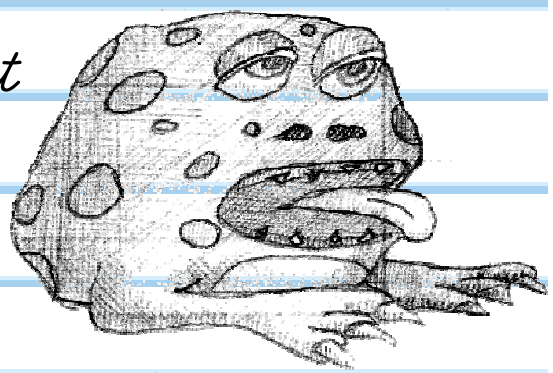
A Grammar of Gameplay

game atoms: can games be diagrammed?

Raph Koster

Chief Creative Officer

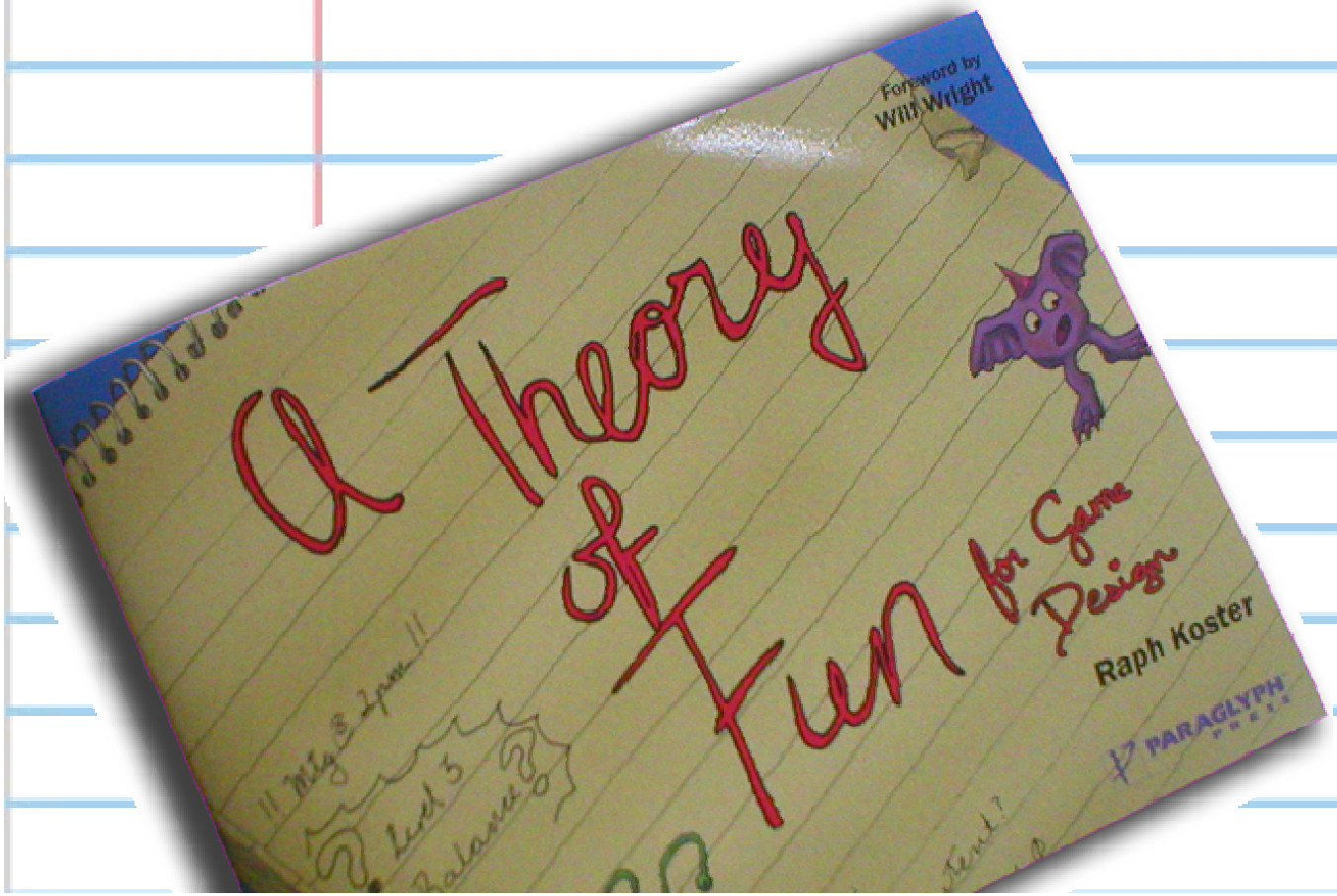
Sony Online Entertainment



Game Developers Conference 2005: Futurevision

A bit of background

I spent the last year and a half writing a book about why games matter.



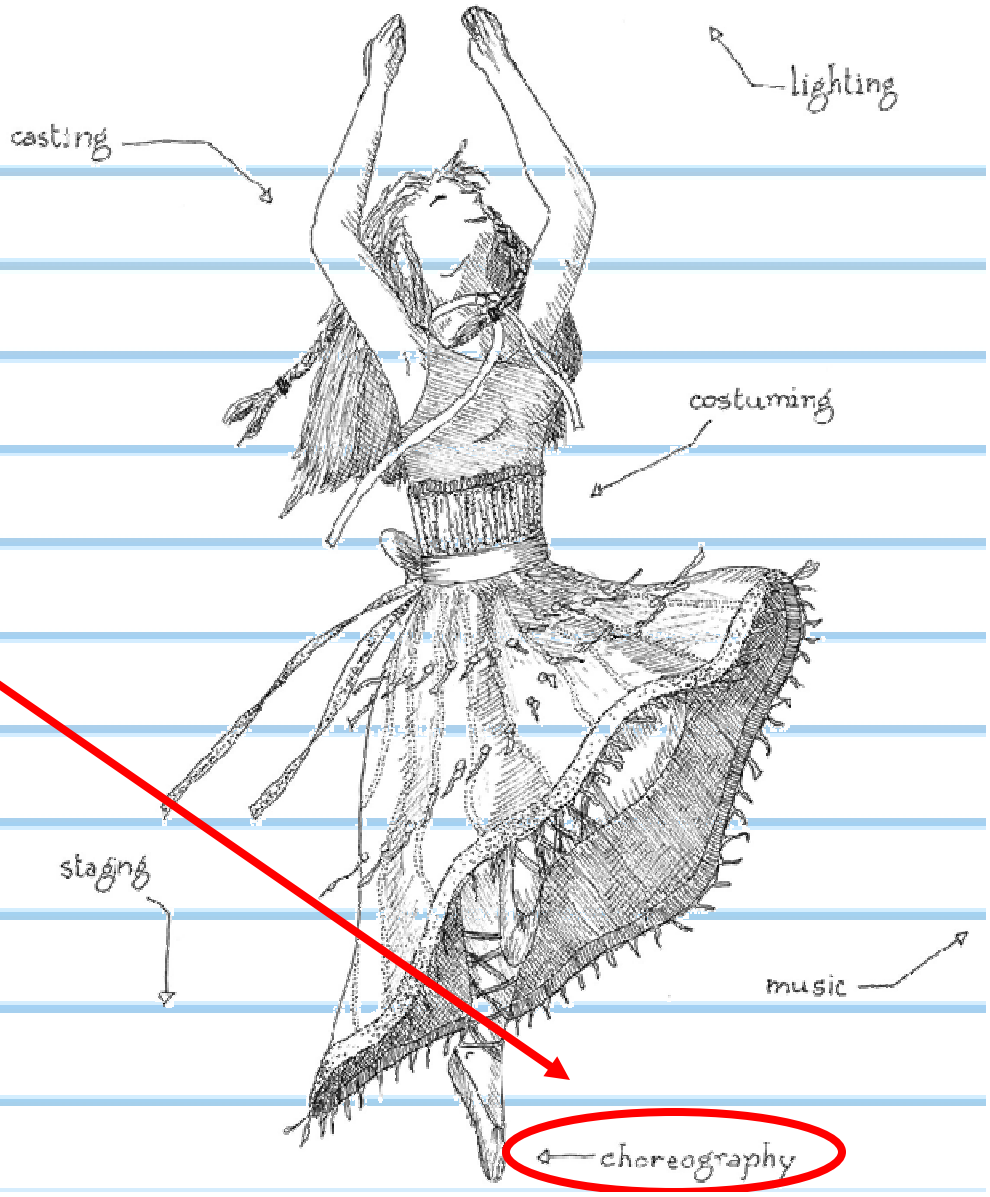
Games are like dance...

Many disciplines are involved... but one is critical.

Choreography.

Games are the same way.

Ludemography?

