred genetics makes them a useful model for disease biology, allowing the development of new therapies for veterinary and human use. **By Carrie Arnold**

Tucked into the back of a cul-de-sac in a bustling medical complex in the city of Roanoke, Virginia, the brick walls and dark tinted windows of the cancer center at the Virginia Tech Carilion Health Sciences and Technology campus look like those of any other state-of-the-art clinic. It is only when you look closer that the differences become apparent. A box of dog treats sits on the counter next to the MRI machine,

and several muzzles of different sizes hang on the wall. The equipment, explains veterinary oncologist Joanne Tuohy of the Virginia–Maryland College of Veterinary Medicine, with a wry smile, is not for fractious human patients. Instead, the equipment, along with much of the building, is shared between veterinary patients and humans participating in clinical trials.

The shared space is not by accident; it is by design, to allow dogs and humans to be treated

side by side. Tuohy and her colleagues are at the forefront of a new trend in research that is blending the previously siloed fields of veterinary medicine and clinical medicine in an effort to improve both the health of humans and their animal companions.

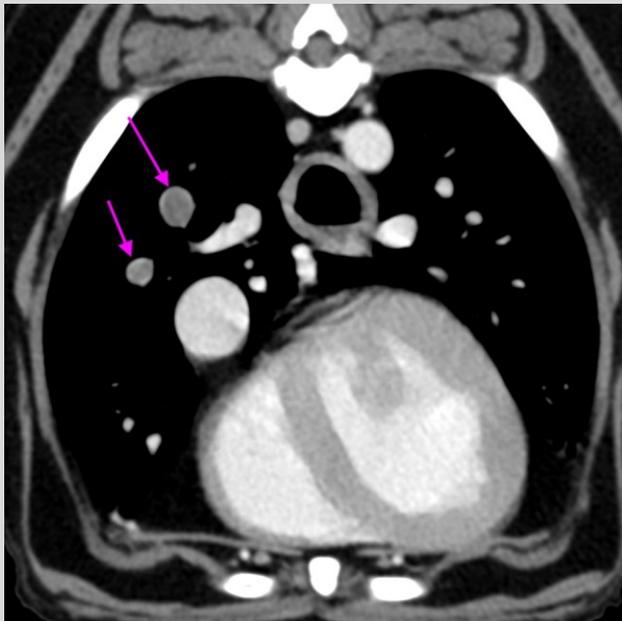
The new model organism

With millions of dollars invested into each potential new therapeutic agent, and a

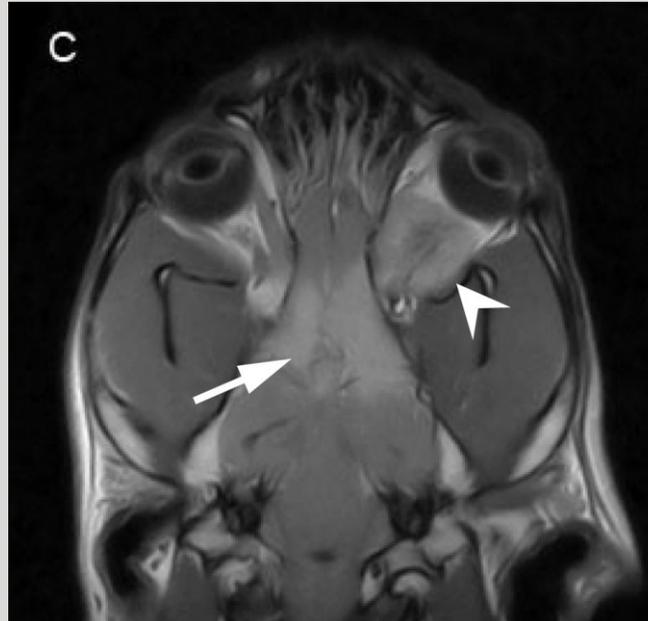
Ma cosa è veramente cambiato nel concetto di Medicina Comparata?



