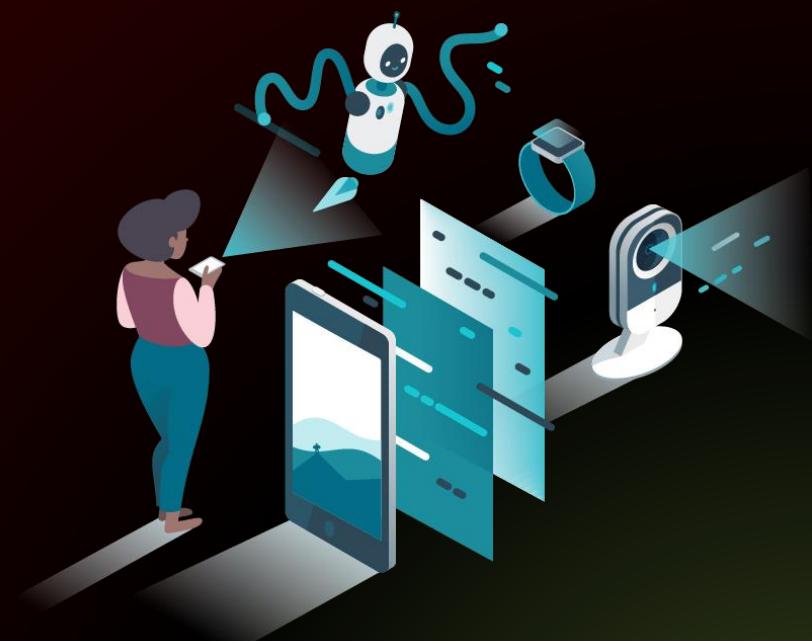




# Explainable Artificial Intelligence for Internet of Things

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## ~ CONTENT ~

- **What is Artificial Intelligence?**
- **Explainable Artificial Intelligence**
- **Explainable Artificial Intelligence Applications**
- **Explainable Artificial Intelligence and Internet of Things**
- **Open Problems**
- **Suggestions**
- **Questions?**





## ~ Before Starting ☺ ~



### Academic Profiles:

- Google Scholar
- ResearchGate
- Academia
- Mendeley
- *for more:*

[www.utkukose.com](http://www.utkukose.com)

**Dr. Utku Kose** received the B.S. degree in 2008 from computer education of Gazi University, Turkey as a faculty valedictorian. He received M.S. degree in 2010 from Afyon Kocatepe University, Turkey in the field of computer and D.S. / Ph. D. degree in 2017 from Selcuk University, Turkey in the field of computer engineering. Between 2009 and 2011, he has worked as a Research Assistant in Afyon Kocatepe University. Following, he has also worked as a Lecturer and Vocational School - Vice Director in Afyon Kocatepe University between 2011 and 2012, as a Lecturer and Research Center Director in Usak University between 2012 and 2017, and as an Assistant Professor in Suleyman Demirel University between 2017 and 2019. Currently, he is an Associate Professor in Suleyman Demirel University, Turkey. He has more than 100 publications including articles, authored and edited books, proceedings, and reports. He is also one of the series editors of the Biomedical and Robotics Healthcare Series by CRC Press. His research interest includes artificial intelligence, machine ethics, artificial intelligence safety, optimization, the chaos theory, distance education, e-learning, computer education, and computer science.



~ Before Starting ☺ ~



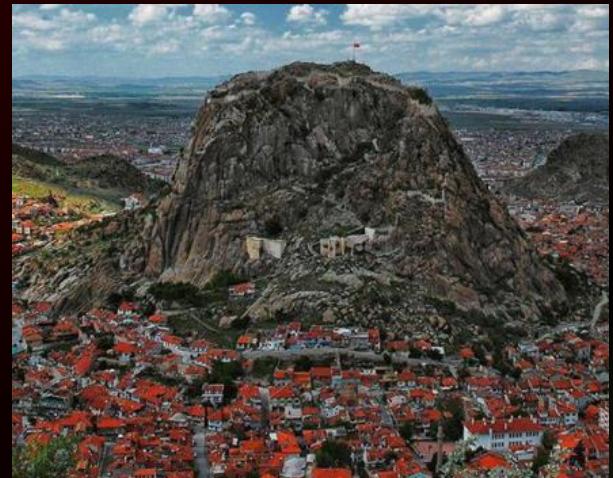


## ~ Before Starting ☺ ~

Isparta / Turkey



Afyonkarahisar / Turkey





## ~ Before Starting ☺ ~

Suleyman Demirel University



Süleyman Demirel University (SDU) is a public university located in Isparta, Turkey. Established in 1992, the university, with around 70.000 students, is a large academic institution in Turkey. SDU is known for its programs in agricultural research, medicine, engineering, and business sciences.

Dept. of Computer Engineering



SDU-CEng currently has three Profs., two Assoc. Prof., eight Assist. Profs. and two Res. Assists. working in three different areas of Computer Science, Computer Software, and Computer Hardware. The dept. has BSc., MSc., and PhD. degrees.



## Content

- What is AI?
- Explainable AI
- Explainable AI Applications
- Explainable AI & IoT
- Open Problems
- Suggestions
- Questions?



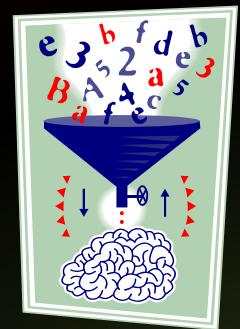
# 1. WHAT IS AI?

- *What is it?*
  - Somehow a simulation of humans, animals, and the nature,
  - Technology based intelligent solutions,
  - A way for improving effectiveness and efficiency,
  - Science of the future,
  - A multidisciplinary science,
  - An interface between human and the machine,
  - Mathematical and logical algorithms.
- *An utopia?*
- *A technological risk, threat?*
- *Cause of extinction?*
- *A science without human?*
- *A science evolving by its own efforts?*
- *A stoppable technology?*



John McCarthy

«Science and  
engineering of making  
intelligent machines...»





