20.318
Creative Machine Learning
Fall 2019

Course Instructor

Immanuel Koh

Students

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Sean Lee Jun Wei
Wan Mengcheng
Naomi Marcelle Bachtiar
Sim I-En Grace
Kyaw Htet Paing
Lee Hsien Toong
Samson Sim
Simon-Kyle Rocknathan
Benjamin Chong Mun Choen
Chiew Jia Hui
Abdul Irfan Hadi Bin Amir
Ho Di Xiang Darren
Sodano Michele
Tina Cerpnjak (Aalto)
Joonas Hermanni Saarinen (Aalto)

Course Description

The course provides an overview of today's machine learning apparatus for generative design and in turn speculates on the ways in which architectural design process itself might be altered as a result of this epistemological shift towards a 'Software 2.0' paradigm. By situating the discourse within an experimental prototyping context, students will not only gain the practical experience of applied machine learning workflow, but more importantly the architectural sensibility to conceptualize, articulate and implement their design applications in relation to these state-of-the-art Artificial Intelligence (AI) tools. Major architectures of deep neural networks implemented during the course include, fully connected neural networks, convolutional neural networks (CNNs), recurrent neural netwroks (RNNs), generative adversarial networks (GANs), variational autoencoders (VAEs), flow-based generative models...etc.
Students work in small groups, curating and preparing the dataset; selecting and training the machine learning model; and finally generating designs from the learnt data distribution.

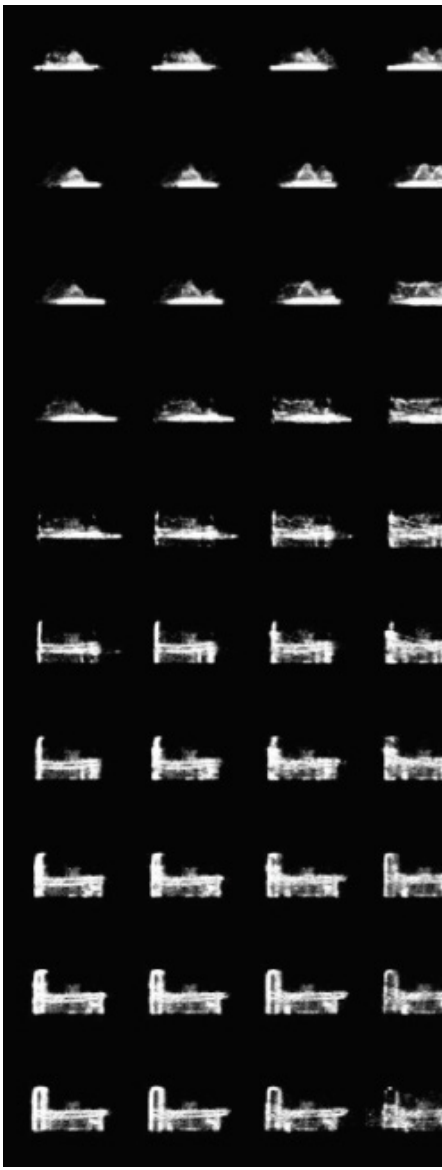
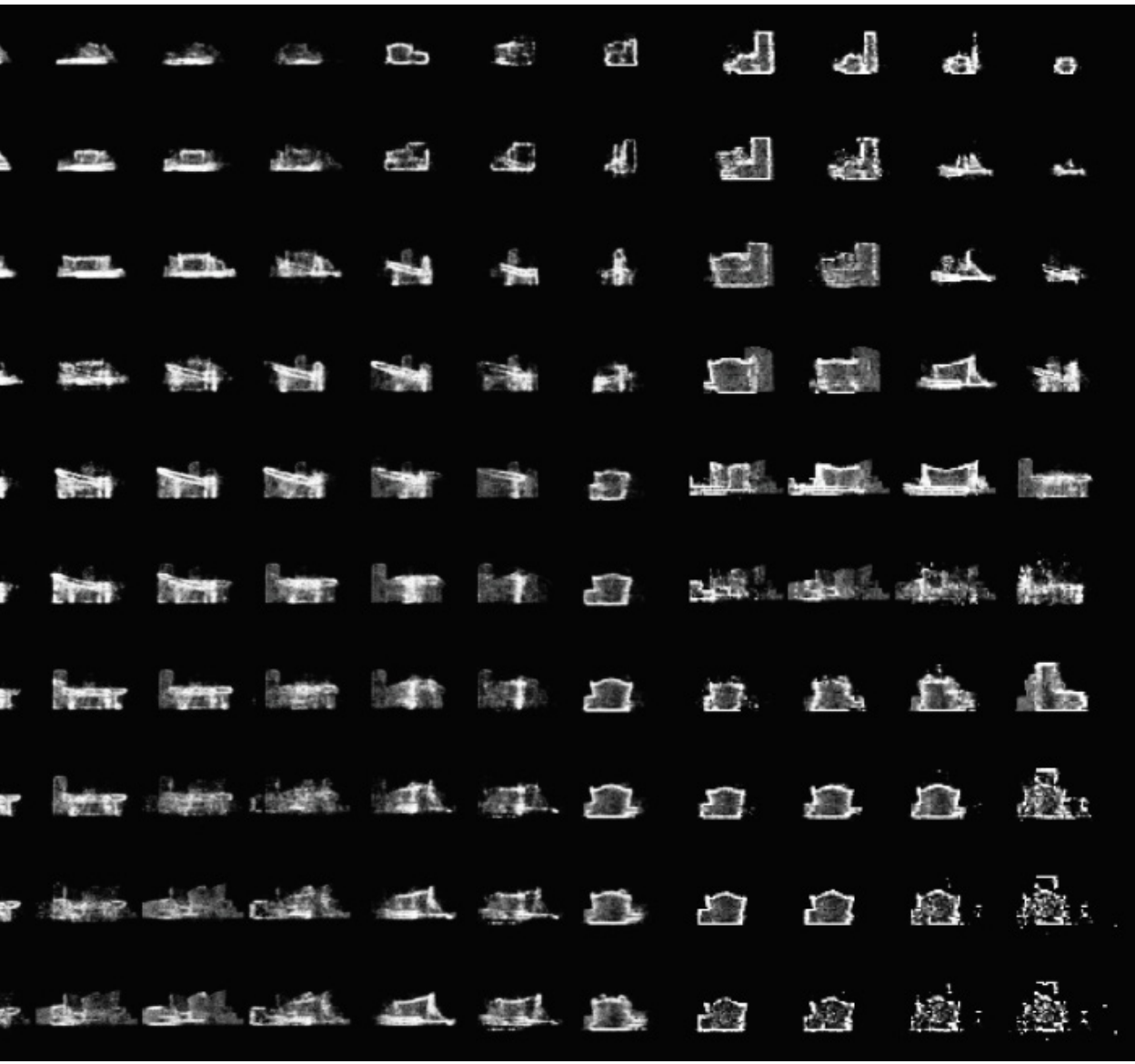


