Work cycles of independent ensembles

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Work cycles of independent ensembles

Abstract

The active and independent ensemble is redistributing substrate from source to sink, controlling internal giving and taking by its own. This will lead to superadditivity in comparison to the inactive ensemble. The surface area of superadditivity differs from dependent ensembles. The line of strict symbiosis is unchanged. The symmetric independent ensemble will not be irrational or subadditive or show signs of antibiosis as long as internal giving by source and taking by sink ends at b-c=0 (b/c=1). The use of brute force and deception shifts this border into an area where the ensemble was inactive before. A subadditive and therefore irrational area appears in asymmetric ensembles as well as in symmetric ensembles with transfer costs. There, giving and taking takes place although the inactive ensemble has a higher productivity. In case the ensemble alternates between a connected and an unconnected phase work cycles appear. In the connected phase a costing good is transferred to become an earning good. In the unconnected phase the starting point for a new cycle is created by over-accumulation in source and by over-consumption in sink. Work cycles may include brute force and deception to further increase the transferred amount within the independent ensemble. A surprising outcome of my model is the observation that a complete rational independent and active ensemble may end in irrationality being less productive than an inactive ensemble.

Keywords: dependent ensemble, independent ensemble, irrationality, source, sink, superadditivity, subadditivity, deception, brute force, peaceful ensemble, violent ensemble, work cycles

Introduction

Ensembles consist of a source and a sink. Productivity within an active ensemble may be superadditive or subadditive compared to an inactive ensemble depending on productivity parameters, cost, distribution and transfer of substrates. In the past I have concentrated on the structure of the ensemble space and the transfer space when a constant amount of substrate is transferred from source to sink in different conditions of saturating productivity and linear cost, including conditions not preferred to give or to take (1, externally dependent ensemble). However this is exceptional as source and sink should per definition only give or take substrates when the benefit (b) to cost (c) ratio is appropriate. An external force was used to make the source give at $b_{so}-c_{so}\leq 0$ ($b_{so}/c_{so}\leq 1$) and the sink was externally forced to take at $b_{si}-c_{si}\geq 0$ ($b_{si}/c_{si}\geq 1$). The past treatment of the ensemble helped to establish a general understanding of the overall structure and non-linearity of transfer space and ensemble space including the introduction of ideas like active and inactive ensembles, symmetric and asymmetric ensembles, superadditivity, subadditivity, rationality and symbiosis or irrationality and antibiosis, strict equivalence, productive (wise) exploitation and consumptive exploitation.

Benefit and cost have aspects of quantity and quality. If source and sink share the same quality with respect to benefit and cost the transfer space is used. If quantity and quality of benefit and cost are different in source and sink the ensemble space is used. This is especially necessary when source and sink produce different benefits from the same substrate.

In this paper I examine the structure of the transfer space when the size of the internal transfer is decided solely by source and sink (independent, autonomous ensemble). Symmetric and asymmetric ensembles are examined as well as symmetric ensembles with transfer costs like deception and brute force.

Theory

In the past I set up a system of a “source” (so), a productive entity where substrates may come from, a “sink” (si), a productive entity where substrates may go to and an “ensemble” (e), a productive entity consisting of source and sink. Both parties use the same substrate and may or may not transfer this substrate. The source will “give” or “give not”, the sink will “take” or “take not” the substrate depending on the degree of the actual benefit (b) to cost (c) ratio. Besides the transfer of substrate both parties continuously take up substrates and produce products on their own. This has been described earlier in detail (1). In an independent autonomous ensemble varying amounts of substrate are transferred only from the source in the condition $b_{so}-c_{so}<0$ ($b_{so}/c_{so}<1$) to the sink in $b_{si}-c_{si}>0$ ($b_{si}/c_{si}>1$). The transfer stops when one or both sides reach b-c=0. This differs from the past when a constant amount of substrate was transferred also under non-favoured conditions.

Calculations

The benefit b is produced by a saturating productivity v (v in micromoles per minute) from the substrate S with the concentration [S] according to the Michaelis-Menten equation (2):

v= ([S]/(Km+[S])*Vmax

Vmax is the maximal reaction velocity, Km is a substrate concentration where the productivity is half-maximal (If [S]=Km then v=Vmax/2). The reaction is kept under steady state equilibrium conditions. An amount of substrate will be converted to an amount of product in a fixed amount of time. Within the same time twice as much substrate will not be converted to twice as much product (saturating behaviour). In all considerations the reaction time is fixed to the same value avoiding a separate consideration of reaction time (e.g. µmol/min*1000min = mmol). The dimension of the ensemble space is b/c like density in physics whatever the unit of benefit or cost may be.

The two parties produce either isolated

$v_{so}=([S_{so}]/(Km_{so}+[S_{so}])*Vmax_{so}$; $v_{si}=([S_{si}]/(Km_{si}+[S_{si}+])*Vmax_{si}$

then the productivity of benefit by the inactive ensemble is $v_{so} + v_{si}$.

or the parties transfer a small amount of substrate ΔS

$v_{so}=([S_{so}-\Delta S]/(Km_{so}+[S_{so}-\Delta S])*Vmax_{so}$;

$v_{si}= ([S_{si}+\Delta S]/(Km_{si}+[S_{si}+\Delta S])*Vmax_{si}$

then the productivity of benefit by the active ensemble is $v_{so\ (-\Delta S)}+ v_{si(+\Delta S)}$.

The cost of the substrate is a linear function to the amount.

In the transfer space benefit and cost share the same quality (Joule or Euro) with different quantity. The substrate concentrations of source and sink form the x-y plane. The z-axis is used to mark off the b-c values of active and inactive ensemble resulting in two curved surfaces. In the ensemble space quantity and quality of benefit and cost are different. Active ensemble and inactive ensemble form two curved surfaces, too. The coordinates of this space are b/c ratios of source (b_{so}/c_{so}, X-axis), sink (b_{si}/c_{si}, Y-axis) and ensemble (b_e/c_e, Z-axis). The origin of the ensemble space is 1.

Along the line of strict equivalence the absolute value of the loss of benefit weighted by the absolute value of the cost lost in the source is exactly compensated by the gain of benefit weighted by the cost in the sink (transfer space: $|\delta b_{so}|-|\delta c_{so}| = \delta b_{si}-\delta c_{si}$ and ensemble space: $|\delta b_{so}|/|\delta c_{so}| = \delta b_{si}/\delta c_{si}$). This boundary is black in all pictures. It should run in the x-y plane of the transfer space. However, there it would not be visible in most of the pictures. Therefore, it is projected to the red surface of the inactive ensemble. This does not mean that this line is relevant also for the inactive ensemble. Strict equivalence is only relevant for the judgement of ensembles with transfer. Strict equivalence and the inactive ensemble are independent tools to judge the outcome of the active ensemble. The line of strict symbiosis is formed by all points where giving by source to reach $b_{so}-c_{so}=0$ ($(b_{so}-\Delta b_{so})-(c_{so}-\Delta c_{so})=0$) is completely taken up by the sink reaching $b_{si}-c_{si}=0$ ($(b_{si}+\Delta b_{si})-(c_{si}+\Delta c_{si})=0$) simultaneously.

Symmetric and asymmetric independent ensembles

There are two types of ensembles, symmetric and asymmetric ensembles. Symmetric ensembles possess in source and sink the same productivity (Km and Vmax identical in both sides) and cost. However, there is a small asymmetry as one side behaves as a source getting rid of a costing ($b_{so}-c_{so}<0$, $b_{so}/c_{so}<1$) substrate and the other as a sink taking this substrate because it will be earning ($b_{si}-c_{si}>0$, $b_{si}/c_{si}>1$).

The active symmetric ensemble is always superadditive in comparison to the same substrate concentrations of the inactive ensemble (figure 1, green surface above red surface). In other substrate distributions of source and sink the active independent (autonomous) ensemble does not exist! There only the inactive ensemble exists. The maximal possible overall productivity of the inactive ensemble may be higher than the maximal possible productivity of the active ensemble (1C, 1D). At high substrate concentration in source and low substrate concentration in sink the active ensemble does better. The active symmetric ensemble acts completely rational. Substrate concentrations of source and sink form the x and y plane of the transfer space and the difference of benefit and cost (b-c) of the active or inactive ensemble are depicted in z direction.