## Content

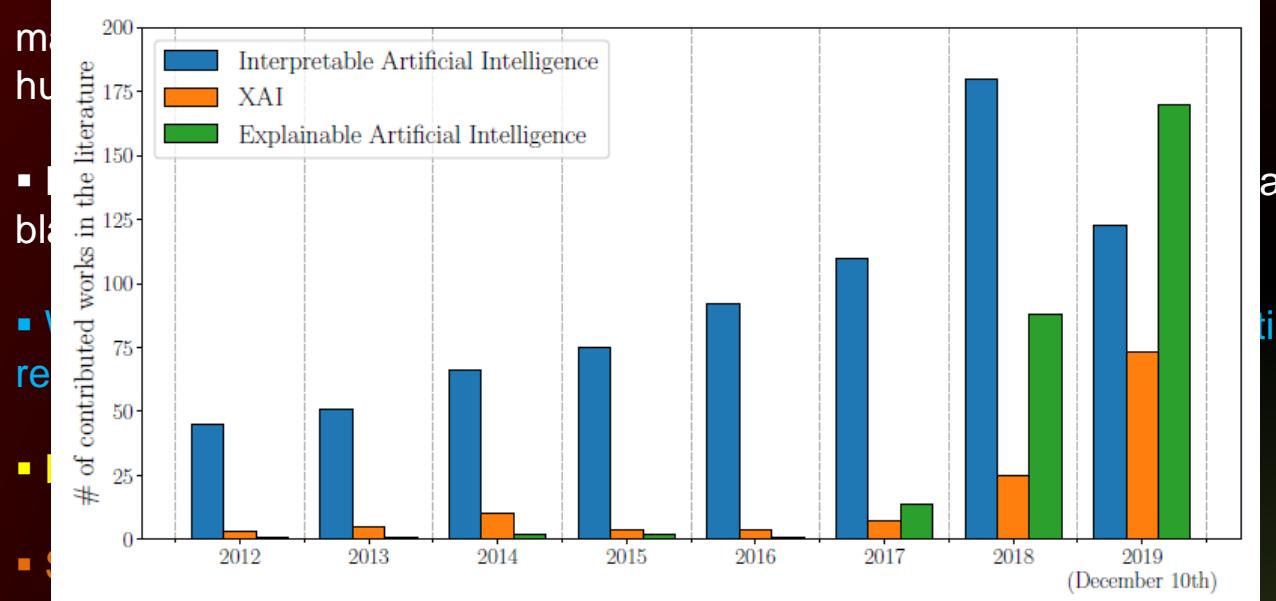
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## 2. EXPLAINABLE AI (XAI)

- Traditional AI solutions are widely used in all fields of the modern life.
- Growing literature of XAI in time

These fields include many critical ones including careful decision



- That can be achieved by extending rule-based, expert systems oriented AI models.
- Nowadays, the combination of the related efforts are combined under the research area: Explainable AI (XAI).

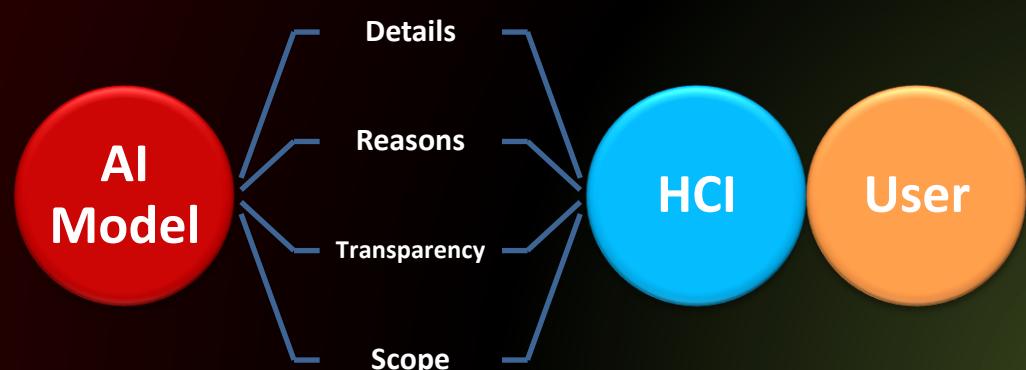
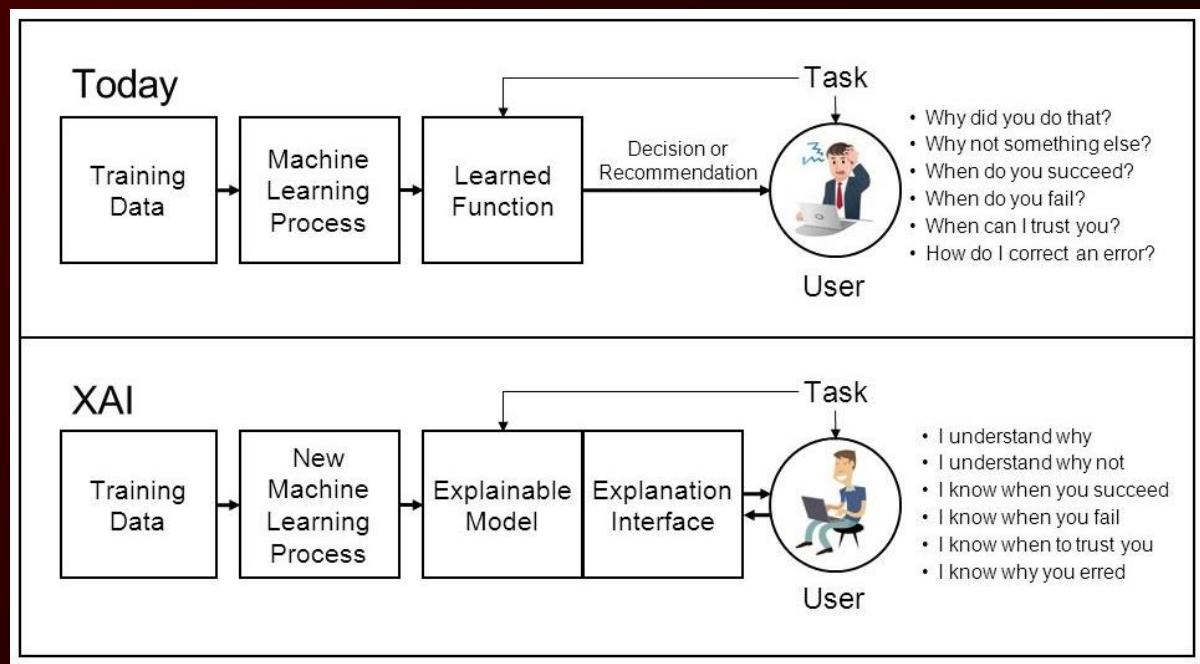