Figure 01: <Sectional Morphing>
Students: Jeanette Lee, Sean Lee and Nurul Nabilah Iz
Synthesized architectural sections from the latent
Waltz Disney Concert Hall and Ronchamp Chapel.

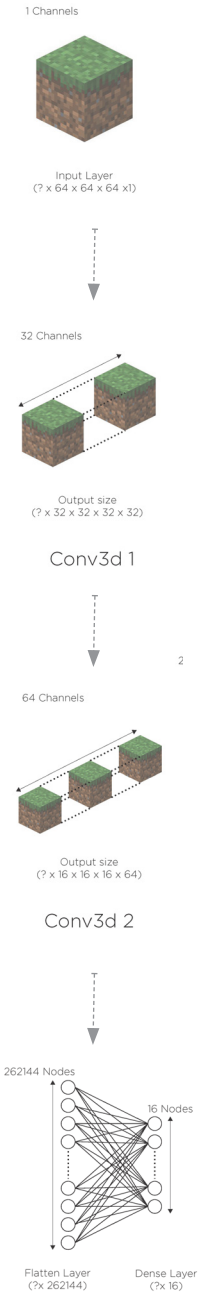


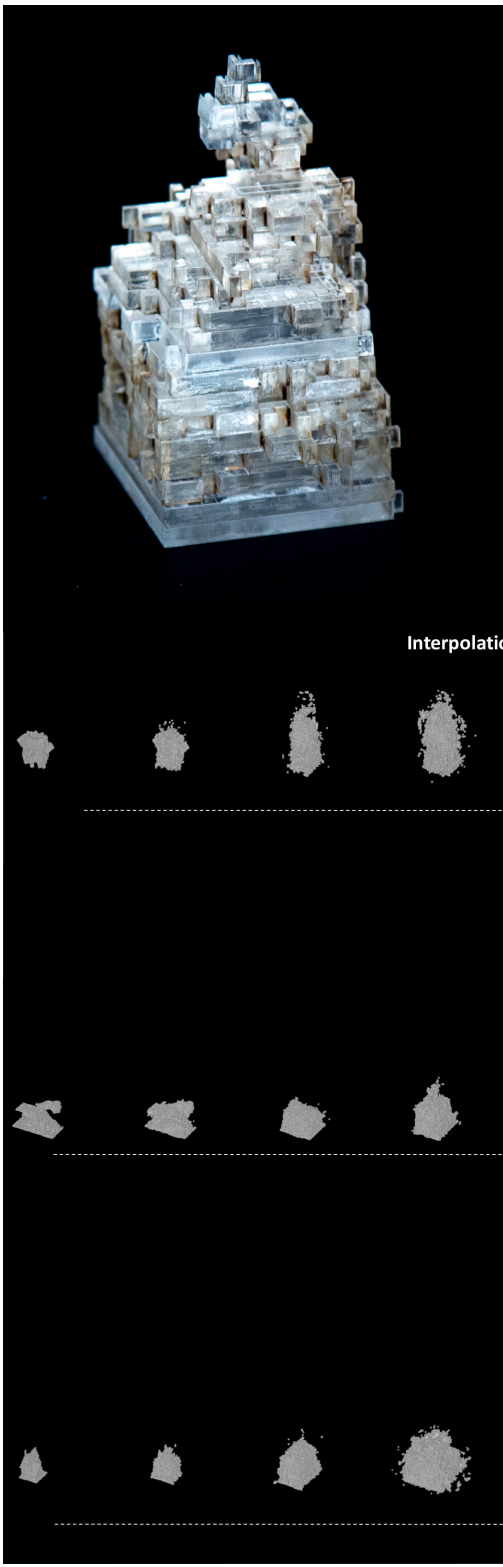
zzati

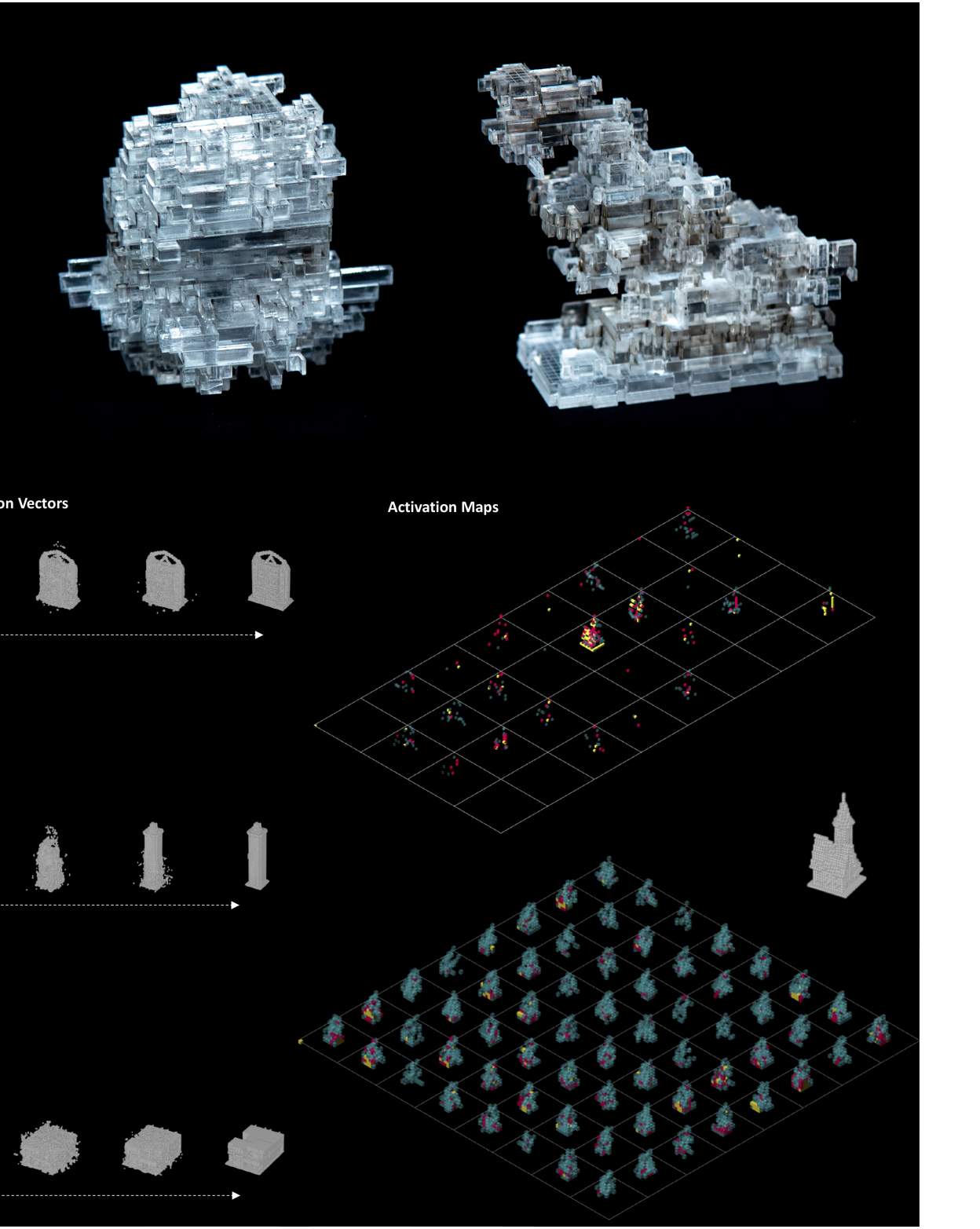
space of a deep generative model trained with several well-known buildings, such as Guggenheim Bilbao, Sydney Opera House,