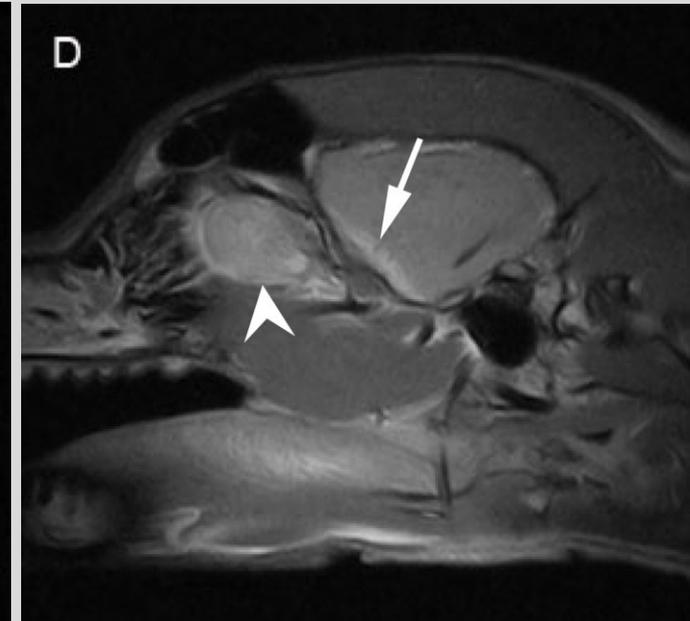
La straordinaria evoluzione nell'ultimo ventennio dello **Standard of Care** – ovvero il livello standard di assistenza medica, di capacità diagnostica ed evoluzione terapeutica – del mondo Medico Veterinario, divenuto in alcuni settori tecnicamente sovrapponibile a quello umano, **consente di considerare alcune malattie spontanee degli animali da compagnia: internistiche, oncologiche, infettive quale naturale connessione tra il modello traslazionale ed il paziente uomo.**



TC: Trombo-embolismo arteria polmonare lobare caudale e media DX

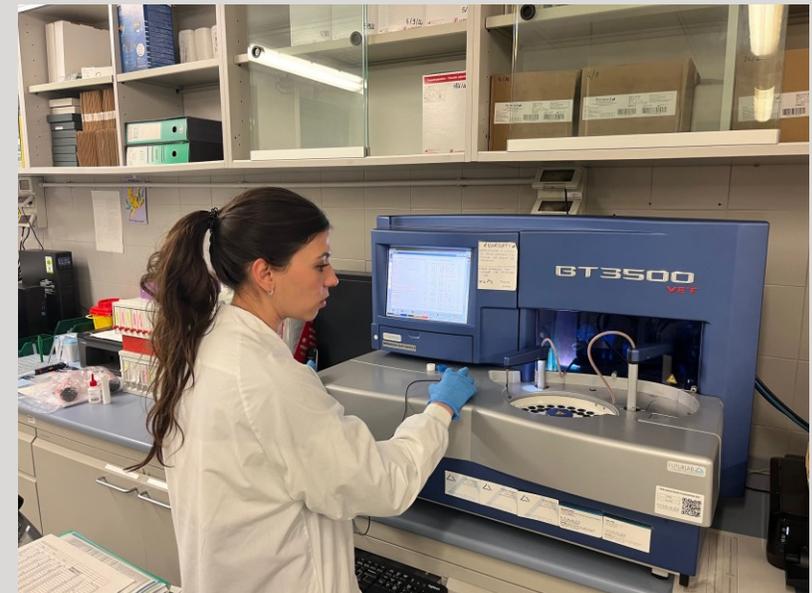


MR: Linfoma cerebrale con estensione retro-bulbare



Lo sviluppo di sinergie tra le due medicine **si realizza con la possibilità di mantenere soggetti malati in *follow up* con un livello diagnostico e assistenziale tecnicamente comparabile tra Medicina Umana e Veterinaria.**

La **Medicina Unica** necessariamente passa attraverso la mutua intelligibilità delle procedure cliniche, condizione quest'ultima evidentemente irrealizzabile sino ad alcune decadi fa



Emerge altresì come la piena realizzazione della medicina unica preveda la necessità di approfondimenti genetici ma soprattutto genomici (caratterizzazione molecolare, spt per l'oncologia), farmacologici ed anche diagnostici e inoltre che il medico veterinario, così come il medico, non è più l'unico protagonista della salute ma vi concorre in sinergia con genetisti, biologi molecolari, farmacologi e tossicologi, bioinformatici (fisici e matematici, ovvero i gestori della IA).