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## 2. EXPLAINABLE AI (XAI)





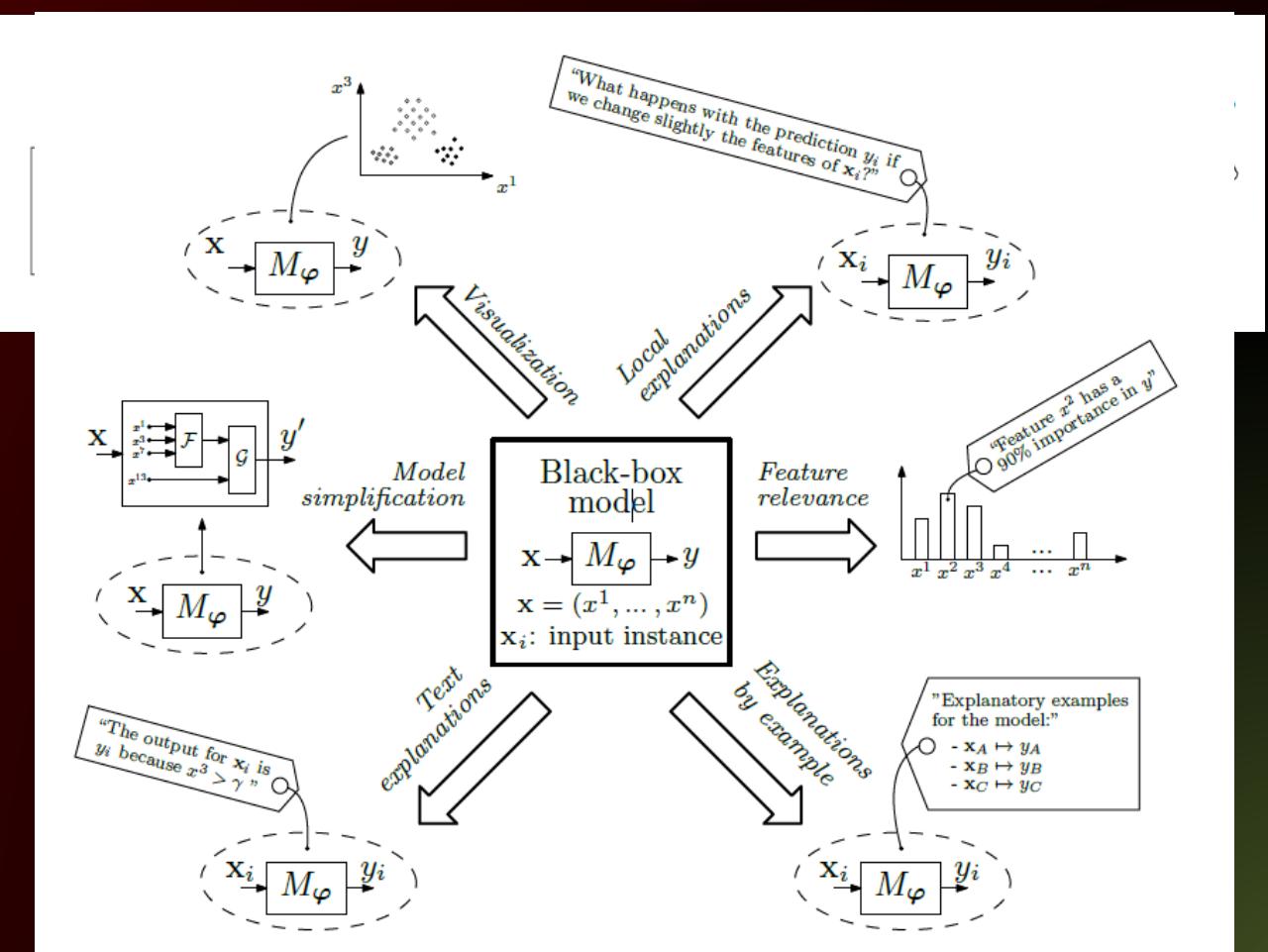
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## 2. EXPLAINABLE AI (XAI)