Figure 02: <Mine Crafted>
Students: Benedict Tan and May Thinzar Lin

Deep learning of 3D voxel models from 'Minecraft' video game to generate new worlds. 3D feature maps are used to visualize the complex 3D layers of activations in the neural network. The model could interpolate between different building types found in 'Minecraft' to generate new and hybrid ones.






on Vectors
Activation Maps

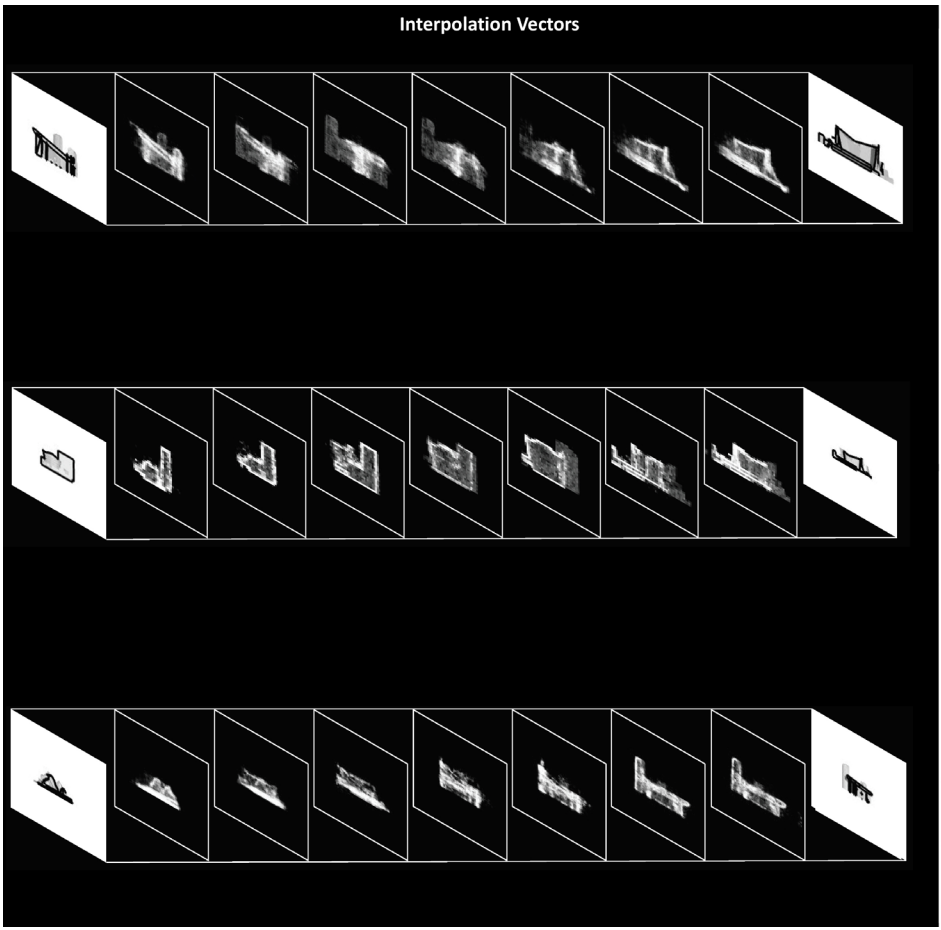


Figure 03: <Sectional Morphing>
Students: Jeanette Lee, Sean Lee and Nurul Nabilah Izzati

Generated architectural sections used to synthesize new building types via simple lofting and layering operation. Activation maps showing the deep neural network's perception of architectural sections at different scales.

