https://orcid.org/0000-0002-4168-7190

UDC 623.764

**P.S. SAPATY***

# SPATIAL NETWORKS AS MODELS FOR ORGANOID CULTURES AND BRAIN RESEARCH

*Institute of Mathematical Machines and Systems Problems of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

***Анотація.*** *Стаття орієнтована на концепцію органоїдів, спрощених версій органів, створених штучним шляхом, які стають все більш важливими і популярними, особливо для прогнозування та профілактики захворювань, а також для дослідження мозку. Вона досліджує потенційні можливості створення, еволюції та аналізу моделей органоїдів за допомогою розробленої моделі та Технології просторового захоплення (ТПЗ), яка вже була випробувана в різних сферах застосування, включаючи управління мережевими технологічними, соціальними та оборонними системами. Спершу в роботі аналізуються та класифікуються останні публікації про органоїдів, а потім коротко описуються основні функції ТПЗ, у тому числі її базова Мова просторового захоплення з її мережевою інтерпретацією, завдяки якій створюються потужні просторові двигуни, здатні охоплювати земне та небесне середовище. Потім у ній демонструється практичне та дуже компактне вираження зростаючих моделей органоїдів за допомогою ТПЗ, які включають ріст клітин, поділ і реплікацію, створення та рух клітинних черв'яків, роботу клітин-убивць і, нарешті, повну органоїдну модель з її функціонуванням. У статті також пояснюється, як досліджувати параметри зростаючих органоїдів, які можуть передбачити поведінку, пов'язану із хворобою. У роботі розглядаються деякі інші розробки органоїдів, які становлять інтерес для використання ТПЗ, включаючи мінімозок у робототехніці, мозкові хвилі, що їх випромінюють органоїди, і розвиток органоїдів у космосі. Стаття завершується планами стосовно отримання більш детальних і розширених результатів за допомогою ТПЗ, які можна використовувати різними способами. По-перше, мережеві моделі органоїдів можна отримувати набагато швидше, ніж шляхом вирощування тканини в лабораторіях. По-друге, поєднання віртуальних та живих особливостей в єдиному процесі розробки органоїдів і в рамках дослідження може виявитися корисним. По-третє, якщо для заміни органу дійсно потрібна жива тканина, передовий віртуальний ріст таких органоїдів можна зорієнтувати і спрямувати на розвиток реальної тканини.*

***Ключові слова:*** *органоїд, in vivo, in vitro, органоїди мозку, органоїди пухлин, моделювання захворювання, боротьба з раком, Технологія просторового захоплення, динамічна мережа, розумне управління, розподілене моделювання.*

***Abstract.*** *The paper relates to the concept of organoids, the simplified versions of organs produced artificially, which are of growing importance and popularity, especially for disease prediction and prevention and brain research, too. It investigates the potential capabilities of the creation, evolution, and analysis of organoid models with the developed Spatial Grasp Model and Technology (SGT) which has already been tested on various applications, including the management of networked technological, social, and defense systems. The paper first analyzes and classifies the latest organoid-related publications, then briefs the main SGT features, including its basic Spatial Grasp Language with its networked interpretation, resulting in powerful spatial engines capable of covering terrestrial and celestial environments. Then it shows a practical and very compact expression of growing organoid models under SGT which include cell growth, division and replication, cell worm creation and movement, killer cell operation, and finally, a full organoid model with its operation. It also explains how to investigate parameters of the growing organoids that can predict disease-related behavior. The paper reviews some other organoid developments of interest for the use of SGT, including mini-brains in robotics, organoid-emitting brain waves, and the development of organoids in outer space. It concludes with the plans for more detailed and extensive results with SGT which may be used in different ways. Firstly, the networking models of organoids can be obtained much quicker than the growing tissue in labs. Secondly, it may appear useful to combine virtual and living features in the united organoid development and research process. Thirdly, if a living tissue is really needed*

*for organ replacement, advanced virtual growth of such organoids can orient and direct the real tissue development.*
***Keywords:*** *organoid, in vivo, in vitro, brain organoids, tumor organoids, disease modeling, cancer fighting, Spatial Grasp Technology, dynamic networking, intelligent management, distributed simulation.*

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## 1. Introduction

This paper is devoted to the phenomenon called *organoid*, which has been of enormously growing interest, importance, and popularity for the last few years. An organoid is a miniaturized and simplified version of an organ produced in vitro that mimics the key functional, structural, and biological complexity of that organ. Constructed from both normal and diseased tissues, organoids serve as a valuable tool for fundamental research, disease modeling, drug screening and discovery, and regenerative medicine as well. For example, brain organoids address fundamental questions in human brain research, whereas tumor organoids are cultured to accelerate finding more precise therapies to fight cancer.

The *aim of this paper* is to investigate the potential applicability of the developed Spatial Grasp Model and Technology (SGT) based on active distributed self-evolving networking and to simulate and enrich the existing and planned works on organoids. Such symbiosis can effectively combine laboratory tissue growth with intelligent control and management capabilities guaranteed by SGT, contributing altogether to this extremely important area for mankind. The rest of the paper is organized as follows.