Figure 1

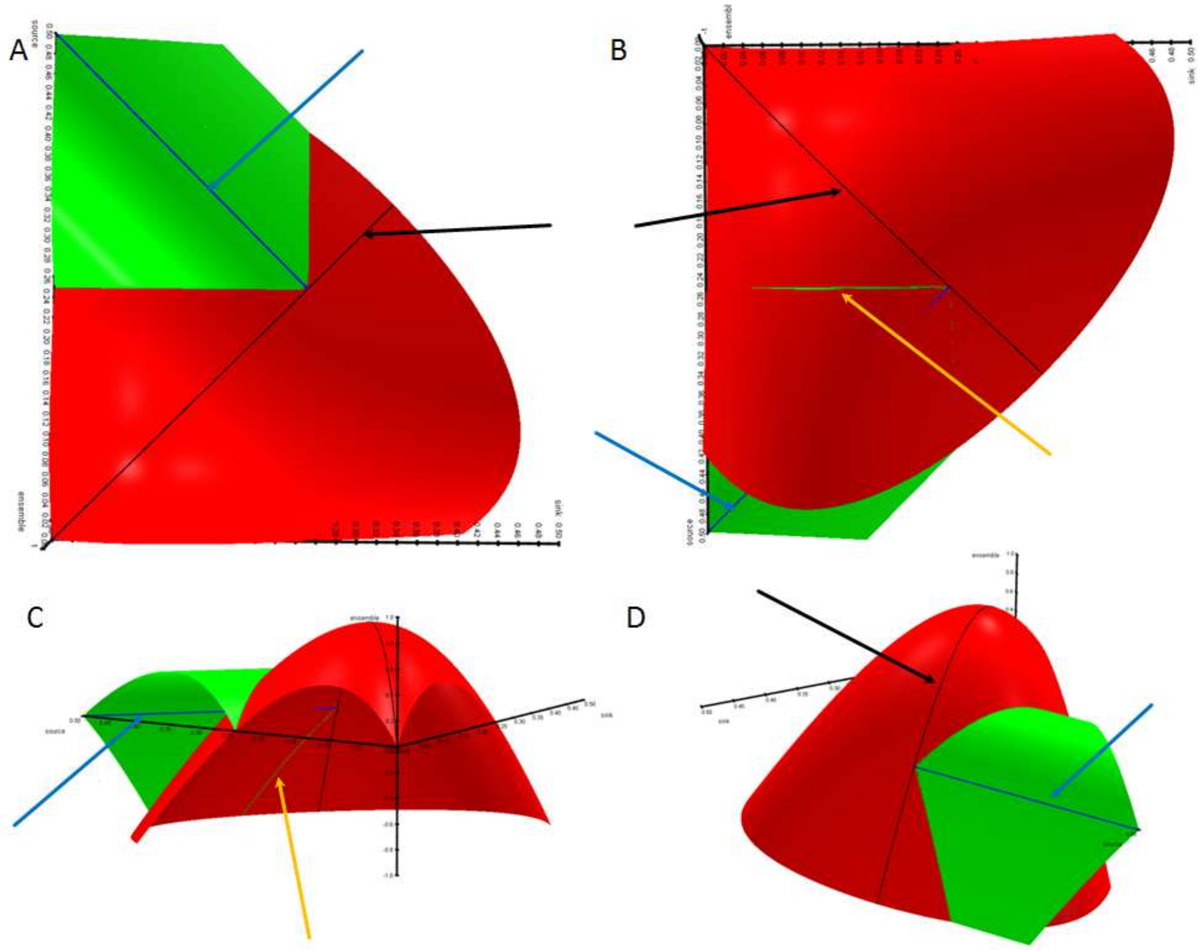


Figure 1: The active ensemble is displayed in green; the inactive ensemble in red. We observe a symmetric ensemble top down (A) and bottom-up (B) in the transfer space. The axis of source is to the left. The side view of the transfer space from the front (C; ensemble axis up, source left, sink right) and from behind (D). The black arrows point to the line of strict equivalence projected to the red surface for better visibility. The blue arrow points to the line of strict symbiosis and the orange arrow to a handy artefact of the program indicating in some pictures where the active ensemble ends (b-c value of active and inactive ensemble are identical). The green surface in B is not completely hidden by the red surface as the b-c axis ends.

In strict symbiosis (blue line) the source will give a certain amount of substrate to reach b_{so}-c_{so}=0. This amount is completely taken up by sink also ending in b_{si}-c_{si}=0. Productivity and cost in source and sink are symmetrically: Vmax= 5µmol/min, Km=0.25mmol, c is adjusted so that b-c=0 is at 0.25mmol substrate.

The active ensemble is able to be more productive in a particular region of substrate distribution. This region is characterized by simultaneously high cost and productivity in source and low cost and productivity in sink. There, a small loss in costing productivity in the source is overcompensated by a high gain in cheap productivity in the sink.

Asymmetric ensembles consist of a source and a sink with different Km, Vmax and cost values. Still one side behaves as a source (b_{so}-c_{so}<0, b_{so}/c_{so}<1) and the other as a sink (b_{si}-c_{si}>0, b_{si}/c_{si}>1).

In Figure 2 we observe a first type of asymmetric ensemble with higher productivity in sink. Productivity and cost in source: Vmax= 5µmol/min, Km=0.25mmol, c is adjusted so that b_{so}-c_{so}=0 at 0.25mmol substrate. Productivity and cost in sink: Vmax=15µmol/min, Km=0.1mmol, b_{si}-c_{si}=0 at 0.1mmol substrate. Starting at any substrate concentration source gives only as much substrate to reach b_{so}-c_{so}=0 and sink starts at any substrate concentration and will take only as much to reach b_{si}-c_{si}=0. The active ensemble rearranges productivity and is active in the green area. The active ensemble appears this time partially above and partially below the red surface of the inactive ensemble. The active ensemble is superadditive where the green surface is above the red surface at the same substrate concentrations. In contrast to this small area a much larger area of the active ensemble is this time below the red surface (figure 2 B and D)! There the active ensemble is subadditive in comparison to the inactive ensemble. Again the active ensemble does not exist in the other areas as the source will not give at b_{so}-c_{so}≥0 and the sink will not take at b_{si}-c_{si}≤0.

Figure 2

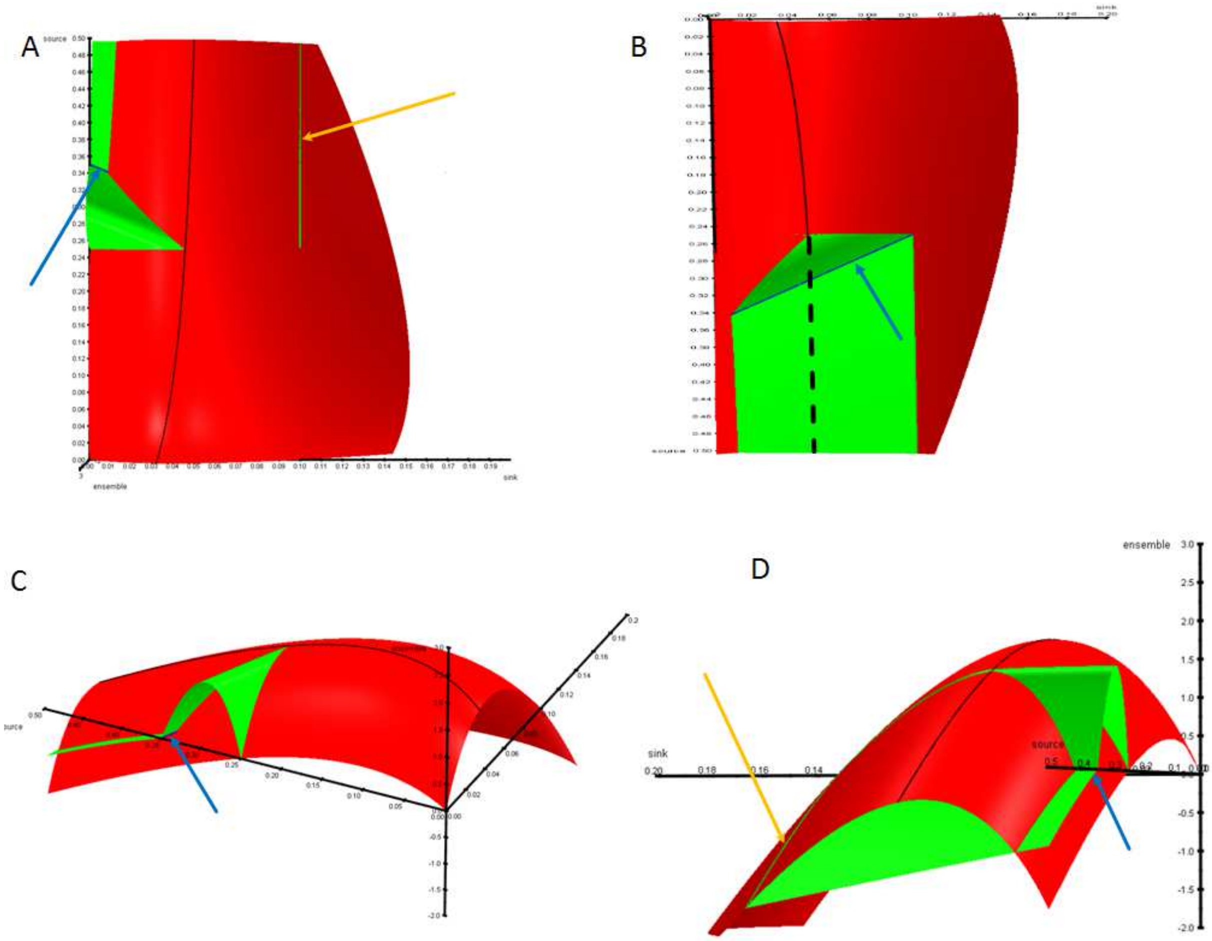


Figure 2: The active ensemble is displayed in green; the inactive ensemble in red. We observe an asymmetric ensemble top down (A) and bottom-up (B) in the transfer space. The axis of source is to the left. The side view of the transfer space from the front (C; ensemble axis up, soured left, sink right) and partially from behind (D).