### ▪ Explaination techniques



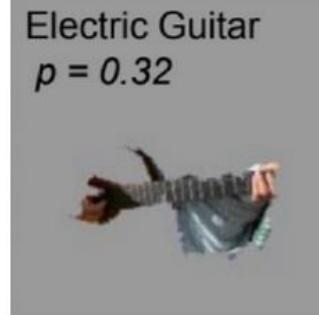
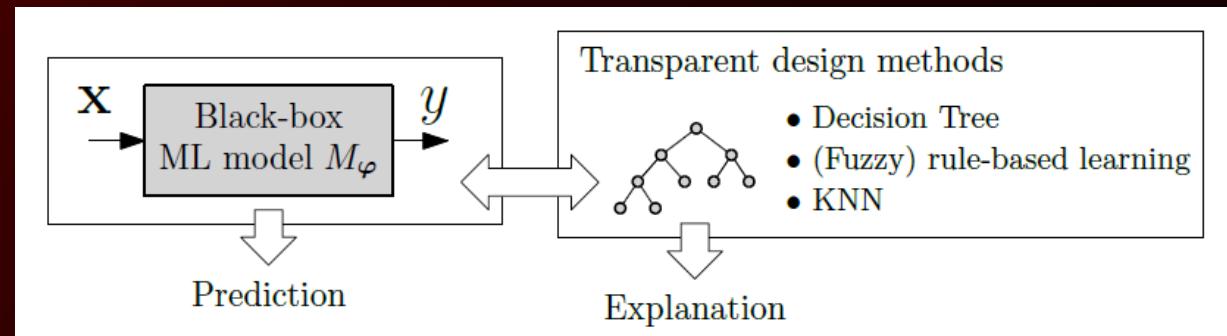


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## 2. EXPLAINABLE AI (XAI)

- Hybrid model for explaining black-box model





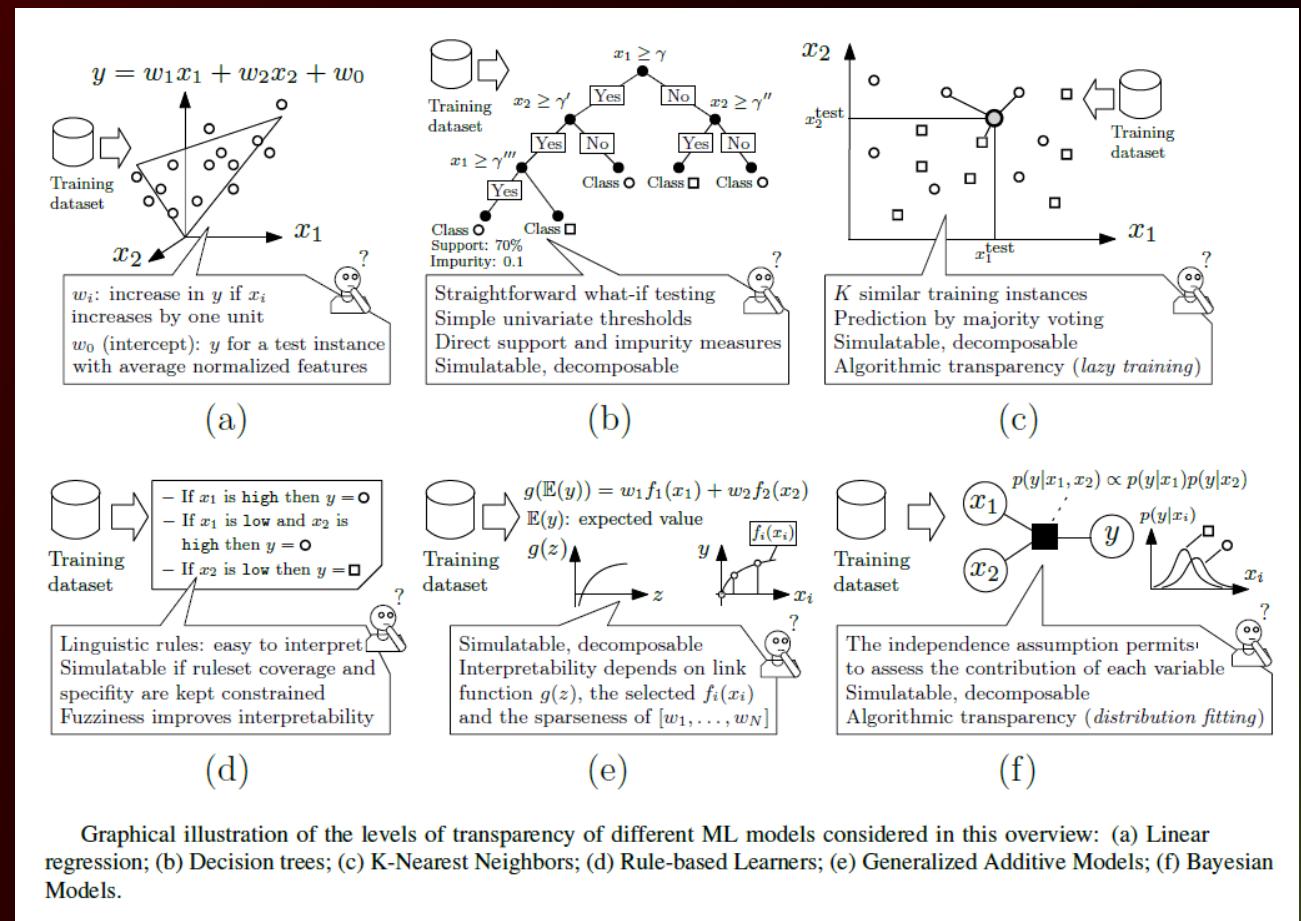
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## 2. EXPLAINABLE AI (XAI)