La IA rappresenta lo strumento idoneo alla gestione della grandissima mole di dati da analizzare oltre che, come nel caso dei sistemi di *deep learning*, ad essere in grado di analizzare dati non direttamente valutabili dagli stessi sviluppatori (*Black Boxes*)



I Dipartimenti di Medicina Veterinaria, ed in particolare i Policlinici Veterinari Universitari, inseriti negli ambienti multiculturali delle Accademie, **rappresentano il luogo formativo naturale per questa evoluzione di pensiero** che riguarda olisticamente lo studente di medicina veterinaria.

La Didattica Innovativa non può essere disgiunta dalla ricerca di qualità

La moderna ricerca di qualità è MULTIDISCIPLINARE e TRASVERSALE





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The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvj

Short Communication

Development of a deep convolutional neural network to predict grading of canine meningiomas from magnetic resonance images

T. Banzato^a, G.B. Cherubini^b, M. Atzori^c, A. Zotti^{a,*}^a Department of Animal Medicine, Production and Health, Clinical Section, Radiology Unit, University of Padua, Viale dell'Università 16, Legnaro 35020, Padua, Italy^b Dick White Referrals (Cherubini), Six Mile Bottom, Cambridgeshire CB8 0UH, UK^c Information Systems Institute, University of Applied Sciences Western Switzerland (HES-SO Valais), 3960 Sierre, Switzerland

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Histopathology
Magnetic resonance imaging
Meningioma

ABSTRACT

An established deep neural network (DNN) based on transfer learning and a newly designed DNN were tested to predict the grade of meningiomas from magnetic resonance (MR) images in dogs and to determine the accuracy of classification of using pre- and post-contrast T1-weighted (T1W), and T2-weighted (T2W) MR images. The images were randomly assigned to a training set, a validation set and a test set, comprising 60%, 10% and 30% of images, respectively. The combination of DNN and MR sequence displaying the highest discriminating accuracy was used to develop an image classifier to predict the grading of new cases. The algorithm based on transfer learning using the established DNN did not provide satisfactory results, whereas the newly designed DNN had high classification accuracy. On the basis of classification accuracy, an image classifier built on the newly designed DNN using post-contrast T1W images was developed. This image classifier correctly predicted the grading of 8 out of 10 images not included in the data set.

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Accuracy of Deep Learning to Differentiate the Histopathological Grading of Meningiomas on MR Images: A Preliminary Study

Tommaso Banzato, DVM, PhD,^{1*} Francesco Causin, MD,² Alessandro Della Puppa, MD,³ Giacomo Cester, MD,² Linda Mazzai, MD,² and Alessandro Zotti, DVM, PhD¹