Section 2 reviews existing organoid publications, including the ones telling what an organoid is and the latest books on organoids, and provides examples of cells-based techniques to be investigated in this paper, like cell differentiation and tissue, shapes of organoids, worms, and killer cells.

Section 3 briefs the developed Spatial Grasp Model and Technology (SGT), including its general issues, basic Spatial Grasp Language, its interpreter organization and networked implementation.

Section 4 provides examples of networking solutions under SGT, like creation, movement, reshaping of nodes, creation of networks in virtual and physical spaces, finding paths in the network, and proper nodes.

Section 5 practically shows an expression of organoid models under SGT, which include cell growth, division and replication, worm creation and moving, killer cell operation, full organoid model and its operation, and explains how to study parameters of the growing organoids. Section 6 describes and explains some other organoid developments that are of interest for their application under SGT which include mini-brains in robotics, organoids emitting brain waves, and the creation of organoids in outer space.

Section 7 concludes the paper by evaluating the obtained results and outlining plans for the following works in this area under the developed networking paradigm. References include the reviewed publications about organoids, the patent, published books, and the latest journal papers on SGT.

## 2. Publications about organoids

We will be providing here a review of organoid definition, classification, research, reproduction, and simulation in some latest organoid-related publications, mainly books by reputable publishers. Also reviewing a number of existing cells-based growth, differentiation, communication, and shaping techniques to be analyzed and modeled later in this paper.

### 2.1. What is an organoid

An organoid [1] is a miniaturized and simplified version of an organ produced in vitro in three dimensions that mimics the key functional, structural, and biological complexity of that organ. They are derived from one or a few cells from a tissue, embryonic stem cells, or induced pluripotent stem cells, which can self-organize in three-dimensional culture owing to their self-renewal and differentiation capacities.

Organoids are anatomically and functionally close to the organs in the living body [2]. They can be constructed from both normal and diseased tissues, allowing for utilization in various research applications. These tissue structures are used for basic research such as embryology, physiology, and evolution, as well as more involved research, including characterizing pathological disease conditions and drug discovery research. See Fig. 1 for examples.

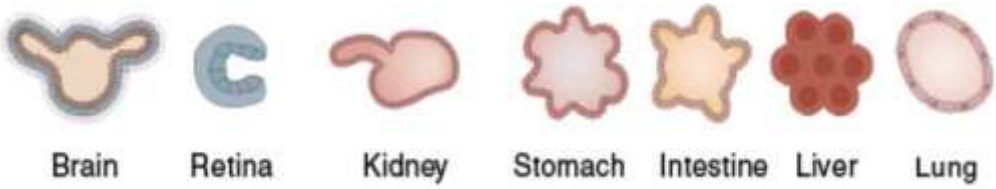



Figure 1 – Organoid examples

### 2.2. Latest books on organoids and their main ideas

The investigation from [3] highlights recent and emerging advances that describe organoid differentiation protocols for different organ systems that implement organoids as tools to understand complexity and maturation, high-content drug screening, disease modeling, development, and evolution.

Brain organoid research is discussed in [4], which explores multiple methods and approaches used to generate human brain and neuro-retinal organoids to address fundamental questions in human brain research. Comprehensive and brain organoid research is a valuable resource for researchers at various levels of learning, ranging from undergraduate students to advanced laboratories.

Organoid bioengineering is investigated in [5], with organoids as three-dimensional miniature tissues made from embryonic stem cells, human pluripotent stem cells, adult stem cells, and cancer cells. These fascinating 3D organoids serve as a valuable tool for fundamental research, disease modeling, drug screening and discovery, regenerative medicine, and deciphering the mechanism of disease pathogenesis.

Organoid technology for disease modeling and personalized treatment is described in [6]. It provides a comprehensive overview of current knowledge of the organoid as a human-organ-in-a-dish, a powerful new technology for studying fundamental aspects of human organ development and disease progression in the search for drugs for personalized treatment.

Stem cells, structure, and function of organoids are studied in [7], which addresses the challenge of how to instruct stem/early progenitor cells to progress through appropriate steps to generate functional 3-dimensional organs, one of the outstanding issues in regenerative medicine. The field of organoids is geared towards defining and demonstrating in vitro conditions that achieve this goal.

Organoids and mini-organs are discussed in [8], which combines contributions from leading practitioners. It begins with an introduction but then delves into chapters giving advice on how to make organoids for many systems. Case studies that illustrate the uses of organoids are presented, along with discussions on future directions and specific problems that need to be solved.

Tumor organoids are discussed in [9]. Cancer cell biology research in general and anti-cancer drug development specifically still rely on standard cell culture techniques that place the cells in an unnatural environment. By encapsulating the respective cell type or combining several cell types to form tissues, these model organs are cultured to develop functional properties similar to native tissues.

From organoid to cancer tissue engineering is considered in [10]. It focuses on fundamental and applied research involving the combination of biomaterials and cancer cells to develop a three-dimensional tumor microenvironment in vitro, in which carcinogenesis mechanisms can be studied and therapies can be screened. The aim is the acceleration of more precise therapies to fight cancer.