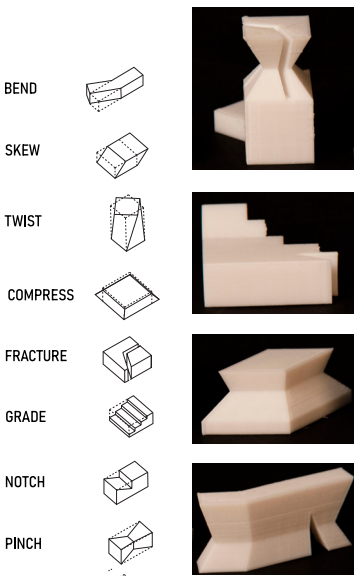
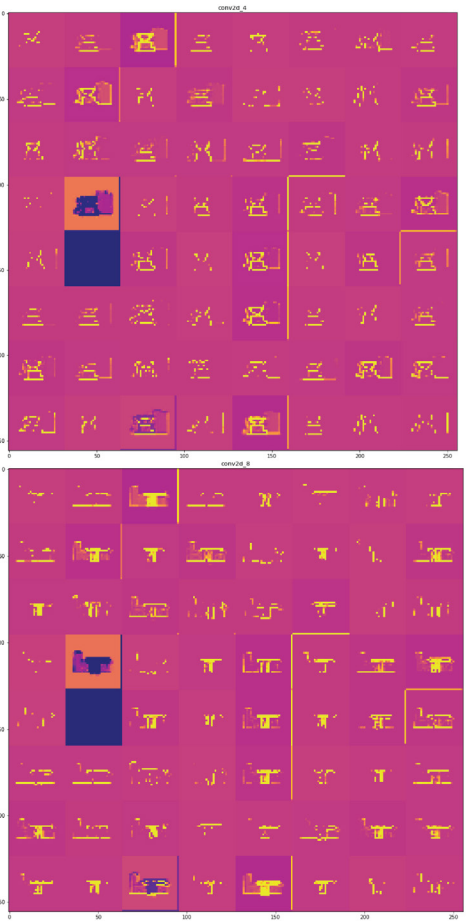
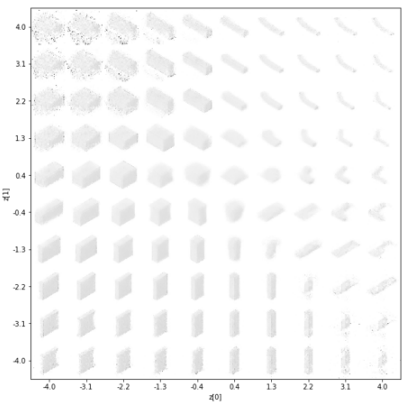


Figure 04: <Operative Design>
Students: Cher Jia Xi and Ye Huzheng

Urban massing used to train a deep neural network over several epochs. The trained model has the generative capacity to manipulate forms using typical geometrical operations, such as 'bending', 'skewing', 'twisting', 'compressing', 'fracturing'...etc.


conv2d_4
conv2d_8


z[0]


z[1]
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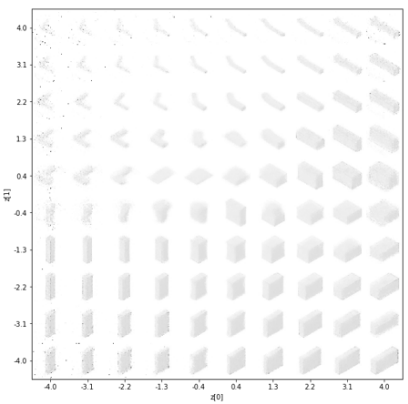
z[1]
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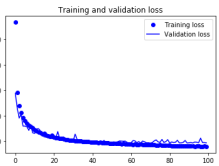
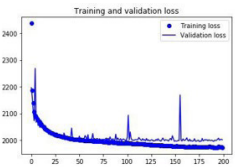