Background: Grading of meningiomas is important in the choice of the most effective treatment for each patient. **Purpose:** To determine the diagnostic accuracy of a deep convolutional neural network (DCNN) in the differentiation of the histopathological grading of meningiomas from MR images. **Study Type:** Retrospective. **Population:** In all, 117 meningioma-affected patients, 79 World Health Organization [WHO] Grade I, 32 WHO Grade II, and 6 WHO Grade III. **Field Strength/Sequence:** 1.5 T, 3.0 T postcontrast enhanced T₁ W (PCT₁W), apparent diffusion coefficient (ADC) maps (b values of 0, 500, and 1000 s/mm²). **Assessment:** WHO Grade II and WHO Grade III meningiomas were considered a single category. The diagnostic accuracy of the pretrained Inception-V3 and AlexNet DCNNs was tested on ADC maps and PCT₁W images separately. Receiver operating characteristic curves (ROC) and area under the curve (AUC) were used to assess DCNN performance. **Statistical Test:** Leave-one-out cross-validation. **Results:** The application of the Inception-V3 DCNN on ADC maps provided the best diagnostic accuracy results, with an AUC of 0.94 (95% confidence interval [CI], 0.88–0.98). Remarkably, only 1/38 WHO Grade II–III and 7/79 WHO Grade I lesions were misclassified by this model. The application of AlexNet on ADC maps had a low discriminating accuracy, with an AUC of 0.68 (95% CI, 0.59–0.76) and a high misclassification rate on both WHO Grade I and WHO Grade II–III cases. The discriminating accuracy of both DCNNs on postcontrast T₁W images was low, with Inception-V3 displaying an AUC of 0.68 (95% CI, 0.59–0.76) and AlexNet displaying an AUC of 0.55 (95% CI, 0.45–0.64). **Data Conclusion:** DCNNs can accurately discriminate between benign and atypical/anaplastic meningiomas from ADC maps but not from PCT₁W images. **Level of evidence:** 2 **Technical Efficacy:** Stage 2

J. MAGN. RESON. IMAGING 2019;50:1152–1159.

MENINGIOMAS account for 33.8% of all the primary intracranial neoplasms in the USA.^{1,2} Different treatment options, based on the histopathological grading of the lesions, are recommended for meningiomas.¹ Nevertheless, no widely accepted methods to predict the histopathological grading of these neoplasms by means of magnetic resonance imaging (MRI), using either standard MRI sequences or advanced MRI sequences such as diffusion-weighted imaging, have been available to date. The possibility to accurately predict

the grading of meningiomas from MR images could enable a more targeted, and therefore more effective, treatment plan for each patient.

Machine learning has grown increasingly popular in radiology research in recent years, mostly driven by the perspective of creating greater interconnection between radiologists and machines.^{3,4} Currently, the main scope for applying machine learning in medical imaging is the creation of an integrated environment where the machines support, speed

Banzato et al. *BMC Veterinary Research* _____
<https://doi.org/10.1186/s12917-018-1638-2>

BMC Veterinary Research

METHODOLOGY ARTICLE

Open Access



A methodological approach for deep learning to distinguish between meningiomas and gliomas on canine MR-images

Tommaso Banzato¹, Marco Bernardini¹, Giunio B. Cherubini² and Alessandro Zotti^{1*}

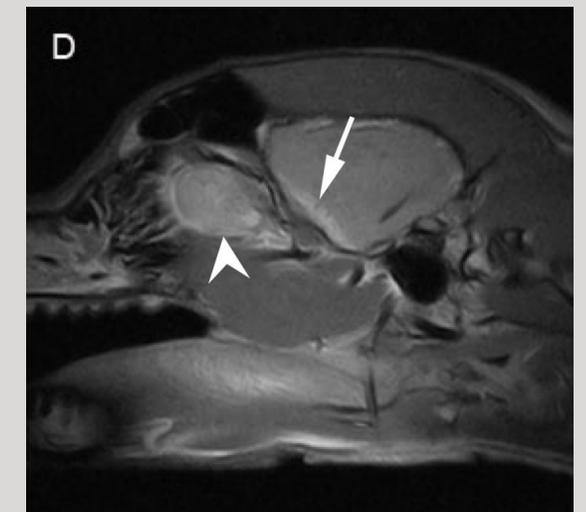
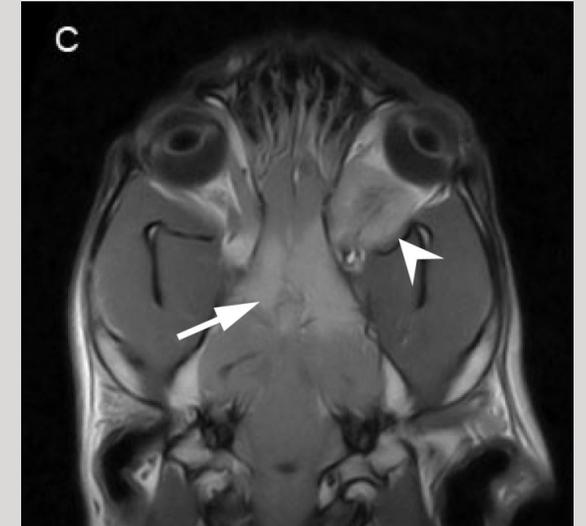
Abstract

