



BITM3213 • INTERACTIVE COMPUTER GRAPHICS

Visualization

Module 8 — Turning data and simulations into pictures the mind can read

Why visualize • Visual metaphors • The role of realism • Handling complexity

Week 14 • Lecture 14 • FTMK • Session 2025/2026

WHAT YOU'LL GET TODAY

Learning Outcomes



Explain why we visualize

Say what visualization is for and when a picture beats a table of numbers.



Describe the viz pipeline

Trace data from raw numbers through mapping and rendering to human insight.



Choose visual metaphors

Map data onto position, colour, size, shape, and motion deliberately.



Judge the role of realism

Decide when photorealism helps and when abstraction communicates better.



Handle complexity

Tame large or messy data with aggregation, clustering, and levels of detail.

A table of 10,000 numbers hides its story. One good chart tells it instantly.

The numbers

Rows and columns are precise but slow to read. Trends, outliers, and clusters stay invisible to the eye.

The picture

Map those numbers to position and colour and the pattern jumps out — the brain reads images in parallel.

Visualization exploits the fact that human vision is massively parallel.

What Is Visualization?

Visualization is the use of computer-generated, interactive, visual representations of data to amplify understanding.

Three words matter:

- Visual — it uses the eye, our highest-bandwidth sense
- Data — it is grounded in real measurements or models
- Understanding — the goal is insight, not decoration



Not the same as 'graphics' All visualization uses graphics, but not all graphics is visualization. A game explosion is graphics; a chart of crash-test forces is visualization — it exists to inform.

Two broad families

Scientific visualization — data with a natural spatial layout (a brain scan, airflow over a wing).

Information visualization — abstract data with no inherent shape (sales, networks, text).

Why Visualize?



See the unexpected

Patterns, trends, and outliers you never thought to query for simply appear.



Compress information

One image can carry what pages of tables cannot, in less time.



Communicate

A shared picture aligns a team or an audience far faster than raw data.

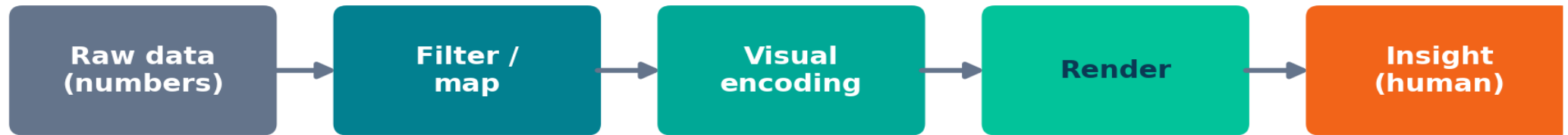


Explore interactively

Zoom, filter, rotate — ask new questions of the data on the fly.

The Visualization Pipeline

The visualization pipeline: turn data into something the eye understands



Every stage throws away detail on purpose — the goal is insight, not a data dump



Each stage discards detail on purpose Raw data is filtered, mapped to visual form, rendered, then read by a human. The art is choosing what to keep at each step so the final image answers the question — a data dump is not a visualization.

Mapping Data to Visual Channels

Visual channels: how we encode a number as something you can SEE

Position / length



Colour (hue / value)



Size / area



Shape / glyph



Motion / time



Not all channels are equal Position and length are read most accurately; colour and area are good for categories or rough magnitude; pick the channel that matches how precisely the value must be judged.

The metaphor must fit

Encode temperature as colour (warm/cool) and it reads instantly. Encode it as shape and nobody understands. Match meaning to channel.

Colour: Powerful and Easy to Misuse

Sequential



Light → dark of one hue. For ordered values: low to high (e.g. temperature, density).

Diverging



Two hues meeting at a neutral midpoint. For data with a meaningful centre (e.g. profit vs loss).

Categorical



Distinct, unordered hues. For labels with no order (e.g. country, material type).



Two rules that fix most colour mistakes 1) Don't use a rainbow scale for ordered data — it invents false boundaries. 2) Check it works for colour-blind viewers; never rely on red-vs-green alone.