- Transparency of different techniques





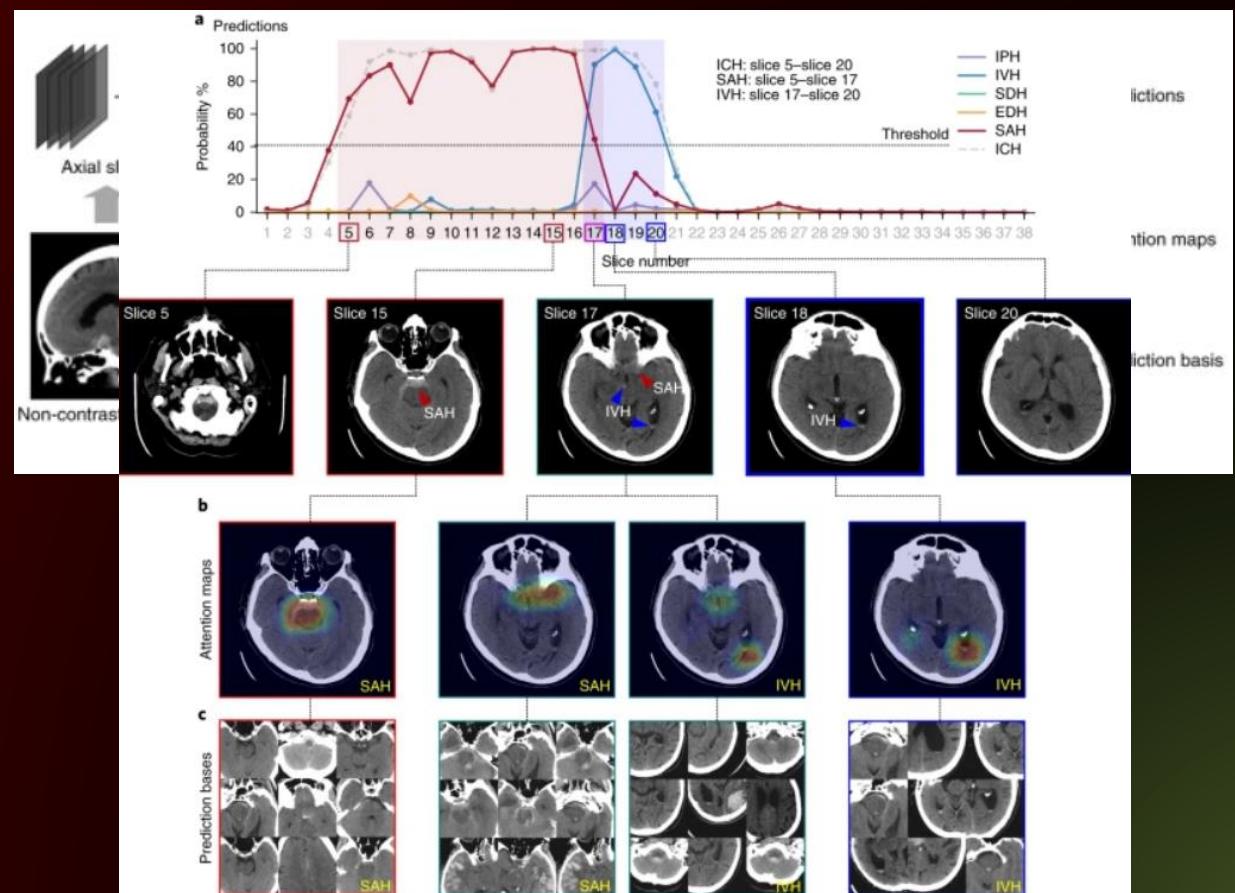
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## 3. EXPLAINABLE AI (XAI) APPLICATIONS

- Lee, H., Yune, S., Mansouri, M., Kim, M., Tajmir, S. H., Guerrier, C. E., ... & Gonzalez, R. G. (2019). An explainable deep-learning algorithm for the detection of acute intracranial haemorrhage from small datasets. *Nature Biomedical Engineering*, 3(3), 173.





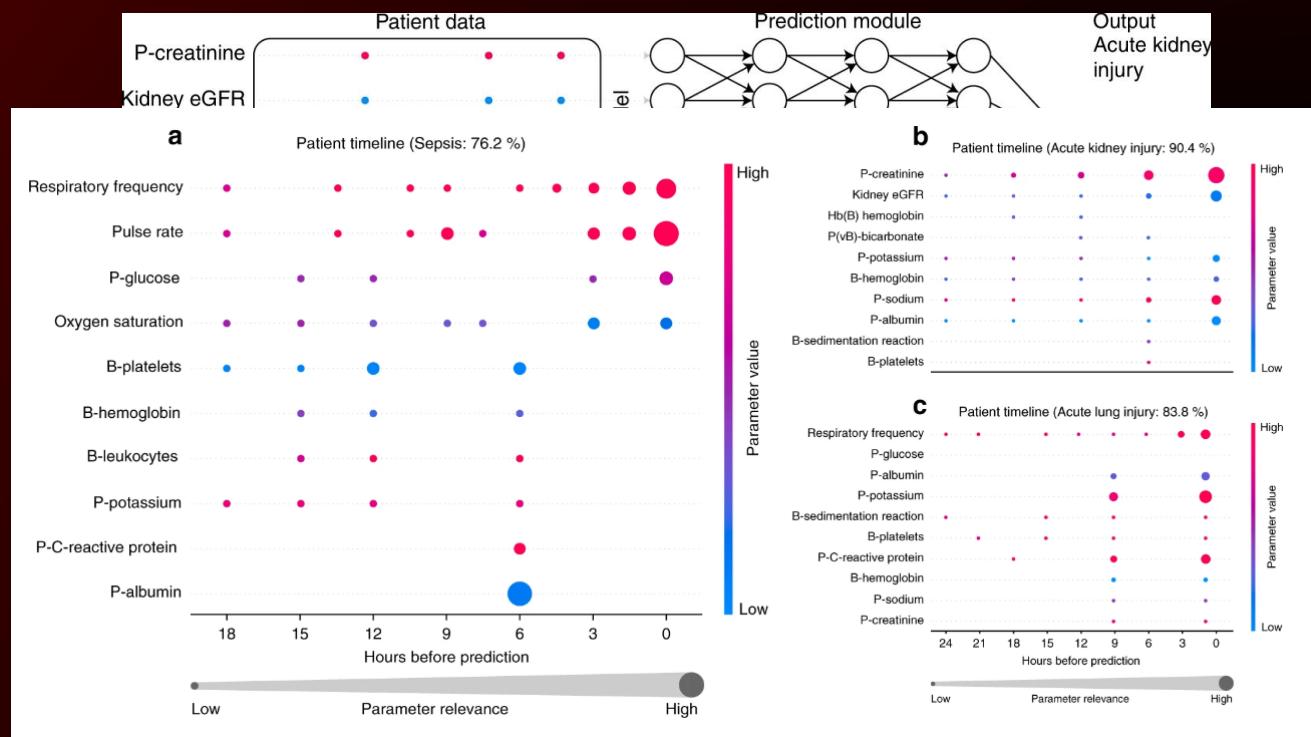
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## 3. EXPLAINABLE AI (XAI) APPLICATIONS

- Lauritsen, S. M., Kristensen, M., Olsen, M. V., Larsen, M. S., Lauritsen, K. M., Jørgensen, M. J., ... & Thiesson, B. (2020). Explainable artificial intelligence model to predict acute critical illness from electronic health records. *Nature Communications*, 11(1), 1-11.