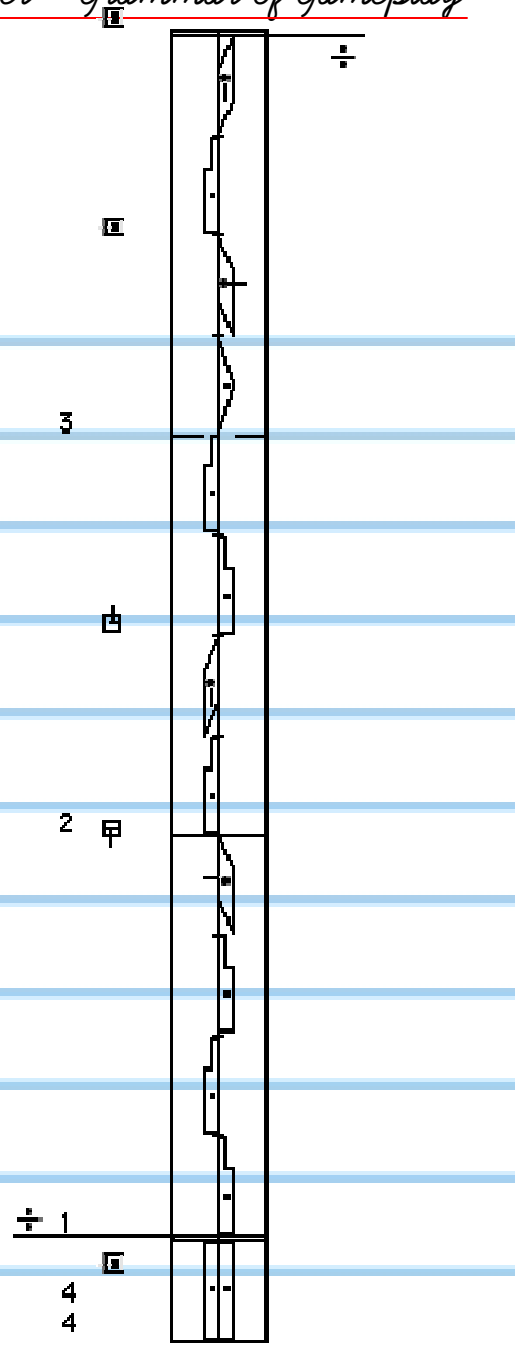


Dance notation

This is called Laban notation.

It's very abstract, but this is what choreography actually is.

(I can't read it either.)



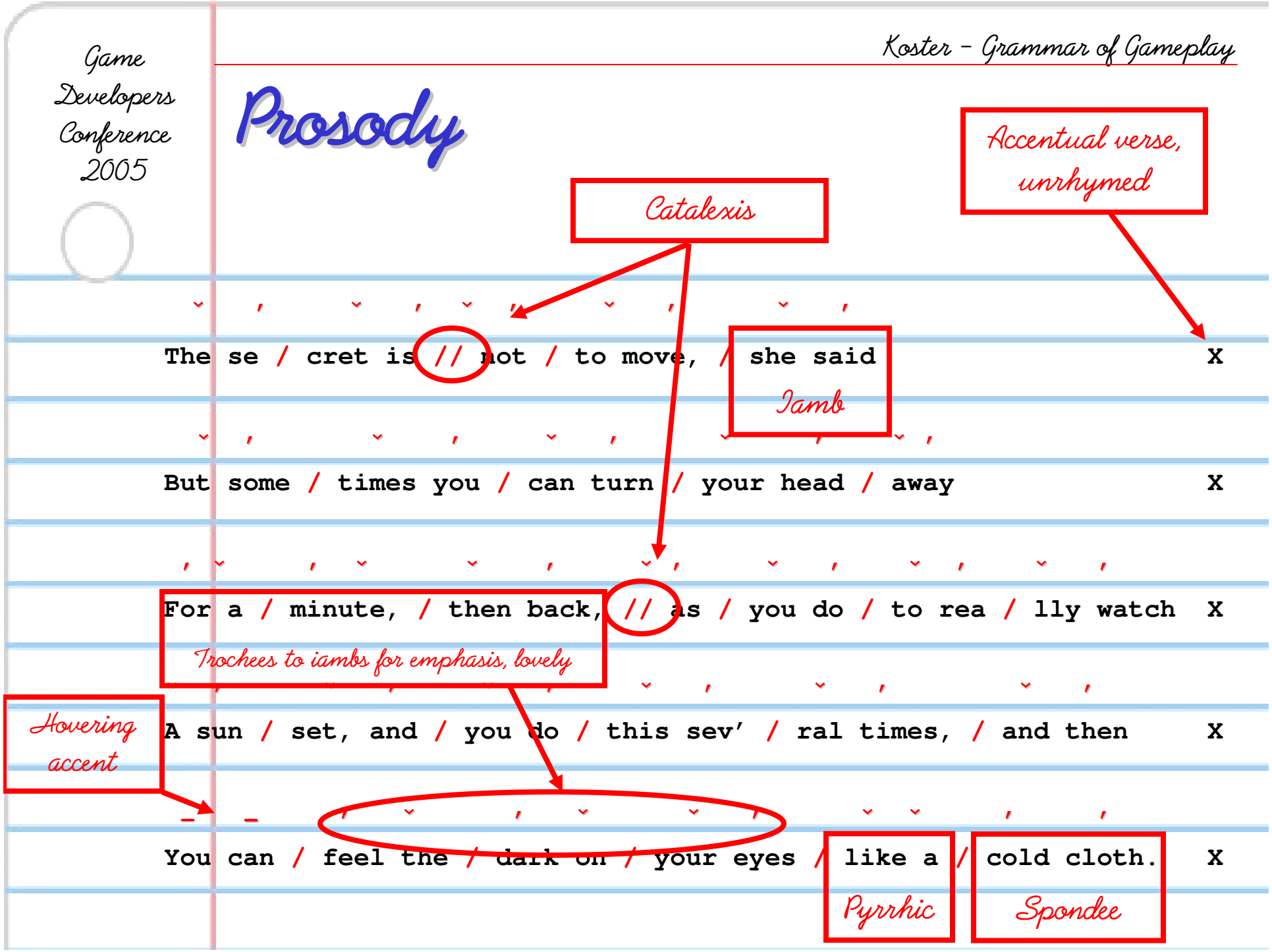
Poetry

The secret is not to move, she said
But sometimes you can turn your head away
For a minute, then back, as you do to really watch
A sunset, and you do this several times, and then
You can feel the dark on your eyes like a cold cloth.

-Dick Allen, "Cities & Empires"

Game Developers Conference 2005

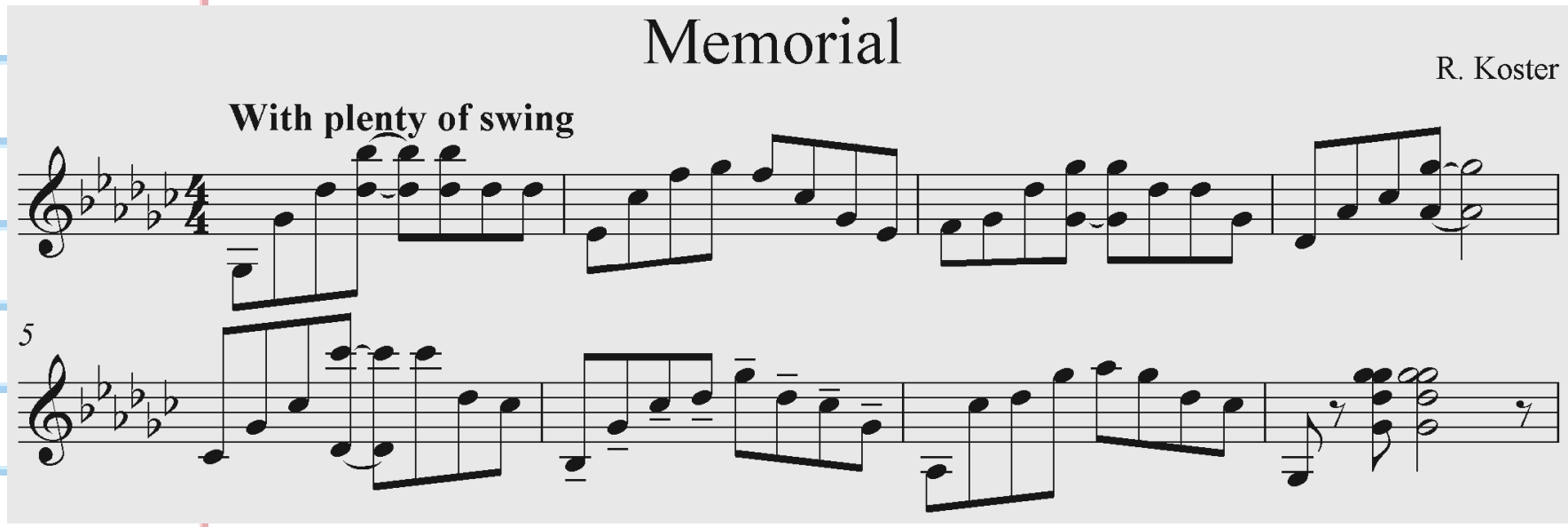
Prosody



Music

Musical notation is sufficient to reproduce the experience of listening

It will not, however, equal the delivery by a skilled player.



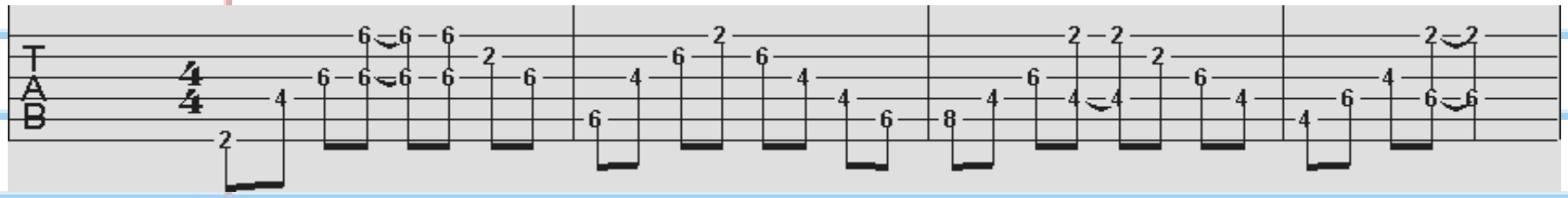
Let's poke at music for a bit...

There's harmonic notation as well:

I - I_7 - | IV - I - | V_7 IV I -

This is a second axis on the same problem.

There are also instrument-specific ways to notate, such as tablature :



Can we notate games?

Yes, but I
didn't succeed.