Ethical and legal aspects of organoids are considered in [11]. These are arising from the use of brain organoids for research, therapeutic, and enhancement purposes. Until recently, only post-mortem tissue was available for a structural examination of the brain. However, in order to better understand the development and function of the human brain, dynamic and functional investigations of different human brain cells are necessary.

### 2.3. Examples of cell-based techniques to be investigated in this paper

*Cell differentiation and tissue*

Essentials of cell biology are considered in [12]. Within multicellular organisms, tissues are organized communities of cells that work together to carry out a specific function; they also have different transcriptional programs and may well divide at different rates. Without cell division, long-term tissue survival would be impossible. Transcription factors can turn on at different times during cell differentiation, see Fig. 2.

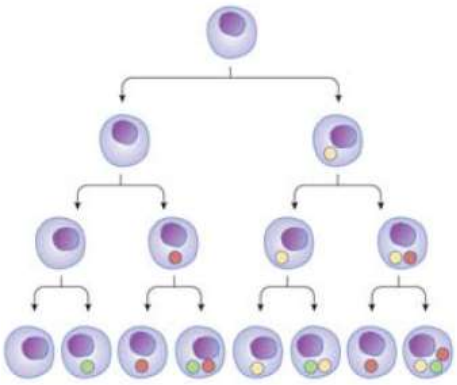


Figure 2 – Cells division and proliferation

*Shapes of organoids*

Tissue geometry driving organoid patterning is in [13]. Organoids can mimic real organs, but guiding stem cells to grow an organoid of defined shape and size is difficult. Bioengineers have developed new methods for successfully guiding stem cells to grow into intestinal tissue with real-life 3D structure and function. Some examples of possible organoid shapes are shown in Fig. 3.

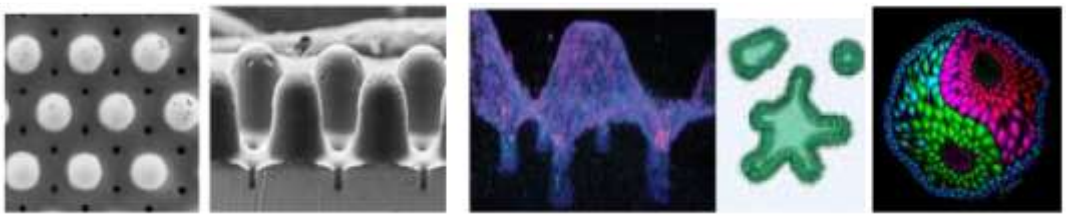


Figure 3 – Different organoid shapes

The extracellular matrix and cell wall are considered in [14]. Plants and fungi have tough cell walls for protection and support, while animal cells can secrete materials into their surroundings to form a meshwork of macromolecules called the extracellular matrix. The paper looks in more detail at these external structures and the roles they play in different cell types. The extracellular matrix is directly connected to the cells it surrounds.

*Worms*

Cell migration in worms in relation to human cancer is discussed in [15]. A new study has used migrating stem cells in flatworms to investigate regenerative properties that are found in cancer cells. Researchers have taken advantage of a special type of worm that is full of stem cells that migrate. The worms, called planarians, are known for their ability to regenerate all their tissues and organs repeatedly again and again.

Figure 4 – Worms

What worms can tell us about the brain and behavior is discussed in [16]. Published in the prestigious journal *Cell*, the MIT team produced an atlas of how each brain cell encodes the animal's actions, revealing the underlying «logic» of how the worm's brain produces a sophisticated and flexible repertoire of behaviors. See also Fig. 4.

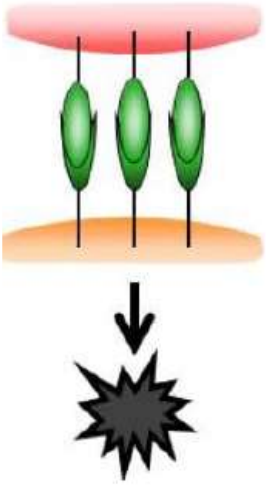


Figure 5 – Killer cells operation

*Killer cells*

Killer cells and their behavior are considered in [17]. Natural killer (NK) cells are lymphocytes in the same family as T and B cells, coming from a common progenitor. However, as cells of the innate immune system, NK cells respond quickly to a wide variety of pathological challenges. NK cells are best known for killing virally infected cells and detecting and controlling early signs of cancer (see Fig. 5).

## 3. Spatial Grasp Model and Technology

Only the most general features of the developed paradigm are included, with the availability of existing extended publications on its philosophy, features, organization, and numerous applications, some in [18–33].

*General issues*

Within Spatial Grasp Model and Technology (SGT), a high-level operational scenario in recursive Spatial Grasp Language (SGL), starting at a world point (or points), propagates, covers, and matches the distributed environment in a parallel wave-like mode, as symbolically shown in Fig. 6. Such propagation can result in leaving or echoing the reached states and data (including arbitrarily remoted) to be represented as the final result or used for launching more waves.

