The river banks of Ellsworth Kelly’s Seine

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Ellsworth Kelly (1923–)

Drafted in 1943, went to Boston Museum School in 1946.

Spent 1948-1954 in France.

In 1951, worked on capturing the **reflections of light on water** in a grid.

Also began to cut up brushstrokes and **arrange them randomly**.

*Seine* unified these ideas:


Rectangles were placed according to numbers drawn out of a hat!

Each of the first 41 columns contains one more black rectangle than the one to its left.

Each of the next 40 following columns contains one more white rectangle than the one to its left.
Perhaps it’s too restrictive to think of *Seine* as the particular instance which was painted – let’s consider rather the **whole ensemble of possibilities**!

**Questions:**
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What can art do for physics?

In 1985, Sapoval, Rosso, and Gouyet introduced a model for diffusion fronts now called gradient percolation.

Imagine a snapshot of dye molecules in water diffusing away from a vertical source. What does it look like?

It’ll look like Seine!

① What can art do for physics?

The frontier of any sort of random propagation can be modeled by gradient percolation:

A line of ants pouring out of a nest, the edge of a rusted metal, the spread of a disease...

They’ll look like Seine, too!

Questions / Answers:

① Seine ended up being a model for diffusion fronts!
② What can physics do for art?

Let’s look “deeper” into Seine, and focus on one visual feature that has physical significance.
What do we usually see in the Seine model?

Let’s draw some numbers out of a hat computer!
What do we *usually* see in the *Seine* model?

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Why do we *always* see this sort of picture, with $384\pm15$ clusters?
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And *never* something like this, with three connected clusters?
What do we **usually** see in the *Seine* model?

There are roughly $1.98 \times 10^{665}$ different possible configurations.

How many times would we have to “win the lottery” in a row to draw one of these?
Key physics fact: Large random systems often exhibit predictable behavior!
**Predictable behavior in random systems?**

This is expressed by various **central limit theorems:**
– why “everything” is statistically distributed via the **bell curve**
– why stock prices look like **Brownian motion**

Distribution of number of clusters in the *Seine* model

Number of amalgam fillings

http://www.xs4all.nl/~stgvisie/AMALGAM/EN/SCIENCE/tubingen.html
**Predictable** behavior in **random systems**?

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http://gammamath.com/sub/RandomWalk.shtml

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– why stock prices look like Brownian motion

This principle applies very broadly!

What do these sorts of laws say about what we see in Seine / diffusion fronts?
Three biggest clusters:

Land ———— Water ———— Land
Three biggest clusters:

Land -- Water -- Land
Three biggest clusters:

Land ——— Water ———— Land
Three biggest clusters:

Land ———— Water ———— Land
Three biggest clusters:

Land ———— Water ———— Land
Three biggest clusters:

Land ——— Water ——— Land
I’ll call the boundaries of the three biggest clusters “shorelines”:

(These curves are precisely the diffusion fronts!)
These shorelines are random curves.

It was guessed that they are very, very likely to be wiggles around the columns that are 59.4% white and 59.4% black.

(59.4% is the critical probability in ordinary percolation)

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The width of these curves is **guessed** to scale as 
$$\text{(Width of the grid in squares)}^{4/7}.$$ 
The shores get wider, but they widen slower than the grid itself does!

The random curves on the river banks of Seine are just one geometric feature we might study...
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Conclusions

I described the set of possibilities of the painting *Seine*.

It turned out to be gradient percolation, a model of *diffusion fronts*.

The model is *random*, but large random objects are almost deterministic in some ways!

The “shorelines” of *Seine* are a strange *random curve* with properties that are still not well understood.
6 years after Kelly painted *Seine*, Broadbent and Hammersley wrote a paper introducing **percolation**.

59% open (white)  
Will water flow between left and right?  
61% open (white)

6 years after Kelly painted Seine, Broadbent and Hammersley wrote a paper introducing percolation.

Only if there’s a connected open cluster from left to right!

References