Well-trod ground

We've been tackling formal design tools for a while

- LeBlanc/Hunicke/Zubek
- Salen/Zimmerman
- Church
- Falstein/Barwood
- Cousins
- Crawford

Academics too

Academics have also been codifying things

- Sutton-Smith et al
- Caillois
- Karse
- Huizinga

I warned you this was an advanced lecture, so I am going to assume you know about all of these to some degree.

MDA, Mahk, Robin, and Robert

Their goal was to get us to look at games on three levels:

- Mechanics (a.k.a., the rules)
- Dynamics (i.e., interactions with the system)
- Aesthetics (e.g., emotional responses evoked)

MDA versus notation

Notation will likely tackle only mechanics,
with perhaps some hinting for dynamics.

(Interestingly, music calls its performance hinting "dynamics" too.)

We're especially leaving out aesthetics,
which delve into "what is fun."

Katie and Eric

Defining the types of rules:

- Constitutative rules are abstract systemic patterns
- Operational rules are the verbal description thereof
- Implicit rules are assumed restrictions of etiquette

Notation vs. Rules of Play

Notation will work with constituative rules

Operational rules are for the audience, not fellow craftspeople.

Doug, Noah, & Hal

The 400 Project and Formal Abstract Design Tools

...both focus on textual interpretations of game design practices.

Notation vs. abstract design tools

But all successful notation systems have been

- Visual
- Iconic
- Not textual

They are always new written languages.

This doesn't mean this work isn't valuable, of course.

Ben

This talk owes a lot to the concept of "ludemes."

Ben renamed them "primary elements."

They are similar to "choice molecules" but Ben likes empiricism, not theory...

Some things this isn't

- Game maps.

  Duh. We'll talk about space, but not this way.

- Math.

  The shape of probability curves is explicitly out of scope. Mathematical balancing is a data issue, not a systemic issue.

Some things this isn't

- Flowcharts

  We're not tracing the game path from an experiential point of view.

- Game theory diagrams

  We're not interested in graphing the possibility space. Rather, we want to know the algorithm for the possibility space.

Methodology

Basically,

reverse

engineering.

Picking our example

Phase-based RPG combat

Is it fun? Fun enough for our purposes.

It has lots of variables: enemies, equipment, areas, levels, stats, spells, specials, combos, parties, settings, etc.

(If we can't see all elements of an atom with this, then we're not trying hard enough.)

A game experience

Off to slay Foozle the Vincible Dragon...

I need to find him in Murkydark. I have my best armor and sword. I've fought him before and he kicked my ass. It's just a hack 'n' slash problem, really. He's got Vile Minions to defend him, but I can use my Mystic Missiles on them. I have to time my attack right, and he might not drop the Helm of Holy Hell, but I'm at the right level to get max XP. If I die, though, life will suck.

The ingredients

- Territory
- Preparation
- Core mechanic
- Range of challenges
- Choice of abilities
- Skill required
- Variable feedback
- Dealing with the Mastery Problem
- Cost of failure

The whole game AND each NPC have these!

Territory, aka topology

Looking at games topologically

Definition

"Exposed information coupled to your game token."

It is the operational space for a given asset, including

- all of the vectors of force the asset can apply, and
- all of the vectors of force that can apply to that asset.

Topology is not space

Game dressing ("aesthetics" or "player experience") LIES about territory!

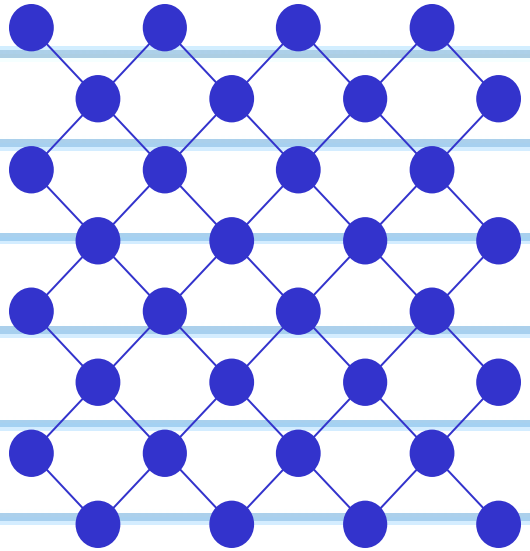
It is space in a purely mathematical sense.

It likely does not jibe with visual presentation at all.

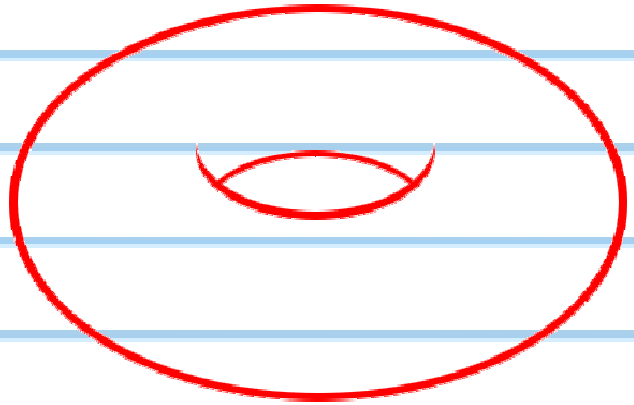
TIME is a valid topological axis!

Territory examples

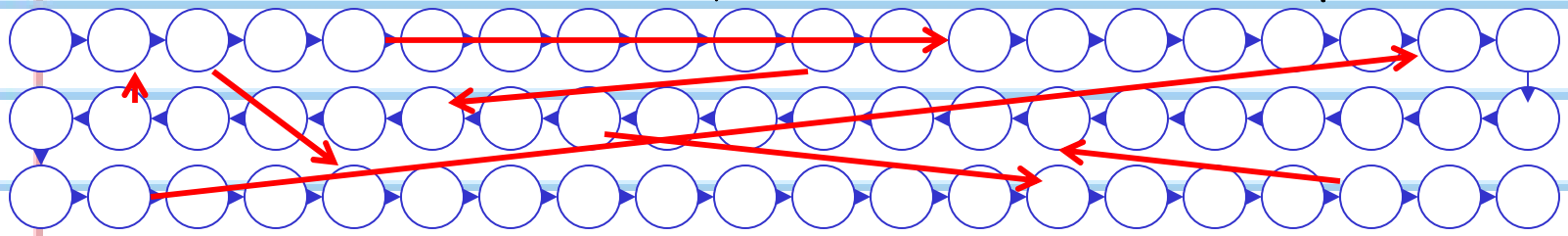
Checkers



Asteroids, a torus

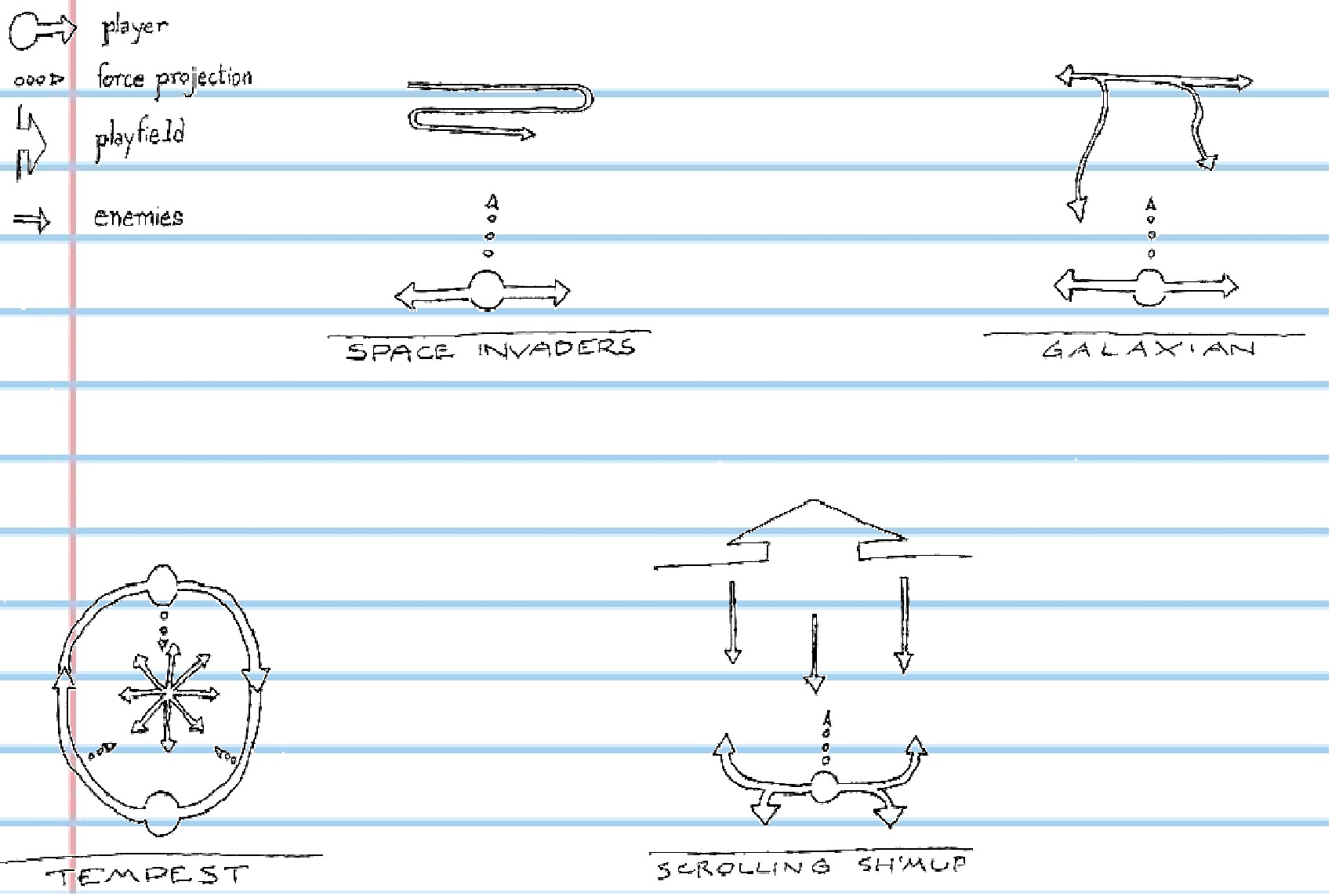


Chutes and Ladders, a non-Euclidean space



Game Developers Conference 2005

Looking at early shooters

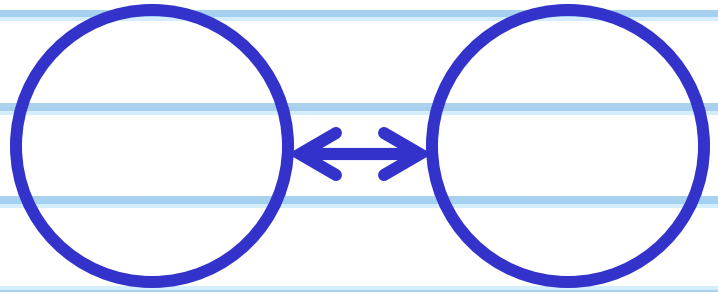


Looking at fighting games

Rock-paper-scissors

A point in a physical sense; topologically, it's a two-node game.