LRP decomposes the problem of explaining a complex multilayer neural network model into simpler sub-functions that are easier to analyze and explain. The relevance score at input neuron  $R_i$  is obtained by pooling all incoming relevance values  $R_j$  from the output neurons in the next layer.



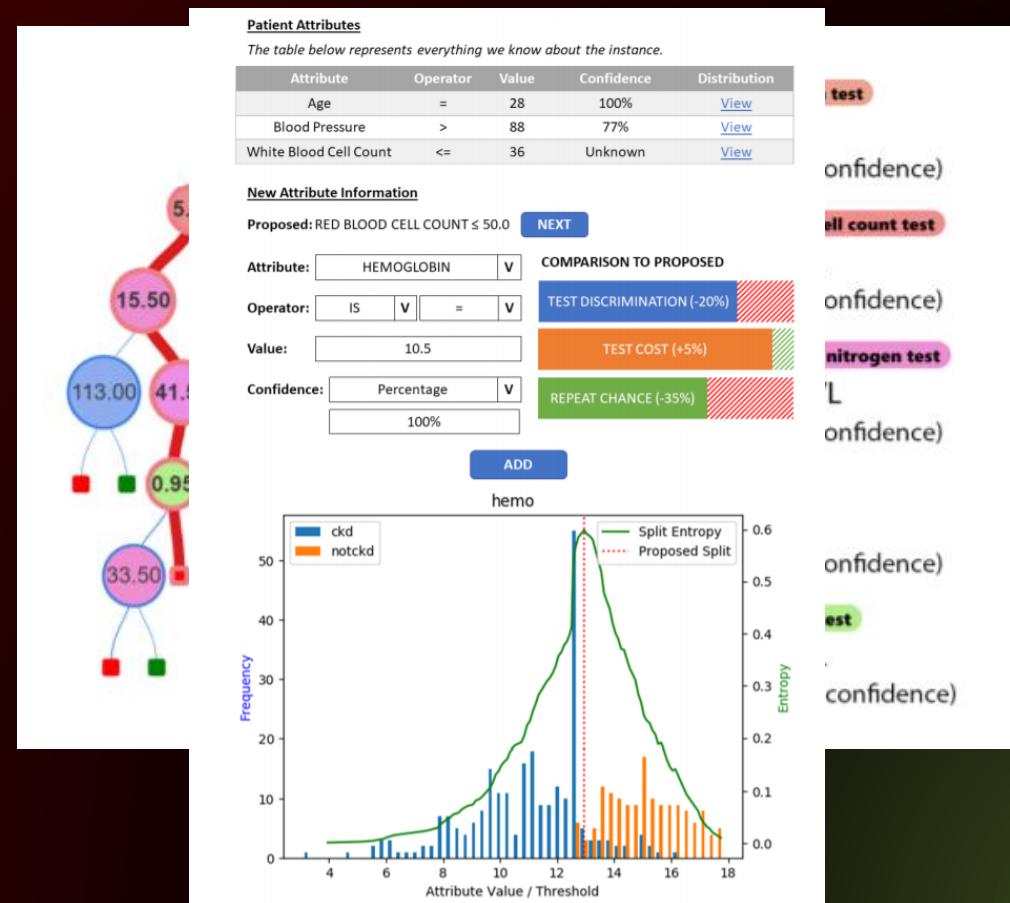
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# 3. EXPLAINABLE AI (XAI) APPLICATIONS

- Monteath, I., & Sheh, R. (2018). Assisted and incremental medical diagnosis using explainable artificial intelligence. In *Proceedings of the 2nd Workshop on Explainable Artificial Intelligence* (pp. 104-108).





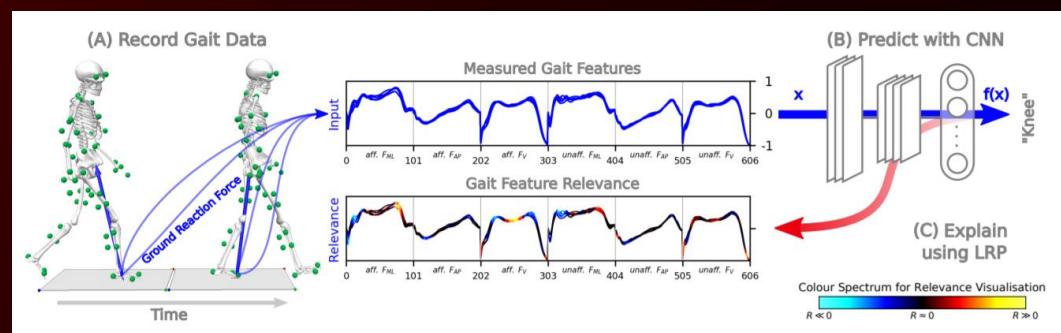
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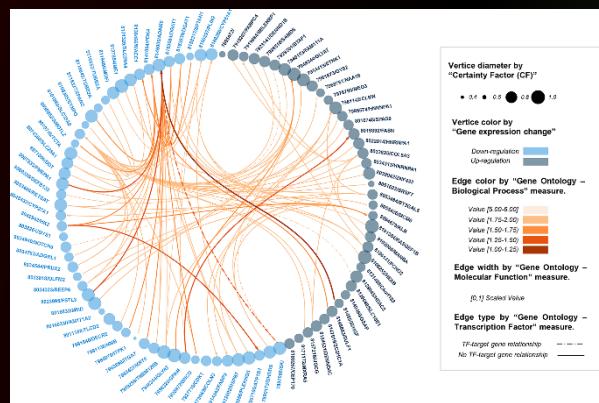


# 3. EXPLAINABLE AI (XAI) APPLICATIONS

- Horst, F., Slijepcevic, D., Lapuschkin, S., Raberger, A. M., Zeppelzauer, M., Samek, W., ... & Horsak, B. (2019). On the Understanding and Interpretation of Machine Learning Predictions in Clinical Gait Analysis Using Explainable Artificial Intelligence. *arXiv preprint arXiv:1912.07737*.