Is More Realism Always Better?

The role of realism: more realism is NOT always better

Abstract / schematic

Photorealistic



subway map,
chart

flat-shaded
3D model

ray-traced
film frame

Pick the point on this axis that makes YOUR message clearest

Realism helps when...

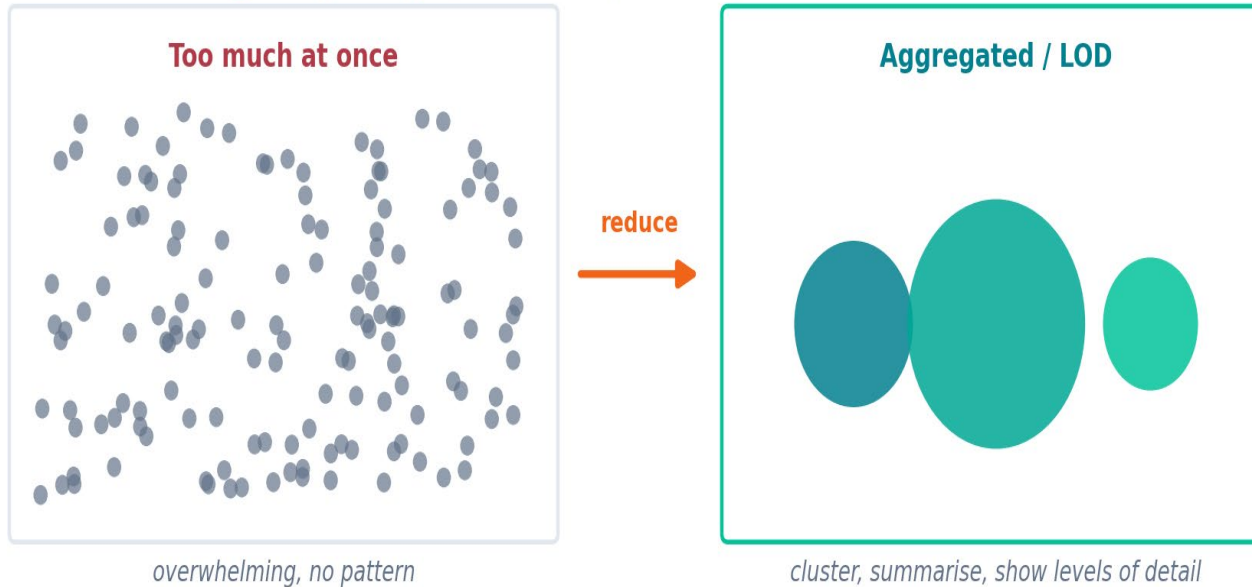
the goal is presence or recognition — training simulators, medical models, architecture walkthroughs.

Abstraction helps when...

the goal is clarity — a subway map or a chart strips away realism to show structure, not appearance.

When There's Too Much Data

Handling complexity: summarise, cluster, and show detail on demand



Clutter destroys insight Plotting every point at full detail produces a grey smear. The fix is to summarise: aggregate, cluster, sample, or show detail only where the user looks.

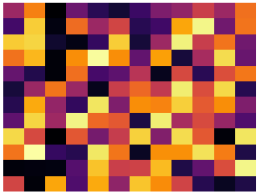
Levels of detail (LOD)

Show a coarse overview first; reveal fine detail on zoom. Same idea as LOD meshes in 3D rendering.

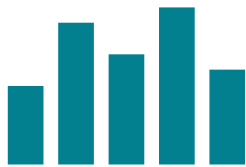
Visualization in the Wild

Where visualization shows up

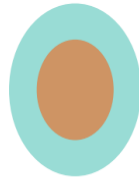
Scientific



Information



Medical



Simulation



Your bouncing ball in Lab 9 is a simulation visualization — physics you can SEE



Same craft, many fields Scientific fields, information dashboards, medical imaging, and physics simulations all apply the same pipeline — only the data and the metaphors change.

Closest to this course

Simulation visualization. Your Lab 9 ball — with its grid floor and shadow blob added purely to make motion readable — is exactly this.