Background: Distinguishing between meningeal-based and intra-axial lesions by means of magnetic resonance (MR) imaging findings may occasionally be challenging. Meningiomas and gliomas account for most of the total primary brain neoplasms in dogs, and differentiating between these two forms is mandatory in choosing the correct therapy. The aims of the present study are: 1) to determine the accuracy of a deep convolutional neural network (CNN, *GoogleNet*) in discriminating between meningiomas and gliomas in pre- and post-contrast T1 images and T2 images; 2) to develop an image classifier, based on the combination of CNN and MRI sequence displaying the highest accuracy, to predict whether a lesion is a meningioma or a glioma.

Results: Eighty cases with a final diagnosis of meningioma ($n = 56$) and glioma ($n = 24$) from two different institutions were included in the study. A pre-trained CNN was retrained on our data through a process called transfer learning. To evaluate CNN accuracy in the different imaging sequences, the dataset was divided into a training, a validation and a test set. The accuracy of the CNN was calculated on the test set. The combination between post-contrast T1 images and CNN was chosen in developing the image classifier (trCNN). Ten images from challenging cases were excluded from the database in order to test trCNN accuracy; the trCNN was trained on the remainder of the dataset of post-contrast T1 images, and correctly classified all the selected images. To compensate for the imbalance between meningiomas and gliomas in the dataset, the Matthews correlation coefficient (MCC) was also calculated. The trCNN showed an accuracy of 94% (MCC = 0.88) on post-contrast T1 images, 91% (MCC = 0.81) on pre-contrast T1-images and 90% (MCC = 0.8) on T2 images.

Conclusions: The developed trCNN could be a reliable tool in distinguishing between different meningiomas and gliomas from MR images.

Keywords: Convolutional neural network, Meningioma, Glioma, Magnetic resonance imaging, Histopathology



scientific reports

OPEN

Improving the classification of veterinary thoracic radiographs through inter-species and inter-pathology self-supervised pre-training of deep learning models

Check for updates

Weronika Celniak^{1,2✉}, Marek Wodziński^{1,2}, Artur Jurgas^{1,2}, Silvia Burti³, Alessandro Zotti³, Manfredo Atzori^{1,4,7}, Henning Müller^{1,5,6} & Tommaso Banzato³

The analysis of veterinary radiographic imaging data is an essential step in the diagnosis of many thoracic lesions. Given the limited time that physicians can devote to a single patient, it would be valuable to implement an automated system to help clinicians make faster but still accurate diagnoses. Currently, most of such systems are based on supervised deep learning approaches. However, the problem with these solutions is that they need a large database of labeled data. Access to such data is often limited, as it requires a great investment of both time and money. Therefore, in this work we present a solution that allows higher classification scores to be obtained using knowledge transfer from inter-species and inter-pathology self-supervised learning methods. Before training the network for classification, pretraining of the model was performed using self-supervised learning approaches on publicly available unlabeled radiographic data of human and dog images, which allowed substantially increasing the number of images for this phase. The self-supervised learning approaches included the Beta Variational Autoencoder, the Soft-Intropective Variational Autoencoder, and a Simple Framework for Contrastive Learning of Visual Representations. After the initial pretraining, fine-tuning was performed for the collected veterinary dataset using 20% of the available data. Next, a latent space exploration was performed for each model after which the encoding part of the model was fine-tuned again, this time in a supervised manner for classification. Simple Framework for Contrastive Learning of Visual Representations proved to be the most beneficial pretraining method. Therefore, it was for this method that experiments with various fine-tuning methods were carried out. We achieved a mean ROC AUC score of 0.77 and 0.66, respectively, for the laterolateral and dorsoventral projection datasets. The results show significant improvement compared to using the model without any pretraining approach.