- Anguita-Ruiz, A., Segura-Delgado, A., Alcalá, R., Aguilera, C. M., & Alcalá-Fdez, J. (2020). eXplainable Artificial Intelligence (XAI) for the identification of biologically relevant gene expression patterns in longitudinal human studies, insights from obesity research. *PLOS Computational Biology*, 16(4), e1007792.





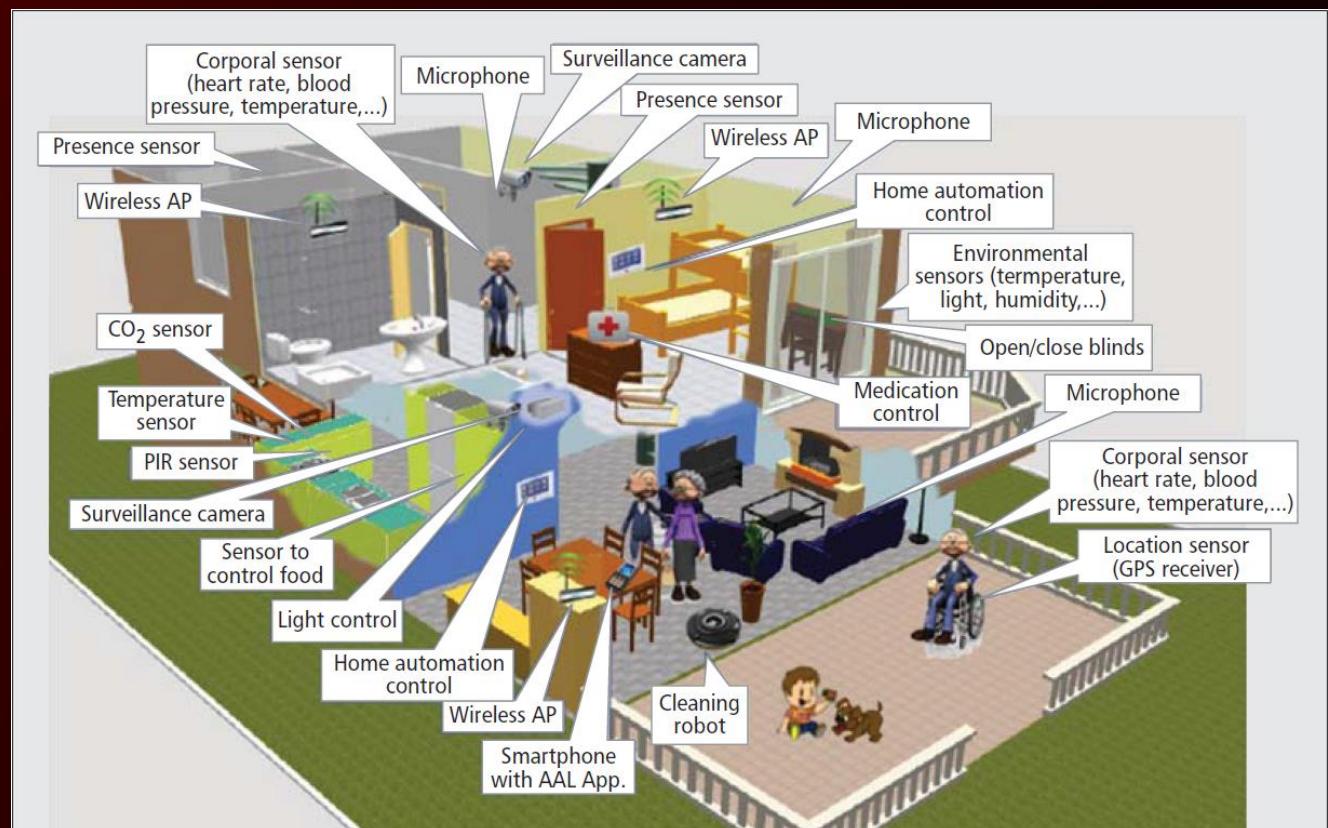
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## 4. XAI AND IoT

### ▪ Ambient Intelligence





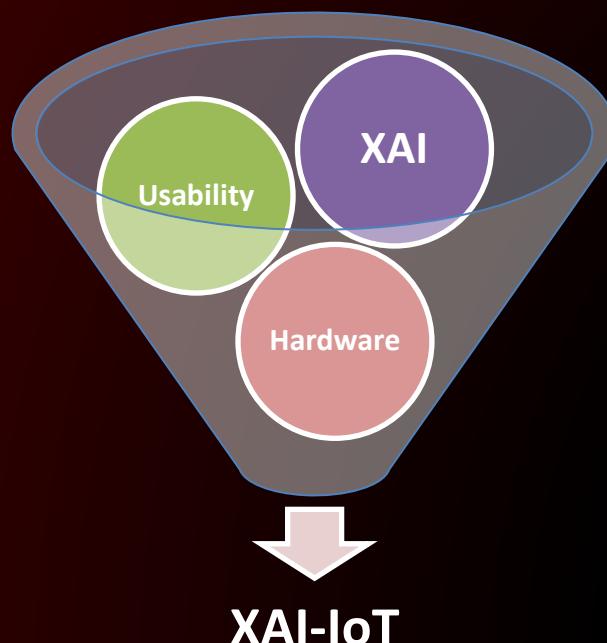
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## 4. XAI AND IoT