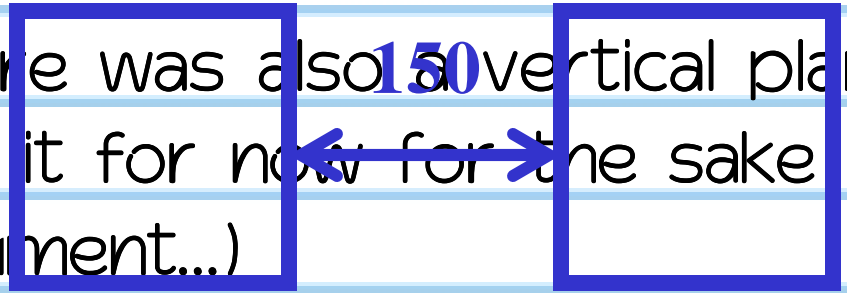
Nodes are not spaces; they are points.



Looking at fighting games

Old fighting games (say, Epyx' Karate Champ):

The two node map expands to involve an axis of movement with around 150 nodes (if I recall my 8-bit graphics resolutions right). We can now call this "space."



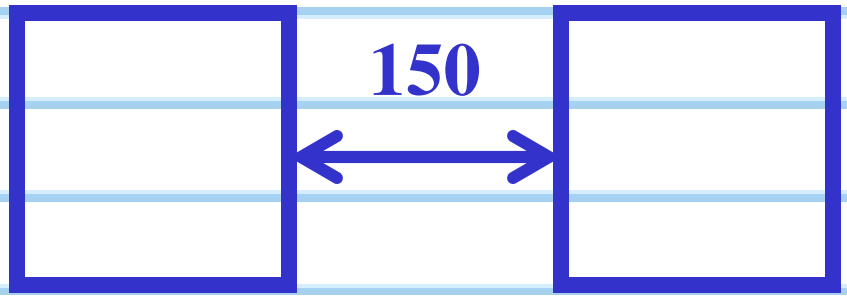
(There was also a vertical plane, but let's skip it for now for the sake of the argument...)

Looking at fighting games

Early 3d fighting games

Weren't.

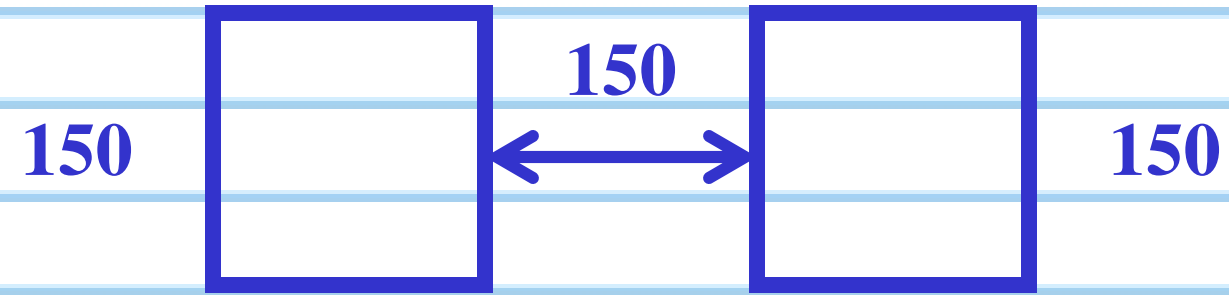
The visuals made the axis look like it pivoted.



Looking at fighting games

Battle Arena Toshinden

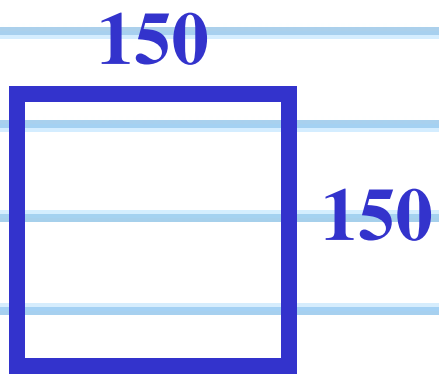
Offered a true 3d Cartesian environment, but movement was relative to the opponent.



Looking at fighting games

Bushido Blade

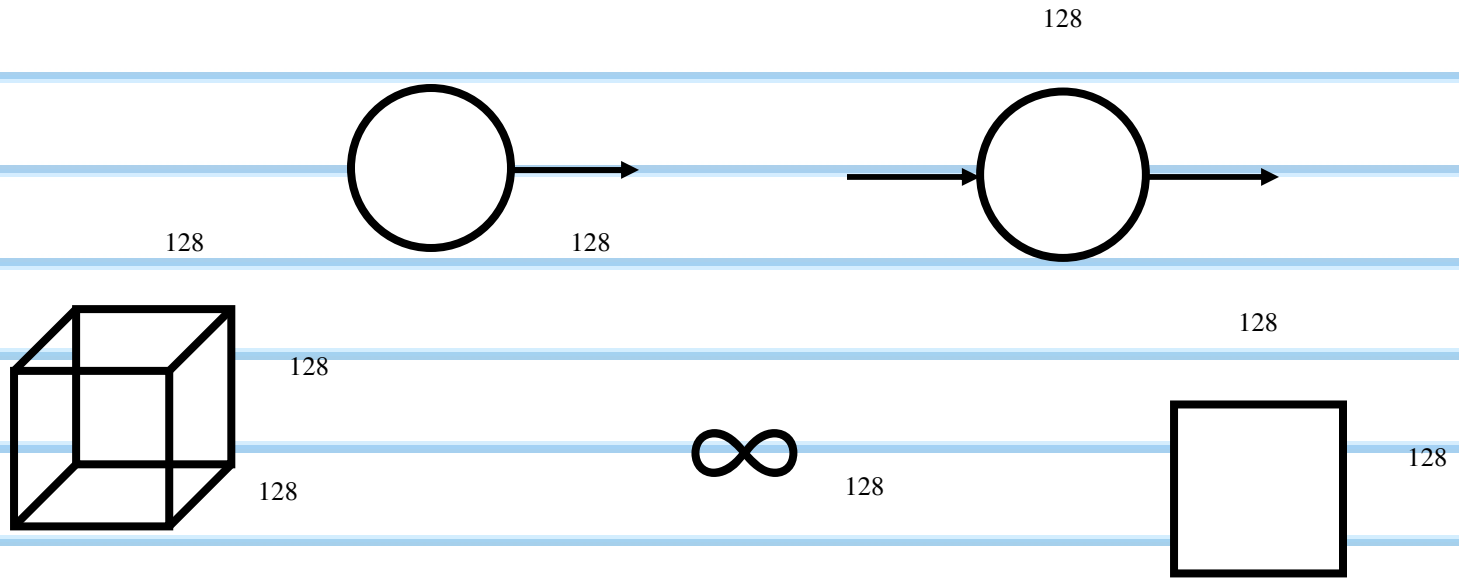
Gave true free motion.



Notation

Must break the habit of using the operational version of the playfield.

Iconic descriptions would force us to examine the actual space.



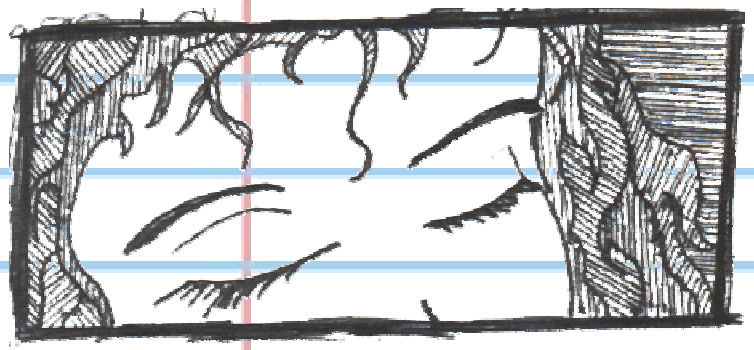
Time

Time is a valid dimension!

Need a separate bit to notate duration of a space.

Suggest "T" to indicate turn-based or user-determined, "P" for determined by opponent, and a span in milliseconds or seconds otherwise.

Preparation



Or, "logical connections"

Chris Crawford's Conversation

Chris defines interactivity as an iterative process:

"a cyclic process where two actors alternatively listen, think, and speak."

All games must be perceived as iterative, looping.

Seems obvious as we program them...

Definition

"Prior choices made that influence the next atom."

Examples

Handicapping

Any form of adjusting the relative skill levels of participants.

Any form of intervention that comes from outside the topmost atom (the magic circle).

Examples

Prior moves

All games are sequences of challenges.