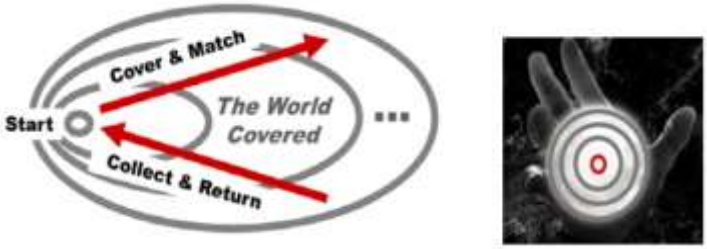



Figure 6 – Parallel covering, collecting, and returning knowledge with Spatial Grasp Model

This concept is based on a quite different philosophy of dealing with large distributed systems. Rather than representing them in the form of communicating parts or agents, SGT organizes spatial solutions through holistic and parallel coverage of distributed worlds, which may in-

clude Physical World (PW), Virtual World (VW), and Executive World (EW), as well as their different combinations.

*Spatial Grasp Language (SGL)*

SGL allows for direct space presence and operations with unlimited powers and parallelism. Its universal recursive organization with operational scenarios called *grasp* can be expressed just by a single formula

$$grasp \rightarrow constant \mid variable \mid rule\ (\{\ grasp,\ \}),$$

where *rule* expresses certain action, control, description, or context accompanied by operands, which can themselves be any *grasps* too. Top SGL details can be expressed as follows:

*constant* → *information* | *matter* | *custom* | *special*
*variable* → *global* | *heritable* | *frontal* | *nodal* | *environmental*
*rule* → *type* | *usage* | *movement* | *creation* | *echoing* |
*verification* | *assignment* | *advancement* | *branching* |
*transference* | *exchange* | *timing* | *qualifying*

The rules, starting at certain world points, can organize the navigation of the world sequentially, in parallel, or in any combination. They can result in the same application points or move to other world points with the obtained results. The final world points reached after the rule invocation can become the starting ones for other rules. The rules, due to recursive language organization, can form arbitrary operational and control infrastructures.

*SGL interpreter organization*

The interpreter consists of a number of specialized functional modules working with specific data structures, serving SGL scenarios or their parts that happen to be within this interpreter, and also organizing exchanges with other interpreters for distributed scenarios. As both the backbone and nerve system of the distributed interpreter, its self-optimizing Spatial Track System provides hierarchical command and control, supports spatial variables, and merges distributed control states for higher-level decisions.

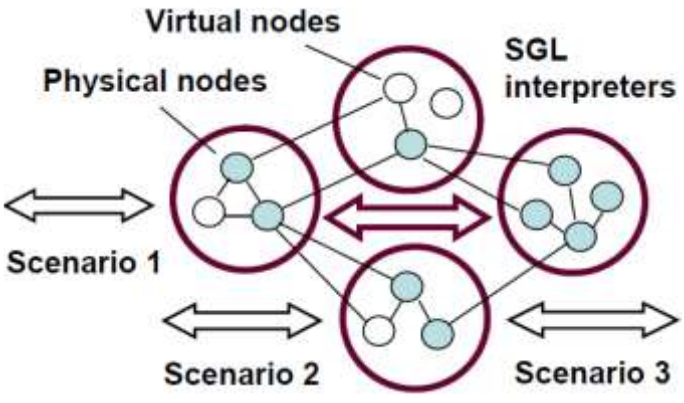



Figure 7 – Active distributed networking in SGL

*Networked SGL implementation*

Communicating interpreters of SGL can be in arbitrary numbers, up to millions and billions, which can be effectively integrated with any existing systems and communications, and their dynamic networks can represent powerful spatial engines capable of solving any problems in terrestrial and celestial environments. Such collective engines can simultaneously execute different cooperative or competitive scenarios, including those dealing with large distributed and active networks, without any central resources or control, as shown in Fig. 7.

## 4. Examples of networking under SGT

The section shows how some elementary operations on distributed networks can be expressed in SGL.

*Creation, movement, and reshaping of nodes*

Creation of a node in a virtual space, changing its size, then moving into physical space with proper coordinates and subsequent reshaping are shown in Fig. 8, also by the SGL expression below.

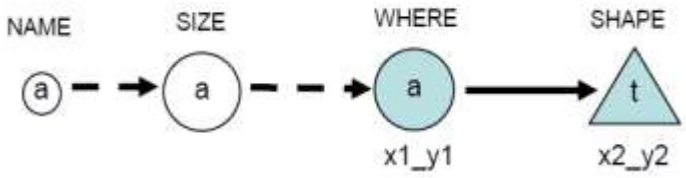
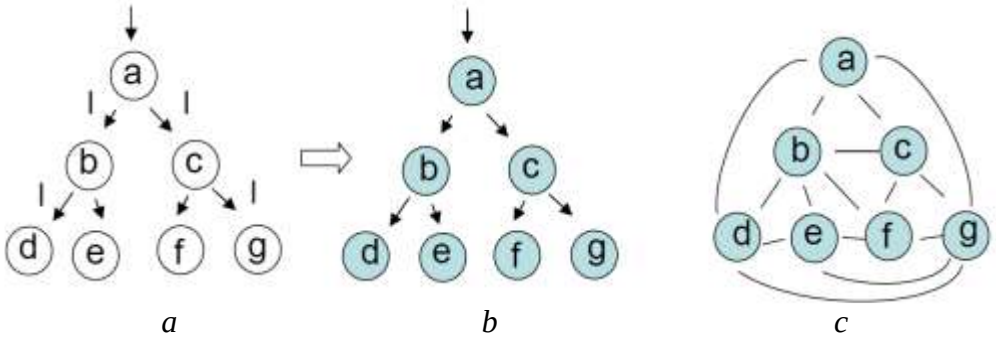



