Technical applications:

IMPAINTING:

Retouching of image errors ("holes") by searching and inserting the best fitting patches from a directory of patches from the own image or image sequence.

Litmax/Bigmin comes into play when searching.

https://arxiv.org/ftp/arxiv/papers/1712/1712.06326.pdf

SIMULATION:

SMOOTHED PARTICLE HYDRODYNAMICS

A fluid is described by a multitude of particles of constant mass, so that the flow is expressed or calculated by the (free) motion of the particles. (...). The calculation method is very flexible and allows the introduction of complex boundary conditions. Due to these advantages, SPH is widely used in industry.

Physical parameters such as density, pressure and velocity are assigned to each SPH particle, whose time evolution is described by a closed differential equation system of continuity, momentum and state equations and solved by neighborhood weighting. (...) The change of density or velocity of a reference particle is calculated on the basis of the parameters of the neighboring particles, so that instead of a partial differential equation a system of ordinary differential equations is solved numerically.

Explanation from
https://link.springer.com/article/10.1007/s00506-015-0217-z

With BIGMIN:
https://www.cambridge.org/core/journals/communications-in-computational-physics/article/abs/efficient-implementation-of-

smoothed-particle-hydrodynamics-sph-with-plane-sweep-algorithm/7C56E46BDC4A1FA121C456EEED6D90B2

PERIDYNAMICS

approach similar to SMOOTHES PARTICLE HYDRODYNAMICS, but for solids; special advantage: inhomogenities like cracks can be modeled.

General explanation
https://www.math.uni-bielefeld.de/~emmrich/studenten/henrik-diplom.pdf

https://www.tu.berlin/diffeqs/studium-lehre/abschlussarbeiten
Dimitri Puhst (2012): Analysis der peridynamischen Bewegungsgleichung
(Explanations not picturesque)

With Citation:
https://elib.uni-stuttgart.de/bitstream/11682/2896/1/DIP_3268.pdf

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Adaptive Sampling in Position-Based Fluids

Lucas Geyer, Technische Universität Wien, März 2022

Position-Based Fluids (PBF) belong to the Lagrangian fluid simulation methods, it is based on Smoothed Particle Hydrodynamics (SPH) and extends the Position-Based Dynamics (PBD) framework… -- > *ability to simulate fluids.*

The Z-order [Mor66, TH81] assigns a scalar value to any multidimensional data point in a way so that two data points that are close together in their multidimensional space are likely also close together in their one-dimensional mapping. This makes the Z-order very useful for storing the particles, because then neighboring particles are mostly close together in memory (…)

https://www.cg.tuwien.ac.at/courses/konversatorium/Adaptive-Sampling-Position-Based-Fluids-DAAV

TRACKING

Storing constantly changing spatial and temporal (spatio-temporal) features requires multi-dimensional data support in data management applications. …. We suggest that in the cases where the tracked objects are close to each other, we can obtain better performance from z-order partitioning than sweep-space filling curve.

https://ieeexplore.ieee.org/document/5978495/references#references

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SEARCH IN GEO DATA

Multiresolution select-distinct queries on large geographic point sets

https://dl.acm.org/doi/10.1145/2424321.2424343

Partitioning, Indexing Quering Spatial Data on Cloud

https://arxiv.org/abs/1612.05858

Location-based services outside the mass market

Similar to RAIMA (see here under Databases), the special advantage that the database and spatial queries are separate from each other is also emphasized here, and geodata are stored and retrieved at runtime:

Database extensions to relational databases are increasingly gaining acceptance for managing large amounts of geographic data; however, due to the special role of geometric and geographic data structures, an application's access to database functions must be significantly extended. In HomeRun, an approach is implemented in which the spatial extension is not understood as part of the database, but is added to the application as an additional software library. ...Ortsbezogene Dienste außerhalb des Massenmarktes

Database with spatial extension: here the maps and user generated geodata are stored and retrieved at runtime.