Training and validation loss
Training loss
Validation loss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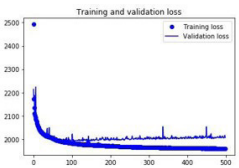
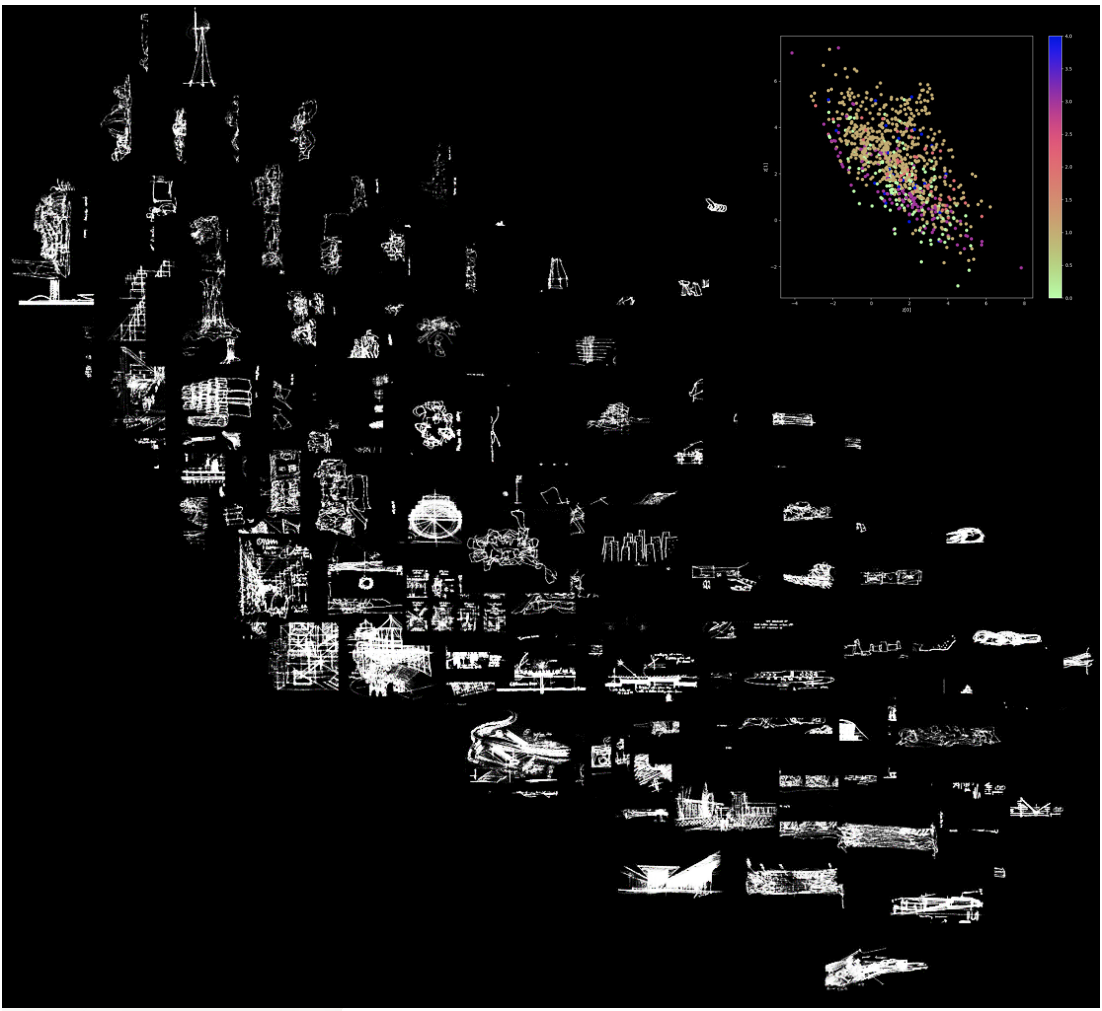
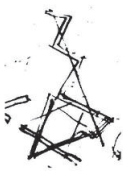

Training and validation loss
Training loss
Validation loss

Figure 05: <Polygraphia>
Students: Simon Rocknathan and Benjamin Chong

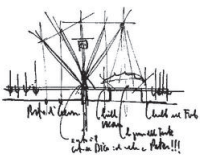
Deep learning of sketches by starchitects (e.g. Frank Gehry, Daniel Libeskind, Oscar Niemeyer, Renzo Piano and Tadao Ando). The neural network's latent space is shown clustering these sketches based on their implicit vertical and horizontal orientations. Instead of an architect's mongraph, a 'polygraphia' book is eventually printed -- synthesizing the imaginary sketches of all 5 architects.





Libeskind

Niemeyer

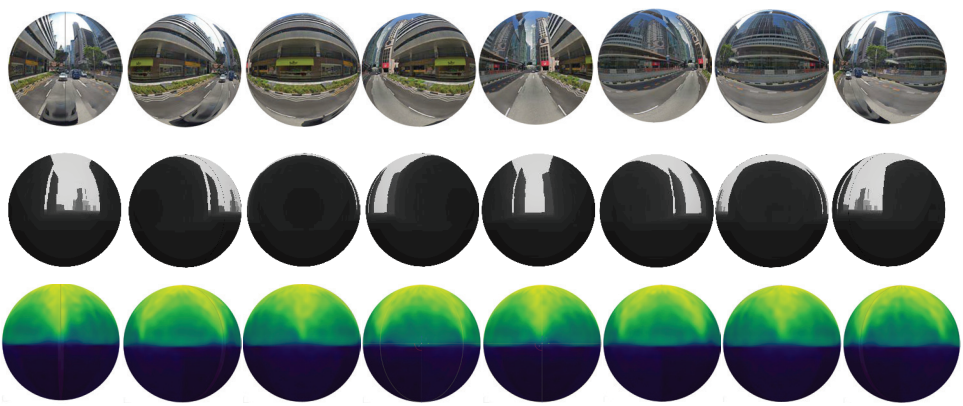


Piano

Gehry

Figure 06: <Neighbourhood Watch>
Students: Abdul Irfan Hadi Bin Amir, Darren Ho and Chiew Jia Hui

Deep learning of Singapore streetviews using panoramic images to discover the genius loci of 3 specific planning areas, namely Tampines, Central Business District (CBD) and Hillview.