Figure 8 – Node creation and moving

```
create_node(a); SIZE = bigger; WHERE = x1_y1;
move(x2_y2); SHAPE = triangle
```

*Creation of networks in virtual and physical spaces*

Different variants of the creation of networks are shown in Fig. 9.




*a* *b* *c*

Figure 9 – Network creation

In Fig. 9 *a* and the following SGL scenario, a virtual tree-like network is created in a parallel top-down mode, having certain names of nodes (`a`, `b`, `c`, `d`, `e`, `f`, `g`) and connecting them with links (all named as `l`).

```
create(node(a);
       ((link(l), node(b)); (link(l), nodes(d, e)),
       ((link(l), node(c)); (link(l), nodes(f, g)))
```

In Fig. 9 *b* and the following scenario, the creation of a similar network (with the same structure and names of nodes and links) that also covers physical space (with physical coordinates of nodes `x` as `Wx`) is shown.

```
create(node(a_Wa);
       ((link(l), node(b_Wb)); (link(l), nodes(d_Wd, e_We)),
       ((link(l), node(c_Wc)); (link(l), nodes(f_Wf, g_Wg)))
```

For Fig. 9 *c* with same nodes and link names but more complex network structure, the following scenario shows how to create this whole network in parallel, using its advanced `Top` description (keeping node names and physical addresses, as well as the names of direct neighbors of each node), which first splits by its nodes, then synchronously creates all these nodes in parallel. After that, each node forms links to the already existing neighboring nodes (as nodes may operate simultaneously and try to create the same link between them twice, such competitions is easily resolved by allowing this link creation to be performed only by the node with stronger name of the two).

```
Top = (a_Wa:(b,c,d,g), b_Wb:(a,c,d,e,f), c_Wc:(a,b,f,g),
d_Wd(a,b,e,g),
       e_We:(b,d,f,g), f_Wf:(e,b,c,g), g_Wg:(a,c,f,d,e))
align(split(Top); frontal(Next) = VAL[2]; create(VAL[1]));
hop(Next); NAME > BEFORE; linkup(1, BEFORE)
```

*Finding paths in the network*

It is easy to find different paths in networks in SGL. For example, all simple paths from node `a` to node `g` (i.e. the ones with non-repeating nodes) can be easily found by

```
frontal(Path); hop(a);
repeat(append(Path, NAME); if(NAME == g,
done(output(Path)));
       hop(all_links); notbelong(NAME, Path)).
```

If to apply this scenario to the network of Fig. 9 *a*, *b*, only a single path will be received like `(a,c,g)`.

But if to apply it to the more complex network of Fig. 9 *c*, we will receive multiple simple paths as follows:

```
(a,c,g),(a,c,f,g),(a,b,c,f,g),(a,b,c,g),(a,b,d,e,f,g),(a,b,e,f,g),
(a,b,e,g),(a,b,f,g)
```

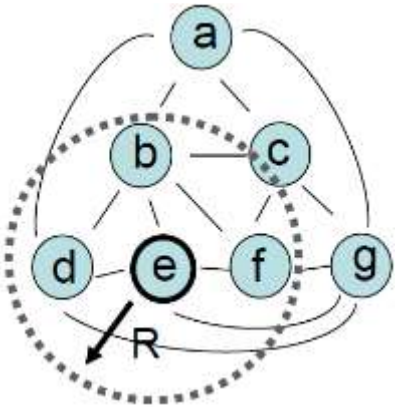



Figure 10 – Finding other nodes in a physical space from a certain node

*Finding proper nodes in virtual and physical spaces*

It is possible to address network nodes in very different ways: by their names and addresses, by links to or from other nodes, their individual physical locations, belonging to some territory or area defined properly, or by physical distances from other nodes. For example, doing this from a certain node `e` and distance `R` from it, we may receive the following nodes, see also Fig. 10.