The black line is the line of strict equivalence projected to the red surface for better visibility. The blue arrow points to the line of strict symbiosis and the orange arrow to a handy artefact of the visualization program indicating in some pictures where the active ensemble ends when hidden by the red surface. Strict equivalence crosses strict symbiosis (2B), dashed line.

In Figure 3 we look at a second type of an asymmetric ensemble with higher productivity in source. Productivity and cost in sink: Vmax= 5µmol/min, Km=0.25mmol, c is adjusted so that b_{si}-c_{si}=0 at 0.25mmol substrate. Productivity and cost in source: Vmax=15µmol/min, Km=0.1mmol, b_{so}-c_{so}=0 at 0.1mmol substrate.

Figure 3

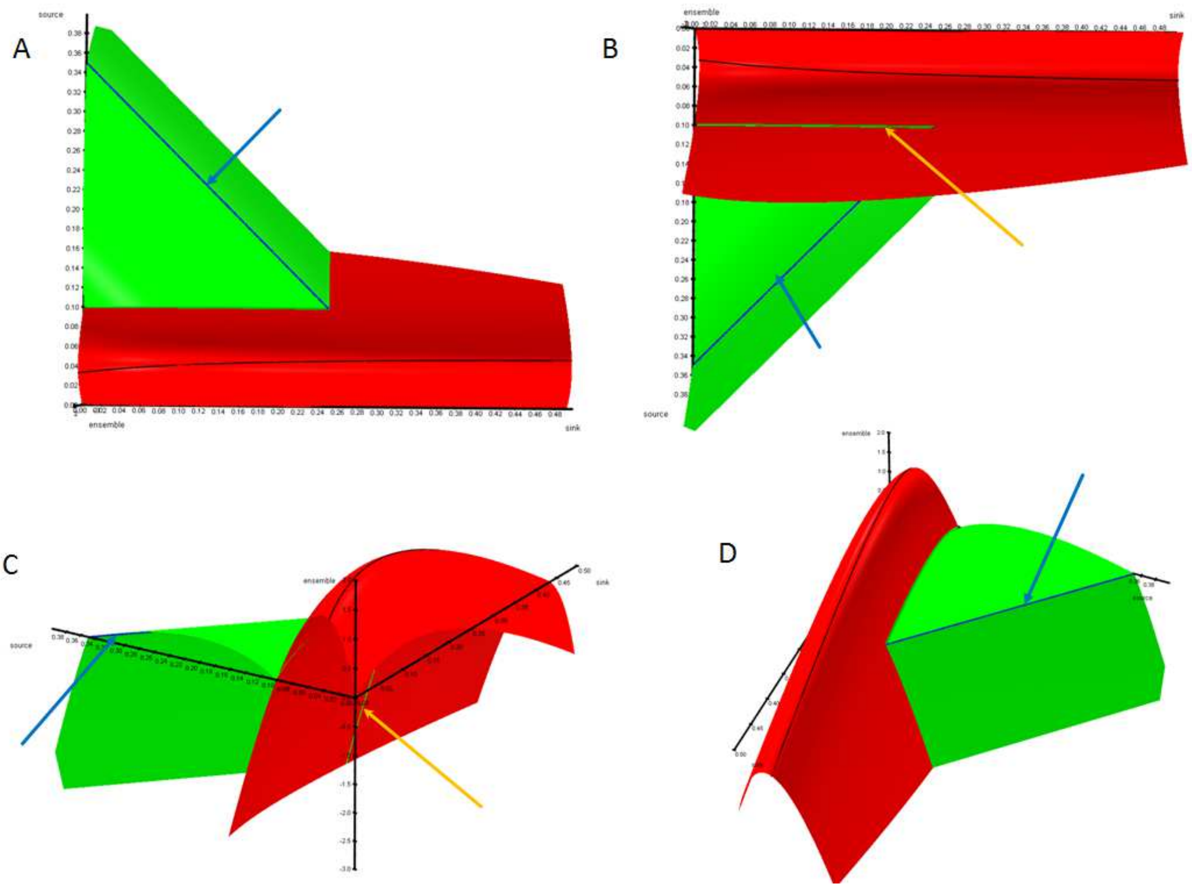


Figure 3: The transfer space of the second asymmetric ensemble is again depicted in a top down (A) and bottom-up (B) view. The source axis is to the left. The side view of the transfer space from the front (C; ensemble axis up, soured left, sink right) and from behind (D). The active ensemble is the green surface; the inactive ensemble is the red surface. The black line is the line of strict equivalence projected to the red surface for better visibility. The blue arrow points to the line of strict symbiosis and the orange arrow to a handy artefact of the visualization program indicating in some pictures where the active ensemble ends when hidden by the red surface.

Starting at any substrate concentration source gives only as much substrate to reach $b_{so}-c_{so}=0$ and sink starts at any substrate concentration and will take only as much to reach $b_{si}-c_{si}=0$.

The active ensemble this time rearranges cost and is active in the green area. The active ensemble appears in the chosen extension of the z-axis partially above and on the side of the inactive ensemble (red surface). The inactive ensemble is everywhere subadditive as the red surface is always below the green surface (top down). Again the active ensemble does not exist in the other areas as the source will not give at $b_{so}-c_{so}\geq 0$ and the sink will not take at $b_{si}-c_{si}\leq 0$. The line of strict symbiosis does neither cross nor touch the line of strict equivalence.

Asymmetric ensembles of both types are not able to occupy a new area in the transfer space. A different type of asymmetry is necessary.

Work cycles in symmetric ensembles

There are many different explanations for cyclic behaviour in biology and economy. An additional possibility could be that we observe work cycles of an ensemble. In the symmetric ensemble below (figure 4) a costing good of the source is transformed into an earning good in the sink. In the first step of the cycle (1) the ensemble changes from an inactive ensemble at particular substrate concentrations in source and sink (red surface) to an active ensemble at the same substrate concentrations (green surface). Within an active ensemble substrate is transferred from source ($b_{so}-c_{so}<0$, $b_{so}/c_{so}<1$) to sink ($b_{si}-c_{si}>0$, $b_{si}/c_{si}>1$) until both parties in this example simultaneously reach b-c=0 (b/c=1) following the line of strict symbiosis. While source moves downward in the concentration of substrate and sink upwards in substrate concentration the ensemble moves diagonally along the line of strict symbiosis (2). The transfer ends as we observe an independent ensemble. The boundary of strict equivalence is reached (black line) but not crossed. The ensemble becomes inactive. The sink has increased the substrate concentration (3) and the source has decreased its substrate concentration (4) both to b-c=0. In the unconnected phase of the ensemble the source will over-accumulate new substrate (arrow A) increasing substrate concentration (5) and sink will consume the transferred substrate and produce additional benefit (arrow B) decreasing its substrate concentration (6).

Figure 4

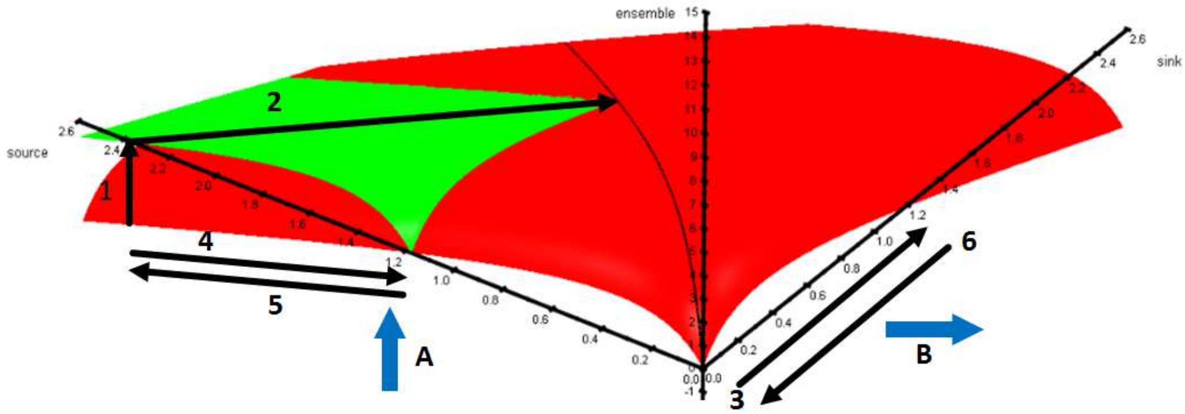


Figure 4: In step 1 of the cycle the ensemble is activated, maybe by physical contact. Within the active ensemble substrate is transferred from source to sink. The substrate concentration in source decreases and the substrate concentration in the sink increases (2) simultaneously. The arrow 2 is the ensemble path. Both parties follow the line of strict symbiosis and reach the endpoint (b-c=0; b/c=1) at the line off strict equivalence. Source stops to give, sink stops to take simultaneously. The ensemble falls apart possibly including a physical separation. During the unconnected phase the source is accumulating (A) a costing substrate faster than consuming it. The substrate concentration is raising again (5). The sink is consuming the transferred substrate also faster than accumulating it thereby decreasing (6) its substrate concentration and producing an earning benefit (B).