Ageing Research Reviews 111 (2025) 102814

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Review article

Markers of biological age in dogs

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Federico Bonsembiante ^a, Manuela Campisi ^d, Luana Cannella ^d, Simona Buscarnera ^b,
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ABSTRACT

As human life expectancy continues to rise, ageing and age-related diseases have become critical societal challenges, driving extensive research across genetics, molecular biology, biochemistry, and behavioral sciences. In this context, domestic dogs (*Canis lupus familiaris*) offer a unique model for ageing research due to their shared environmental exposures with humans, diverse genetic profiles, and relatively short lifespans. This review aims to identify potential biomarkers of ageing in dogs, facilitating a deeper understanding of age-related mechanisms and supporting the evaluation of interventions designed to promote healthy ageing. We present a research of peer-reviewed literature on age-related variations of various parameters across multiple biological systems, including epigenetic, telomere, immune, metabolic, and cognitive markers in dogs. Our findings highlight several robust biomarkers, such as DNA methylation-based epigenetic clocks, telomere attrition, CD4+/CD8+ T-cell ratio, hematological markers (e.g., globulin levels), and cognitive function scores. These biomarkers demonstrate strong parallels with human ageing processes, particularly concerning genomic and epigenetic alterations. However, challenges remain, including breed-specific variability, body size differences, and inconsistent evidence regarding inflammageing markers, such as pro-inflammatory cytokines. Despite these limitations, indicators of chronic inflammation (e.g., anemia of chronic disease and elevated globulins) are evident in older dogs. Future research directions include the standardization of biomarker protocols for dogs, the development of longitudinal studies to track dynamic age-related changes, and further exploration of emerging biomarkers, such as those related to microbiome composition and oxidative stress.

Contents



Analisi multifattoriale dei fattori ambientali, genetici (ed epigenetici) che agiscono sull'invecchiamento