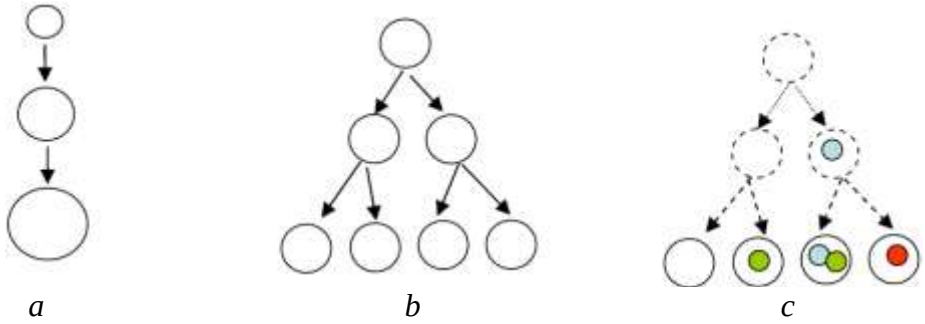
For: `output(hop(e); hop(distance < R)))`, will have `(d, b, f)`, and
for: `output(hop(e); hop(distance > R)))`, will receive `(a, c, g)`.

## 5. Organoid models under SGT

In this section, some examples of how SGL spatial networking can express and simulate some basic organoid features are considered.

*Cells growth, division, and replication*

Such activities are shown in Fig. 11 in relation to those already discussed in [12].



*a* *b* *c*

Figure 11 – Cells dynamics: a) growth; b) replication;
c) using transcriptional regulators

Just staying in the same place and increasing its size in time can be expressed as follows (see Fig. 11 *a*):

```
create_node(x); repeat(steps)(increase(SIZE); sleep(time)).
```

Abstract cells replication scheme in time can be expressed as (see Fig. 11 *b*)

```
hop(x); repeat(steps)(create(double(x)); sleep(time)).
```

A more realistic scenario for the cell's replication may be when their doubling result includes the original nodes (i.e. the node logically providing replication symbolically disappears as a unit afterward), it is in physical space with certain distances between cells, and allows new cells to obtain additional features (say, expressed by different transcriptional colors), as below and in Fig. 11 *c*.

```
frontal(Color = (w,b,g,r), R = radius); hop(x); WHERE = start;
repeat(steps)(
  sequence(create(double(x, random(Color), distance(R))),
           remove(current));
  sleep(time))
```

*Worm creation – moving*

One of the living cells possibilities is their collective movement in physical space as a worm, as discussed in [15, 16]. Fig. 12 first shows the creation of an original virtual worm structure, and then, starting from the first cell, moves in physical space with pulling behind the following cells, which stepwise obtain physical existence and finally become the completed worm. The following SGL scenario describes this worm-creating process with the whole worm moving in the same direction, each time using the same incremental position change by the first cell.

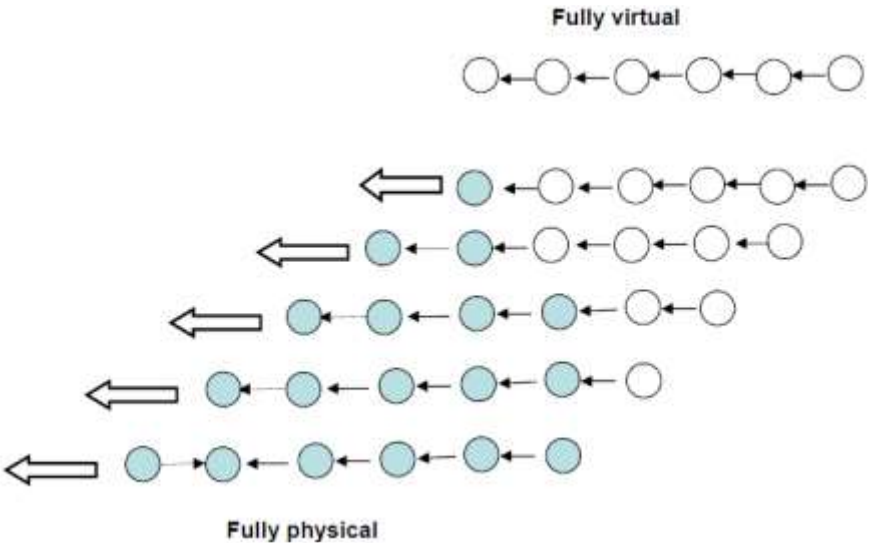



Figure 12 – Worm creation and movement

```
frontal(Shift = dX_dY, Start = X_Y, Old, old1);
create_node(x);
stay(repeat(five)(create(link(+l), node(x))));
WHERE = Start;
repeat(
  Old = WHERE; SHIFT(Shift);
  stay(repeat(hop(+l); Old1 = WHERE; WHERE = Old; Old = Old1)));
```

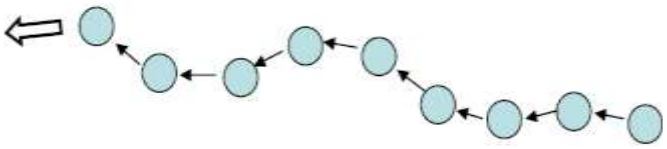
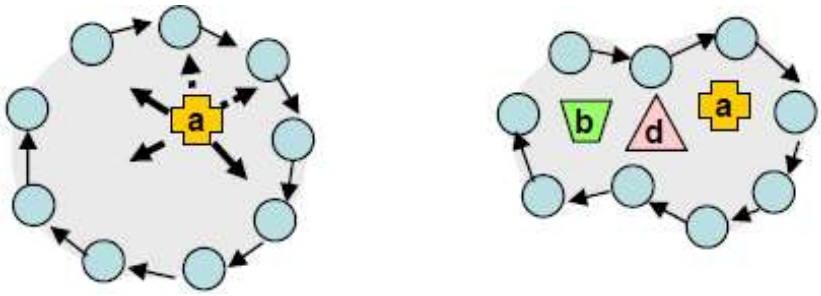