Some challenges are risk-free as atoms.

(there is no risk involved in dragging a piece of armor onto your character's equipment slot)

but they're still atoms, and therefore count.

Logical progression

Chaining

Games can be seen as sequenced events

This is an experiential point of view.

There are also often game events that are order-dependent.

- Dragging items into slots then pressing "combine."

Logical progression

Recursion

Games can be seen as nested events

A given challenge is part of a meta-challenge, or includes challenges within itself.

Logical progression

Parallelism

Games can be seen as multiple challenges undertaken at once.

A chained game

Moon Patrol

- A tank is moving across the landscape.
- It can fire up and fire forward.
- It can slow down or speed up, but not stop.
- It can jump.

- Enemies roll towards it, scroll towards it, and drop bombs.

A recursive game

Moon Patrol

The game is getting the highest score possible

Within which is

The game is making it to the other side of each level

Within which is

The game is defeating a given enemy.

Within which is

The game is timing a button press

A parallel game

Even simple games tend to be parallel!

In Checkers:

One atom is removing all the enemy pieces.

Another is removing one enemy piece.

OR

Setting up a defensive move.

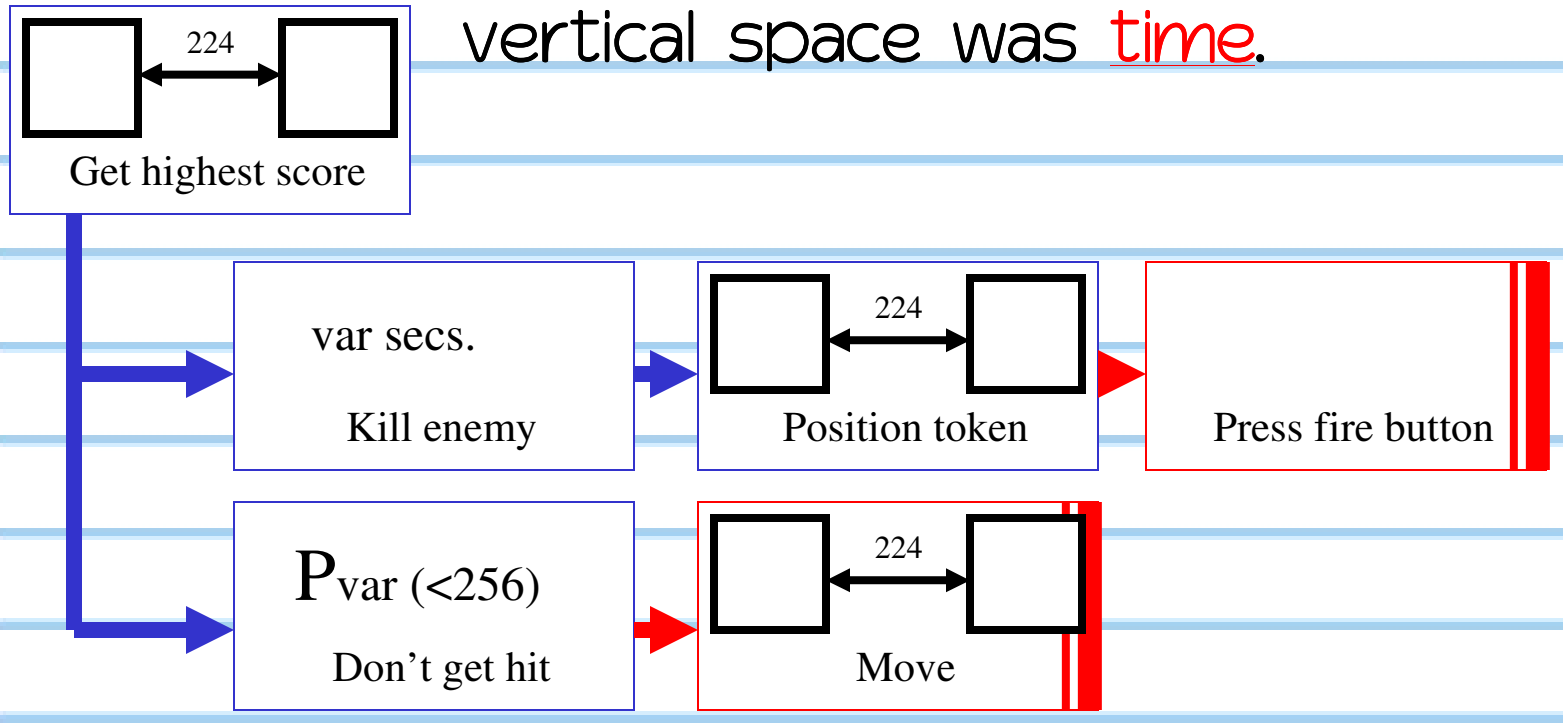
OR

Setting up a future attack.

Notation

Galaxian

Played on a 224x256 screen, but the vertical space was time.



Parallel, recursive, and sequential!

Notes on logical sequence

All games have at least one level of recursion

The last level is the "magic circle."

Games where we cannot define the singular goal will tend to be termed "play" rather than "game."

- Most MMORPGs are of this sort
- So are "software toys"

Notes on logical sequence

All good games can be played on a parallel level

The more levels of parallelism, the "broader" we consider the game

- If there's only one challenge to surmount, then we will grok the game quickly

Notes on logical sequence

All games are perceived sequentially

Most games, however, are not mentally played sequentially!

- Even in a linear game, we are thinking about the longer-term objective!

Clarifying dimensionality

Depth

Literally, the depth of recursion

Breadth

Literally, the amount of parallelism

Size

Literally, the amount of sequentially chained atoms

(Isn't it nice to finally know what these mean?)

Cost of failure

Syntactically, atoms must always have a failure state link, even if said failure is only an opportunity cost.

Why?

Any atom that involves risk must have at least a binary result.

This is why we do not consider moving a checker piece without a capture or a setup to be an atom.

I've notated these using red arrows rather than blue.

Core mechanic

Or "ludeme"

The heart of games

What is it?

Crawford says "verbs."
Meier says "choices."
Others say "conflict."

I give the nod to Chris. Verbs are the nucleus. Without a verb, there is no atom.

The Fullerton/Swain/Hoffman list

- Capture
- Chase
- Race
- Alignment
- Rescue
- Escape
- Forbidden act
- Build
- Explore
- Solve
- Outwit

Issues with the list

For our purposes,

- It's not atomic enough ("solve")
- It ignores topology ("alignment")
- It's intended as a list of objectives
- It includes operational assumptions ("rescue")

An alternative list

Higher level

- Remove all
- Survive
- Remove
- Exist at
- Intersect
- Move to
- Touch
- Press button

Lower level

Breaking down Quake

Kill a guy!

OK, we'll keep it simple, I need to:

- Run around a corner
- Jump into the air
- Get him in my crosshairs
- Headshot him
- Enjoy the gibs

Breaking down Quake

But each of these breaks down a lot

Running involves

- Determining direction in 3d space
- Pointing
- Applying a vector of force

Jumping adds

- Timing

Breaking down Quake

Now it gets weird

Aiming involves

- Determining position in 2d space
- Pointing

Headshotting involves

- Timing
- Pressing a button

(Enjoyment optional.)

In the end

The most basic ludemes involve a user interface action.

If you haven't drilled down that far, you haven't actually figured out what your game is doing.

One way to think of it: UI comes last, not first.

Where recursion ends

Another way to think of it

Fundamental atoms will be ones demanding no skill, providing no risk of failure.

e.g. physically picking up the checker piece and moving it to its new square.

Or, perhaps, "a verb outside the magic circle."

Providing direction

Users need direction

At atom that has too many other atoms nested immediately within is one where there may be too many choices.

Users have a threshold for number of choices.

We can probably find this number in psych literature...