The benefit is now produced under earning conditions and not under costing conditions. The ensemble does not become irrational. Irrationality would be in this context the fact that the ensemble transforms an earning good (b-c>0, b/c>1) of the source into a costing good (b-c<0, b/c<1) in the sink. On the left side of strict equivalence we observe a productive ensemble and on the right side we would observe a consumptive ensemble.

The described ensemble is acting in a cyclic, stepwise manner. It is also imaginable that an ensemble acts in a coordinated manner. The transfer velocity in such an ensemble would compensate completely the uptake and delivery velocity leading to a steady state equilibrium. The substrate would enter the ensemble in the source acting as a funnel and would then leave the ensemble by the sink as a disposer. A working cycle would not be visible to an external observer.

The discussed ensemble (figure 4) is perfectly matched as both sides stop giving and taking at the same moment. In an autonomous, independent ensemble both parties are able to stop giving and taking on their own at b-c=0 (b/c=1).

It will not always be the accidental case that both sides reach the endpoint at the same time. In figure 5 the substrate concentration in source is lower than in figure 4. The source therefore will reach b_{so}-c_{so}=0 earlier. In case the sink has the same substrate concentration as in figure 4 the transfer ends although sink has not yet reached b_{si}-c_{si}=0. The ensemble path through the transfer space in figure 5 characterizes an ensemble controlled by the source. The source stops giving. The sink can´t take anymore. The ensemble falls apart.

Figure 5

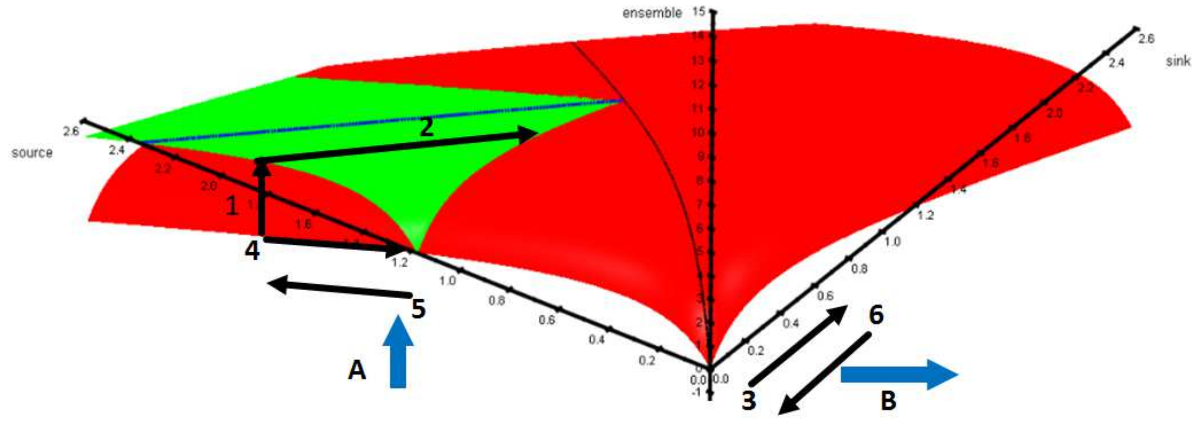


Figure 5: The single cycle steps are similar to figure 4. This time the ensemble is controlled by the source. The transfer stops when the source has reached b_{so}-c_{so}=0 (b_{so}/c_{so}=1) although the sink is not yet at b_{si}-c_{si}=0 (b_{si}/c_{si}=1). The blue line of strict symbiosis is visible. The arrow does not reach the line of strict equivalence anymore. The independent ensemble stays on the productive side of line of strict equivalence.

If the sink wants to reach b_{si}-c_{si}=0 some investment to stick to the source and some kind of pressure on the source would be necessary. If the sink could actively take, the source would be no longer in b_{so}-c_{so}=0. The use of force will be discussed later. Force and deception can be interpreted as transfer costs.

In case the concentration of substrate is higher in sink than in figure 4 the sink will reach b_{si}-c_{si}=0 (b_{si}/c_{si}=1) earlier than the source. The sink in the independent ensemble will then stop to take. The source will therefore not reach b_{so}-c_{so}=0. A surplus of costing substrate will be left in the source. The ensemble in figure 6 is controlled by the sink. To go on with giving the source also would be able to force the sink to take.

Figure 6

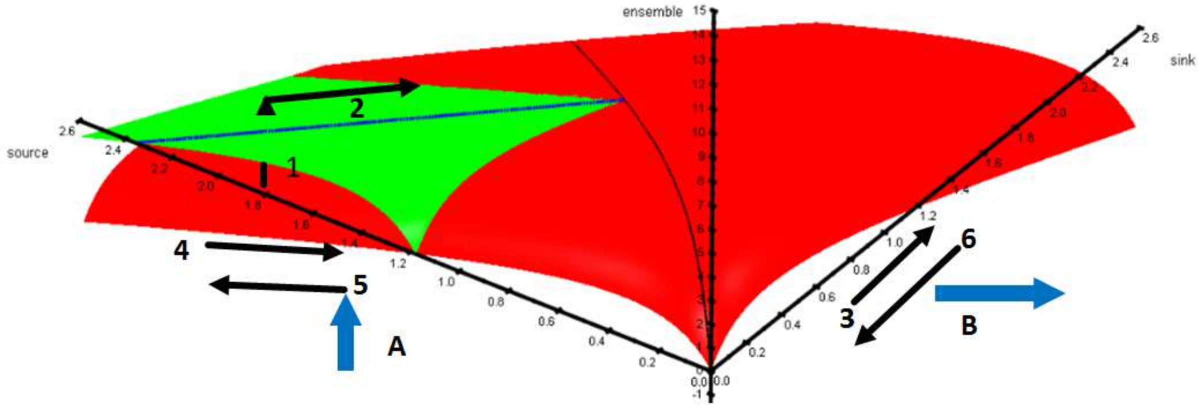


Figure 6: The single cycle steps are similar to figure 4. This time the ensemble is controlled by the sink. The transfer stops when the sink has reached b_{si}-c_{si}=0 (b_{si}/c_{si}=1) although the source is not yet at b_{so}-c_{so}=0 (b_{so}/c_{so}=1). The blue line of strict symbiosis is visible. The arrow does not reach the line of strict equivalence anymore. The independent ensemble stays on the productive side of line of strict equivalence.

Work cycles in asymmetric ensembles

There are many possible types of asymmetry imaginable. I want to concentrate on two interesting cases. In the first case the cost and productivity are low in source and high in sink. This type of ensemble rearranges productivity. An example of this type has been completely shown in figure 2. A work cycle of such an ensemble is basically identical to symmetric ensembles. However, the path of the ensemble shows some interesting features (figure 7). There we look top down and bottom up on a detail of figure 2A and 2B. The blue line of strict symbiosis is visible as well as the black line of strict equivalence.