Figure 13 – Worm following any path

The worm creation and movement in physical space along any route, as in Fig. 13, may be organized in SGL as follows. For this, the head cell instead of the same incremental move is supplied with a full set of route coordinates from the beginning, taking the next one each time and dragging behind the remaining cells of the worm. Each remaining cell will follow the position of the previous cell during their collective movement, reflecting altogether the established curvature of the route.

```
Points = coordintes; Start = X_Y; frontal(Old, old1);
create_node(x);
stay(repeat(five)(create(link(+l), node(x))));
WHERE = Start;
repeat(
  Old = WHERE; WHERE = withdraw(Points, 1);
  stay(repeat(hop(+l); Old1 = WHERE; WHERE = Old; Old = Old1)))
```

This simulated worm technique forming curved lines of interconnected cells can be used for different purposes. For example, potentially reflecting any shapes (very different shapes discussed in [13, 14]), it can effectively outline the whole regions to be occupied by organoids like in Fig. 14. This will allow cells to move only inside and not outside the region, as in Fig. 14 *a*, also permitting multiple cells to grow, replicate, move, and communicate exclusively within their borders as in Fig. 14 *b*. Of course, such organoid borders can also be created in SGL at once and in parallel, if all their coordinates are planned in advance.




*a* *b*

Figure 14 – Possible forming of organoid boundaries by a worm

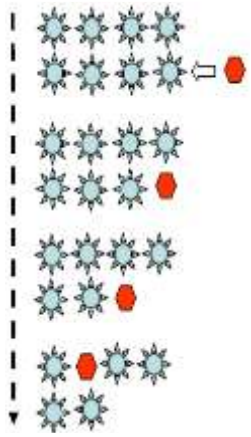


Figure 15 – Killer cell operation

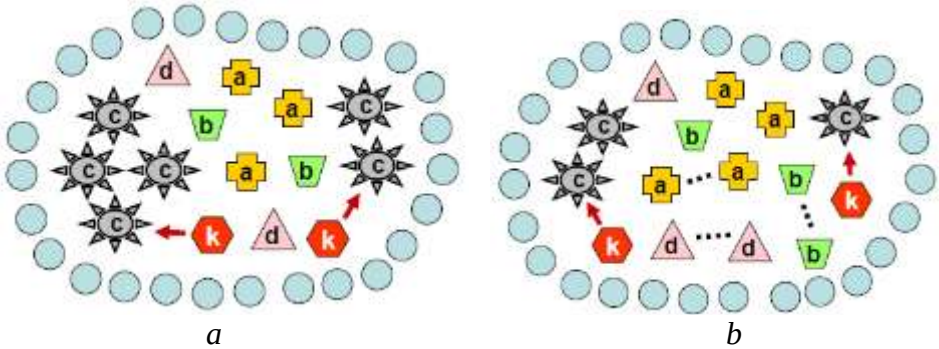
*Killer cell operation*

Natural killer (or NK) cells, as in [17], propagate, detect, and kill infected cells, including those related to cancer. It is easy to represent this activity in SGL, see also Fig. 15, where the killer node (the red one) is propagating in physical space and searching for and removing cancerous cells reached at some distance, as follows:

```
stay(create_number(node(cancer, ran-
dom(area(x1_y1))));
create(node(killer, x2_y2));
repeat(move_random(R); if(see(danger, dis-
tance), kill_remove)).
```

*Simplified full organoid model and its operation*

Having considered and tested some elementary techniques for dealing with cell models and their interactions, we can now compose a very simple united organoid model, which can autonomously exist and evolve in physical space. This is symbolically shown in Fig. 16 *a* for the initial organoid stage, and in Fig. 16 *b* for some further stages in time, as well as by its implementation with the following active SGL code. This scenario first creates organoid borders and then inhabits this region with different types of cell nodes named `a`, `b`, `c`, `d` (including cancer cells `c`), which may self-grow and self-replicate taking into account their individual features, if this is allowed by remaining available space inside organoid borders. The scenario also injects into the organoid space a number of killer nodes (each named `k`), which will be randomly propagating inside the organoid space and looking for cancer `c` nodes, while killing and removing them when seen at the proper distance. The released physical spaces after the removal of cancer nodes may be immediately and effectively used by other cell types for their further growth and replication, and so on.