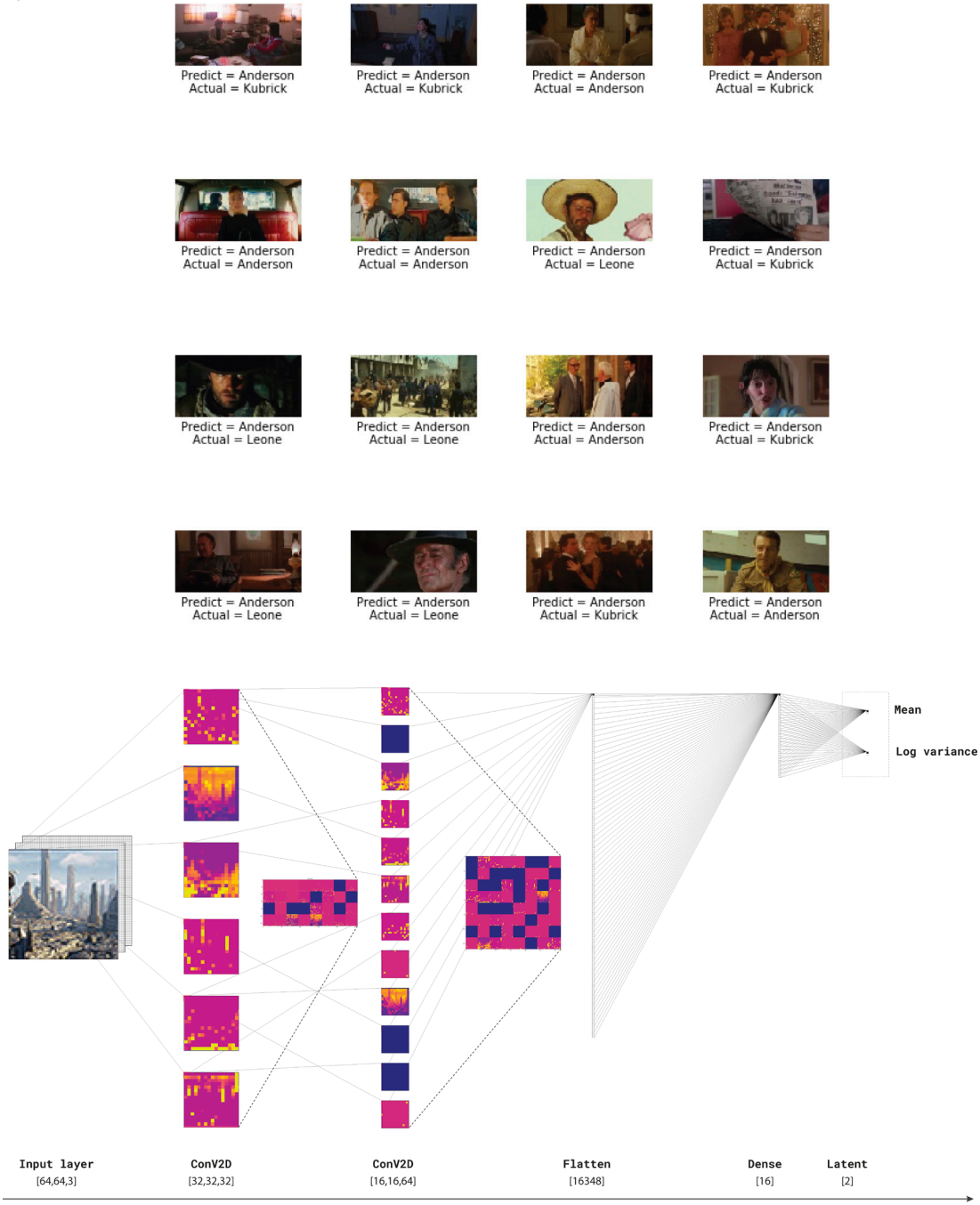


Figure 07: <Sci-fi-cities>
Students: Tina Cerpnjak and Joonas Saarinen

Inspired by the different cityscapes found in sci-fi movies, the deep learning model is used to extract the stylistic features belonging to a selection of directors, namely Stanley Kubrick, Wes Anderson and Sergio Leone. The movies included for the training of the neural network are Star Wars (episode 1,2,3,5), Matrix, Matrix Revolutions, Fifth Element, Blade Runner and Metropolis. Neural network's prediction of a director style when given an array of film stills. A diagram showing a partial view of the neural network architecture implemented.