Figure 7

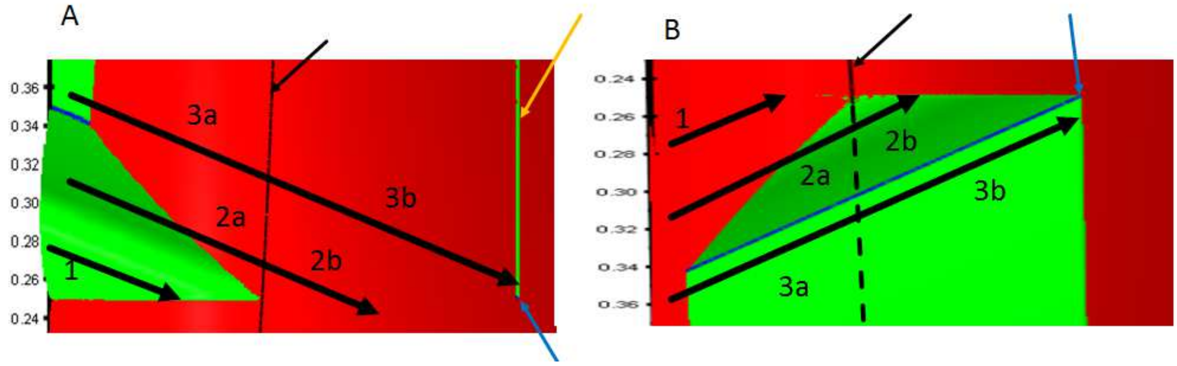


Figure 7: In A we look at three ensemble paths in a top down perspective of a section of figure 2A. In B the same three paths are observed in a bottom up perspective (section of figure 2B). The ensemble following the path of arrow 1 and 2 is controlled by the source. The ensemble following path 3 is controlled by the sink. Ensembles controlled by source or sink may lead to consumptive conditions crossing the line of strict equivalence (2b, 3b). The orange arrow indicates the line where active and inactive ensembles have the same b-c value. The blue arrow indicates the endpoint of strict symbiosis. In this asymmetric ensemble parts of strict symbiosis are on the consumptive side of strict equivalence (black arrows, black line and black dashed line).

All three ensemble paths (1, 2 and 3) start in an area of the ensemble surface where superadditivity of the active ensemble over the inactive ensemble is observable. There the green surface is above the red surface in top down (figure 7A). The red surface then is visible in the bottom up perspective (figure 7B).

The most interesting observation is that the ensemble path in source controlled (arrow 1 and 2) and sink controlled (arrow 3) ensembles will lead to a condition where the inactive ensemble will be more productive than the active ensemble (figure 7, arrow 2a and 3a, red over green) or where the ensemble will not only be less productive than the inactive ensemble but where it also will be consumptive as the line of strict equivalence is crossed (2b and 3b). This is completely surprising. Both parties will give or take at “free will” until one or both sides will arrive at the border b-c=0 but the ensemble will be less productive than in the case of no transfer (inactive ensemble). On top of that, there is a change from a productive transfer to a consumptive transfer. An earning good has been transformed to a costing good. The ensemble in complete consent of source and sink rearranges productivity to a bad place.

A second interesting case to be discussed in the light of working cycles is the ensemble presented in figure 3. A detailed view in top down and bottom up perspective is presented in figure 8.

Figure 8

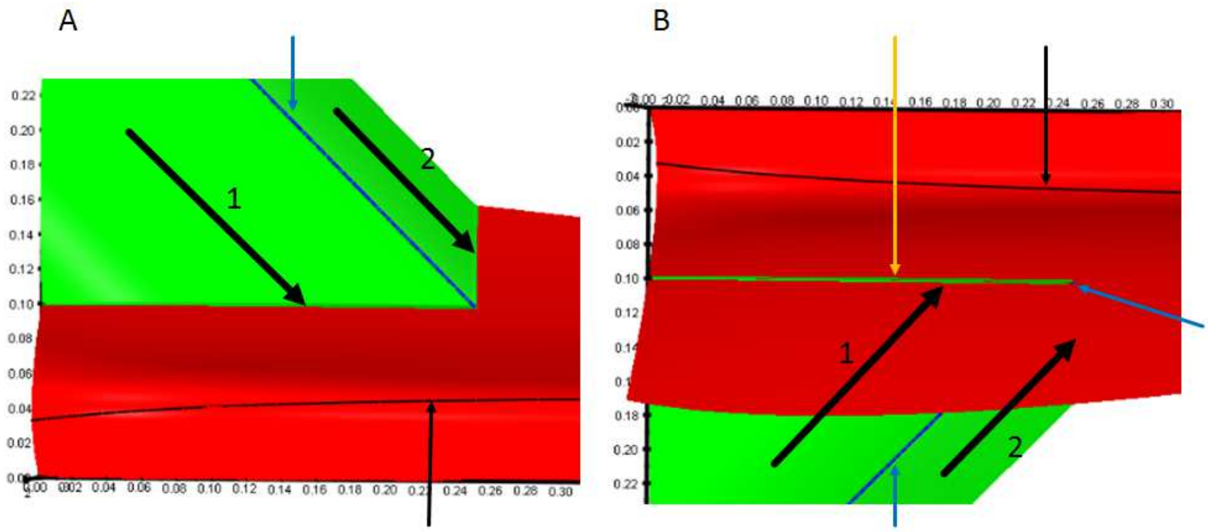


Figure 8: In A we look at two ensemble paths in a top down perspective of a section of figure 3A. In B the same two paths are observed in a bottom up perspective (section of figure 3B). The ensemble following path 1 is controlled by the source. The ensemble following path 2 is controlled by the sink. The orange arrow indicates the line where active and inactive ensembles have the same b-c value. The blue arrow in A points at the line of strict symbiosis, in B at the endpoint of strict symbiosis. The black arrows mark the line of strict equivalence.

In this type of asymmetric ensemble the source has a high productivity at high cost and the sink has a low productivity at low cost. Such a type of ensemble rearranges cost. Following the path of arrow 1 in a source controlled ensemble or arrow 2 in a sink controlled ensemble we observe that both active ensembles are always more productive than the inactive ensemble and both always stay on the productive side of the line of strict equivalence. Even symbiosis will never reach rational equivalence.

Any port in a storm

Benefits and costs are neither fixed quantities nor absolute qualities. Fat reserves for little birds are beneficial (high survival value) during wintertime. In the presence of predators the benefit will turn into a cost due to lower manoeuvrability (weight) during escape by flight (3). Also the perception of the size of benefits and costs may vary.

Simple organisms usually behave in the same predictable manner according to a certain stimulus. However, not in all cases of the same stimulus it is useful to behave with a blind reflex. In addition, a predictable behaviour is easily exploitable by more intelligent species. Therefore, in the course of evolution organisms have developed the ability to change the assessment of benefits and costs by learning. This ability in return can be exploited by other organisms to change the behaviour of a target organism influencing the assessment of benefit and cost. In doing so the behaviour of an organism may be changed from not giving to giving or from not taking to taking and vice versa. Brute force and deception are able to change the perception of benefits and costs according to quantity and quality. This has interesting consequences when applied within autonomous ensembles as I will demonstrate.

Brute force and deception

In symmetric and asymmetric ensembles the transfer will end when one or both sides side arrives at b-c=0 (b/c=1). There is only one point where both sides stop to give and to take simultaneously. In case one side arrives first at b-c=0 (b/c=1) this side will no longer give (source) or take (sink). However, the other side has not yet arrived at b-c=0 (b/c=1) and therefore wants to take (sink) or give (source). Using brute force or deception this goal may be achieved. Brute force and deception are an important part of transfer costs.

The following assumptions have been made:

1. Source arrives at b_{so}-c_{so}=0 and stops giving. Sink is still in a condition of b_{si}-c_{si}>0. Sink invests an amount of substrate equal to 25% of the amount of substrate necessary for sink to arrive at the goal b_{si}-c_{si}=0. The total amount of transferred substrate equals 125% as the source is forced or convinced to pay everything.
2. Sink arrives at b_{si}-c_{si}=0 and stops taking. Source is still in a condition of b_{so}-c_{so}<0. Source invests an amount of substrate equal to 25% of the total amount of substrate necessary for source to arrive at b_{so}-c_{so}=0. Here the sink is forced or convinced to take only an additional 75% of the substrate.

In figure 9 we observe what happens to a symmetric independent ensemble when the source is forced or convinced through deception by the sink to give an earning substrate beyond the limit of b_{so}-c_{so}=0 reaching any value of b_{so}-c_{so}>0 while sink will reach its goal b_{si}-c_{si}=0. The ensemble is active in an area where it was not active before (blue). Parts of this new area are superadditive (blue over red, 9A) and other parts of the new area are subadditive (red over blue, 9A, B). In case more force is needed to overcome the source. The blue surface becomes bent upwards (9D inset).