Assessing difficulty

We can look at our diagram and tell if a game is too hard to learn

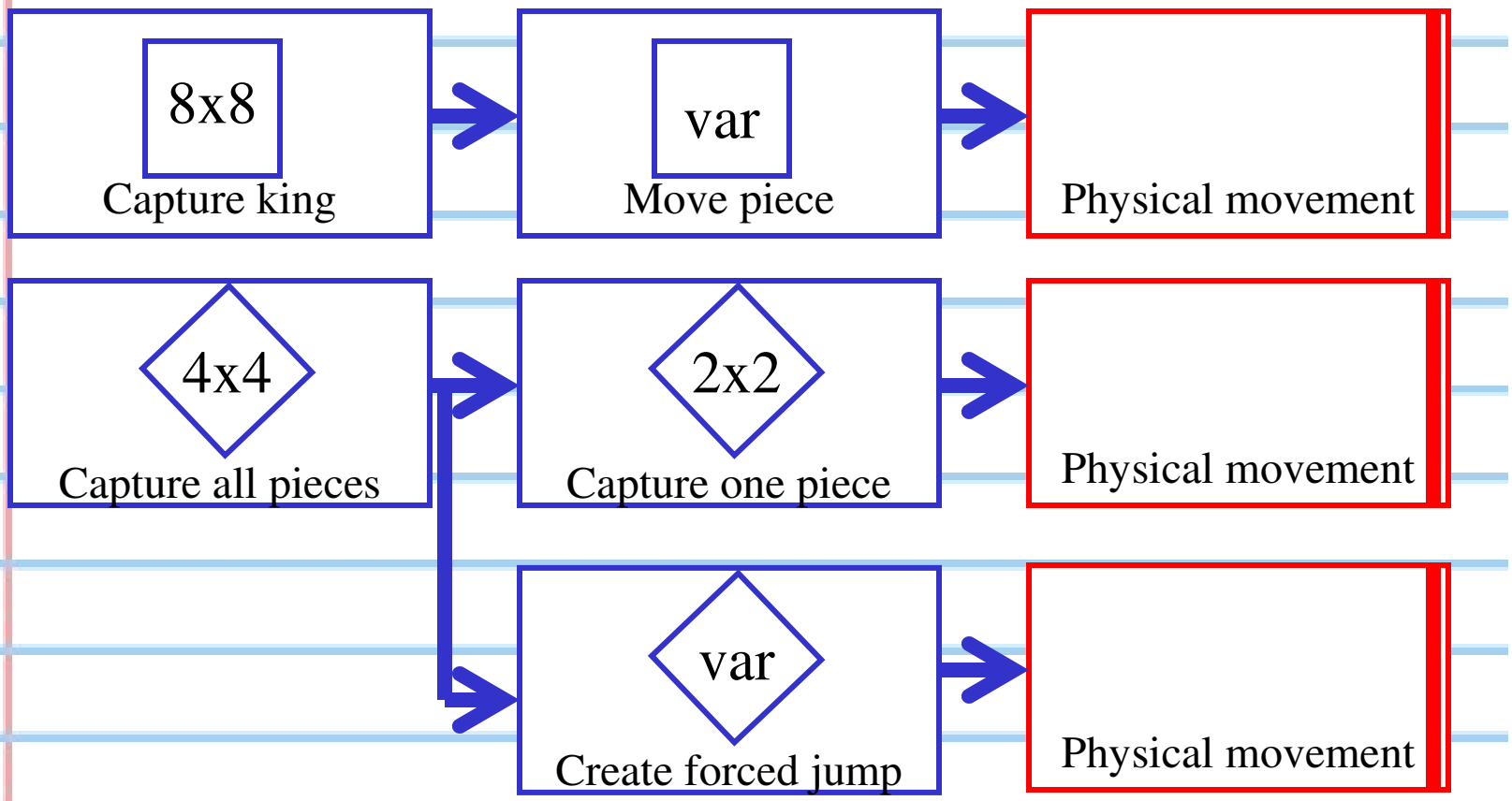
If one atom has too many branches, then we have a problem.

Chunking is implicit in atom construction

"Move" may break down into many possible directions, but those can be chunked.

Chess vs checkers

Leaving out defense and strategy...



So why is chess harder and deeper?

Choice of abilities

(need a better word than "ability")

Definition

A verb embodied by an asset or token.

Each piece you have in chess is a verb

- They behave differently
- You may have more than one of each.
- Each has associated topology

You have the choice of which verb to use

Examples of abilities

- Each checker piece
- Each chess piece
- Each spell
- Each attack move
- Each movement direction
- Each button to press

When we say "I can do X with Y" we are actually identifying abilities.

They are tools.

A range of tools

Even simple games offer multiple tools

Checkers gives us the forced jump—it's like a combo!

- But every piece is the same. They have substantially similar topologies around them

Chess offers different pieces with different characteristics of movement and therefore radically different topologies.

Game complexity

Complexity can be seen as a measure of abilities

A complex game will offer many abilities in one atom

Could this be subject to Miller's Number?

Perhaps a rule of thumb is to limit to 7±2 abilities per atom.

Range of challenges

A.k.a. "content"

Pole vaulting

The game itself is diagrammable and deep

- Break record
- By jumping the bar
- By running forward
- Then lowering the pole
- Then hitting the right spot
- Then twisting the body
- Then letting go of the pole

But we also raise the bar

And that is content

An RPG example

Monsters

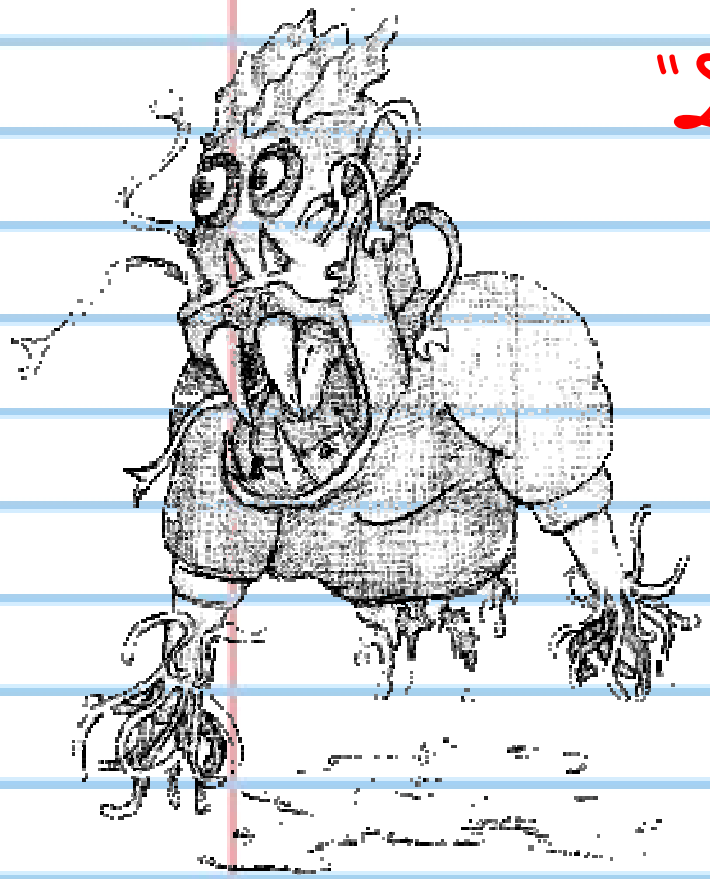
They differ in stats and in the abilities they bring to the challenge.

They exist within the topology, and not defining it.

They are not verbs.

They are acted upon by verbs (and may use verbs themselves). Nouns? No.

Defining "content"



"Descriptive characteristics of a challenge."

(Adjectives.)

Sample questions

The pieces in chess

They aren't content--they are verbs.

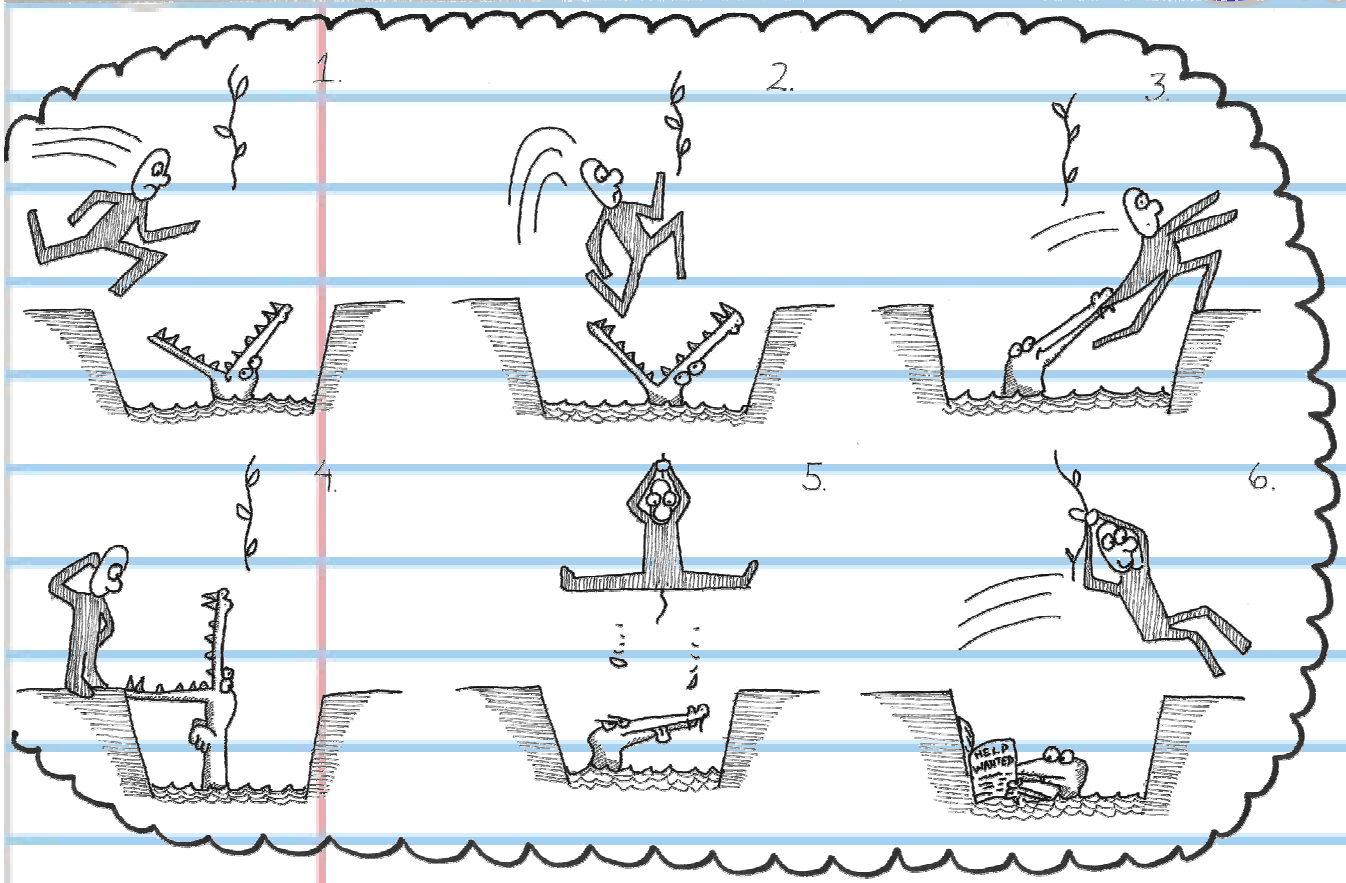
The map in a platformer

It's content because the topology is the challenge to overcome in the atom of movement.

Other players in Counterstrike

They are variations on the challenge of shooting & completing mission objectives

Skill required



Game Developers Conference 2005: Futurevision

Going back a bit...