Principles of a Good Visualization

1

Serve the question

Every mark should help answer a specific question. If it doesn't, remove it.

2

Maximise data-ink

Cut chartjunk — gridlines, 3D bevels, decoration that carries no data.

3

Encode honestly

Don't distort scales or truncate axes to exaggerate a trend.

4

Match channel to task

Position for precise comparison; colour and size for categories or rough magnitude.

5

Overview, then detail

Show the big picture first; let the viewer drill down interactively.

Visualization in Simulation & Animation Research



Make models legible

A simulation outputs torrents of numbers. Visualization is what turns them into behaviour a researcher can judge.



Compare & validate

Side-by-side visuals reveal whether a model matches reality — the heart of validating a simulation.



Communicate findings

A clear animation or figure is often what gets a result understood, published, and used.

This is the bridge from a course project to real research and consultation work.

From Concepts to the Final World

This module

- Why we visualize
- The data → insight pipeline
- Visual metaphors & colour
- Realism vs clarity
- Taming complexity



Lab 10 — Final Project

3D Interactive World

Integrates Labs 1–9: a textured, lit, OBJ-populated world you can walk through.

Your visualization job: arrange and present it so a viewer instantly understands the scene.

Lab 10 — 3D Interactive World

1

Assemble the scene

Place lit, textured OBJ models in a world using a small scene hierarchy.

2

Walk through it

FPS camera from Lab 4: move and look around your own environment.

3

Light it for legibility

Use Module 6 lighting so shapes and depth read clearly, not just prettily.

4

Compose the view

Apply visualization principles: guide the eye, avoid clutter, frame the subject.

5

Present & defend

Show it and explain your design choices — the research-presentation skill.

Common Visualization Mistakes

Chartjunk

3D pie charts, heavy textures, decoration

Strip it. Decoration that carries no data only hides the data that matters.

Rainbow scale for ordered data

jet / rainbow colormap on a continuous field

Use a perceptually ordered sequential scale instead; rainbow invents false edges.

Truncated / distorted axes

y-axis not starting at zero to dramatise

Be honest with scales, or label the break clearly. Don't manufacture trends.

Too much at once

every point, every label, all the time

Aggregate and use overview-then-detail. Respect the viewer's attention.

Key Terms — Know These Cold

Visualization

Visual representation of data to amplify understanding.

Information viz

Abstract data with no inherent shape (sales, networks).

Visual channel

A property used to encode data: position, colour, size, shape, motion.

Level of detail (LOD)

Coarse overview first, fine detail on demand or on zoom.

Scientific viz

Data with a natural spatial form (scans, flow fields).

Visualization pipeline

Raw data → filter → encode → render → human insight.

Data-ink

The fraction of a graphic that actually encodes data; maximise it.

Chartjunk

Decoration that conveys no data and should be removed.

Self-Check Questions

1

In one sentence, what is the purpose of visualization?

2

Name the stages of the visualization pipeline in order.

3

Give one value best encoded by position and one best encoded by colour.

4

When does realism help, and when does abstraction help more?

5

Why is a rainbow colour scale a poor choice for ordered data?

6

Name two techniques for visualizing data that is too large to show raw.

Recap — Screenshot This Slide



Visualization turns data into pictures to amplify understanding.



Human vision is parallel — images reveal what tables hide.



Pipeline: raw data → filter → encode → render → insight.



Map values to channels: position, colour, size, shape, motion.



Position is read most precisely; colour suits categories.



More realism isn't always better — match it to the task.



Tame big data with aggregation and level-of-detail.



Next: Lab 10 — present your 3D world using these principles.

Module 9 — Special Topics in CGI



Virtual Reality

Immersive worlds rendered for each eye — and what that costs.



Mixed Reality

Blending the real and the virtual along one continuum.



Game Engines

The layered systems that sit on top of the renderer you built.

The road beyond OpenGL — and where your skills go next.

Reading: Marschner & Shirley, Fundamentals of CG • Akenine-Möller, Real-Time Rendering • learnopengl.com