*a* *b*

Figure 16 – Simplified model of an organoid

```
Border = (x1_y1, x2_y2, ..., xn_yn); Types = (a, b, c, d);
stay(create_nodes(Border));
parallel(
  (create_nodes(Types, random(inside(Border)));
   repeat(
     move(style(NAME), random(R), inside(Border));
     if(empty(around(R), inside(Border)), replicate(myself));
     sleep(delay1)),
  (create_number(k, random(inside(Border)));
   repeat(move(style(NAME), random(R), inside(Border));
          if(see(Types, R), kill_remove); sleep(delay2))))
```

*Investigating parameters of growing organoids*

The previously described simple organoid model may be further investigated during its operation in time, using different overall parameters hinting at the state and quality of its evolution in time, like the following.

Counting the current number of all healthy cells:

```
output(count(hop(a,b,d))).
```

Counting the current number of all still existing cancer cells:

```
output(count(hop(c))).
```

Counting the current proportion of cancer cells to all other cells, reflecting in some sense the overall «health» of this organoid, which may vary over time due to different individual cell growth and evolution, as well as the deletion of killed cancer nodes which can self-grow and self-replicate:

```
output(count(hop(c))/count(hop(a,b,d))).
```

## 6. Other organoid developments that are of interest

Some newest organoid features and capabilities, which may be of particular interest for simulation and practical use by the described networking technology, are considered below and will be analyzed in detail and reported in subsequent reports and publications.

*Robotics*

Connecting «mini brains» grown in a laboratory to robots is considered in [34]. A cerebral organoid is hooked up to a computer that is also linked to a spider-like four-legged robot. The computer picks up spontaneous electrical signals from the organoid, then, based on programming from the researchers, provides information to the robot, and after that, it walks forward.

Tiny living robots made from human cells can move, as in [35]. Scientists have created tiny living robots from human cells that can move around in a lab dish and one day may be able to help heal wounds or damaged tissue, according to a new study. They moved in different ways and survived up to 60 days in laboratory conditions.

Having sufficient experience of using networking models for the individual and collective behavior of advanced robots, SGT can also simulate the creation and behavior of such biological brains, effectively integrating them with powerful control and management solutions in SGL,

thus contributing to the development of advanced physical-virtual robotic brains with practically unlimited applications.

*Brain waves*

Cerebral organoids produce complex brain waves similar to those of newborns, as in [36]. Despite their small size, the cerebral organoids generated several types of brain waves, according to electrodes placed at multiple spots on them. Their neurons fired at frequencies indistinguishable from those that animate actual brains, including gamma waves, alpha waves, and delta waves. No one has ever seen this level of complexity in cerebral organoids.

A mini brain grown in a laboratory has human-like brain waves, as in [37]. Does the brain organoid have a consciousness? This work does show that the organoid has complex patterns of neural activity for future studies. Growing mini brains on-demand, ones with actual brain waves, can enable researchers to rapidly carry out trials and test drugs that might lead to better treatments.

Fundamentally based on self-spreading recursive waves which can create any distributed networks, with the latter spreading waves in distributed spaces themselves, SGT can effectively simulate the creation and behavior of such wave-producing organoids, moving together with these biological mini-brains towards simulation and understanding of this great but mysterious phenomenon called consciousness [27, 31].

*Mini brains in space*

Growing mini human brains in space is discussed in [38]. Mini-sized, round brain organoids are being developed. Organoids from stem cells in the skin are grown in outer space. These organoids can be used for neurological disease therapy, drug testing, and biocomputer development. The report states that brain organoids are unlikely to have the ability to «think» in the future as feared.

Time-traveling mini brains to conquer space are described in [39]. It discusses the launch of brain organoids into outer space and how microgravity enriches our understanding of brain development and disease. In terms of cellular aging, one month on the space station is equivalent to between ten to thirty years on Earth. The idea of using the space station as an incubator for aging may be transformative.

This great idea of moving organoid creation and investigation into outer space may have enormous applications, where the simulation and creation of living tissue beyond Earth may be on the way to the conquest of the Universe. SGT, potentially uniting any terrestrial and celestial networking facilities for arbitrary complex spatial solutions, can be used in full for this mission, including networking and integration of biological and virtual brains from different space locations.

## 7. Conclusions

As a result of this paper, we can acknowledge the tested capability and efficiency of using the developed Spatial Grasp networking paradigm to express and simulate almost any organization, behavior and functionality of an individual, and multiple cells with their combinations and interactions up to the whole organoids, traditionally grown in vitro mode in laboratories. We have shown some very basic organoid simulation techniques in SGL, with plans for more detailed and broad investigations and results to be obtained. Such results can be believably used in different cases, as follows.

First, the virtual networking models of organoids can be obtained much quicker than the growing organoid tissue in laboratories, and the resultant advanced networking solutions, which can employ any computational facilities throughout the whole internet, can be quickly and in detail analyzed for different, like medical, purposes.

Second, if living tissue organoids are really needed, like in medical surgery and organ replacement, then advanced virtual modeling of the growth of such organoids by SGT can assist, properly orient and coordinate the development of the related living tissue.

Third, it may appear useful to strategically combine virtual and live growth and investigation in the united organoid development process, where living tissue growth can be under constant supervision and control by the intelligent SGT networks, the latter dynamically evolving in the combined virtual-physical space too.

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