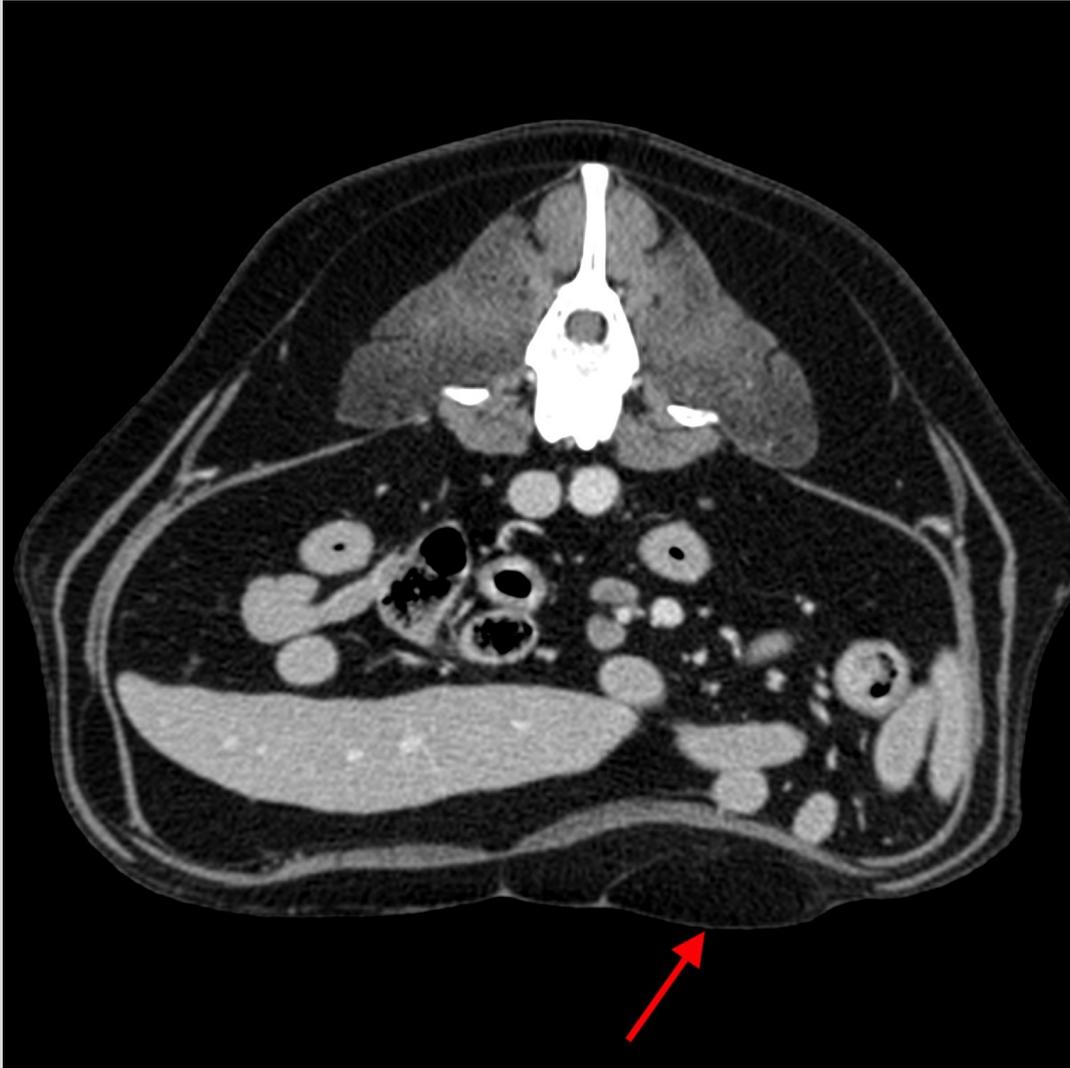


ChatGPT

*This CT image appears to be a sagittal section of a **dog's forelimb**, particularly showing the region around the **carpal (wrist) joint**. The red arrow is pointing to the distal end of the radius and the adjacent carpal bones.*

*The region indicated by the arrow shows a distinct change in the bone density and structure at the end of the radius. There appears to be **bone lysis (destruction), irregularity, and possible proliferation, which might suggest an aggressive bone lesion**. This could be due to a variety of causes, such as a **bone tumor (like an osteosarcoma)**, infectious osteomyelitis, or a bone cyst. It's important to note that such changes are significant and require further investigation, ideally including a full orthopedic evaluation, additional imaging, and possibly a biopsy to determine the nature of the lesion.*

The surrounding soft tissue structures do not show overt abnormalities in this slice, but a thorough review of the entire CT study would be necessary to assess for any soft tissue involvement. The clinical context, such as the presence of lameness, pain, or swelling, would also play a crucial role in the interpretation of these imaging findings.



ChatGPT

The CT image provided is an axial cut of a dog, with the red arrow pointing to a lesion in the abdomen. Here's a brief description based on this single slice:

- **Location:** *The lesion is in the abdominal cavity, possibly involving the spleen given its typical left-sided location and the appearance of surrounding structures which could be other abdominal organs.*
- **Appearance:** *The lesion is relatively well-circumscribed and has a heterogeneous texture, with areas of different densities. This could indicate a mix of solid and cystic or necrotic components.*
- **Size:** *It appears to be quite large relative to the size of the abdominal cavity, although without markers or a scale, the exact dimensions cannot be provided.*

*A lesion with these characteristics in a dog's spleen could potentially **be a hematoma, hemangiosarcoma, or another type of splenic tumor.** However, for an accurate diagnosis, a full review of the entire CT series, along with the dog's clinical history and any other relevant tests, would be essential.*