Heidelberger Geographische Bausteine Heft 18, 2010, Geografisches Institut Heidelberg.

https://docplayer.org/54514532-Die-homerun-plattform-fuer-ortsbezogene-dienste-ausserhalb-des-massenmarktes.html

http://wireless-earth.net/paper/FG_LBS09.pdf

COMPLEX EVENT POCESSING:

Prediction can be performed by answering the range queries over the historical sequence space.

LITMAX / BIGMIN are called here Nextjumpin / NextJumpOut. Everything equal otherwise.

https://hal.science/hal-01613798/document

POINT CLOUDS (Mass Data)

Time and Space Efficient Data Analytics (Diss. 2019)

https://infoscience.epfl.ch/record/263662

Dictionary Compression in Point Cloud Data Management

https://dl.acm.org/doi/abs/10.1145/3139958.3139969

(k) NEAREST NEIGHBOURS

Tropf and Herzog [96] present a precursor to many nearest neighbour algorithms

https://diginole.lib.fsu.edu/islandora/object/fsu:181739/datastream/PDF/view

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Constructing a High-Dimensional kNN-Graph Using a Z-Order Curve
https://dl.acm.org/doi/10.1145/3274656

ANALYTICS, general

Title: Towards Longitudinal Analytics on Social Media Data

https://ieeexplore.ieee.org/document/8731609/references#references

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AREA SEARCH IN TEMPORALLY, NUMERICALLY AND GEOGRAPHICALLY ANNOTATED DOCUMENTS

Vebjorn Ohr, Norwegian Universit if Science and Technology, June 2022

From the summary:

The annotated documents are stored using inverted indexes in a layered data model. Each layer represents one annotation type, and all layers share the positional information of the tokens. To support efficient retrieval, the numerical, temporal, and geographical expressions are reduced to one dimension by using Z-order curves, which translate the two-dimensional values into one-dimensional hashes.
(…)

BIGMIN and LITMAX

Tropf and Herzog [19] implemented a more sophisticated approach for range searches using the Z-order curve. The authors do this by iterating through the stored objects, sorted by the Z-order value, just as with the naive approach.
(…)
The range search over the Z-order curve is done by recursively splitting the search range into Z-order ranges which are continuous at the current recursion level (…). This is done by utilising a modified version of the previously mentioned *BIGMIN* and *LITMAX* approach described by Tropf and Herzog [19]

Algorithm 3 Calculates BIGMIN and LITMAX values

Input: Tuple of values for known dimension K, Tuple of values for unknown dimension U, Boolean indicator of unknown dimension d
Output: Calculated values for unknown dimension $litMax$ and $bigMin$

1: **procedure** CALCULATEBIGMINLITMAX(K, U, d)
2: $cb \leftarrow$ number of common MSB between $U[0]$ and $U[1]$
3: $litMask \leftarrow$ bit-string equal to 011..., total length equal cb
4: $bigMask \leftarrow$ bit-string equal to 100..., total length equal cb
5: $litMask \leftarrow$ first cb MSBs of $U[0]$ followed by $litMask$
6: $bigMask \leftarrow$ first cb MSBs of $U[1]$ followed by $bigMask$
7: **if** $d = 0$ **then** ▷ Unknown dimension is Y
8: $litMax \leftarrow$ bit interleave $litMask$ and $K[1]$, starting with mask
9: $bigMin \leftarrow$ bit interleave $bigMask$ and $K[0]$, starting with mask
10: **else** ▷ Unknown dimension is X
11: $litMax \leftarrow$ bit interleave $K[1]$ and $litMask$, starting with K
12: $bigMin \leftarrow$ bit interleave $K[0]$ and $bigMask$, starting with K
13: **return** $litMax, bigMin$

https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/3020761/no.ntnu%3Ainspera%3A112046434%3A32782454.pdf?sequence=1

GAMES

Collision detection and warning for many moving objects

See under "Optimizations": It needs some work to compete with the naive implementation….I used the method described here to achive this. (>RAIMA, *corresponds and cites Tropf/Herzog, see here under Databases.*) They call the two points that will identify the split as LitMax and BigMin.

https://snorrwe.onrender.com/posts/morton-table/