Figure 9

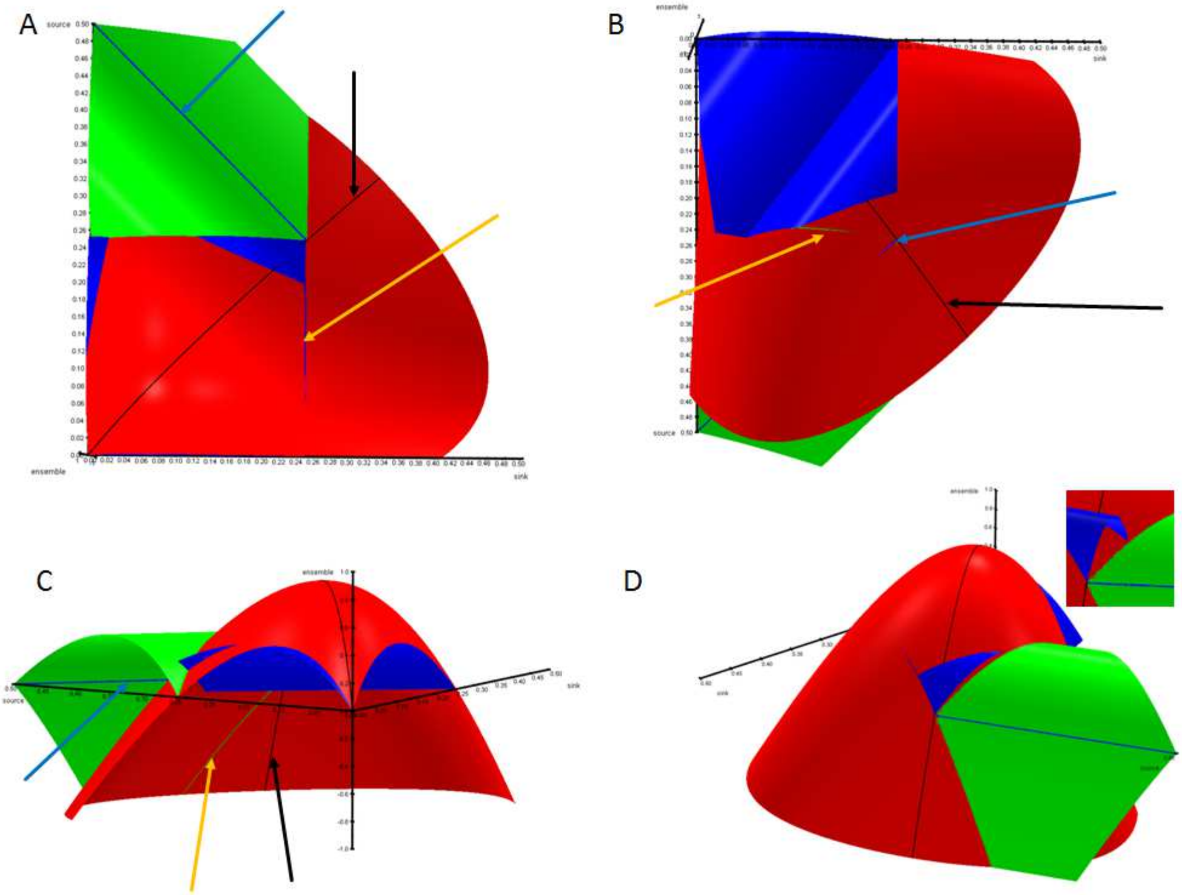


Figure 9: The view of a symmetric ensemble top down (A) and bottom-up (B) in the transfer space. The axis of source is to the left. In C and D we take a look from the side on the transfer space. From the front (C; ensemble axis up, source left, sink right) and from behind (D). The active ensemble is the green surface; the inactive ensemble is the red surface. The blue surface is an active, independent ensemble with use of internal brute force or deception. The sink uses brute force to take away from a source because the source stopped giving at b_{so}-c_{so}=0. This ensemble appears only outside to the borders of the peaceful ensemble.

The black arrows point to the line of strict equivalence projected to the red surface for better visibility. The blue arrow points to the line of strict symbiosis and the orange arrow to the artefact of the program indicating in some pictures where the active ensemble (with or without force) ends (b-c of active and inactive ensemble are identical). The inset in D displays what happens to the curvature of the blue surface on the line of strict equivalence if brute force costs 75% of the transferred substrate.

The ensemble path of a working cycle of such a violent ensemble is shown in figure 10.

Figure 10

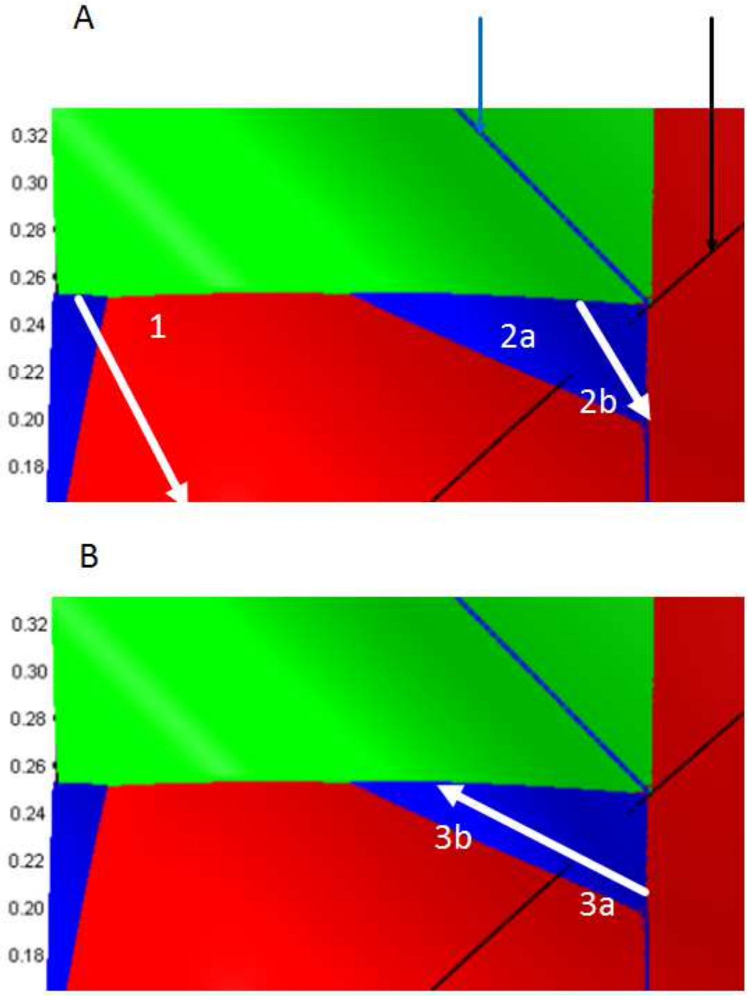


Figure 10: In A and B we look at ensemble paths in a top down perspective of a section of figure 9A. The ensemble following path A1 starts source controlled. Source stopped giving. Sink is using brute force or deception to take. Path 1 leaves the productive, blue area and becomes irrational where the inactive ensemble is more productive (red above blue). In path 2 the ensemble stays rational and productive until b_{si}-c_{si}=0 is reached. The ensemble changes from productive (2a) to consumptive (2b) behaviour crossing the line of strict equivalence. In B we observe counterforce or enlightenment (3a, 3b) as the source realizes that b_{so}-c_{so}>0. Here the arrow is also not parallel to the line of strict symbiosis as the sink is forced to bear the full price. The angle between arrows 2 and 3 is a measure of the increasing substrate loss to the investments of force and counterforce. The blue arrow points towards strict symbiosis, the black arrow towards the line of strict equivalence.

In case the ensemble path starts from the border of the green surface adjacent to a blue surface the use of brute force and deception is rational. Rational or not – the ensemble is now active in a concentration range where it would not have been active before.

Moreover, the active independent ensemble with brute force or deception (violent ensemble) has higher cost normalized productivity than the inactive ensemble! Although there are paths (figure 10A, path 1) leading quite fast to irrationality (blue surface under red) there are other paths (figure 10A, path 2) superadditive and rational until the end. The end of all paths will be reached when sink arrives at b_{si}-c_{si}=0 or the source is exhausted (path 1). With path 2 we observe a phenomenon we already know from the asymmetric ensemble (figure 7). The path starts rational and productive (figure 10A, 2a) but crosses the line of strict equivalence and becomes consumptive (figure 10A, 2b). On the productive side the ensemble produces more than it consumes including the investment for transfer. This area has been called in the past “wise exploitation”. On the consumptive side the investment is no longer paid and yet the ensemble shows a better productivity than the inactive ensemble. This differs from the asymmetric ensemble.

In figure 11 we observe what happens to a symmetric independent ensemble when the sink is forced or convinced through deception by the source to take a costing substrate beyond the limit of b_{si}-c_{si}=0 reaching any value of b_{si}-c_{si}<0 while source will reach its goal b_{so}-c_{so}=0. Again the ensemble becomes active in an area where it was not active before (blue surface). The productivity is highest next to the border of the peaceful ensemble (11, c). The surface of the violent ensemble starts as wise and productive exploitation and then crosses the line of strict equivalence and becomes consumptive (11, A). Finally the ensemble becomes even irrational (11 A and B, blue surface under red surface, grey circle).