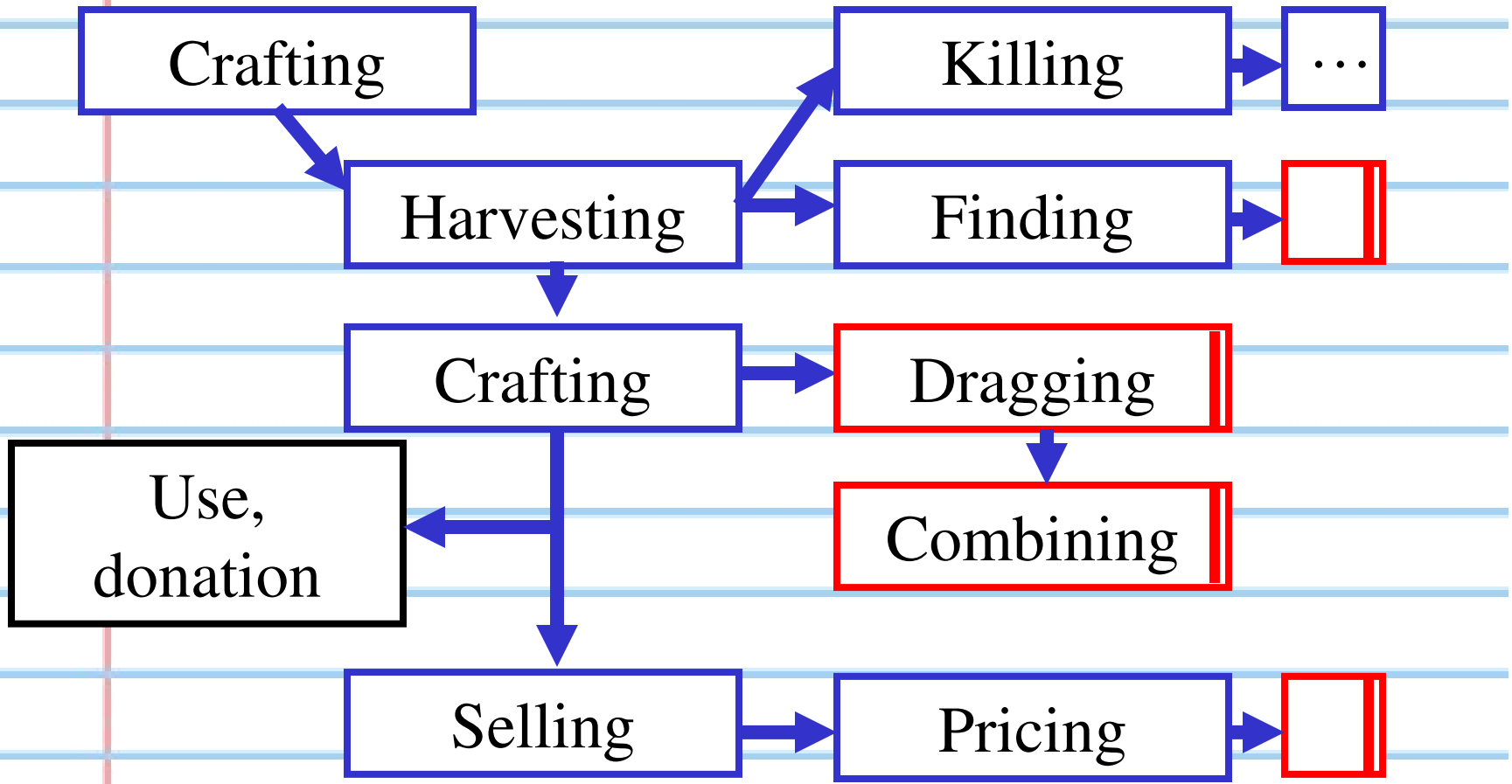
Nesting ends when there is no skill involved in executing the verb

The verb no longer involves "risk" (cf Epstein)

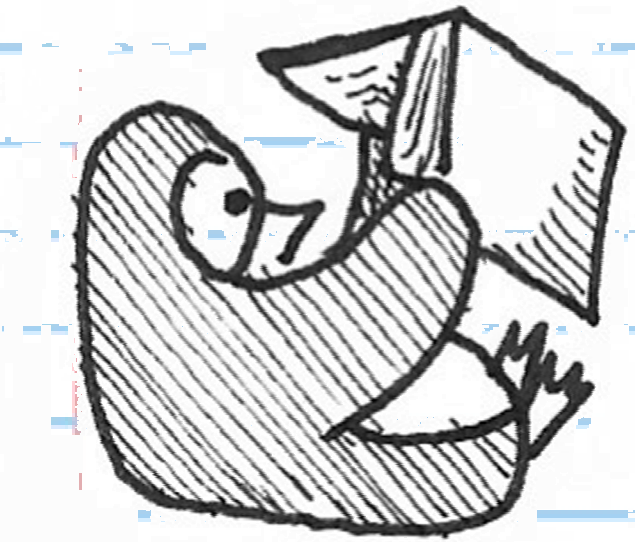
- "Certainty" - guaranteed outcome
- "Risk" - an assessment of probability
- "Uncertainty" - true randomness

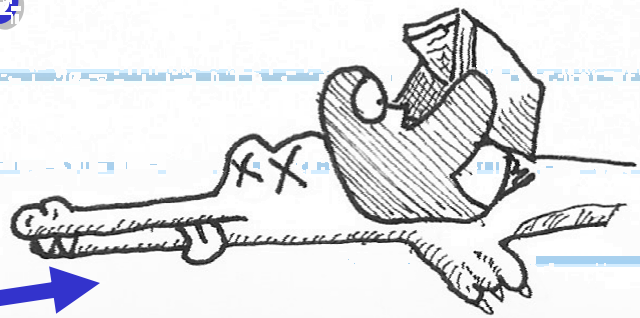
Spotting bad atoms

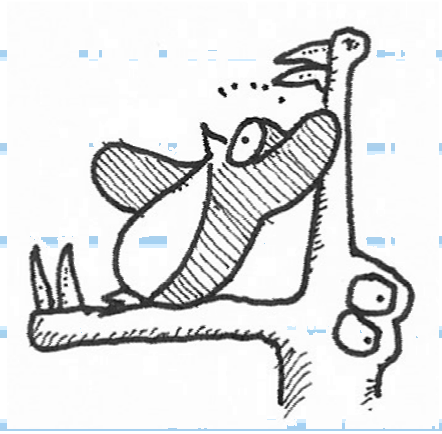
Never link or nest too many base atoms...



Variable feedback







Definition

"There must be more than one possible outcome to the successful completion of the challenge in an atom, prior to the execution of the next atom."

Examples

The loot might not be the same every time you kill the dragon.

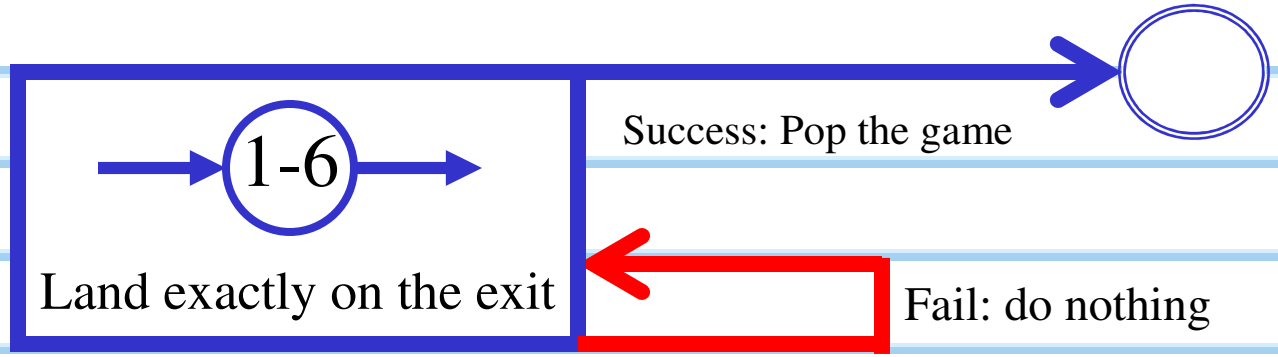
Your target might jink left instead of right.

You might have captured the checker, but set yourself up to get double-jumped.

Diagramming outcomes

There may be multiple positive and negative outcomes

- Affecting topology (a move)
- Affecting assets (a capture)
- Affecting opportunity (pop off stack)
- Affecting content (losing hit points)



Forms of variability

The most basic sort of variable feedback is your opponent's move.

Sometimes, you can force an outcome, but usually, the opponent's move is a calculation of risk, rather than a certain outcome.

- Your opponent might be a computer...

All games are turn-based

The question is whether the opponent is playing the same atom you are

- In checkers, they have the same diagram
- In *Galaxian* (or *Fox & Geese*), they don't

One is a symmetrical game, the others are not.

Detecting feedback

You can have feedback loops where the opponent does not get a move

Imperative (skips opponent)

- Uninterruptible combos
- Triple jumping in checkers

Sequential (returns to turn-based)

- Taking turns in checkers
- Your opponent manages to block

Types of loops

Triple jumps in Checkers are an example of a positive feedback loop.

Getting triple jumped is an example of a negative feedback loop.