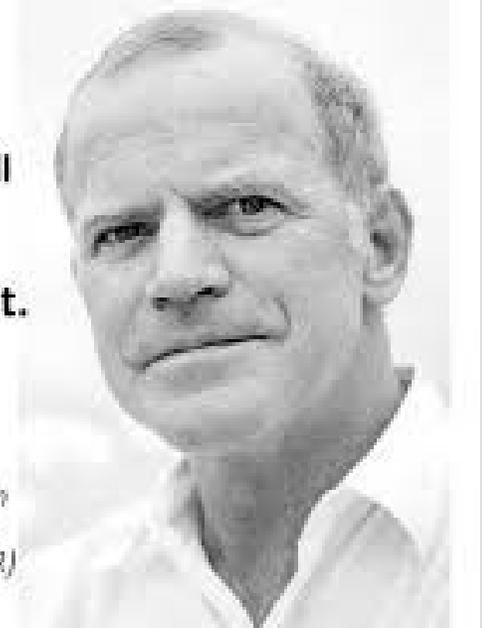
- Le **allucinazioni dell'IA** devono essere governate
- E' proprio l'educazione all'uso dell'IA ad essere fondamentale
- Fidarsi troppo (anche troppo poco) dell'IA può rappresentare un problema
- Certamente l'IA non dovrebbe sostituire la conoscenza della materia
- **Al giorno d'oggi non esiste, a livello internazionale, un'Agenzia per la regolamentazione dei dispositivi medico-veterinari.**

"What if I had not taken
LSD ever; would I have still
invented PCR?"

**I don't know. I doubt it.
I seriously doubt it."**

- *Kary Mullis*

*(Winner of the 1993 Nobel Prize in
Chemistry for his discovery of the
polymerase chain reaction, or PCR)*



OPEN ACCESS

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Integrating artificial intelligence into veterinary education: student perspectives

Christelle de Brito^{1*}, José I. Redondo¹, Irene Tadeo-Cervera², Esther Bataller², Mireia García-Roselló¹, Inmaculada Cuquerella Madoz³ and José Terrado^{1*}

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Introduction: Advancements in technology have fostered a continuous evolution of higher education, driving the adoption of innovative tools, including artificial intelligence (AI). This study explores veterinary students' interest in AI, their training and experiences, and their perceptions on AI integration in veterinary medicine.

Methods: A comprehensive survey was administered to veterinary students at the Faculty of Veterinary Medicine of a single international university in Spain, focusing on their experience with AI, their perception of its integration into veterinary education, and their views on its future role in veterinary medicine.

Results: Six hundred and four students of 34 nationalities across all academic years answered the survey. Most students were familiar with AI tools and primarily utilize them in academic settings, recognizing AI as a valuable educational resource. The majority believed universities should encourage and regulate AI use. There was a strong desire to integrate AI-related education into the veterinary curriculum, with students eager to learn more about specific AI applications in various veterinary fields, in particular clinical patient monitoring and veterinary management. The study also highlights the need for training in AI principles and regulation. Likewise, students expressed concerns about ethical and responsible use of AI, as well as the reliability of AI responses.

MAPS



One Health, Medicina Unica, IA &....Didattica *Minacce e Sfide*



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Politiche di indirizzo dell'Ateneo di Padova per un uso responsabile dell'Intelligenza Artificiale Generativa nella didattica e nella ricerca

Ufficio dell'insegnamento
universitario è di formare teste,
addestrare cervelli a ragionare, a
costruire, a capire.

Luigi Einaudi

- *One Health*, IA, Ricerca, Trasversalità, ... fanno i conti con **sostenibilità**, non solo economica, ma anche dei programmi formativi
- La digitalizzazione e la IA sono strumenti che **migliorano ed ampliano ma non sostituiscono la formazione tecnica specifica**; anche la assunzione di consapevolezza da parte dello studente della figura del medico veterinario quale operatore di salute globale richiede tempo.
- **Durata del corso a 6 anni con un ultimo anno esclusivamente esperienziale nei diversi ambiti**