Figure 11

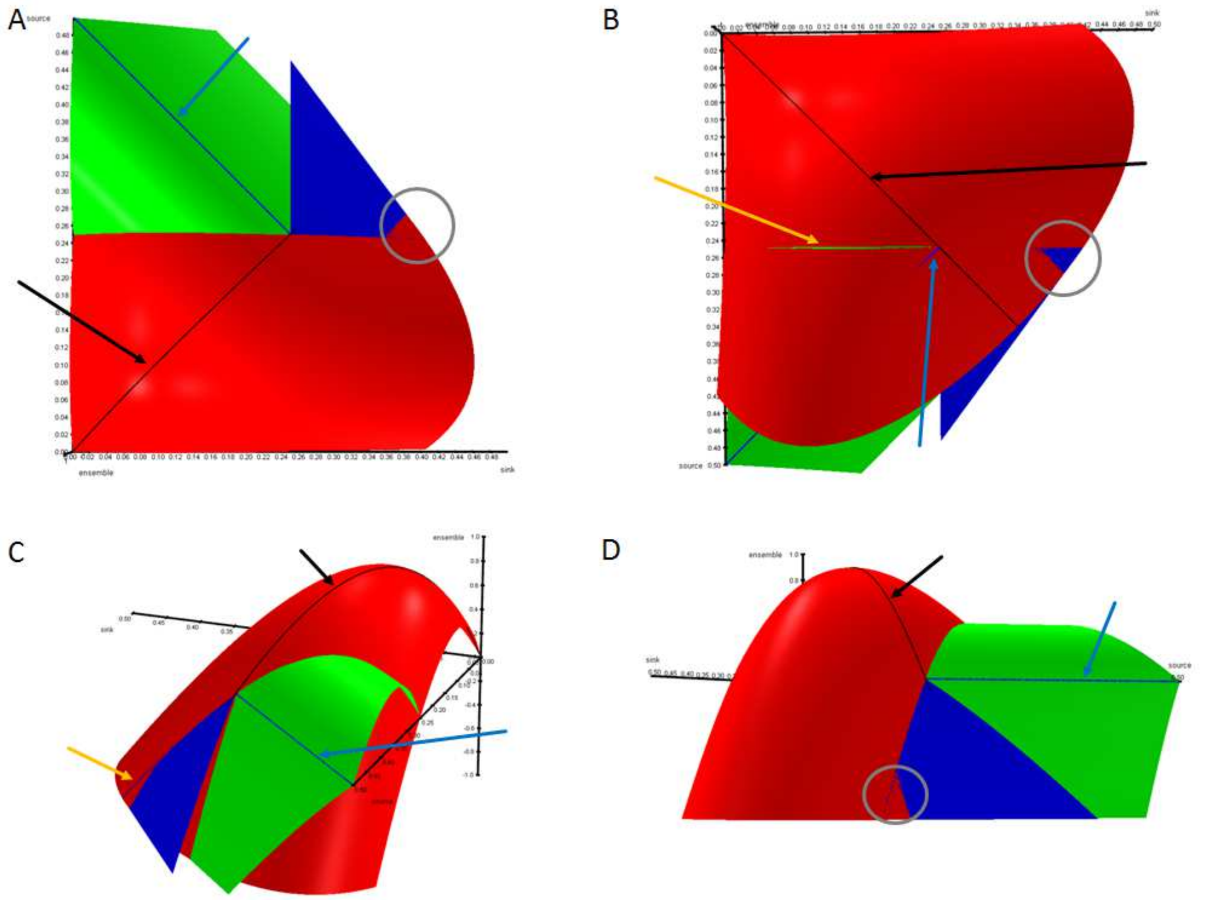


Figure 11: The view of a symmetric ensemble top down (A) and bottom-up (B) in the transfer space with the axis of source to the left. The side view of the transfer space (C; ensemble axis up, sink left, source towards observer) and from behind (D, sink left, source right). The active independent ensemble is the green surface; the inactive ensemble is the red surface. The blue surface is an active, independent ensemble with use of internal brute force. The source (b_{so}-c_{so}<0) is using brute force to give to the sink as the sink stopped taking (b_{si}-c_{si}=0). This ensemble appears only outside to the borders of the peaceful ensemble (green).

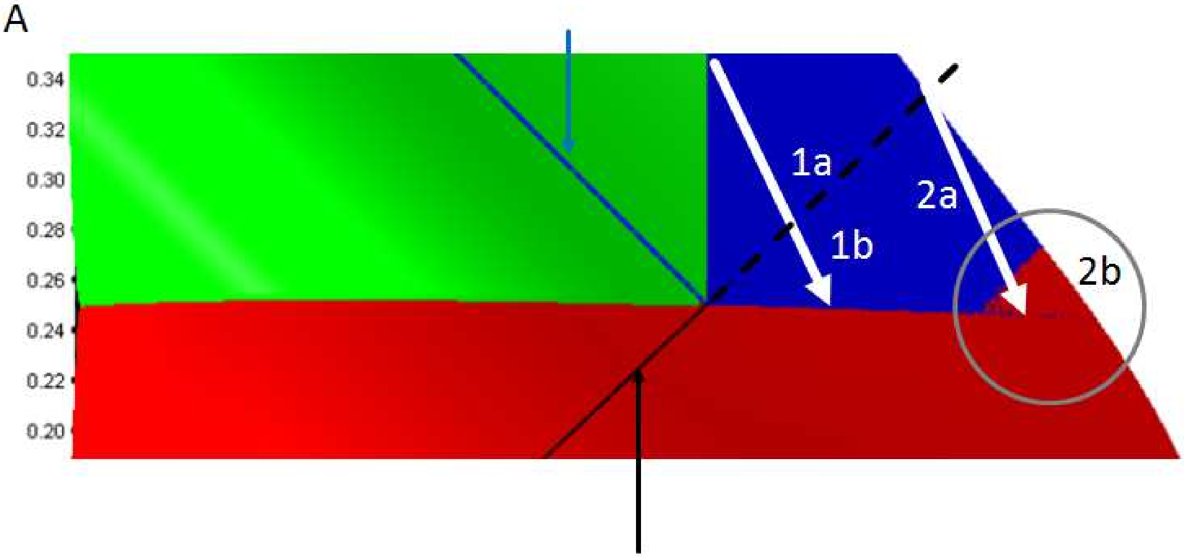
The black arrows point to the line of strict equivalence projected to the red surface for better visibility. The blue arrow points to the line of strict symbiosis and the orange arrow to the artefact of the program indicating in some pictures where the active ensemble (with or without force) ends (b-c of active and inactive ensemble are identical). The grey ring circles the irrational (inactive ensemble better than active ensemble) and consumptive area in A. B and D. Some parts of the blue and green surface are visible only because the z-axis ends and cuts off the red surface.

Again, an ensemble path of a working cycle is shown in figure 12. The ensemble path starts from the border of the green surface (b_{si}-c_{si}=0) adjacent to a blue surface. The use of brute force and deception starts everywhere rational! The ensemble is active in a concentration range where it would not have been active before.

The white arrow crosses the line of strict equivalence changing the ensemble character from a productive ensemble (arrow 1a) to a consumptive ensemble (arrow 1b, 2a). The ensemble may stay rational (arrow 1) or it may even become irrational (arrow 2b). A zigzag movement of the ensemble by decreasing investments in force and counter force, propaganda and counterpropaganda (arrow 3) would finally end at a point where strict symbiosis and the border of strict equivalence meat. It is always easy to annihilate affluence. However, this just and then peaceful outcome is only possible in perfect symmetric ensembles. The outcome in asymmetric ensembles may be tragic and will be discussed in an additional paper.

Figure 12

A



B

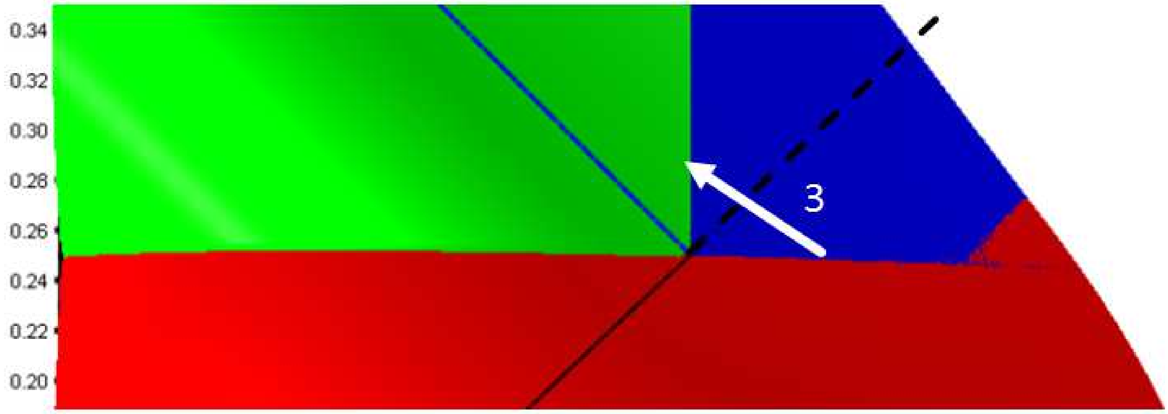


Figure 12: In A and B we look at ensemble paths in a top down perspective of a section of figure 11A. The ensemble following paths in A1 starts from a sink controlled situation as sink stopped taking. Source is now using brute force or deception to give. Path 1 (1a) leaves the productive, blue area and becomes consumptive (1b) crossing the line of strict equivalence (dotted black line) but will stays rational all the time. In path 2 the ensemble will change from rational and consumptive (2a) to irrational and consumptive at the end of the path (2b, grey circle) until b_{so}-c_{so}=0 is reached.