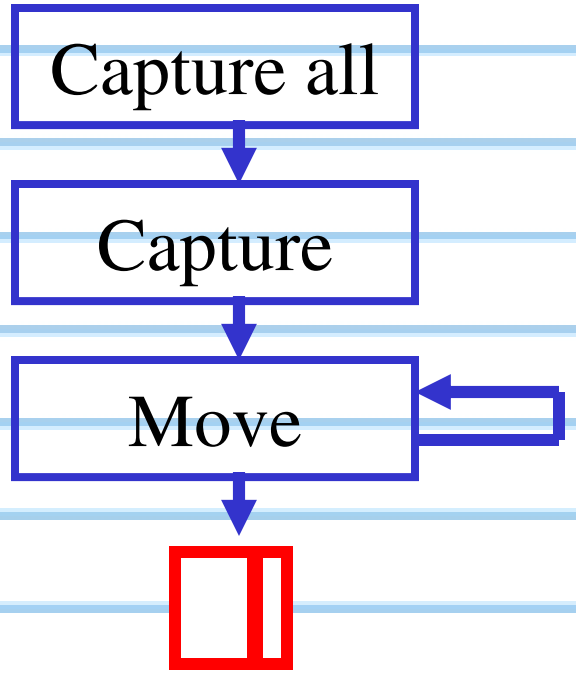
- (notice we mean loops literally in the diagram, not in Mahk's sense)

Detecting bad feedback

If your diagram shows a loop to itself, it's a valid loop

Checkers multiple jumps fit this pattern.

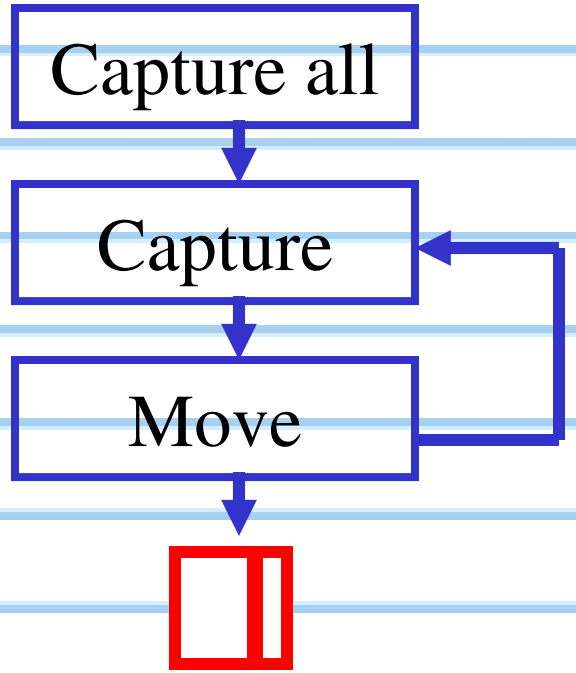
So do combos in fighting games.



Detecting bad feedback

Popping the stack in a loop seems to be a bad thing

I'd need to run through more examples to be sure, but for example this is an unbeatable combo in a fighting game.



Forms of variability

Varying reward

In a given atom, the result may be different because of the topology (as in checkers or chess), or because of the challenge (as in RPGs).

- Getting to the last row of the board gives a different result in both checkers and chess.

Why variable?

Behavioral psych reason

Because humans find random reinforcement schedules to be more interesting.

Cognitive science reason

Because brains find variability to be more interesting than predictability.

The real answer

Diagrammatically

Guaranteed feedback makes the entire atom "turn red" and become a risk-free challenge.

Only "leaf" atoms should have fixed outcomes!

Notes

Clearly, however, it needs to be tuned.

Variable feedback never means no feedback.

At the very least, there should be updated information as to the topology that the player is working within.

The Mastery Problem

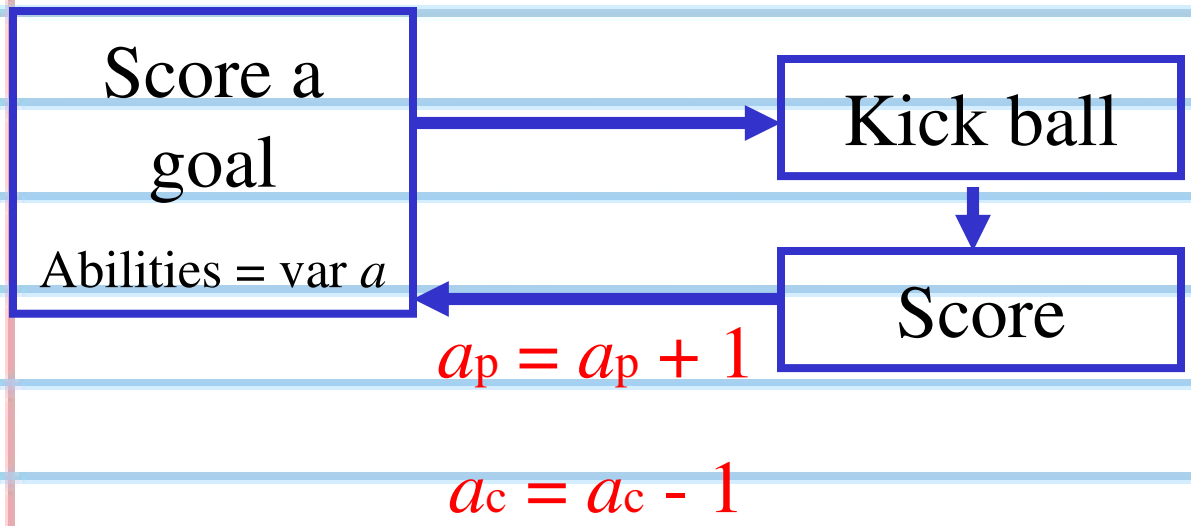
Definition

Any loop that trends towards certainty is a bad loop.

The challenge is whether we can see this via notation.

Mahk's type of loops

Soccer this way makes sense

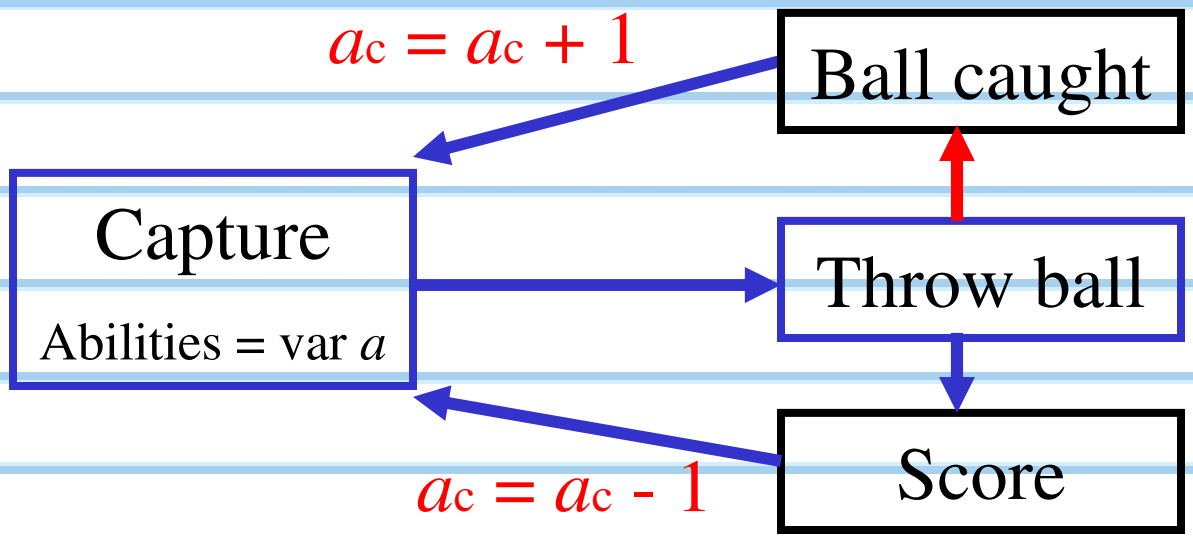


Adding abilities at each loop is stupid

A better way

Dodgeball

The feedback loop is greatly reduced.



So I didn't finish...

We have grammar, but we don't have orthography.

Challenges for the future

Music can find parallel fifths & octaves

- Can we find other degenerate strategies or exploits?

Emergent behaviors

- Can the notation reveal when emergence is likely?

Can this be made practical?

- What's faster, notating a rhythm game or writing "rhythm game"?

Tools we can take away

This is all mostly useless right now

- I can't yet picture designing a game from this notation

- Then again, most people in other art forms do not use straight notation to initially create things either. They rely heavily on iteration and experience. Notation is a capture tool primarily.

Some things we do get

But we do gain a heuristic

We might not have musical notation, but maybe we have the concept of pitch?

And a framework

An atomic model allows us to examine logical links and feedback loops clearly

And a vocabulary

We have firm definitions of depth, breadth, size, cheat, content, playfield...

The absence of fun

A game is built of nested challenges

Do you have to prepare before taking on the challenge?

- ...where prep can include prior moves?

- Can you prepare in different ways and still succeed?

The absence of fun

Does the topology of the space affect the challenge?

- Is the topology mutable?

Is there a singular core verb for your challenge?

- Can the verb be modified by the adjectives you encounter?

The absence of fun

Can you bring multiple abilities to bear?

- At higher levels, do you have to use multiple abilities?

Is there skill and risk involved in using an ability?

- If not, is this an atomic unit of gameplay?

The absence of fun

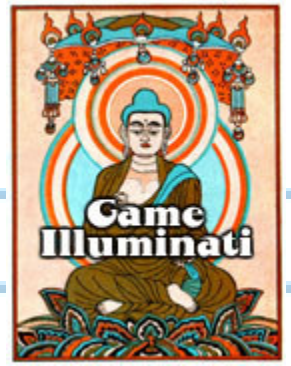
Are there multiple success states?

- Is bottomfeeding avoided?
- Does failure have a cost?

If you answered "no" to any of these, your design is flawed.

Thanks

This would not exist (even incomplete as it is!) without:



And also and especially, Mr. Rod Humble

http://www.theoryoffun.com
http://www.legendmud.org/raph

Send me your diagrams at

rkoster@soe.sony.com

Checkers (my best take so far)