Figure 08: <Jenga Tower Generator>
Student: Michele Sodano

Fast deep learning of physical Jenga block's aggregational features in approximating structural stability. An experiment speculating on alternative methodologies to computationally expensive physics-based structural simulations.

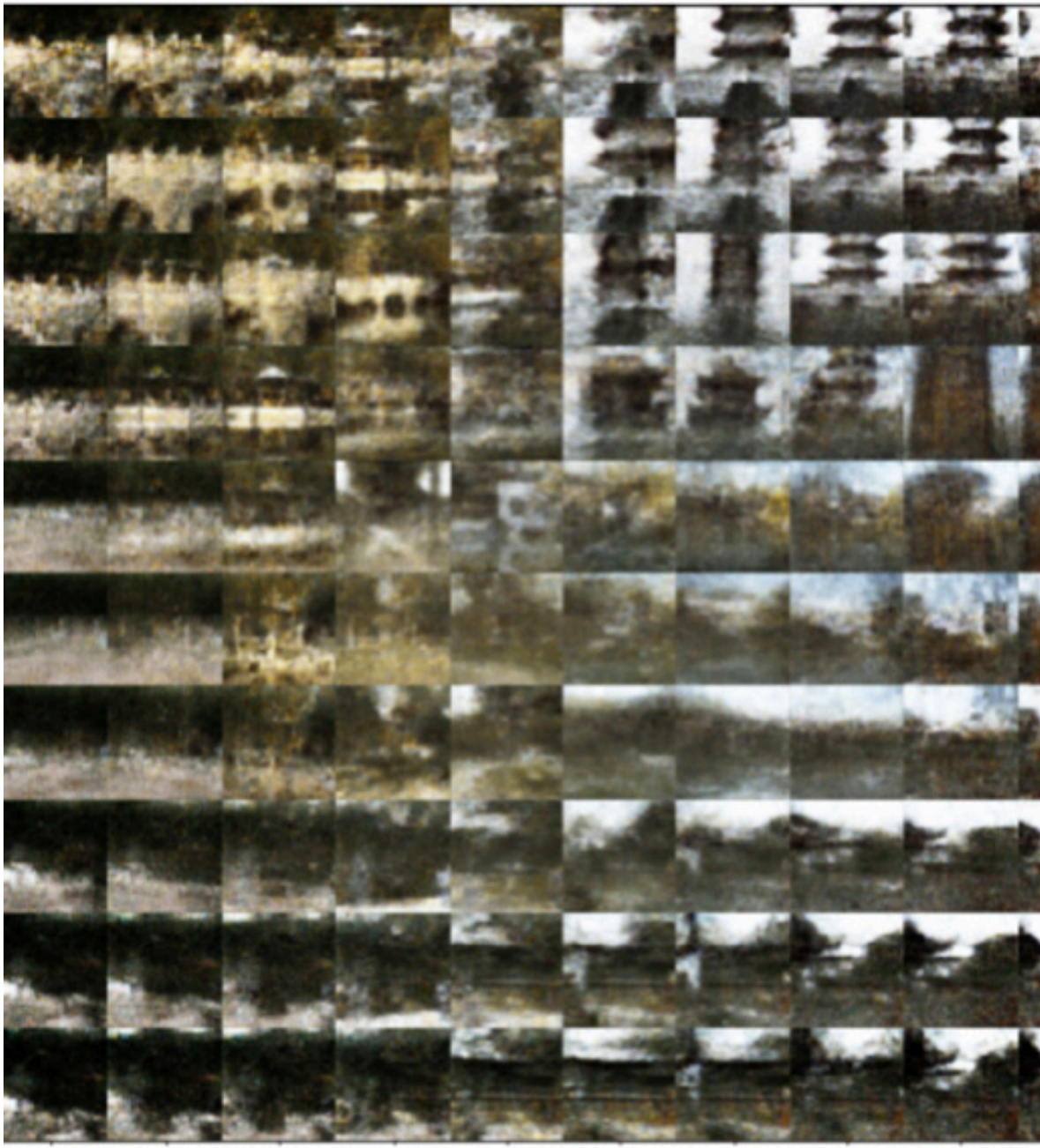


Figure 09: <Reimagining Chinese Gardens>
Students: Samson Sim and Lee Hsien Toong

Deep learning visual compositions of Chinese pictorial space to reimagine novel Chinese gardens. Continuous interpolations along specific features provide a means for synthetic generation of new relationships between landscapes and buidings.