In B we observe counterforce or enlightenment (3) as sink realizes now that b_{si}-c_{si}>0. This is a step forward as the ensemble leaves the consumptive area on the way back into the productive area. The angle between arrows 1 and 3 is a measure of the decreasing substrate loss to the investments of force and counterforce.

The blue arrow in A points at the line of strict symbiosis and the black arrow points towards the line of strict equivalence. The white arrows of the ensemble paths are not parallel to the line of strict symbiosis as a 1:1 relationship of substrate transfer does not exist as 25% of the surplus is lost to force and counterforce.

The concept of the transfer space (ensemble space) is able to explain the sometimes confusing observations of live especially in connection to brute force and deception, rational acting subjects and irrational outcomes. While the green surface stands for a peaceful, harmonic ensemble, the blue surface describes an ensemble with force and counterforce, propaganda and counterpropaganda, yet its productivity is in some areas superior to an inactive ensemble. Both, peaceful and violent ensembles are active in different concentration ranges of source and sink. Therefore, it is not quite fair to compare (apples and oranges) them – but if we do so we surprisingly find that violent ensemble possess in some areas the best productivity (figure 9D).

The white arrows indicate possible ensemble paths in violent ensembles. Along these arrows tensions between source (b_{so}-c_{so}=0) or sink (b_{si}-c_{si}=0) arise. In case the force or counterforce would change along the path according to size (e.g. increasing with distance to the desired condition) the arrows would become bent. In an arms race with alternating use of force and counter force a sideways zigzag movement between the productive and consumptive side will be observed until both arrive either in peace at the meeting place of strict symbiosis and strict equivalence wasting all surplus or at the border to irrationality and exhaustion. In case scarcity is the problem the zigzag movement of the clash will lead to irrationality. But even in irrationality there will be a productive and a consumptive side.

An independent ensemble is not a closed system. Substrates and energy will still flow into both sides and products will come out of both sides. Therefore, a consuming ensemble may be stable as long as the shortage costing over-production are compensated and no side is exhausted or overloaded. Independency relates to the fact that both parties decide by their own whether to transfer or not.

Discussion

The view of an ensemble as a surface within the transfer space is not new (4, 5). New is the idea to compare two independent productive parties before and after a transfer. Two parties with particular productivity, cost parameters and substrate concentrations may form an inactive ensemble (no transfer) or an active ensemble (with transfer). An inactive ensemble may look like an artificial entity, but it serves as a useful reference for the basic cost normalized productivity of two parties. Besides being a reference the inactive ensemble is also a competitor to the active ensemble. This competitor is separated from the active ensemble like two predator-prey ensembles on two unconnected islands. One ensemble may transfer information (stotting, inspection; 6, 7) while the other does not. The single parties of the ensemble not transferring information might be superior in direct competition. However, the active ensemble may be more productive (number of offspring) than the inactive ensemble on the long run as it saves energy avoiding exhausting hunts for predator and prey.

When inactive ensembles become active this may appear to an external observer like “Baron von Münchhausen and his horse escaping the swamp” – very surprising because physically impossible. Why is “The Whole” more than the sum of the single parties – or less? Where does the additional productivity come from or where to does the productivity vanish.

The independent active ensemble is basically a very rational ensemble as it exists only where it is superior to the inactive ensemble. The dependent active ensemble in contrast (1) possesses large areas of irrationality where the inactive ensemble has a higher productivity.

Things become difficult and interesting at borders. The independent ensemble has two borders. At one border sink has arrived at b_{si}-c_{si}=0 (b_{si}/c_{si}=1) but source would still like to give substrate (b_{so}-c_{so}<0, b_{so}/c_{so}<1). At the other border source has arrived at b_{so}-c_{so}=0 (b_{so}/c_{so}=1) and sink would still like to take substrate (b_{si}-c_{si}>0, b_{si}/c_{si}>1). The side which is not yet in equilibrium may now use brute force or deception to reach the goal. This makes an investment necessary (muscles, weapons, arguments). The investments are a transfer-cost reducing the effectiveness of the measures.

Cycles in Biology or Economy have many different reasons. Many explanations are discussed. I suggest an idea similar to the Carnot cycle (Nicolas Léonard Sadi Carnot, 1823). In the process of going through this cycle, the system performs additional work. Cycles in ensembles appear in two areas. The active ensemble without transfer costs alternates between an unconnected phase (isolated accumulation and production on one side and additional productivity on the other side) and a connected phase of transfer. This is usually difficulty to observe as both phases may happen simultaneously. The second type of cycle appears in the region where brute force and deception take place. Force and counter force, information and counter information drive the cycle here. The system may cycle between a rational and an irrational phase (figure 10, arrow 1) until source is exhausted or sink is overloaded. The system may follow a zigzag path of an arms race leading sideways into a region of irrationality (figure 10, arrow 2 and 3) until one side will be exhausted in an ensemble with deficiency problems. Finally, the system may find a stable point along a zigzag path in an ensemble with affluence problems - a wasteful peace at the end of strict symbiosis on the line of equivalence (figure 12).

However, if force and counter force, information and counter information are well balanced the independent ensemble becomes active and productive in a region of the transfer space where it would otherwise not exist and therefore would not be able to compete with an inactive ensemble. The most surprising finding is a sub-region where the independent active ensemble becomes consuming and is yet better productive than the inactive ensemble. This may have been described as early as in the use of the fable “The belly and the members” (8) by *Agrippa Menenius Lanatus* in 494 BC (according to *Livius*) to persuade the plebs to end their secession.

$$(b_{so}-c_{so})+(b_{si}-c_{si})<(b_{so}-\Delta b_{so})-(c_{so}-\Delta c_{so})+(b_{si}+\Delta b_{si})-(c_{si}+\Delta c_{si}) \text{ or}$$

$$(b_{so}/c_{so})+(b_{si}/c_{si})<(b_{so}-\Delta b_{so})/(c_{so}-\Delta c_{so})+(b_{si}+\Delta b_{si})/(c_{si}+\Delta c_{si})$$

The plebs must stay exploited for the sake of the Roman Republic. However, negotiations lead to integration by reciprocity as the *tribunus plebis* is introduced.

Exploitation has two faces: The source is exploited to give an earning substrate ($b_{so}-c_{so}>0$, $b_{so}/c_{so}>1$, figure 9) or the sink is exploited to take a costing substrate ($b_{si}-c_{si}<0$, $b_{si}/c_{si}<1$, figure 11). The surprising finding is that in this new region of exploitation there will be enough productivity (superadditivity) to pay the cost of brute force and deception and still be more productive than the inactive ensemble. This I have called in past papers “wise (productive) exploitation” and “consumptive” exploitation. The biggest surprise is that consumptive exploitation can be still more productive than an inactive ensemble.

Irrationality has at least three faces in independent ensembles. The first is irrationality observed under “free will” in asymmetric ensembles. The two other faces appear in symmetric ensembles using brute force and deception. There is a direct way into irrationality (figure 10A, arrow 1). In case the ensemble will not find a way to stop at the border to irrationality there is a long way of irrationality without hope ahead. The third face of irrationality appears (figure 10A and 10B) when the repeated use of brute force and counter force or propaganda and counter propaganda move the system sideways into irrationality consuming all productivity until irrationality either on the productive or the consumptive side appears. However, on this way the ensemble may be misled by the curvature of the surface, as increased force will increase productivity (figure 9D, inset) for some time.

Conclusion

Exploitation by brute force or deception may lead to ensembles active and productive in a region of the transfer space where an active, independent and peaceful ensemble would not be active. There, force and counterforce or deception and counter information may lead to a new equilibrium either in a consumptive or in a productive region. In this areas the trick is not "not minding that it hurts". The real trick there is to make another organism behave like "not minding that it hurts". However, this is a cynical view. Cheap information on the sizes of cost and/or benefit may transform an inactive ensemble into an active and highly productive ensemble or change an ensemble using costly brute force for transfers to a peaceful transferring ensemble. In addition, information may transform an irrational ensembles glued together by brute force or propaganda into a rational and inactive ensemble.

Simple ensembles may find stability in mutational adjustments of reaction parameters and behaviour to adjust surplus and shortage. Complex ensembles may develop moral and compassion to fine-tune the use of force and propaganda in a way that the ensemble stays active in the simultaneous absence of surplus in the source and shortage in the sink. Synergistic and antagonistic effects will be observed when evolutionary pre-adjustments meet culture and tradition.

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