- Even IoT systems will need explainable views for humans...
- ***The more IoT use, more cyber and ethical anxieties rises...***
- ***So, there will be always need for XAI-IoT synthesis...***
- ***For the future medical smart cities, that will be in the form of XAI-IoMT / XAI-IoHT.***



### **Things to be considered:**

- *Target problem,*
- *Accessibility,*
- *Data Analytics,*
- *Data Security,*
- *Interaction in IoT Devices,*
- *Humans!?*

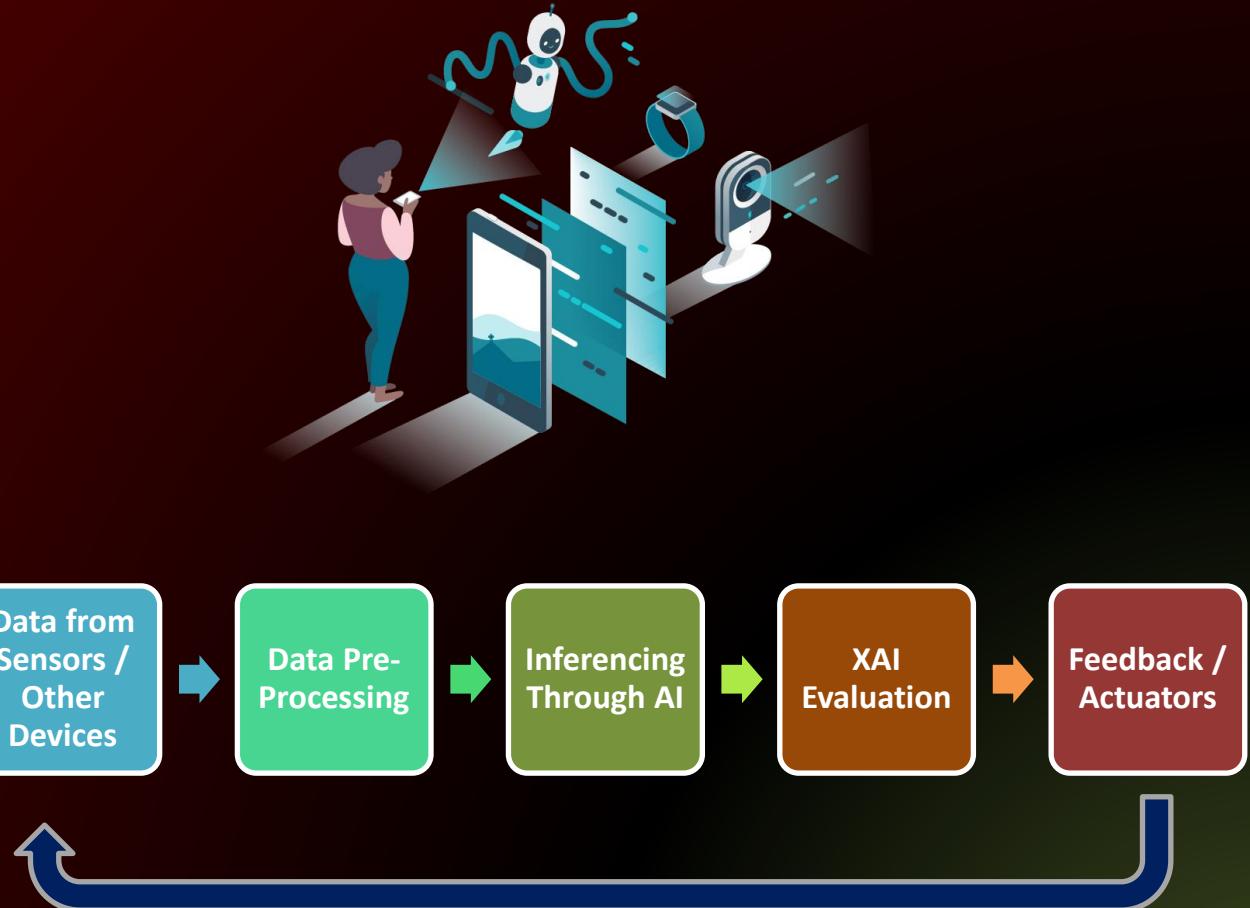


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## 4. XAI AND IoT





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## 5. OPEN PROBLEMS

- Target users' characteristics...
- Data! (Big Data, Small Data); bias!...
- Which techniques to combine for explanability...
- Target problem (modeling, representation)...
- Performance, optimization for XAI-IoT synthesis...
- Cyber Security...
- User Experience...
- Transparency...
- Ethical issues, safety...
- Software-Hardware combination issues...
- Problems in target fields...
- Societal impacts...
- ...etc.





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## 6. SUGGESTIONS

- Learn about philosophy of AI and its essentials...
- Learn algorithmic details of AI techniques...
- Write codes first (do not use libraries directly)...
- Learn about XAI techniques...
- Learn about smart technologies, and HCI...
- Learn about IoT and XAI collaboration...
- Learn about hybrid models of AI...
- Learn about data science, statistics...
- Learn some about mathematics and logics...
- Join to events, training programmes, online courses...
- Read about AI (news, blogs, videos, newsletters...etc.)...
- Read publications about AI and XAI...
- Follow famous scientists...



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## 7. QUESTIONS?

«Thank you very  
much for listening!»



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<http://www.utkukose.com>



- Majority of the images in XAI slides are from great work:

Arrieta, A. B., Díaz-Rodríguez, N., Del Ser, J., Bennetot, A., Tabik, S., Barbado, A., ... & Chatila, R. (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. *Information Fusion*, 58, 82-115.